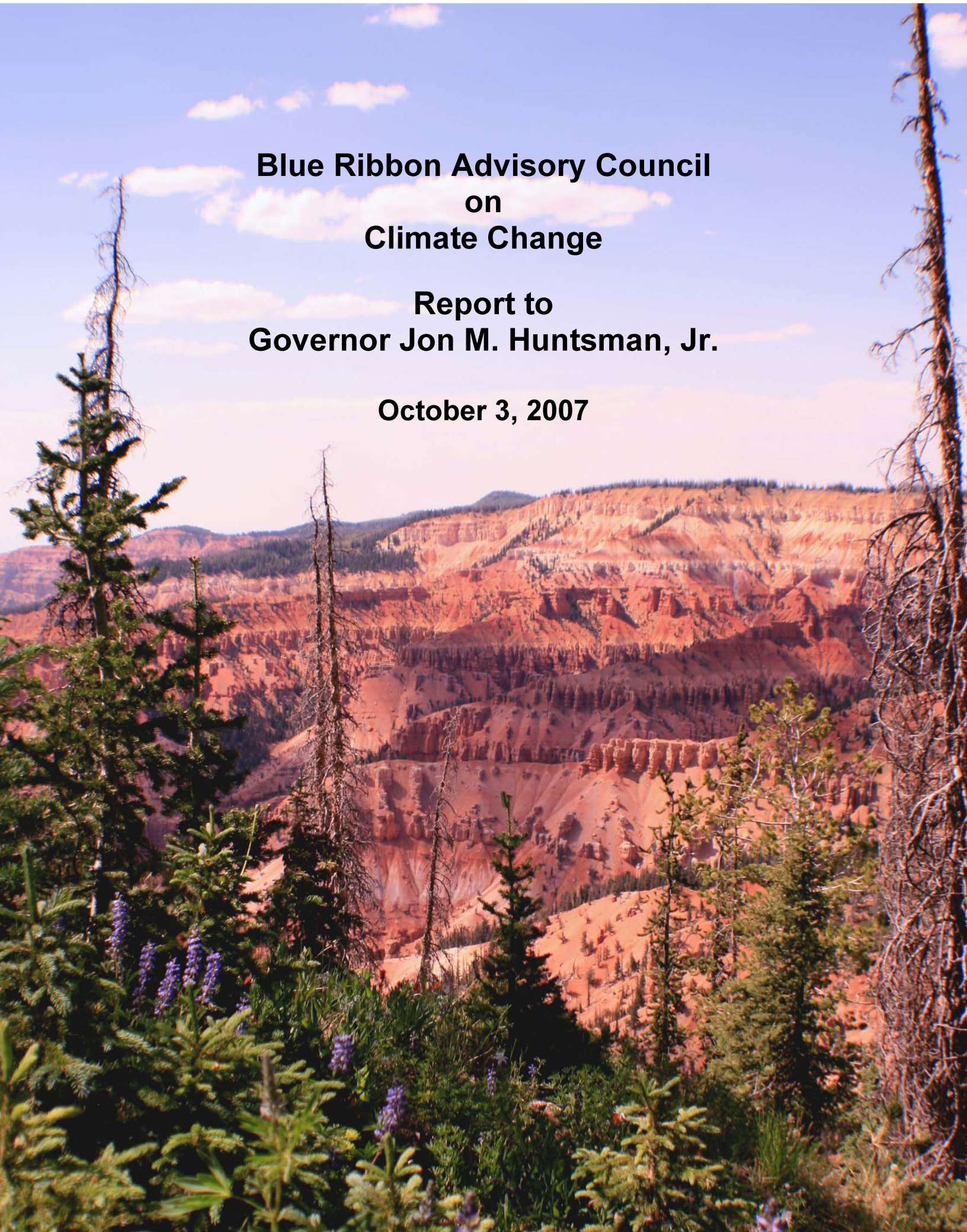


Blue Ribbon Advisory Council on Climate Change

Report to Governor Jon M. Huntsman, Jr.

October 3, 2007

Photo: Cedar Breaks Alpine Pond Trail
Courtesy Utah Office of Tourism
(Iron County Travel Council)

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I. EXECUTIVE SUMMARY

The Blue Ribbon Advisory Council on Climate Change (BRAC) was organized by Governor Jon M. Huntsman, Jr. on August 25, 2006, to provide a forum where government, industry, environment, and community representatives[1] could identify proactive measures that Utah might take to mitigate the impacts of greenhouse gases (GHG).

Governor Huntsman provided the following charge to the Council:

1. Consider science, economics, and policy around climate change in a forum where we as a State – industry, environment, community – could have productive dialogue;
2. Understand and recognize what we are trying to leave for the next generation; and
3. Bring back information and policy recommendations for review and consideration.

This report provides a summary of the work the BRAC and Stakeholder Working Group (SWG) have conducted to date. The BRAC has completed a number of significant tasks as charged by the Governor. The Science Report is summarized in this Executive Summary and the entire Science Report is included as Appendix A of this report. A number of policy options are summarized and included in this report. The policy options are ambitious but achievable if the necessary resources are provided to implement them. Because of the volunteer nature of the BRAC and the limited time the BRAC has had to follow the Governor's charge, the BRAC has not independently conducted any economic cost/benefit analyses on the policy options. Such analyses may be necessary prior to implementation of some of the options.

In June 2007, Governor Huntsman requested that the BRAC also evaluate options for a Renewable Energy Initiative. The BRAC established a work group and will prepare final recommendations for the Governor in October 2007. Those recommendations will be included in this report in Appendix E.

THE SCIENCE OF CLIMATE CHANGE

As directed by the BRAC, the science report, "Climate Change and Utah: The Scientific Consensus," summarizes the present scientific understanding of climate change and its potential impacts on Utah and the Western United States and emphasizes the consensus view of the scientific community. The report also includes a discussion of confidence and uncertainty as defined by the BRAC. The Executive Summary from the science report is included below.

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[1] BRAC members are listed in the Appendix C

"There is no longer any scientific doubt that the Earth's average surface temperature is increasing and that changes in ocean temperature, ice and snow cover, and sea level are consistent with this global warming. In the past 100 years, the Earth's average surface temperature has increased by about 1.3°F, with the rate of warming accelerating in recent decades. Eleven of the last 12 years have been the warmest since 1850 (the start of reliable weather records). Cold days, cold nights, and frost have become less frequent, while heat waves have become more common. Mountain glaciers, seasonal snow cover, and the Greenland and Antarctic ice sheets are decreasing in size, global ocean temperatures have increased, and sea level has risen about 7 inches since 1900 and about 1 inch in the past decade.

Based on extensive scientific research, there is very high confidence that human-generated increases in greenhouse gas concentrations are responsible for most of the global warming observed during the past 50 years. It is very unlikely that natural climate variations alone, such as changes in the brightness of the sun or carbon dioxide emissions from volcanoes, have produced this recent warming. Carbon dioxide concentrations are now more than 35% higher than pre-industrial levels and exceed the highest natural concentrations over at least the last several hundred thousand years.

It is likely that increases in greenhouse gas concentrations are contributing to several significant climate trends that have been observed over most of the western United States during the past 50 years. These trends are: (1) a several day increase in the frost-free growing season, (2) an earlier and warmer spring, (3) earlier flower blooms and tree leaf out for many plant species, (4) an earlier spring snowmelt and run off, and (5) a greater fraction of spring precipitation falling as rain instead of snow.

In Utah, the average temperature during the past decade was higher than observed during any comparable period of the past century and roughly 2°F higher than the 100 year average. Precipitation in our state during the 20th century was unusually high; droughts during other centuries have been more severe, prolonged, and widespread. Declines in low-elevation mountain snowpack have been observed over the past several decades in the Pacific Northwest and California. However, clear and robust long-term snowpack trends have yet to emerge in Utah's mountains.

Climate models estimate an increase in the Earth's average surface temperature of about 0.8°F over the next 20 years. For the next 100 years, the projected increase is between 3 and 7°F, depending on a range of credible estimates of future greenhouse gas emissions. These projections, combined with extensive scientific research on the climate system, indicate that continued warming will take place over the next several decades as a result of prior greenhouse gas emissions. *Ongoing greenhouse gas emissions at or above current levels will further alter the Earth's climate and very likely produce global temperature, sea level, and snow and ice changes greater than those observed during the 20th century.*

What does this mean for Utah? *Utah is projected to warm more than the average for the entire globe and the expected consequences of this warming are fewer frost days, longer*

growing seasons, and more heat waves. Studies of precipitation and runoff over the past several centuries and climate model projections for the next century indicate that *ongoing greenhouse gas emissions at or above current levels will likely result in a decline in Utah's mountain snowpack and the threat of severe and prolonged episodic drought in Utah is real*. Preparation for the future impacts of climate variability and change on Utah requires enhanced monitoring and knowledge of Utah's climate, as well as better understanding of the impacts of weather and climate on the state's water availability, agriculture, industry, and natural resources."

Table 1. Levels of confidence

Terminology	Degree of confidence in being correct
Very high confidence	At least 9 out of 10
High confidence	About 8 out of 10
Medium confidence	About 5 out of 10
Low confidence	About 2 out of 10
Very low confidence	Less than 1 out of 10

Table 2. Likelihood

Terminology	Likelihood of the occurrence/outcome
Virtually certain	Greater than 99%
Very likely	Greater than 90%
Likely	Greater than 66%
About as likely as not	33 to 66%
Very unlikely	Less than 10%
Exceptionally unlikely	Less than 1%

UTAH'S EMISSIONS INVENTORY

BRAC members wanted to ensure that carbon reduction efforts actually targeted Utah's GHG emissions. To identify those emissions, information was taken from Utah's "Final Greenhouse Gas Inventory and Reference Case Projections, 1990-2020." The inventory was prepared by the Center for Climate Strategies and is included in this report at Appendix B.

The inventory identified the following factors of interest:

- Activities in Utah accounted for approximately 69 million metric tons (MMt) of gross carbon dioxide equivalent (CO_2e) emissions in 2005, an amount equal to about 1% of total U.S. gross GHG emissions.[2]

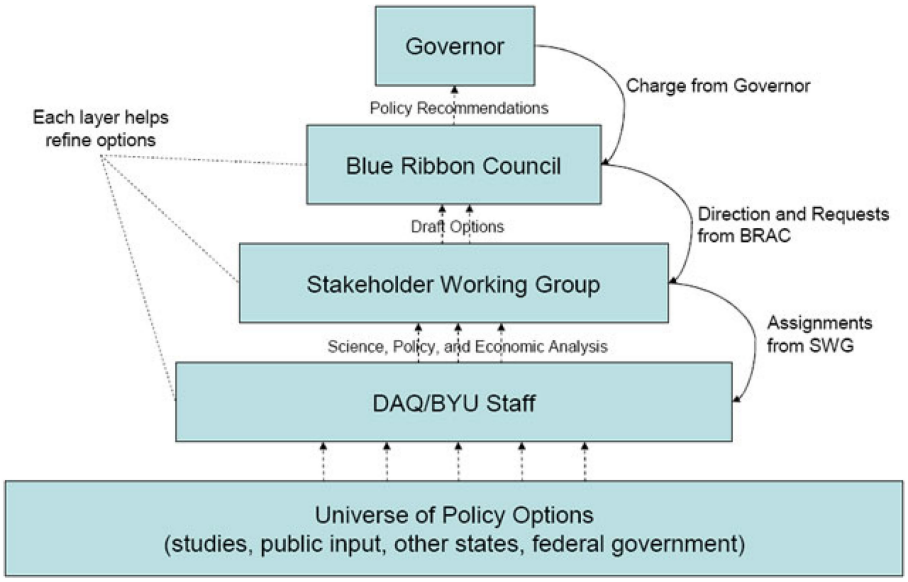
[2] Gross emissions exclude carbon sinks, such as forests, that offset emissions.

- On a per capita basis, Utahns emits about 27 metric tons (Mt) of CO_2e annually, slightly higher than the national average of 25 $MtCO_2e$/yr.
    - Our annual per capita emissions were relatively unchanged during the 1990-2005 period, a pattern that is consistent with the nation as a whole.
- Economic and population growth combine to produce steadily increasing total emissions.
    - Utah's gross GHG emissions are rising at a faster rate than those of the nation as a whole. Statewide, emissions increased 40% from 1990 to 2005.
    - Nationally, emissions rose only 16% during the same period.
- During the 1990s, improvements in energy efficiency resulted in a decline in emissions per unit of gross product (called energy intensity) of 40% nationally, and of 52% in Utah.
- The principal source of Utah's GHG emissions is electricity use[3], accounting for 37% of total State gross GHG emissions in 2005.
    - The next largest contributors are transportation sector (25%) and the residential, commercial, and industrial fossil fuel combustion sector (18%).
- Utah's gross GHG emissions are projected to climb to 96.1 $MMtCO_2e$ per year by 2020, 95% above 1990 levels.
- Approximately 12.3 $MMtCO_2e$ are sequestered annually in Utah forest biomass[4]. There is, however, a significant degree of uncertainty in the size of the forest sink in Utah. This estimate is believed to be at the high end of the possible range of sequestration estimates.

DETERMINING RECOMMENDATIONS

The following chart summarizes the process used by the BRAC to develop recommendations:

[3] Specifically, electricity production netting out electricity exports.
[4] According to data from the U.S. Forest Service for the Final Utah Greenhouse Gas Inventory and Reference Case Projections, 1990-2020. The inventory is summarized in this report and available online, in its entirety at: http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_080907.pdf



Twenty-four industry, government, community and environmental leaders were invited to participate as BRAC members. To assist the BRAC in meeting Governor Huntsman's directive, a Stakeholder Working Group[5] (SWG) was formed to provide a preliminary evaluation of a broad list of policy options. The initial policy option list was based on suggestions by BRAC and SWG members and options included in reports by the U.S. Environmental Protection Agency and other organizations where stakeholder groups did similar work. Nearly 200 options were organized under five major sectors headings:

- Agriculture/Forestry
- Cross-Cutting Issues
- Energy Supply
- Residential/Commercial/Industrial
- Transportation/Land Use

Working within each sector group, the SWG:

(1) Refined the list of options by consolidating overlapping and related issues; then

(2) Provided an initial evaluation of each option by considering information, where available, on:

- the costs per ton of reducing or avoiding or sequestering CO_2 emissions;
- any associated environmental, economic, and other co-benefits;
- the ease or difficulty with which the option could be implemented;
- its impact on consumers, businesses, and governments; and
- Related political challenges involved in pursuing the option.

[5] See Appendix C for BRAC and SWG members

Each group was co-chaired by two SWG members and participation was open to any SWG or member of the public who had an interest. A running list of meeting times and locations was maintained on the DEQ website. Participants had the option of attending a meeting in person or calling-in via a toll-free number. In the end, over 100 people participated in a total of 52 meetings.

The quick timeframe outlined for completion of the task did not allow for original research or state-specific economic evaluation of each option. BYU research assistants and DEQ staff members gathered existing information on each option from climate reports written for EPA and other States, from the 2000 Utah Office of Energy and Resource Planning Report, and, as a last resort, from credible information sources readily available on the web. This information was augmented by information provided by SWG members and other subject experts who participated in the sector group discussions. Then, within the sector groups, each option was assigned a bin and priority designation.[6]

The sector groups[7] reported the results of their deliberations back to the entire SWG which then considered the information and bin and priority designations. Of the 88 options, only 14 sector designations were challenged. In these cases, a vote was taken of the SWG members present. The option papers and a summary table were then given to the BRAC for its consideration. The BRAC added three more options and then finalized priorities.

The BRAC, SWG members, and sector group participants have invested an enormous amount of work in discussing and assessing these options. Their discussions have been exhaustive, thorough, thoughtful, spirited, and congenial.

The meetings of the BRAC and SWG were open to the public and information from meetings and presentations was posted on the website at http://www.deq.utah.gov/Issues/Climate_Change/index.htm . Questions and comments were accepted from the public throughout the process. Written public comments have been posted at the end of each sector chapter in this report.

The assumption guiding this process is that there was only time to identify a wide range of options, organize and consolidate the options into a manageable list, provide a brief assessment, and then make an initial effort to rank and prioritize them. Both the BRAC and SWG felt it was important to offer a variety of options and an economy-wide approach. To the extent possible, they commented on the costs and benefits of implementing various strategies. The options papers contain notes from the comments made by sector group members during their working meetings, comments made at the final meeting of the SWG to which all members agreed, and comments made by BRAC members. The option papers also include information on the cost per ton of CO_2 avoided or reduced that was obtained from analyses used by other western states. That information was typically quite cryptic and rarely included detailed explanation.

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[6] See Section III, Final Summary of Options, for definitions used to determine bin and priority designations

[7] See Appendix C for list of participants in sector discussions.

However, it gives some idea of the range of costs that might be relevant in Utah. Future, Utah-specific economic cost benefit analyses must be completed on policy recommendations where appropriate. The BRAC acknowledges that while there may be costs and benefits associated with the policy recommendations in this report, any economic analyses conducted must also take into account the potential costs associated with inaction. Both may need to be considered. Finally, any process followed from this point on should include stakeholder involvement.

SUMMARY OF RECOMMENDATIONS

The BRAC recommends that the Governor and the legislature consider the following options to reduce greenhouse gas emissions in Utah.

High Priority Options

Agriculture/Forestry

- Preserve open space/agricultural land
- Protect forest land by reduced conversion to non-forest land
- Promote the production of biomass fuels
- Increasing forest health risk reduction programs
- Increase fire management and risk reduction programs
- Promoting urban and community trees

Cross-Cutting Issues

- GHG registry
- GHG reduction targets
- Regional/state cap and trade program, carbon tax, or hybrid
- Research and development into low/no carbon energy strategies
- Public education and outreach
- Climate adaptation strategies and policies
- Guidelines for climate policy and coordinate with other policies
- Evaluate existing climate proposals at the regional, federal, and international levels
- Bridging strategies to achieve low-carbon economy

Energy Supply

- Develop significant amounts of renewable energy resources
    - Renewable portfolio standard
    - Creation of energy development zones
    - Green power purchases and marketing
    - Public benefit charge
    - Tax credits and incentives for renewable energy
    - Pricing and metering strategies
    - Research and development

- Encourage carbon capture and sequestration technology
  - CO_2 capture and sequestration policy
  - Issues for CO_2 transmission
  - Research and development
- Develop and deploy advanced generation technology
  - Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits
- Improve efficiency and reduce CO_2 at existing electricity generation plants through
  - Generation or emissions performance standards
  - Efficiency improvements
  - Retrofit plants with CO_2 capture
  - Retire old plant: building new, low-carbon Greenfield plants
- Promote combined heat and power distributed generation using incentives and removing institutional and other barriers
  - Incentives and barrier reductions for CHP and DG
- Improve efficiency of electric transmission and distribution systems by
  - Remove transmission/distribution system limitations and other infrastructure barriers for renewables and other clean distributed generation
  - Transmission system upgrading
- Miscellaneous energy supply options
  - Research and development
  - Remove regulatory barriers
  - Tax credits and incentives

Residential/Commercial/Industrial

- Utility demand side management
- Voluntary efficiency targets
- Rate design
- Government leading by example with mandatory efficiency targets
- Distributed generation with combined heat and power systems
- Distributed generation with renewable energy applications
- State appliance efficiency standards
- State promotion and tax or other incentives for efficient products
- Focus on small and medium enterprises
- Incentives for improved design and construction (Energy Star, LEED, green buildings)
- Improved building codes
- Waste/recycling

Transportation/Land Use

- Develop and implement aggressive mass transit strategy
- Quality growth programs
- Trip reduction, rideshare, vanpool, telecommuting

- Clean Car program
- Idle reduction program
- Vehicle speed reduction
- State fleet lead by example
- Promote low-carbon fuels and vehicle technologies
- Education programs
- Explore funding options for suite of transportation and land use options

Medium Priority Options

Agriculture/Forestry

- Improve manure management
- Change livestock feed and improve productivity to reduce methane emissions
- Expand use of forest biomass feedstocks for energy production

Energy Supply

- Develop and deploy Advanced Generation Technology
    - Landfill gas/waste to energy that yields carbon reduction benefits
    - Nuclear development

Residential Commercial Industrial

- Green power purchasing
- Solar hot water and photovoltaic codes for new buildings
- Energy management training and training of building operators
- Fuel switching to less carbon-intensive fuels
- Reinvestment fund
- Participate in voluntary industry-government partnerships
- Implement water pumping, treatment, and use efficiency

Transportation/Land Use

- "Buy Local" program
- Develop congestion pricing programs

II. INTRODUCTION

The Blue Ribbon Advisory Council (BRAC) on Climate Change was established by Governor Jon M. Huntsman, Jr. on August 25, 2006. The broad, stakeholder based membership of the BRAC[1] provided a forum where government, industry, environment and community representatives could identify proactive measures that Utah might take to mitigate the impacts of greenhouse gases (GHG). The completion date for the report was established for the end of August 2007.

Governor Huntsman provided the following charge to the Council:

1. Consider science, economics, and policy around climate change in a forum where we as a State – industry, environment, community – could have productive dialogue;
2. Understand and recognize what we are trying to leave for the next generation; and
3. Bring back information and policy recommendations for review and consideration.

In order to utilize the expertise of BRAC member's staff and other resource experts, work to identify and initially evaluate potential options was assigned to Sector Workgroups.[2] Recommendations on options for GHG reductions were grouped in five sectors:

Agriculture and Forestry,
Cross-Cutting,
Energy Supply,
Residential/Commercial/Industrial,
Transportation and Land Use.

The Utah Department of Environmental Quality had already commissioned an inventory of GHGs in Utah,[3] which provides information on GHG concentrations as of 2005 in Utah, and considered the benefit of natural GHG sinks, such as forest. The BRAC looked to a group of Utah scientists with expertise in climate science and GHG concentrations to evaluate existing studies on GHG and Climate Change, to provide information on the potential impact on Utah.[4]

The BRAC represents a broad range of stakeholders from state agencies, the Legislature, local government, industry, utilities, and interest groups. The value of these recommendations reflects the broad stakeholder participation. Similarly, successful implementation will depend on the ongoing involvement and feedback from stakeholders. The recommendations of the BRAC, including the priority and relative ease of implementation, will be presented to the Governor for his consideration and further action. Some of the options can be implemented administratively within existing statutory and regulatory authorities. Other options may require additional statutory

[1] BRAC members are listed in Appendix C.
[2] BRAC Stakeholder Working Group and Sector Group members are also listed in Appendix C.
[3] Emissions Inventory is provided in Appendix B
[4] Science Report is provided in Appendix A

authority and some will require funding. The option papers contain notes from the comments made by sector group members during their working meetings, comments made at the final meeting of the SWG to which all members agreed, and comments made by BRAC members. The option papers also include information on the cost per ton of CO_2 avoided or reduced that was obtained from analyses used by other western states. That information was typically quite cryptic and rarely included detailed explanation. However, it gives some idea of the range of costs that might be relevant in Utah. Future, Utah-specific economic cost benefit analyses must be completed on policy recommendations where appropriate. The BRAC acknowledges that while there may be costs and benefits associated with the policy recommendations in this report, any economic analyses conducted must also take into account the potential costs associated with inaction. Both may need to be considered. Finally, any process followed from this point on should include stakeholder involvement.

In June 2007, Governor Huntsman requested that the BRAC also evaluate options for a Renewable Energy Initiative. The BRAC established a work group and will prepare final recommendations for the Governor in October 2007. Those recommendations will be included in this report in Appendix E.

The BRAC membership was established by Laura Nelson, Ph.D., former Energy Advisor to the Governor. Dianne Nielson, Ph.D., was appointed Energy Advisor and Chair of the BRAC in May 2007. The BRAC wishes to thank the members of the Stakeholder Working Group and Sector Groups, Gary Bryner and Brigham Young University Public Policy Program staff and students, staff of the Department of Environmental Quality and the Governor's Energy Advisor's Office, and facilitator Michele Straube for their assistance in the preparation of this report, and the authors of the Science Report for their evaluation. Some of the funding for this work was provided by the Hewlett Foundation.

III. FINAL SUMMARY OF OPTIONS

The following tables and charts order the options based on the number of votes of support and the Priority assigned by the BRAC. Descriptions of the Sectors, Priority and Bin ranking, and designations of GHG reductions and cost per ton are summarized below.

Table 1: Options Organized by Sector with Page Number
Table 2: Options Organized by Number of Votes
Table 3: Options Organized by Priority, then by Number of Votes
Chart 1: Estimated Greenhouse Gas (GHG) Emission Reductions by Option (based on information from other States)
Chart 2: Estimated Cost per Ton CO_2e Reduced by Option (based on information from other States)

Sector Abbreviations

AF = Agriculture/Forestry; CC = Cross Cutting; ES = Energy Supply; RCI = Residential/Commercial/Industrial; TL = Transportation/Land Use. Details of each option are in the Appendices.

Priority Ranking – High, Medium, or Low

Considerations:

- How much "bang for the buck" in terms of cost and CO_2e reduction potential?
- Is it critical to the accomplishment of an end result? (Keep in mind that some options are "enablers.")
- Can we assign it a higher priority, if we can't afford to do it?
- Does it have an immediate or a long-term pay-off?

Bin Ranking – Difficulty

BIN A: "No-Brainers" - Benefit appears to be high; it can be readily implemented; changes to existing laws and regulations are minimal or will be readily supported; the cost is modest or reasonable; and there is little or no harm associated with it.

BIN B: "Worth Consideration" - Most of the Bin A conditions can be met and the rest can be met with some effort. It is the opinion of the group that the effort required, in terms of cost and do-ability, are worth the benefit gained.

BIN C: "Difficult" - While the idea may have merit, the cost and/or effort required to make it work will either be very difficult but something that needs to be done OR may not be worth the benefit realized. There is a likely probability of significant impact OR "unintended consequences" other than cost to implement.

BIN D: "Need more information" - The option is too general/vague or not enough analytical information can be obtained to evaluate in the time allowed.

Votes

Twenty-two BRAC members participated in the final vote (i.e. there were 22 potential votes for each item). Any of the original options that received less than 5 votes were not included in the report.

Table 1. Options Organized by Sector with Page Number

Number	Policy Option	Priority	Bin	Vote	Page
AF-1	Promote Production of Biomass Fuels	High	B	20	IV-2
AF-2	Improve Manure Management	Medium	B	13	IV-3
AF-3	Change Livestock Feed and Improve Productivity to Reduce Methane Emissions	Medium	B	9	IV-5
AF-6	Preserve Open Space/Agricultural Land	High	B	18	IV-6
AF-7	Protect Forestland by Reduced Conversion to Non-forest Uses (Urban, Suburban, and Rural lands)	High	B	9	IV-7
AF-9	Promote Urban and Community Trees	High	A	21	IV-8
AF-12	Increase Fire Management and Risk Reduction Programs	High	A	9	IV-9
AF-13	Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs	High	B	15	IV-10
AF-15	Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)	Medium	D	6	IV-11
CC-1	GHG Registry	High	A	19	V-2
CC-2	GHG Reduction Target	High	B	15	V-3
CC-3	Public Education and Outreach	High	A	18	V-5
CC-4	Research and Development into Low/No Carbon Energy Strategies	High	A	16	V-6
CC-5	Climate Adaptation Strategies and Policies	High	B	13	V-7
CC-6	Regional/State Cap and Trade Program, Carbon Tax, or Hybrid	High	B	13	V-8
CC-7	Guidelines for Climate Policy (in general); Coordination with Other Policies	High	A	16	V-11

Number	Policy Option	Priority	Bin	Vote	Page
CC-8	Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels	High	A	19	V-12
CC-9	Bridging Strategies to Achieve Low-Carbon Economy	High	A	20	V-13
ES-1	Renewable Portfolio Standard	High	B	17	VI-3
ES-2	Create Renewable Energy Development Zones	High	B	11	VI-3
ES-3	Green Power Purchases and Marketing	High	A	15	VI-4
ES-4	Public Benefit Charge	High	B	9	VI-4
ES-5	Tax Credits and Incentives for Renewable Energy	High	A	18	VI-4
ES-6	Pricing and Metering Strategies	High	B	9	VI-4
ES-7	Renewable Energy and Energy Storage Research and Development	High	B	16	VI-5
ES-8	Develop CO2 Capture and Sequestration Policy	High	B	18	VI-6
ES-9	Issues for CO2 Transmission	High	B	10	VI-6
ES-10	Carbon Capture and Sequestration Research and Development	High	B	20	VI-6
ES-11	Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits	High	B	20	VI-7
ES-12	Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits	Medium	A	17	VI-7
ES-15	Nuclear Development	Medium	C	14	VI-7
ES-16	Generation or Emissions Performance Standards	High	B	7	VI-8
ES-17	Efficiency Improvements	High	A	18	VI-8
ES-19	Retrofit Plants w/CO2 Capture	High	C	15	VI-8
ES-20	Retire Old Plant; Build New Low-Carbon Greenfield Plant	High	B	9	VI-9
ES-21	Incentives and Barrier Reductions for CHP and DG	High	B	14	VI-10
ES-22	Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation	High	B	16	VI-11
ES-23	Transmission System Upgrading	High	B	19	VI-11
ES-26	Research and Development	High	A	15	VI-12
ES-27	Remove Regulatory Barriers	High	B	18	VI-12
ES-28	Tax Credits and Initiatives	High	B	19	VI-12
RCI-1	Utility Demand Side Management	High	A	18	VII-2
RCI-2	Voluntary Efficiency Targets	High	A	19	VII-3
RCI-4	Green Power Purchasing	Medium	A	16	VII-4
RCI-5	Rate Design	High	A	15	VII-6

Number	Policy Option	Priority	Bin	Vote	Page
RCI-6	Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)	High	B	19	VII-7
RCI-7	Distributed Generation with Renewable Energy Applications	High	B	17	VII-8
RCI-8	State Appliance Efficiency Standards	High	A	17	VII-10
RCI-9	Solar Hot Water and Photovoltaic Codes for New Buildings	Medium	B	15	VII-11
RCI-10	Energy Management Training/ Training of Building Operators	Medium	B	17	VII-12
RCI-11	Government Lead by Example w/Mandatory Efficiency Targets	High	A	19	VII-13
RCI-12	State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)	High	B	19	VII-14
RCI-14	Fuel Switching to Less Carbon-Intensive Fuels	Medium	D	17	VII-15
RCI-15	Reinvestment Fund	Medium	B	11	VII-16
RCI-16	Focus on Small and Medium Enterprises (SMEs)	High	D	9	VII-17
RCI-17	Participation in Voluntary Industry-Government Partnerships	Medium	B	7	VII-18
RCI-19	Water Pumping, Treatment, and Use Efficiency	Medium	B	14	VII-19
RCI-20	Incentives for Improved Design and Construction (e.g. EnergyStar, green buildings, expedited permitting)	High	A	21	VII-20
RCI-21	Improved Building Codes	High	A	20	VII-21
RCI-23	Waste/Recycling	High	A	19	VII-23
TL-1	Develop and Implement Aggressive Mass Transit Strategy	High	B	19	VIII-2
TL-2	Quality Growth Program	High	A	17	VIII-3
TL-4	Trip Reduction, Rideshare, Vanpool, and Telecommuting	High	A	20	VIII-4
TL-6	"Buy Local" Program	Medium	B	10	VIII-5
TL-7	Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)	High	A	20	VIII-6
TL-8	State Fleet Lead by Example	High	A	19	VIII-7
TL-9	Clean Car Program	High	B	16	VIII-8
TL-10	Idle-Reduction Program	High	B	18	VIII-10
TL-11	Vehicle Speed Reduction	High	B	9	VIII-12
TL-13	Education Program	High	A	18	VIII-13
TL-14	Explore Funding Options for the Suite of Transportation and Land Use Options	High	B	9	VIII-14
TL-15	Develop Congestion Pricing Programs	Medium	A	19	VIII-15

Table 2. Options Organized by Number of Votes

Number	Policy Option	Priority	Bin	Vote	Page
AF-9	Promote Urban and Community Trees	High	A	21	IV-8
RCI-20	Incentives for Improved Design and Construction (e.g. EnergyStar, green buildings, expedited permitting)	High	A	21	VII-20
AF-1	Promote Production of Biomass Fuels	High	B	20	IV-2
CC-9	Bridging Strategies to Achieve Low-Carbon Economy	High	A	20	V-13
ES-10	Carbon Capture and Sequestration Research and Development	High	B	20	VI-6
ES-11	Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits	High	B	20	VI-7
RCI-21	Improved Building Codes	High	A	20	VII-21
TL-4	Trip Reduction, Rideshare, Vanpool, and Telecommuting	High	A	20	VIII-4
TL-7	Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)	High	A	20	VIII-6
CC-1	GHG Registry	High	A	19	V-2
CC-8	Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels	High	A	19	V-12
ES-23	Transmission System Upgrading	High	B	19	VI-11
ES-28	Tax Credits and Initiatives	High	B	19	VI-12
RCI-2	Voluntary Efficiency Targets	High	A	19	VII-3
RCI-6	Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)	High	B	19	VII-7
RCI-11	Government Lead by Example w/Mandatory Efficiency Targets	High	A	19	VII-13
RCI-12	State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)	High	B	19	VII-14
RCI-23	Waste/Recycling	High	A	19	VII-23
TL-1	Develop and Implement Aggressive Mass Transit Strategy	High	B	19	VIII-2
TL-8	State Fleet Lead by Example	High	A	19	VIII-7
TL-15	Develop Congestion Pricing Programs	Medium	A	19	VIII-15
AF-6	Preserve Open Space/Agricultural Land	High	B	18	IV-6

Number	Policy Option	Priority	Bin	Vote	Page
CC-3	Public Education and Outreach	High	A	18	V-5
ES-5	Tax Credits and Incentives for Renewable Energy	High	A	18	VI-4
ES-8	Develop CO2 Capture and Sequestration Policy	High	B	18	VI-6
ES-17	Efficiency Improvements	High	A	18	VI-8
ES-27	Remove Regulatory Barriers	High	B	18	VI-12
RCI-1	Utility Demand Side Management	High	A	18	VII-2
TL-10	Idle-Reduction Program	High	B	18	VIII-10
TL-13	Education Program	High	A	18	VIII-13
ES-1	Renewable Portfolio Standard	High	B	17	VI-3
ES-12	Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits	Medium	A	17	VI-7
RCI-7	Distributed Generation with Renewable Energy Applications	High	B	17	VII-8
RCI-8	State Appliance Efficiency Standards	High	A	17	VII-10
RCI-10	Energy Management Training/ Training of Building Operators	Medium	B	17	VII-12
RCI-14	Fuel Switching to Less Carbon-Intensive Fuels	Medium	D	17	VII-15
TL-2	Quality Growth Program	High	A	17	VIII-3
CC-4	Research and Development into Low/No Carbon Energy Strategies	High	A	16	V-6
CC-7	Guidelines for Climate Policy (in general); Coordination with Other Policies	High	A	16	V-11
ES-7	Renewable Energy and Energy Storage Research and Development	High	B	16	VI-5
ES-22	Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation	High	B	16	VI-11
RCI-4	Green Power Purchasing	Medium	A	16	VII-4
TL-9	Clean Car Program	High	B	16	VIII-8
AF-13	Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs	High	B	15	IV-10
CC-2	GHG Reduction Target	High	B	15	V-3
ES-3	Green Power Purchases and Marketing	High	A	15	VI-4
ES-19	Retrofit Plants w/CO2 Capture	High	C	15	VI-8
ES-26	Research and Development	High	A	15	VI-12
RCI-5	Rate Design	High	A	15	VII-6
RCI-9	Solar Hot Water and Photovoltaic Codes for New Buildings	Medium	B	15	VII-11
ES-15	Nuclear Development	Medium	C	14	VI-7
ES-21	Incentives and Barrier Reductions for CHP and DG	High	B	14	VI-10

Number	Policy Option	Priority	Bin	Vote	Page
RCI-19	Water Pumping, Treatment, and Use Efficiency	Medium	B	14	VII-19
AF-2	Improve Manure Management	Medium	B	13	IV-3
CC-5	Climate Adaptation Strategies and Policies	High	B	13	V-7
CC-6	Regional/State Cap and Trade Program, Carbon Tax, or Hybrid	High	B	13	V-8
ES-2	Create Renewable Energy Development Zones	High	B	11	VI-3
RCI-15	Reinvestment Fund	Medium	B	11	VII-16
ES-9	Issues for CO2 Transmission	High	B	10	VI-6
TL-6	"Buy Local" Program	Medium	B	10	VIII-5
AF-3	Change Livestock Feed and Improve Productivity to Reduce Methane Emissions	Medium	B	9	IV-5
AF-7	Protect Forestland by Reduced Conversion to Non-forest Uses (Urban, Suburban, and Rural lands)	High	B	9	IV-7
AF-12	Increase Fire Management and Risk Reduction Programs	High	A	9	IV-9
ES-4	Public Benefit Charge	High	B	9	VI-4
ES-6	Pricing and Metering Strategies	High	B	9	VI-4
ES-20	Retire Old Plant; Build New Low-Carbon Greenfield Plant	High	B	9	VI-9
RCI-16	Focus on Small and Medium Enterprises (SMEs)	High	D	9	VII-17
TL-11	Vehicle Speed Reduction	High	B	9	VIII-12
TL-14	Explore Funding Options for the Suite of Transportation and Land Use Options	High	B	9	VIII-14
ES-16	Generation or Emissions Performance Standards	High	B	7	VI-8
RCI-17	Participation in Voluntary Industry-Government Partnerships	Medium	B	7	VII-18
AF-15	Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)	Medium	D	6	IV-11

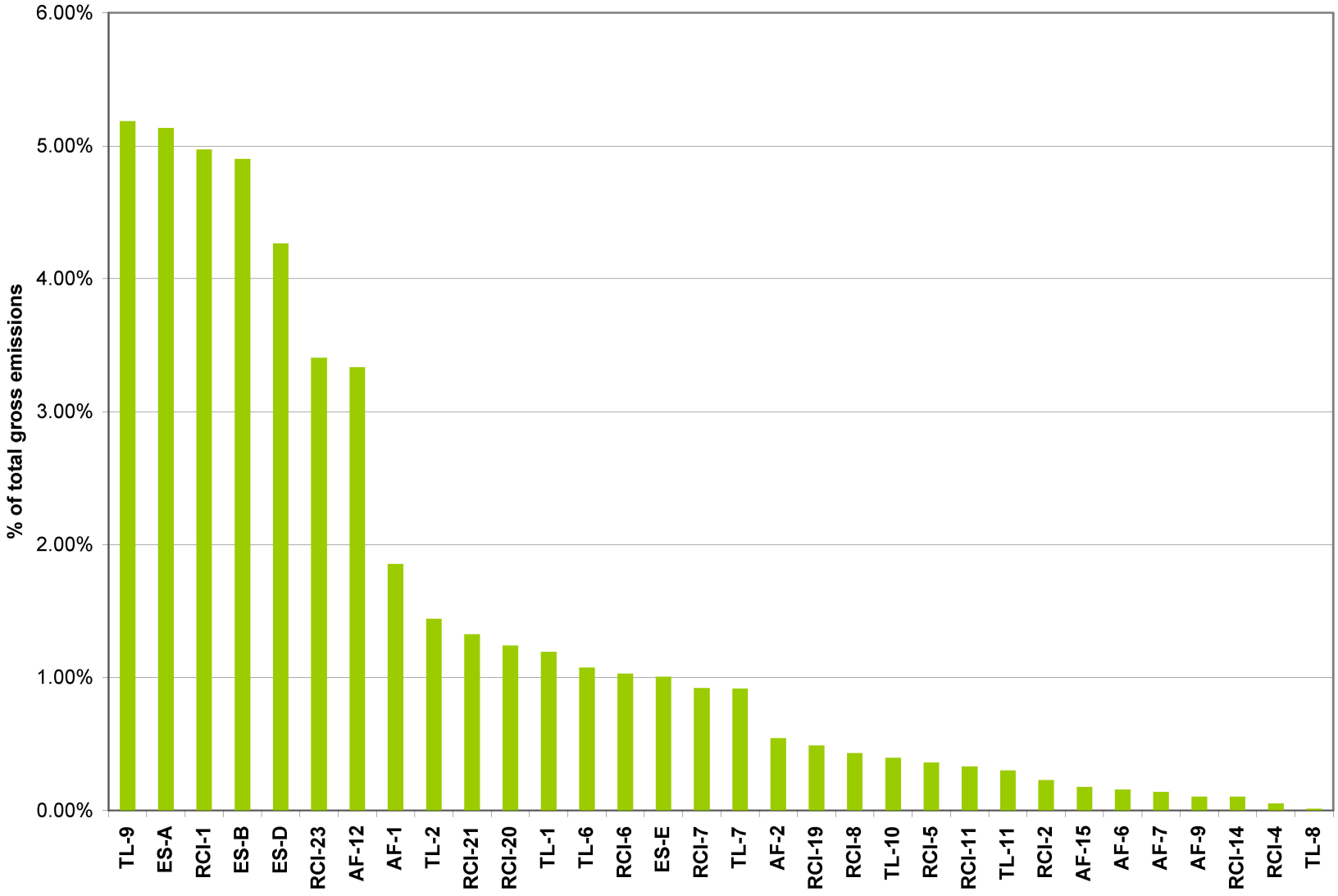
Table 3. Options Organized by Priority, then by Number of Vote

Number	Policy Option	Priority	Bin	Vote	Page
AF-9	Promote Urban and Community Trees	High	A	21	IV-8
RCI-20	Incentives for Improved Design and Construction (e.g. EnergyStar, green buildings, expedited permitting)	High	A	21	VII-20
AF-1	Promote Production of Biomass Fuels	High	B	20	IV-2
CC-9	Bridging Strategies to Achieve Low-Carbon Economy	High	A	20	V-13
ES-10	Carbon Capture and Sequestration Research and Development	High	B	20	VI-6
ES-11	Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits	High	B	20	VI-7
RCI-21	Improved Building Codes	High	A	20	VII-21
TL-4	Trip Reduction, Rideshare, Vanpool, and Telecommuting	High	A	20	VIII-4
TL-7	Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)	High	A	20	VIII-6
CC-1	GHG Registry	High	A	19	V-2
CC-8	Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels	High	A	19	V-12
ES-23	Transmission System Upgrading	High	B	19	VI-11
ES-28	Tax Credits and Initiatives	High	B	19	VI-12
RCI-11	Government Lead by Example w/Mandatory Efficiency Targets	High	A	19	VII-13
RCI-12	State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)	High	B	19	VII-14
RCI-2	Voluntary Efficiency Targets	High	A	19	VII-3
RCI-6	Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)	High	B	19	VII-7
RCI-23	Waste/Recycling	High	A	19	VII-23
TL-1	Develop and Implement Aggressive Mass Transit Strategy	High	B	19	VIII-2
TL-8	State Fleet Lead by Example	High	A	19	VIII-7
AF-6	Preserve Open Space/Agricultural Land	High	B	18	IV-6
CC-3	Public Education and Outreach	High	A	18	V-5
ES-5	Tax Credits and Incentives for Renewable Energy	High	A	18	VI-4
ES-8	Develop CO2 Capture and Sequestration Policy	High	B	18	VI-6
ES-17	Efficiency Improvements	High	A	18	VI-8

Number	Policy Option	Priority	Bin	Vote	Page
ES-27	Remove Regulatory Barriers	High	B	18	VI-12
RCI-1	Utility Demand Side Management	High	A	18	VII-2
TL-10	Idle-Reduction Program	High	B	18	VIII-10
TL-13	Education Program	High	A	18	VIII-13
ES-1	Renewable Portfolio Standard	High	B	17	VI-3
RCI-7	Distributed Generation with Renewable Energy Applications	High	B	17	VII-8
RCI-8	State Appliance Efficiency Standards	High	A	17	VII-10
TL-2	Quality Growth Program	High	A	17	VIII-3
CC-4	Research and Development into Low/No Carbon Energy Strategies	High	A	16	V-6
CC-7	Guidelines for Climate Policy (in general); Coordination with Other Policies	High	A	16	V-11
ES-7	Renewable Energy and Energy Storage Research and Development	High	B	16	VI-5
ES-22	Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation	High	B	16	VI-11
TL-9	Clean Car Program	High	B	16	VIII-8
AF-13	Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs	High	B	15	IV-10
CC-2	GHG Reduction Target	High	B	15	V-3
ES-3	Green Power Purchases and Marketing	High	A	15	VI-4
ES-19	Retrofit Plants w/CO2 Capture	High	C	15	VI-8
ES-26	Research and Development	High	A	15	VI-12
RCI-5	Rate Design	High	A	15	VII-6
ES-21	Incentives and Barrier Reductions for CHP and DG	High	B	14	VI-10
CC-5	Climate Adaptation Strategies and Policies	High	B	13	V-7
CC-6	Regional/State Cap and Trade Program, Carbon Tax, or Hybrid	High	B	13	V-8
ES-2	Create Renewable Energy Development Zones	High	B	11	VI-3
ES-9	Issues for CO2 Transmission	High	B	10	VI-6
AF-7	Protect Forestland by Reduced Conversion to Non-forest Uses (Urban, Suburban, and Rural lands)	High	B	9	IV-7
AF-12	Increase Fire Management and Risk Reduction Programs	High	A	9	IV-9
ES-4	Public Benefit Charge	High	B	9	VI-4
ES-6	Pricing and Metering Strategies	High	B	9	VI-4
ES-20	Retire Old Plant; Build New Low-Carbon Greenfield Plant	High	B	9	VI-9

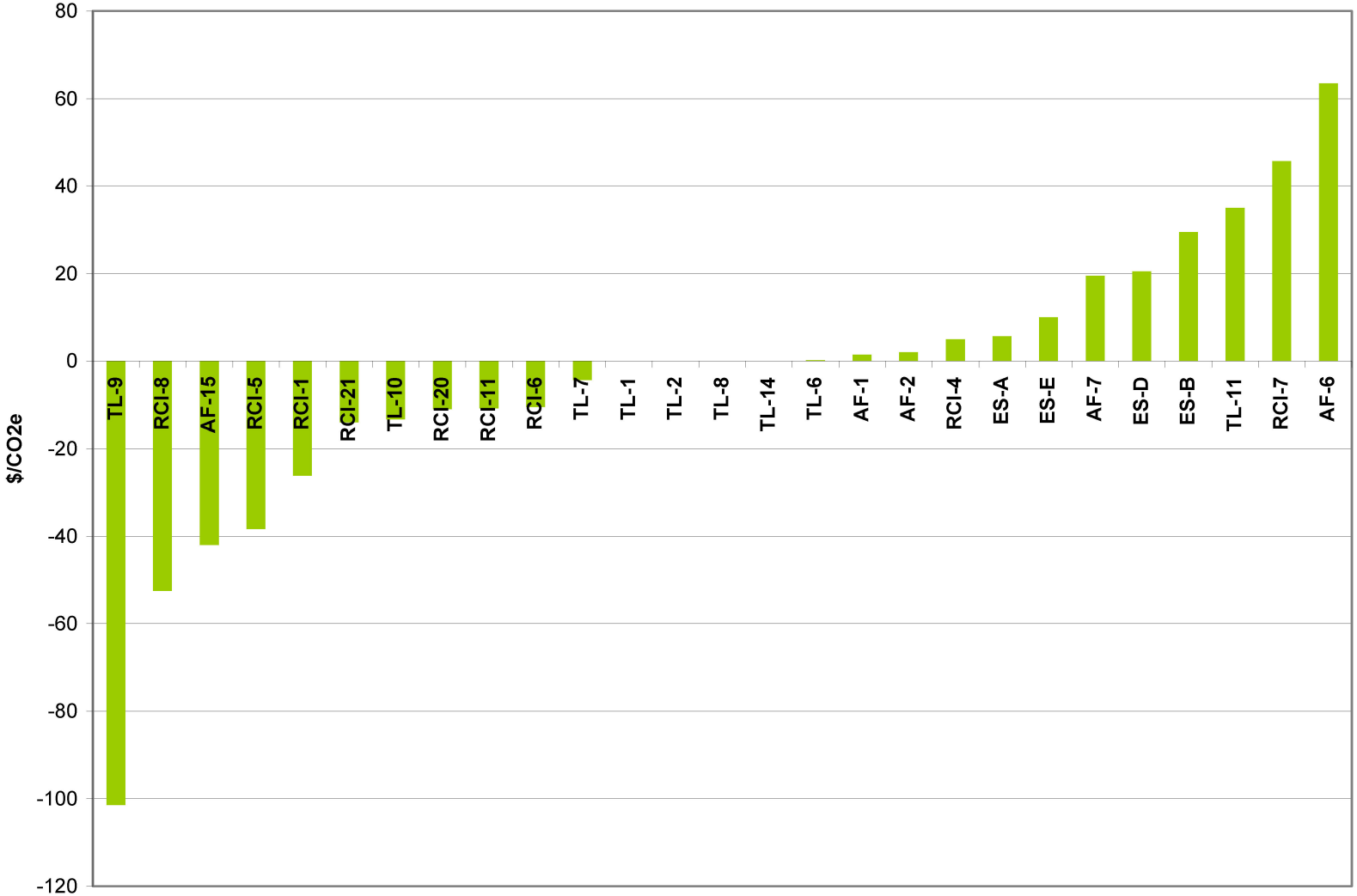
Number	Policy Option	Priority	Bin	Vote	Page
RCI-16	Focus on Small and Medium Enterprises (SMEs)	High	D	9	VII-17
TL-11	Vehicle Speed Reduction	High	B	9	VIII-12
TL-14	Explore Funding Options for the Suite of Transportation and Land Use Options	High	B	9	VIII-14
ES-16	Generation or Emissions Performance Standards	High	B	7	VI-8
TL-15	Develop Congestion Pricing Programs	Medium	A	19	VIII-15
ES-12	Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits	Medium	A	17	VI-7
RCI-10	Energy Management Training/ Training of Building Operators	Medium	B	17	VII-12
RCI-14	Fuel Switching to Less Carbon-Intensive Fuels	Medium	D	17	VII-15
RCI-4	Green Power Purchasing	Medium	A	16	VII-4
RCI-9	Solar Hot Water and Photovoltaic Codes for New Buildings	Medium	B	15	VII-11
ES-15	Nuclear Development	Medium	C	14	VI-7
RCI-19	Water Pumping, Treatment, and Use Efficiency	Medium	B	14	VII-19
AF-2	Improve Manure Management	Medium	B	13	IV-3
RCI-15	Reinvestment Fund	Medium	B	11	VII-16
TL-6	"Buy Local" Program	Medium	B	10	VIII-5
AF-3	Change Livestock Feed and Improve Productivity to Reduce Methane Emissions	Medium	B	9	IV-5
RCI-17	Participation in Voluntary Industry-Government Partnerships	Medium	B	7	VII-18
AF-15	Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)	Medium	D	6	IV-11

Chart 1. Estimated Greenhouse Gas (GHG) Emission Reductions by Option



NOTE: The estimates shown in Chart 1 are based on the simple average of GHG reductions estimates from other states.

Chart 2. Estimated Cost per Ton CO_2e Reduced by Option



NOTE: The estimates shown in Chart 2 are based on the simple average of GHG emissions reduction cost estimates from other states.

IV. Agriculture-Forestry Options

Agriculture accounted for 6 percent of Utah's gross GHG emissions in 2005. For Forestry, it is important to recognize that while large amounts of carbon appear to be sequestered in Utah's forest land annually,[1] more information is needed.

Options include:

AF-1: Promote Production of Biomass Fuels 2

AF-2: Improve Manure Management 3

AF-3: Change Livestock Feed and Improve Productivity to Reduce Methane Emissions 5

AF-6: Preserve Open Space/Agricultural Land 6

AF-7: Protect Forest Land by Reduced Conversion to Non-Forest Uses 7

AF-9: Promote Urban and Community Trees 8

AF-12: Increase Fire Management and Risk Reduction Program 9

AF-13: Increase Forest Health Risk Reduction Programs 10

AF-15: Expand Use of Forest Biomass Feedstocks for Energy Production 11

AF Options Grouped by Goals 12

AF Options Sorted by Priority 13

AF Options Sorted by Votes 13

AF Public Comments 14

Drs. Anthony Turhollow and Helga Van Miegroet, USU

Andre Shoumatoff, Utah Biodiesel

[1] Greenhouse Gas Inventory and Reference Case Projections, 1990-2020; Center for Climate Strategies, February 2007 http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_3-29-07.pdf

AF-1 - Promote Production of Biomass Fuels

This option includes promoting the production of ethanol, biomass, biodiesel, cellulosic ethanol, and other bio-fuels.

Benefit/Cost of Reducing CO_2e:

Arizona: 28 MMt between 2007-2020; 2.4% of 2020 emissions; $0/ton
New Mexico: 9.8 MMt between 2007-2020; 1.3% of 2020 emissions; $3/ton
Colorado: 0.1-1 MMt or more; $5-50/ton; includes starch and cellulosic processes

Assessment: High Priority. Bin B. 20 out of 22 votes.

Further research and development for biofuels to examine Utah's potential to produce and/or manufacture low-carbon, ag-based fuels and energy resources is critical. There is a need for more information and R&D of all biofuels (high priority), but actual implementation in near term is limited (medium priority). Water usage is an important constraint.

The Utah Biodiesel Cooperative reports that biodiesel produces a 78% reduction in GHG per unit of fuel. UDOT and Utah State University are currently undertaking an experiment along Utah's highways to grow biodiesel feedstocks, which will be converted into biodiesel fuel, possibly meeting UDOT's entire fleet needs.

Ethanol: little corn is grown in Utah; cellulosic ethanol depends on future technology.

Feedstocks discussed for biofuel production in Utah included:

- Algae,
- Oil-producing plants,
- Manure,
- Switchgrass, and
- Pinyon-Juniper woodlands.

AF-2 – Improve Manure Management

This broad, umbrella option includes composting, manure, manure digesters, and optimal application of nitrogen fertilizers.

Benefit/Cost of Reducing CO_2e:

Arizona: 3.8 MMt between 2007-2020; 0.3% of 2020 emissions; $1/ton
New Mexico: 6.3 MMt between 2007-2020; 0.8% of 2020 emissions; $3/ton[2]
Colorado: 0.1-1.0 MMt; unknown cost

According to the 2000 Utah Office of Energy and Resource Planning report, assuming that some practices will be adopted, one might assume that nitrogen emissions could be reduced by 5 percent. Based on the 2010 forecast of 127,290 tons of CO_2 equivalents, this translated into a savings of 6,365 tons.[3]

Assessment: Medium Priority. Bin B. 13 out of 22 votes.

This option presents some good opportunities in Utah, while also offering the potential to important co-benefits, such as reduced water pollution and noxious odors. Farmers generally do a good job with nutrient management but there are problems in urban areas with home/hobby gardening. In Utah, there has been some interest in generating electricity from manure onsite and providing excess to the grid. Some research is being conducted at USU on this and related technologies. Digester technology is being improved and there are examples of manure management.[4] The technology is still somewhat early for commercialization and needs more R&D to improve its viability. Some efforts have been abandoned due to technical problems related to the quantity of natural gas produced from manure to generate electricity and engine corroding agents from the gas produced. However, this option may hold additional value because it reduces the flaring of methane, and methane is much more potent GHG than is CO_2.

Utah has identified and inventoried 99% of the State's feeding operations. Included in the inventory process is a plan for managing waste—land application as compost. Estimates suggest that better practices could reduce nitrogen fertilizer use by as much as 20 percent. At this level, there is a low risk of yield penalty and the added possibility of input-cost savings to farmers.[5] Improved management practices coupled with specific technologies may achieve energy savings by reducing the need for plowing and other energy intensive practices. Practices which could be improved include application rates, placements, timing, soil testing frequency, low-nitrogen and/or fertilizer use, and conservation tillage. Technical approaches that could be followed include the use of fertilizer additives that increase nitrogen-use efficiency by decreasing nitrogen loss

[2] Projected for digester systems used on dairies, not feedlots.
[3] 2000 Utah Office of Energy and Resource Planning (OERP) report.
[4] See Circle Four/Smithfield Farms in Milford.
[5] Utah's State Action Plan

through volatilization, limiting or retarding fertilizer water solubility through super-granulation, and reducing nitrogen release. To a large degree, the modification of fertilizer practices is dependent on establishing effective ways of disseminate the knowledge of new practices.

AF-3 - Change Livestock Feed and Improve Productivity to Reduce Methane Emissions

Improved Ruminant Productivity programs increase the efficiency of dairy and beef cattle and other ruminant operations.[6]

Benefit/Cost of Reducing CO_2e:

The 2000 Utah Office of Energy and Resource Planning report indicated that according to industry estimates, methane emissions could be reduced by up to two percent per year if the above practices are employed. At this rate, 284,577 tons of CO_2 equivalents could be reduced by 2010 for a total of 1,271,105 tons emitted.[7]

Assessment: Medium Priority. Bin B. 9 out of 22 votes.

If there are ways to shift feed rations that can impact methane emissions, then this is almost a "no brainer."

USU is researching this issue. Competitive pressures to increase efficiency will encourage the dairy and beef industries to adopt process changes. For example, production-enhancing technologies, such as recombinant bovine somatotropin (rBST), are being deployed that accelerate the rate of productivity improvement. rBST has been on the market for 13 years and has Food and Drug Administration approval. By increasing milk production per cow, methane emissions per unit of milk produced declines. Improving productivity within the cow-calf sector of the beef industry requires additional education and training. The importance and value of better nutritional management and supplementation must be communicated. Energy, protein, and mineral supplementation programs tailored for specific regions and conditions need to be developed to improve the implementation of these techniques. The special needs of small producers must also be identified and addressed. There may be some manure management/methane opportunities further into the future.[8]

[6] 2000 Utah Office of Energy and Resource Planning (OERP) report
[7] 2000 Utah Office of Energy and Resource Planning (OERP) report
[8] Circle Four Farms in Milford is currently looking into this.

AF-6 - Preserve Open Space/Agricultural Land

Benefit/Cost of Reducing CO_2e:

Arizona: 1.6 MMt between 2007-2020; 0.1% of 2020 emissions; $65/ton
New Mexico: 1.6 MMt between 2007-2020; 0.2% of 2020 emissions; $62/ton
Colorado: 0.1-1.0 MMt; unknown cost [9]

Assessment: High Priority. Bin B. 18 out of 22 votes.

Preserving open space and agricultural land should be a high priority for Utah in the face of a rapidly growing population and increasing development. While this effort may require some concerted effort among private and public stakeholders, along with federal and state governments, a coordinated effort to preserve open space and agricultural land will provide numerous benefits in the short and long-term relating to climate change, air quality, water quality, and quality of life. This is an important option near urban centers, but may be difficult to accomplish in the face of development pressure. Other states show this option to have a high cost per ton of carbon emissions, but this option has important co-benefits for ranching and forestry. It is not clear what the true costs and benefits are/will be for Utah, as they have not yet been evaluated. Preserving open space and agricultural land also coincides with other climate change options relating to transportation, renewable energy, and land use.

Sequestration and uptake is greater in agricultural land than other land uses.

Lands could be protected through conservation easements. The Federal Forest Legacy Program through USDA Forest Service provides about $2-3 million a year to Utah. A similar effort could apply to ranches. The state should expand the LeRay McCallister Program to protect open lands.

This option could include promoting "no net loss" of agricultural land.

[9] Reductions here occur from higher carbon retention in soil and decreased transportation activity.

AF-7 - Protect Forestland by Reduced Conversion to Non-Forest Uses (Urban, Suburban, and Rural Lands)

Benefit/Cost of Reducing CO_2e:

Arizona: 3.7 MMt between 2007-2020; 0.2% of 2020 emissions; $17/ton
New Mexico: 1.2 MMt between 2007-2020; 0.1% of 2020 emissions; $22/ton
Colorado: 0.1-1.0 MMt or higher; $5-50 or higher[10]

Assessment: High Priority. Bin B. 9 out of 22 votes.

The benefits here are similar to those for AF-6.

Healthy forests promote carbon sequestration and reduce carbon releases. This option has significant co-benefits such as wildlife habitat, recreational opportunities, water and air filtration, and reduced risk of fires. As the climate changes, it is anticipated that fires will become more severe, and will occur earlier in the year.

Utah should promote existing wildland-urban interface and conservation easement programs. Federal funding is available for these types of projects. In 2006, the State lost over $1 million in funding from federal government; so there is concern about future funding. The Federal Forest Legacy program seems to prioritize Eastern states; the case should be made for more funding to western states. The LeRay McCallister Program could be expanded. Other sources include WUI protection program, and Quality Growth Fund (promoting existing WUI and Federal and State open lands protection/conservation easement programs).

[10] Reductions depend on current rates of clearing; large amounts of carbon can be protected per acre.

AF-9 - Promote Urban and Community Trees

Benefit/Cost of Reducing CO_2e:

Colorado: less than 0.1 MMt; less than $5-50/ton[11]
Oregon: 0.1 MMt; 0.1% of 2025 emissions; Not cost effective over action's lifetime

Assessment: High Priority. Bin A. 21 out of 22 votes.

There are opportunities for carbon uptake here. Other benefits are cooling and reducing the need for air conditioning, thereby reducing the carbon associated with electricity production.

Urban and community tree programs are very popular with the public. Through the Tree City USA program, cities that enact ordinances and require spending on trees can receive federal funding. Other existing programs include Utah Community Forest Council, and the State's urban and community forestry program. The state allocated $200,000 for urban forestry this year. A 37% reduction in next year's federal budget is anticipated so state money was very timely.

There is an ongoing need for people to have information about residential tree planting. An educational program would be useful.

Strategic planting of urban trees can have an energy conservation effect through shading and transpiration cooling of residential and commercial structures. This conservation effect can have a larger impact on CO_2 emissions than the sequestration provided by urban trees and can be large enough to offset the emissions associated with fossil-fuel powered tree maintenance equipment. Importantly, urban tree-related energy conservation represents a permanent avoidance of the CO_2 emissions that would have been used to provide space conditioning for urban structures, while the sequestration benefits of urban and other trees are reversed when the trees ultimately decay.[12]

[11] Cost savings are possible if material from maintenance are directed towards product and energy use.
[12] Effects of Urban Tree Management and Species Selection on Atmospheric Carbon Dioxide, Nowak, Stevens, Sisinni, and Luely, Journal of Arboriculture 28(3): May 2002, 113.

AF-12 – Increase Fire Management and Risk Reduction Programs

Benefit/Cost of Reducing CO_2e:

Colorado: less than 0.1-1.0 MMt[13] between 2007-2020; uncertain cost
Oregon 3.2 MMt between 2007-2025; 3.3% of 2025 emissions; cost effective[14]

Assessment: High Priority. Bin A. 9 out of 22 votes.

It is critical to avoid catastrophic carbon releases from forest fires.

Healthy forests take up carbon and sequester it, and healthy forests are less likely to burn. An entire forest could be lost in a fire. Reducing fires produces an important public safety benefit; other co-benefits are forest health, recreation, and wildlife.

Burning woody biomass is considered to be carbon neutral. If it is left it in the forest, it would burn or decompose anyway. If it is burned in a controlled fashion, there is less particulate.

Better funding and more research on the role of forest fires in climate change are needed.[15] Utah receives $1 million annual under the Federal fire plan. With a reduced budget, the focus is on the wildland-urban interface. Rural fires allowed to burn after years of fuel build-up burn unnaturally hot, baking the soil and killing trees that otherwise might not burn in a less hot fire. There is a need to reset the burning temperature by restoring a more natural fire regime.

There is a conflict with environmental advocates who oppose development of roads to fight fires, or to harvest any small diameter biomass, because affected lands can then no longer qualify for wilderness. Reducing fuels with natural or prescribed fire would still qualify these areas.

It is expensive to do mechanical thinning.[16] Some of the cost can be offset if the wood can be sold, but there typically aren't markets for forest biomass. Another "thinning" option is stewardship contracting – allowing timber companies to cut big trees to pay for the cost of removing the smaller ones, a move opposed by some environmental groups. Utah has signed a MOU that promotes the use of stewardship contracts. Agencies can retain receipts from harvesting and use them locally, unlike regular timber sales. There is also no need to award contracts to the lowest bid contractor, the State can consider other factors such as use of labor from the local community.

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[13] Reductions may be low because primary objective is not carbon sequestration.
[14] Creating a market for biomass from forests is key to this option. It would be important to locate biomass fueled generating plants close to forests to reduce the economic and GHG costs of shipping.
[15] See Steve Running's research on global warming and increasing forest fires (http://www.sciencemag.org/cgi/content/full/313/5789/927).
[16] $900-1300/acre to thin

AF-13 – Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs

An umbrella option that includes:

- Drought management programs - tree selection, placement, protection against drought
- Flood and riparian management programs
- Watershed management programs - stand retention, enhancement and management

Benefit/Cost of Reducing CO_2e:

Colorado: less than 0.1-1.0 MMt; uncertain costs[17]

Assessment: High Priority. Bin B. 15 out of 22 votes.

Healthy forests are of critical importance for carbon and other issues.

Healthy forests take up carbon and sequester it and are less likely to lose it catastrophically. Healthy grasslands and aspen may sequester more carbon than other mixes of trees and plants.

Aspens are declining throughout the West and no one apparently knows exactly why. Douglas fir forests are encroaching on aspen and they use more water. Invasive species, such as cheatgrass, increase the risk of fire. Pinyon-Juniper can be invasive and create increased fire hazard, if not properly managed.

Carbon issues could be integrated with rangeland health, healthy watersheds, fisheries, and aspen concerns. The State should continue to support the Utah Watershed Initiative and the Utah Partnership for Conservation and Development.

This is also likely to be an issue in adaptation.

While Bin A was originally recommended by the sector group, both BRAC and SWG members felt that Bin B would be more appropriate because this type of policy would be easier to do on private rather than public lands.

[17] A recent Colorado forest health report raises concerns. That state lost 1,000 square miles of forests due to multiple stresses of drought and beetles. Drought is the primary stress. When trees are weakened, beetles have more impact. It may be that warmer temperatures also increase the generations of beetles and fewer die during winter months.

AF-15 Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)

Benefit/Cost of Reducing CO_2e:

Arizona: 4.5 MMt between 2007-2020; 0.1% of 2020 emissions; $-8/ton
New Mexico: 2.6 MMt between 2007-2020; 0.3% of 2020 emissions; $-76/ton
Colorado: 0.1-1.0 MMt or higher; less than $5-50/ton
Oregon: 3.2 MMt between 2007-25; 3.3% of 2025 emissions; cost effective

Assessment: Medium Priority. Bin D. 6 out of 22 votes.

Fuel blending is the partial replacement of an existing fossil fuel with a biomass fuel in an energy application. Fuel switching is the complete substitution of a biomass fuel for a fossil fuel. In some applications, fuel switching may be possible. Examples include direct heat pellet or wood chip boilers and thermal electric power plants. The design of some thermal plants, however, may not allow for fuel-switching or even blending. Applications need to be evaluated on a case-by-case basis.

Wood biomass is important because it is carbon neutral and renewable. Incentives, such as tax credits, should be enhanced to encourage this option.

Oregon's assessment noted that creating a market for biomass from forests is key to this option. It is important to locate biomass fueled generating plants close to forests to reduce the economic and GHG costs of shipping.

California is prohibited from purchasing CO_2 intense electricity. This has caused problems for IPP which is now considering co-firing with wood waste or other renewable sources.

The potential for economic extraction is unknown, and we need more information on the biomass inventory, in terms of what can be grown in Utah given water and other constraints, and what would be required to increase harvest at the scale to produce a significant amount of power. It can be costly and/or politically difficult to get product from forests to power generation facilities/energy consumption options.

Goals

The options discussed in this section include goals related to reducing GHG emissions and increasing carbon sequestration in agricultural and forestry management.

Agriculture

1. Reduce carbon emissions:

    a. Promote production of biomass fuels (AF-1)

2. Reduce methane emissions:

    a. Improved manure management (AF-2)
    b. Change livestock feed and improve productivity to reduce methane emissions (AF-3)

3. Increase carbon sequestration:

    a. Preserve open spaces/agricultural lands (AF-6)

Forestry

4. Increase carbon sequestration:

    a. Protect forests and plant trees
        i. Protect forestland by reduced conversion to non-forest uses (AF-7)
        ii. Promoting urban and community trees (AF-9)
    b. Improve forest health
        i. Increase fire management and risk reduction (AF-12)
        ii. Increase forest health (pest/disease, invasive species) risk reduction programs (AF-13)

5. Reduce carbon emissions:

    a. Expand use of forest biomass feedstocks for energy production (fuel blending and/or switching (AF-15)

Sorted by Priority:

#	Policy Option	Priority	Bin	Vote
AF-9	Promote Urban and Community Trees	High	A	21
AF-1	Promote Production of Biomass Fuels	High	B	20
AF-6	Preserve Open Space/Agricultural Land	High	B	18
AF-13	Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs	High	B	15
AF-12	Increase Fire Management and Risk Reduction Programs	High	A	9
AF-7	Protect Forestland by Reduced Conversion to Non-forest Uses (urban, suburban, and rural lands)	High	B	9
AF-2	Improve Manure Management	Medium	B	13
AF-3	Change Livestock Feed and Improve Productivity to Reduce Methane Emissions	Medium	B	9
AF-15	Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)	Medium	D	6

Sorted by Votes:

#	Policy Option	Priority	Bin	Vote
AF-9	Promote Urban and Community Trees	High	A	21
AF-1	Promote Production of Biomass Fuels	High	B	20
AF-6	Preserve Open Space/Agricultural Land	High	B	18
AF-13	Increase Forest Health (pest/disease, invasive species) Risk Reduction Programs	High	B	15
AF-2	Improve Manure Management	Medium	B	13
AF-12	Increase Fire Management and Risk Reduction Programs	High	A	9
AF-3	Change Livestock Feed and Improve Productivity to Reduce Methane Emissions	Medium	B	9
AF-7	Protect Forestland by Reduced Conversion to Non-forest Uses (urban, suburban, and rural lands)	High	B	9
AF-15	Expand Use of Forest Biomass Feedstocks for Energy Production (Fuel Blending and/or Switching)	Medium	D	6

Public Comment

Submitted by Dr. Anthony Turhollow (Oak Ridge National Laboratory and Utah State University) and Dr. Helga Van Miegroet (Utah State University) on June 2, 2007

General Comments

- Overall, the recommendation should link better to past research and assessments conducted elsewhere in the US. Many of the statements and recommendations appear in a relative vacuum relative to current state of the science.
- There is a lot of focus, especially in forest-related activities on the C sequestration in biomass with relative little attention to effects on soil C. But, it should be noted that in terrestrial (wildland) ecosystems 2-3 times as much C is stored in the soil than in the aboveground biomass; therefore what happens to that C can have an important impact on the overall outcome of any of the proposed scenarios
- General caution -- Water is an issue not to be ignored.
  i.e. is there enough to actually grow biomass fuels?
  1.c.ii. Converting lands to grasslands or forests – water issue, how it is done is important!
- In several cases there is a contradiction between recommendations under different headings i.e. as a whole, the bundle of recommendations should be screened for inconsistencies and be made more consistent across the board.

AF-1 – promote production of biomass fuels

Does not make sense to import biomass, but import finished product.
See work at USU by Sims et al on scum (pond, sewage?)
Biodiesel – use waste oils from restaurants, other food processing

Footnote 2 – what replaces Pinyon-Juniper important for C impact ; issue is also what effect PJ encroachment has on soil C stocks – does it decline – there is some evidence in literature that "lignification" i.e. encroachment by woody species may reduce soil C stocks

AF-2 - Improved nutrient management

Do not understand paragraph after benefit/cost numbers

Reduce N emissions and get CO_2 reduction (maybe but I do not follow logic)

What is the true extent of the nutrient management problems with home/hobby gardening? –is there data to back op statement?
Anaerobic digestors:
See **2002 Final Report: Haubenschild Farms Anaerobic Digester Updated**! Attached pdf file "*HaubenschildAnaerobicDigestors.pdf*"
AgSTAR program of EPA/DOE/USDA on anaerobic digestors
See also: Krich, Ken, Don Augenstein, JP Batmale, John Benemann, Brad Rutledge, and Dara Salour. 2005. Biomethane from dairy waste: a sourcebook for the production and use of renewable natural gas in California. Prepared for Western United Dairyman. Accessed at:
http://www.westernuniteddairymen.com/USDA%20Grant/USDAgrantfinalreport.htm.

If designed properly anaerobic digestors can work

Look at: http://bioweb.sungrant.org/ for information on many things biomass.

AF-3 Change Livestock feed

line above **Assessment** 1,271,105 tons emitted of what, CH_4?

AF-4 Innovative Soil Management (**NOTE:** This option was removed in BRAC final vote**)**

Till/no till : not clear whether this approach to planting crops reduces CO_2? – not sure where this statement was derived.

There is quite a significant literature on the importance of conservation tillage and residue management to carbon storage – The focus on C stabilization is through protection of C within soil aggregates and micro-aggregates (C attaches itself to mineral particles in strong bonds). Anything that breaks up aggregates and causes greater physical mixing of soil particles, increases microbial contact and possible decomposition = gaseous loss of stored soil C; in higher rainfall areas C loss can also occur through leaching.

Reference examples are

- Lal, Kimble & Follett 1997 Chapter 1 "Land use and soil C pool in terrestrial ecosystems" and Chapter 31 "Need for research and need for action" IN: Lal, Kimble, Ffollett & Stewart (eds) Management of Carbon sequestration in soil CRC Press –> general recommendations on soil management practices
- Burke et al. 1995. Soil organic matter recovery in semi-arid grasslands: implications for the conservation reserve program. *Ecol Applications* 5: 793-801 -> NE Colorado
- Gebhart et al. 1994. The CRP increases soil organic carbon. Soil and Water Cons. 49:488-492 –> average storage of 1.1 T C per ha per yr (Kansas, Texas, Nebraska)
- Six et al. 2000. Soil macroaggregate turnover and microaggregate formation: a mechanisms for C sequestration under no-tillage agriculture. Soil Biology and Biochemistry 32: 2099-2103
- Denef et al. Carbon sequestration in microaggregates of no-tillage soils with different clay mineralogy *Soil Sci Soc America Journal* 68:1935-1944

Furthermore, alternatives to conventional tillage are already incorporated under the C offset program within the Chicago Climate exchange, so there ism a system being developed to give farmers credit for sequestering C, see:
http://www.chicagoclimatex.com/environment/offsets/index.html

Organic farming increases soil C because manure used instead of commercial fertilizers? Is there any data on how effective this really is. Also, this management practice then overlaps with manure management (nutrient additions) issue under AF-2 and needs to be made consistent with the recommendations made there.

AF-5 Convert Land to Grassland or Forests (**NOTE:** This option was removed in BRAC final vote**)**

It is not clear to what extent this recommendation refers to aboveground biomass C sequestration or to soil C sequestration, if looking at soil C sequestration, a good reference on effect of landuse on soil C is

Guo & Gifford. 2002. Soil carbon stocks and land use change: a meta analysis *Global Change Biology* 8: 345-360.

This reference also indicates that there soil C gain of converted croplands depends on forest vs. plantation, species composition , and rainfall (production potential!) When growing trees for energy (energy plantation), one also has to consider need for fertilization and the greenhouse costs associated with their production.

2nd to last paragraph Utah pays farmers to set aside buffer strips. But farmers do not own all lands. Need to protect riparian areas regardless of ownership.

AF-6 Preserve Open Space

carbon sequestration only secondary benefit of open land preservation – perhaps this should not be the focus, as the argument is not particularly strong or well-documented

2nd paragraph " Sequestration and uptake is greater in agriculture than other landuses" – what is this statement based on? Runs directly counter to AF-5! Perhaps need to specify what "other land uses" are. Compared to forests, plantations, and pastures, croplands results to a reduction in soil C pool (see Meta-analysis in Guo and Gifford 2002). Also, when soils are entirely isolated from the air (i.e. structures, parking lots, roads etc – the C that is residing in soil is ultimately stable as it has not way of decomposing and emitting CO_2

Footnote 15 exactly what does this mean "higher carbon retention and decreased transportation activity" ?

AF-7 Protect Forest Land

What does "rural lands" stand for?

It has indeed been documented that conversion of forests, plantation (and grasslands) to crop lands does indeed reduce the soil carbon stock -- is that the meaning of this statement?

"Healthy forests promote carbon sequestration and reduce carbon release" – What exactly is meant by this? This stop-gap statement shows up under various headings and is not very well documented (AF-7, AF-8, AF-12)

Important to be specific as to what is meant by C sequestration. If one looks at total storage (C pools in biomass and soil) there is indeed a lot stored there; However, many healthy, fully functioning forest ecosystems do not reduce carbon release and are C neutral at best – i.e. the amount of CO_2 that is sequestered annually by the trees is the equal to the amount of C released from the decomposition of debris that sits on top of the soil. Fires are essentially the same C release process, the only thing that differs is the time frame within which this residue-derive C is released. However, taken over decades

or centuries the average amount of C release from fire and natural decomposition may actually be the same (related to how much C was contained in the residue)

Why did state lose over $1 million?

AF-8 Encourage afforestation and restoration non-forest land (**NOTE:** This option was removed in BRAC final vote**)**

This is really supplemental to AF-7 (reduce loss of forest)
"Productive trees can reduce carbon" – see earlier comment – depends largely on where you are in developmental phase of forest, net C accumulation tends to only occur in aggrading phase (rapid growth); older and mature forests have more limited growth (= lower C capturing potential) while more C can be released through decay of accumulated dead woody material laying on ground. The net benefit on C of growing trees depends largely on what is being done with that wood: stored in durable goods vs. combusted for energy? In the latter case, the fossil fuel displacement efficiency needs to be considered. For an interesting conceptual analysis, see for example

Marland, G. and B. Schlamadinger. 1997. Forests for carbon sequestration or fossil fuel substitution? A sensitivity analysis. *Biomass and Bioenergy* 13(6):389-397.

When growing trees for energy (energy plantation), one also has to consider need for fertilization and the greenhouse costs associated with their production.

AF-9 Promote Urban and Community Trees

Statements under Benefit/Cost of reducing CO_2e is nill or not cost effective, yet 1st para states tremendous opportunities. Would say some opportunity, but perhaps the greatest benefit of urban trees is NOT the biological C sequestration by the trees, but the reduction of the heat island effect
Talk with Mike Kuhns, Extension Forester at USU

AF-10 Promote Reforestation and Proper Management of stands (**NOTE:** This option was removed in BRAC final vote**)**

Not exactly clear what the exact recommendations are under this rubric

Compare "Age extension of forest stands…" paragraph versus AF-14 statements on "larger trees that sequester more carbon" -- these statements run a bit counter to what we know about forest and tree ecology i.e. that maximum C capturing capacity occurs at the early stages of forest development (i.e. plantation, secondary forest following disturbance) when overall biomass is increasing. When forest matures, trees are getting bigger, overall wood increment tapers off as the canopy (photo-synthesizing i.e. C capturing apparatus) reaches a plateau value (Leaf area index function of moisture availability), and the tree starts accumulating more and more respiring (i.e. C releasing) structures (such as branches and wood) . Every forester knows this as it is indicated by growth and yield curves. That is how rotation lengths for specific forests are determined. People who have calculated net C balance for forest, also indicate that systems tend towards becoming C neutral (or even sources of C) (see earlier comment).

AF-11 Develop and Implement Best Management Practices fore Biomass Removal (**NOTE:** This option was removed in BRAC final vote**)**

Improved logging residue removal, develop feedstocks for energy production
We have been here before, as a matter of fact, in the 1970 and 1980, the US Dept. of Energy sponsored a series of nation-wide field trials and assessments on this track of thinking and there is an extensive literature to be found on the this topic from the late 1980s to early 1990s. The thinking was the same at that time, and the thought was abandoned because other considerations (besides using wood and residue carbon as an energy source) prevailed such as increased erosion loss, excessive nutrient removal , soil degradation and loss of soil productive capacity (not even including loss of habitat and species diversity issues). As a result of those earlier experiments, there has been a lot more focus on the impact of intensive management practices on productive capacity of forest soils that are contained in the Montreal Protocol (which the US co-signed)

- **Santiago Declaration (1992)** "Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests" **("Montreal Process"1995)**

  Criterion 4. Conservation and maintenance of soil and water: Area or % of land with significantly diminished **soil organic matter** and/or changes in other soil chemical properties.

If fertilization has to be implemented to compensate for the extra nutrient removal associated with intensive harvesting and residue removal, one has to also take into account the CO_2 emission coasts associated with their production and delivery to the site (i.e. C life cycle analysis).

Bottomline – this recommendation is ill-advised based on prior experiences nationwide from DOE-sponsored research

"Options for reducing biomass include burning it, bringing in goats…other mechanical means" Why the focus on removing biomass using fire or animals ? – Anytime you burn (=accelerated natural decay process) or digest C you release CO2, so this recommendation is counter to reducing CO_2 emissions

Woody biomass is carbon neutral – depends on what you do with it and the fossil fuel displacement efficiency (see Marland and Schlamadinger article for discussion)

AF-12 Increase Fire Management

Some of statements are counter to recommendations under AF-11 where you want to remove forest floor residue

"Healthy forests take up carbon" – see earlier comment. Not necessarily so, many mature and old growth forests (with a lot of C stock accumulated) are actually C neutral

"Healthy forests are less likely to burn" – consider that fire is part of normal fire cycle of some forests and that fire is actually needed for regeneration.

Perhaps focus should be on restoring natural fire regimes and avoid catastrophic fires from an ecological NOT carbon standpoint. What happens to dead residue on the forest floor is the same whether it decays, is consumed in prescribed burn, or by catastrophic wildfire: the organic C is converted into CO_2 and released to the atmosphere (only the time frame it which this happens differs)
However other considerations may be more important, such as:

- controlled burn gives off less CO, CH_4 in addition to particulates
- In catastrophic wildfires, standing biomass is also consumed (rather than having the ability to route to C towards fossil fuel displacing energy source, or long-term C storage)
- Increased erosion risk associated with total loss of cover and forest floor
- Loss of soil organic matter, nutrients and reduction in productive capacity see for example Johnson and Curtis. 2001 Effects of forest management on soil C and N storage: a meta analysis. *Forest Ecol. & Manage* 140: 227-238.

Last para – use thinnings for energy purposes: is this really feasible economically?

AF-13 Increase Forest Health

"Healthy forests are of critical importance for carbon and other issues" – recurring stop-gap statement that needs more elaboration to be convincing
"Healthy forests take up carbon and sequester it " – debatable in some cases, see earlier comments " … and are less likely to lose it catastrophically" – is that backed up by real data?

"Healthy grasslands and aspen may sequester more C than other mixes of trees and plants" -- suppose it is possible, but is it generally true? Is there data to support this statement?
If focus is on biomass C, then C sequestration potential depends on net primary productivity which is largely under climatic control, not clear that production of grassland is indeed greater than that of forests
If focus is on soil C, then this statement is currently not always supported by existing data, and findings can be contradictory
There are several statements in the literature that indicate that grasslands have higher soil organic matter stocks than forests and that the soil C is more stable.

- Knoepp et al 1997 Forest Management effect on soils C and N. Soil Sci. Soc. Am.J. 61:928-935. → conversion of mixed hardwoods to white pine increased soil C

- Guo & Gifford. 2002. Soil carbon stocks and land use change: a meta analysis *Global Change Biology* 8: 345-360.→ difference between grasslands and forest plantation function of forest type, species, and regional precipitation ; conversion of pasture to forest plantation is sometimes soil C neutral (hardwood), sometimes associated with C loss (conifers)

Bringing in aspen in this discussion becomes a bit of a diversion point (red hering) as there is no published evidence that transition of aspen to conifer forests is associated with a measurable loss in C in the soil. Current research underway by USU faculty at the

Deseret Land and Livestock and the Wasatch – Cache National Forest to specifically investigate this issue, as conifer encroachment is an issue of public interest.

AF-14 Expand Use of Wood products (**NOTE:** This option was removed in BRAC final vote**)**

"larger trees sequester more carbon"
if one consider total (static) pool in each tree : yes
if one actually looks at net annual C sequestration rate (dynamic) – less straight forward (more respiration costs because more non-photosynthesically active tissues)

AF-15 Expand Use of Forest Biomass Feedstocks

What is "CO_2 intense electricity"?

Credentials Dr. Anthony Turhollow

Ph.D. Agricultural Economics, Iowa State University 1982
MS Environmental Engineering, Utah State University, 1998

Staff economist - Oak Ridge National Laboratory, 1982-1993, 1998-present

Specialty: biomass energy, working in field since 1980

Estimate costs of: 1) collecting corn residues and energy crops for use as energy (also investigate logistics and handling), 2) evaluate cost estimates for new pesticide products, 3) establishing riparian buffer strips and producing biomass on riparian buffer strips, and 4) opportunities to reduce costs, pollutants, and energy use in forest products industries. U.S. Department of Energy's Biofuels Feedstock Development Program as program manager and economic and research analyst. Task manager for oilseed crops development, 1984-1990. Other activities included: CO_2, agriculture, Energy Information Administration biomass research.

Biomass Consultant, October 1993 to present. Estimate cost of harvesting sugar cane residues, cost of herbaceous energy crop harvest, cost of wood transport, CO_2 and other greenhouse gases from energy crops, costs and quantities crop residues for energy, and impacts of increased oilseed production in the Southeast.

Detailee, May 1992 to September 1992, Office of Technology Assessment (OTA), Congress of the United States. Research on chapter on biomass for OTA report on renewable energy.

17 refereed journal articles on biomass and energy use in agriculture.

Published one of first papers on corn ethanol energy balance: Marland, G. and A. F. Turhollow, "CO_2 Emissions from the Production and Combustion of Fuel Ethanol from Corn," *Energy*, 16(11/12):1307-1316, 1991.

Credentials Dr. Helga Van Miegroet

Ph.D. Forest Soils and Mineral Cycling, University of Washington 1986

Research Staff - Oak Ridge National Laboratory, 1987-1993
Faculty – Utah State University, College of Natural Resources, 1993-present

Specialty: Soil processes, mineral cycling, and nutrient transport mechanisms in; Effect of disturbance, management, vegetation change and environmental stressors on carbon and nutrient dynamics in wildland ecosystems.

Consultant: to EPA, Nat. Park Service, U.S. Forest Service and other land stewardship Agencies on effects of pollution on soil processes and nutrient transport mechanisms

70+ Publications focusing on effects of management, anthropogenic and climatic stressors on forest and rangeland systems in various ecoregions of the US, including:

- environmental effects of harvesting and fertilizer applications
- site productivity and soil quality in managed forests
- effects of air pollution on nutrient transport from terrestrial to aquatic systems
- carbon quality/stability and sequestration in forest and rangeland systems

Several Journal articles on C cycling and C sequestration in wildland ecosystems:

Moore, P.T., H. Van Miegroet, and N.S. Nicholas. 2007. Relative role of understory and overstory in carbon and nitrogen cycling in a southern Appalachian spruce-fir forest. *Can. J. Forest Res.* (Accepted).

Tewksbury, C.E. & H. Van Miegroet. 2007. Soil organic carbon dynamics along a climatic gradient in a southern Appalachian spruce-fir forest. *Can. J. Forest Res. (In Press)*

Van Miegroet H. & R. Jandl. 2007. Are nitrogen-fertilized forest soils sinks or sources of carbon? *Environmental Monitoring and Assessment* 128: 121-131.

Van Miegroet, H., P. Moore, C. Tewksbury & N.S. Nicholas. 2007. Carbon sources and sinks in high-elevation spruce-fir forests in the Southeastern US. *Forest Ecol. & Manage.* 238:249-260.

Van Miegroet, H., J.L. Boettinger, M.A. Baker, J. Nielsen, D. Evans, & A. Stum. 2005. Soil carbon distribution and quality in a montane rangeland-forest mosaic in northern Utah. *Forest Ecol. & Manage.* 220: 284-299.

Schoenholtz, S.H., H. Van Miegroet, & J.A. Burger. 2000. Physical and chemical properties as indicators of forest soil quality: Challenges and opportunities. *Forest Ecol. & Manage.* 138: 335-356.

Van Miegroet, H., M.T. Hysell, & A. Denton Johnson 2000. Soil microclimate and chemistry of spruce-fir tree islands in Northern Utah. *Soil Sci. Soc. Am. J.* 64:1515-1525.

Herrmann, R., R. Stottlemyer, J.C. Zak, R.L. Edmonds, & H. Van Miegroet. 2000. Biogeochemical effects of global change on U.S. National Parks. *J. Am. Water Resources Assoc.* 36(2): 337-346.

Public Comment

Submitted by Andre Shoumatoff, Utah Biodiesel, June 19, 2007

Utah Biodiesel Cooperative (UBC), Utah's biodiesel education, advocacy, and research organization, wishing to make the following comments in regards to **AF-1 and biodiesel fuel in Utah in general:**

Biodiesel, unlike other AG fuels, is efficient to produce and is by far, the easiest alternative fuel to implement because you simply put it into any diesel vehicle. Diesel vehicles do not require modification to run it unlike all other alternative fuels. According to data from the National Biodiesel Board (NBB), it is a 78% reduction of greenhouse gas per unit. It also offers drastic, sweeping emissions reductions in all categories, including complete elimination of sulfur, with exception of possibilities of slight increases of NOx . 36 states are currently producing biodiesel including states with similar climates as Utah (Idaho, for example, is a national leader). Utah currently has basically little or no biodiesel production, largely related to the business and political climate, not water issues. Utah, however, developed a fairly advanced biodiesel distribution system. It is possible that Utah may see as high as 15 million gallons of biodiesel produced per year by the end of 2008 based on announcements from several other corporations saying that they plan to produce biodiesel here, including Flying J oil refineries. The big future of biodiesel in Utah lies in its production of feedstocks specifically from algae-for-biodiesel, which is why we requested that AF-1 be place in a high priority category. This is most closely related to Utah's unique geographic location: one day away by transport to every major city in the west, and followed by inexpensive land, high labor quality at low costs, and plentiful sunlight and low required water usage for an enclosed algae production facility, which is the big future of biodiesel feedstock production in general. Recently, USU Logan was awarded a $6.5 million grant to develop biodiesel-from-algae technologies. A $100 million algae-from-biodiesel plant in Utah could produce in excess of 1 billion gallons of low-cost biodiesel feedstock, which currently more than the entire biodiesel industry. NBB estimates that the biodiesel industry will exceed $30 billion by 2020. Related to future impacts of global warming, currently a whopping 30% of all investments are being put into future renewable technologies, including production of biodiesel.

Utah Biodiesel Cooperative
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V. Cross-Cutting Options

Options include:

CC-1: GHG Registry 2
CC-2: GHG Reduction Target 3
CC-3: Public Education and Outreach 5
CC-4: Research and Development into Low/No Carbon Energy Strategies 6
CC-5: Climate Adaptation Strategies and Policies 7
CC-6: Regional/State Cap and Trade Programs, Carbon Tax, or Hybrid 8
CC-7: Guidelines for Climate Policy (In General); Coordination with Other Policies 11
CC-8: Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels 12
CC-9: Bridging Strategies to Achieve Low-Carbon Economy 13
CC Options Sorted by Priority and Vote 14
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Mike Peterson, Utah Rural Electric

CC-1 - GHG Registry

On May 8, 2007, Utah joined with thirty states as a charter member of The Climate Registry. Charter members include Arizona, California, Colorado, Connecticut, Delaware, Florida, Hawaii, Illinois, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Utah, Vermont, Washington, Wisconsin, Wyoming and the Campo Kumeyaay Nation. Two Canadian provinces, British Columbia and Manitoba, have also committed to participate.

Benefit/Cost of Reducing CO_2e:

Registries do not directly result in emissions reductions but are critical for tracking emission reductions.

Assessment: High Priority. Bin A. 19 out of 22 votes.

A GHG registry provides a platform for mandatory or voluntary reporting. It helps ensure consistent data reporting and accounting methodologies. Companies, governments, and others are encouraged to measure emissions. Incentives may be created for those who reduce emissions, and strategies may be developed to manage potential liabilities. A "common currency" for GHG emissions is essential in laying the foundation for carbon markets.

This is a voluntary program for Utah and provides businesses with the opportunity to get credit for early reductions of greenhouse gases. The Registry will begin to accept reporting data in January 2008.

A registry plays an important role in tracking GHG emissions and is a prerequisite for measuring and tracking any GHG goals or targets. Participating in the registry also prepares Utah for federal regulatory action on climate change and benefits early adopters of GHG reductions.

A voluntary registry will be relatively easy to roll out and can build momentum for the support of a mandatory program.[1] A mandatory program will likely require state legislation. A mandatory program could be phased in to allow companies to develop the expertise. The DOE program could serve as an example for a mandatory program.[2]

There will be some expense, but less than for other reporting/monitoring requirements. Carbon dioxide (CO_2) is easier to report than other emissions, as it does not require continuous emissions monitoring; rather, entities are required to track their fuel consumption.

We recommend that the State consider implementing mandatory reporting requirements as soon as practicable.

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[1] See California's program: www.climateregistry.org
[2] http://www.eia.doe.gov/oiaf/1605/frntvrgg.html

CC-2 - GHG Reduction Target

Utah recently joined the Western Climate Initiative, which commits its member states to develop a regional GHG reduction target.

Benefit/cost of Reducing CO_2e:

N/A

Assessment: High Priority. Bin B. 15 out of 22 votes.

Utah has committed to provide a State recommendation for GHG reduction by May, 2008. In developing the target, it is recommended that an economic assessment be done that includes costs and benefits.

A GHG reduction target is essential for implementing and monitoring the range of options discussed across all sectors. A voluntary target may be agreed to rather easily, while a mandatory target will require significant effort. Mandatory targets will result in enforceable emission reductions. Governor Huntsman should take the lead in establishing short-term and long-term goals. Short term goals spur immediate action and should be aggressive, but achievable, based on existing technologies. Long-term goals should be based on scientific projections of the emission reductions necessary to stabilize the climate to a two degree centigrade change.

When assessing and developing GHG reduction targets, it will be important to distinguish between energy production and consumption, commonly referred to as "Load-Based" and "Source-Based". For example, California policy of energy imports affects the GHG emissions of sources in other states. Montana has passed legislation with a similar proposal but is a net exporter of energy. Wyoming, Utah, and New Mexico are net exporters of energy.

Many U.S. states and countries have decided that stabilizing the climate at no more than a two degree centigrade increase requires GHG emission cuts of 60-80 percent from 1990 levels. The following Western states have adopted GHG emissions reduction goals, to date:[3]

Arizona:	2000 levels by 2020; 50 percent below 2000 levels by 2040
California:	2000 levels by 2010; 1990 levels by 2020; 80 percent below 1990 levels by 2050[4]
Oregon:	1990 levels by 2010; 10 percent below by 2020; 75 percent by 2050[5]
New Mexico:	2000 levels by 2012; 10 percent below by 2020; 75 percent below 2050
Washington:	1990 levels by 2020; 70-80 percent below 1990 levels by 2050 [6]

[3] Arizona Climate Change Advisory Group, "Climate Change Action Plan," http://www.azclimatechange.us/ewebeditpro/items/O40F9347.pdf., at 7

[4] California's climate reduction targets are found in state law AB 32. The 2050 Goal is provided for by Executive Order.

[5] Oregon's targets enacted in 2004 were in HB 3543.

Colorado is considering setting separate targets for state emissions, creating a separate body to oversee climate policy, and requiring local governments to develop GHG reduction plans and targets.
Montana is considering statewide GHG reduction targets and separate target for state emissions.

At least 7 other states have set GHG targets; they typically call for a 10 percent cut from 1990 levels by 2020 and a 60-80 percent reduction by 2050. The European Union has adopted a 20 percent reduction goal by 2020 (30 percent reduction if China and other large emitters accept a similar goal), and some European nations have set 50-80 percent reduction goals by 2050.[7]

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[6] Washington's targets can be found in SB 6004. Under the Northeast's Regional Greenhouse Gas Initiative (RGGI), governors of seven states have committed to stabilizing emissions at current levels from 2009-15 and then reducing them by 10 percent by 2019. http://www.rggi.org/.

[7] Europa Press Release, Jan 10, 2007, "Questions and Answers on the Commission Communication Limiting Global Climate Change to 2°C, http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/17&format=HTML&aged=0&language=EN&guiLanguage=en; http://www.theclimategroup.org/index.php?pid=422; http://thewatt.com/article1270.html.

CC-3 - Public Education and Outreach

Benefit/Cost of Reducing CO_2e:

The Utah Energy Efficiency Strategy shows Public Education, with respect to Energy Efficiency, to be extremely cost effective, yielding a $/$CO_2e$ ton of approximately -$70.

Assessment: High Priority. Bin A. 18 out of 22 votes.

Public education and outreach programs can take a variety of forms. Programs should educate the entire public, not just public school students. A combination of state and private funding is needed to implement a successful, statewide education campaign. Partnerships could be formed with other entities, such as utilities and large companies.

Educating the general public, along with businesses, industries, and K-12 grades, will help yield significant reductions in greenhouse gas emissions. Resources invested in public education and outreach can yield a high return, as it can spur people to action, alter habits and influence behavior with respect to energy, energy use, and reducing Utah's carbon emissions. For example, preliminary estimates from Utah's Energy Efficiency Strategy Report show that an effective public education and outreach campaign on energy efficiency has the potential to save 300-400,000 tons of carbon dioxide per year in 2020, while yielding net energy savings of approximately $300 million from 2006-2020.[8]

Arizona and New Mexico identify specific audiences to be targeted, including policymakers, youth, community leaders, and the general public. New Mexico also targets industrial and economic sectors. Colorado is considering establishing an education and outreach committee and outreach coordinator position, holding regular briefings to promote implementation, and adding climate to education performance standards for schools. The Oregon Governor's Advisory Council on Global Warming is developing an education program.

The Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder works with the Office of Oceanic and Atmospheric Research of the National Oceanic and Atmospheric Administration to create programs for K-12 school districts, teachers and students, undergraduates, and other community groups. CIRES has established a K-12 Outreach Program that combines science with innovative teaching practices. Other ongoing projects include classroom and teacher professional development, volunteer opportunities for scientists, education components for research projects, district partnerships, research mentors for high school students and undergraduates, and collections of digital resources for geoscience education project evaluation and for climate change education.[9]

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[8] Gellar, H., S. Baldwin, P. Case, K. Emerson, T. Langer and S.Wright. *Draft Report of Utah Energy Efficiency Strategy: Policy Options*. 21 May 2007.

[9] See http://cires.colorado.edu/education/k12/

CC-4 - Research and Development into Low/No Carbon Energy Strategies[10]

Benefit/Cost of Reducing CO_2e:

This option does not yield immediate GHG reductions, but has potential long-term benefits and emission reductions.

Assessment: High Priority. **Bin A. 16 out of 22 votes.**

Utah should increase support and funding for R&D for renewable energy, energy efficiency, and other low-carbon energy technologies. We should build on research done at Utah universities and the USTAR program but should not duplicate research already being conducted. The University of Utah has a leading research program in coal technology and low carbon energy from coals.

Colorado is considering promoting climate research and technology development at state universities, and the Oregon state university system was asked to develop strategic and targeted research, development, and demonstration programs for GHG reduction technologies.

California's GHG procurement policy has prompted California-Wyoming research on low carbon coal technologies. This option could include nuclear power.

[10] Research and development options are also addressed in the RCI and energy supply sectors; the focus here would be on GHGs not covered in these other categories.

CC-5 - Climate Adaptation Strategies and Policies

Benefit/Cost of Reducing CO_2e:

N/A

Assessment: High Priority. Bin B. 13 out of 22 votes.

Developing and implementing an adaptation strategy will require significant financial and other resources and will require the involvement of numerous stakeholders. This option could include adaptations to address the consequences of reduced snow pack, increased precipitation, more intense droughts, and drier soils; the spread of new diseases affecting humans and other forms of life; shifts in vegetation patterns and distributions and other impacts on ecosystems and on agriculture; and changes in behaviors, habits, and decisions. Utah should focus in particular on the impacts of climate change on water, drought, and reduced snow pack. It is important to bring agencies together to address this. Utah universities could possibly focus research into this area.

Arizona is developing a comprehensive state adaptation strategy and gives priority to adaptation measures that can also help mitigate GHG emissions.

CC-6 - Regional/State Cap and Trade Program, Carbon Tax, or Hybrid

Benefit/Cost of Reducing CO_2e:

The cost and benefits vary with the type of mechanism and are dependent on the scope of policy.

Assessment: **High Priority. Bin B. 13 out of 22 votes.**

Utah is participating in the development of a regional, market-based strategy, in conjunction with the Western Climate Initiative.

Cap and Trade. Cap and trade programs establish a cap on total emissions or an emissions reduction goal, specify caps for major sources and allocate emissions allowances to those sources, and then require sources to demonstrate each year that their actual emissions do not exceed their allowances. Sources that emit less than their allowances can sell excess allowances to other sources that exceed their allowances. Cap and trade programs face considerable challenges, such as how to establish the overall cap, how to allocate allowances to major sources, whether to give away or sell/auction allowances, how to monitor emissions and ensure compliance, and how to certify trades. U.S. EPA's acid rain program established under the 1990 Clean Air Act provides valuable lessons for the design of cap and trade programs.[11] The European Union's Emissions Trading System, established in 2005 to help prepare EU countries for complying with the Kyoto Protocol, is the world's largest GHG trading program.[12]

As indicated above, in May 2007, Utah became a member state of the Western Climate Initiative (WCI), joining Washington, Oregon, California, Arizona, and New Mexico and two Canadian Provinces. Members of the WCI have agreed to develop, within six months of the original charter date (Feb 2007), a regional GHG reduction target. By August 2008, The WCI plans to develop the design for a regional, market-based mechanism to achieve the target.

CO_2 Tax. A carbon tax is a tax placed on the consumption or production of carbon in any form. Proposals typically call for a tax based on fuel use or emissions or some other measure, such as the volume of smokestack emissions from power plants or the fossil fuel content of motor vehicle fuel. Carbon taxes are sometimes championed as an alternative to cap-and-trade programs, because they are simpler to design and implement, can be put in place more quickly, are easier to understand and consequently more likely to be accepted, more likely to lead to predictability in energy prices, can address more sectors of the economy, and create a revenue stream that can be used to reduce other

[11] http://www.epa.gov/airmarkets/cap-trade/index.html

[12] The Protocol requires that the EU as a whole reduce its GHG emissions from 1990 levels by 8 percent during the 2008-12 compliance period. The first phase of the program operates from 2005 through 2007. The core of the system is national allocation plans (NAPs), plans that set out each Member State's allocation of CO_2 emission allowances. NAPs set both the total of emission allocations available in each member state and the allocation made to each installation covered by the scheme; see http://ec.europa.eu/environment/climat/emission.htm.

taxes or fund energy efficiency and renewables. Critics point to the political difficulties associated with raising taxes, the experience with cap and trade programs like acid rain that have been widely viewed as successful, and the advantage of having a cap that, if accurately set, can ensure that environmental protection goals are achieved. Advocates of a carbon tax have created an organization

to promote the idea.[13] A carbon tax may be best pursued nationally or even internationally, but there has been some discussion of state and local governments embracing the idea. In November, 2006, for example, residents of Boulder, Colorado voted to approve what is apparently the nation's first carbon tax, based on the number of kilowatt-hours of electricity consumers use; the tax is estimated to add about $16/year to the average homeowner's bill and $46/year for businesses. Revenues, which are expected to reach $6.7 million by 2012, will be used to fund the city's climate action plan that includes energy efficiency, renewable sources, and reduced vehicle miles traveled.[14]

GHG offset/mitigation requirements for new power plants. A carbon offset requires a source to offset its carbon emissions by avoiding an equivalent amount of emissions elsewhere (either CO_2 or other GHGs) or by sequestering an equivalent amount of carbon. Companies that seek to be carbon neutral, for example, may be unable to completely eliminate emissions and choose to purchase offsets equal to whatever emissions they are unable to eliminate.[15] Under a 1997 law, Oregon requires new power plants to offset some of their CO_2 emissions; plants can meet that goal by making payments to the Climate Trust, a Portland NGO, which invests in greenhouse gas projects that avoid, displace, or sequester CO_2 emissions. Plants are required to ensure their net emissions remain 17 percent below the most efficient base-load gas plant operating in the US.[16]

Recommendation. We recommend that the state continue to work on a market-based strategy including considering the implications of regional cap and trade, carbon tax, product excise tax, and hybrid approaches. There should be an economic analysis of the costs and benefits associated with each of these policy options. A cap and trade program and a carbon tax are not mutually exclusive, and both could be implemented as part of an effort to reduce GHG emissions and achieve a particular target. They are discussed together here because policy discussions often address them at the same time. There are several issues to be explored, such as whether entities should be required to obtain independent verification of emissions. GHG trading programs will be more effective with more entities involved.

As a result of the Supreme Court's decision in April, CO_2 may be designated as a criteria pollutant, which may lead the EPA to regulate GHG from vehicles. Some states are supportive of said regulation. A federal policy on this issue may preempt state

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[13] See http://www.carbontax.org/

[14] Katie Kelley, "City Approves 'Carbon Tax' In Effort to Reduce Gas Emissions," *The New York Times* (November 18, 2006).

[15] Climate Biz, http://www.climatebiz.com/sections/backgrounder_detail.cfm?UseKeyword=Carbon%20Offsets

[16] Oregon Carbon Dioxide Emission Standards For New Energy Facilities, http://www.oregon.gov/ENERGY/SITING/docs/ccnewst.pdf.

regulation; as such any decision regarding this matter should take into consideration current federal proposals (see CC-8).

More information on the matter of vehicle CO_2 emissions can be found in the Transportation/Land Use sector recommendations and the Utah Energy Efficiency Strategy Report.

CC-7 - Guidelines for Climate Policy (in general); Coordination with Other Policies

Benefit/Cost of Reducing CO_2e:

N/A

Assessment: **High Priority. Bin A. 16 out of 22 votes.**

Climate policies should be coordinated with other policies, including air and water policy, to ensure the policies are effective and do not exacerbate other problems. There are examples of the need for coordination, such as the UK moving to diesels to reduce carbon emissions which has increased particulate pollution.

Montana is considering requiring GHG assessments as part of state-mandated environmental impact statements.

CC-8 - Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels

Benefit/Cost of Reducing CO_2e:

N/A

Assessment: High Priority. Bin A. 19 out of 22 votes.

In planning, implementing, and updating Utah's climate change policies and options, it is desirable to monitor other states, regional, federal, and international activities, so we can adopt new ideas that suit Utah's needs.

A summary report of climate change bills and proposals, outlining the potential impact each would have on Utah businesses and residents, may be helpful going forward.

CC – 9 – Bridging Strategies to Achieve Low-Carbon Economy

Benefit/Cost of reducing CO_2e:

N/A

Assessment: High Priority. Bin A. 20 out of 22 votes.

It is recognized that it will take time for many of the advanced fuels, technologies, and strategies represented in this report to be fully realized. It will be necessary to use lower-carbon bridging strategies and fuels to help achieve near- and mid-term GHG mitigation objectives. The State should encourage the environmentally responsible development, production, and use of these bridging strategies and fuels.

Sorted By Priority and Vote:

#	Policy Option	Priority	Bin	Vote
CC-9	Bridging Strategies	High	A	20
CC-1	GHG Registry	High	A	19
CC-8	Evaluate Existing Climate Proposals at the Regional, Federal, and International Levels	High	A	19
CC-3	Public Education and Outreach	High	A	18
CC-4	Research and Development into Low/No Carbon Energy Strategies	High	A	16
CC-7	Guidelines for Climate Policy (in general); Coordination with Other Policies	High	A	16
CC-2	GHG Target	High	B	15
CC-5	Climate Adaptation Strategies and Policies	High	B	13
CC-6	Regional/State Cap and Trade Program, Carbon Tax, or Hybrid	High	B	13

Public Comment

Submitted by Mike Peterson, Rural Electric Association on June 19, 2007

I know I am not part of the Stakeholder Working Group on Climate Change, but I wanted to submit several comments as an observer at the June 12, 2007 meeting.

- It would beneficial for someone seeing the sector group reports for the first time to have an explanation/justification as to why an item was given a high priority or assigned a certain Bin ranking by the sector group.

- I appreciate what appears to be an attempt to assign costs to the various measures by CO2/ton by referencing numbers from other states. However, the group should evaluate what those costs would be to Utah residents.

Utah's carbon foot print is significant compared to some of the other states which signed the Governor's Climate change compact. Thus, the impact to electric ratepayers could be much larger for Utah than for residents of California, Washington and Oregon. We need to have a clear understanding of what that impact would be.

For example, the draft from the CC sector group pointed to one study with a suggested carbon tax of $100/ton of carbon and then showed a resultant price increase for electricity from coal to be 2.2 cents/kWh. Because the number of customers served by Utah's rural electric co-ops is small, and their dependence on coal-fired power higher, this type of tax would be devastating. Rural electric cooperative customers would see triple digit percentage increases in their rates. Our rural members and economies would not have the capacity to absorb this type of increase.

In a similar fashion we need to recognize renewable portfolio standards will also impact regions, states, and communities differently. Utah's rural electric cooperatives formed Deseret Power and built the Bonanza Power Plant nearly 22 years ago. The plant was built to serve potential oil shale development and the MX missile system, both of which did not materialize. As a result these electric cooperatives still have surplus electricity. Thus, any mandate to purchase renewable power could potentially cause those electric cooperatives to displace a lower cost resource into the market to be used by others and replace it with a higher cost alternative for their ratepayers.

We need to be very cautious about making quick, reflexive decisions to recommend policies and/or mandates before technologies are available to meet them and potentially raise electricity rates to incentivize alternative generation that doesn't meet consumer needs. We could cause electricity prices to rise sharply while doing little to change climate.

As a general observation there seems to be, at least from the federal level, an unstated belief that our national energy policy should include policies that will harm consumers. Among our concerns is the idea of raising electric rates very high to promote energy

conservation among consumers by changing their consumption habits and turning devices off or buying high efficiency appliances. This strategy could be the same as a regressive tax on less affluent households with a disproportionate impact on those households if this strategy is not managed well because it does not recognize the regional differences in electricity generation, usage and needs. We need to make sure we understand how Utah citizens and businesses fit into these types of policy initiatives.

I highly recommend the group include estimates of potential cost and overall economic impacts to Utah residents and businesses and not rely on broad regional or national perspectives.

- During the transportation sector report there was mention of the Governor converting his SUV to compressed natural gas. We need to make sure that in our quest for energy independence we do not do things that could switch our dependence on foreign sources from one fuel to another. With natural gas now being used to power most all new electric generation, our nation could soon be dependant on imports of liquified natural gas as much as we are dependant on oil to keep our economy going.

Finally, we need to be careful that our attempts in Utah and the United States to lower levels of CO2 unilaterally don't result in higher energy prices here that could force industry to locate abroad in countries with little or no emphasis on controlling CO2 emissions, thereby actually increasing global levels of CO2.

Thank you,

Mike Peterson
Utah Rural Electric Association

VI. Energy Supply Issues

The Energy Supply sector evaluated policy options that would reduce GHG emissions from the generation and transmission of electricity, and the extraction and transmission of oil and gas.

This sector accounted for 26 percent of Utah's gross GHG emissions in 2005,[1] excluding electricity exports. The two policy strategies that have the largest potential to reduce GHG are encouragement of renewable energy resources and development of Carbon Capture and Sequestration (CCS) technologies. Options include:

ES-A: Develop Significant Amount of Renewable Energy Resources
- ES-1: Renewable Portfolio Standard 3
- ES-2: Create Renewable Energy Development Zones 3
- ES-3: Green Power Purchase and Marketing 4
- ES-4: Public Benefit Charge 4
- ES-5: Tax Credits and Incentives for Renewable Energy 4
- ES-6: Pricing and Metering Strategies 4
- ES-7: Research and Development 5

ES-B: Encourage Carbon Capture and Sequestration Technologies
- ES-8: Develop CO_2 Capture and Sequestration Policy 6
- ES-9: Issues for CO_2 Transmission 6
- ES-10: Research and Development 6

ES-C: Develop and Deploy Advanced Generation Technology
- ES-11: Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits 7
- ES-12: Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits 7
- ES-15: Nuclear Development 7

ES-D: Improve Efficiency and Reduce CO_2 at Existing Electricity Generation Plants
- ES-16: Generation or Emissions Performance Standards 8
- ES-17: Efficiency Improvements 8
- ES-19: Retrofit Plants with CO_2 Capture 8
- ES-20: Retire Old Plant: Build New Low-Carbon Greenfield Plant 9

ES-E: Promote Combined Heat and Power (CHP)—Distributed Generation (DG)
- ES-21: Incentives and Barrier Reductions for CHP and DG 10

ES-F: Improve Efficiency of Electric Transmission and Distribution System
- ES-22: Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation 11
- ES-23: Transmission System Upgrading 11

ES-H: Miscellaneous Energy Supply Options

[1] Greenhouse Gas Inventory and Reference Case Projections, 1990-2020; Center for Climate Strategies, February 2007 http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_3-29-07.pdf.

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Hans Ehrbar, Utah Jobs with Justice
David Litvin, Utah Mining Association
Response by Jordan Gates, Salt Lake City Mayor's Office
John Baza, Utah Division of Oil, Gas and Mining
James Holtkamp for Questar
HEAL Utah

ES-A: Develop Significant Amount of Renewable Energy Resources

Examples of renewable energy resources include wind, geothermal, solar PV, concentrating solar, biomass, and some hydroelectric facilities.

Benefit/Cost of Reducing CO_2e:

Arizona: 116 MMt between 2007-2020; 10% of 2020 emissions; $6/ton
New Mexico: 26 MMt between 2007-2020; 4.1% of 2020 emissions; $8/ton
Montana: 16.9 MMt between 2007-2020; 5.6% of 2020 emissions; $3/ton
Oregon: 0.8 MMt between 2007-2025; 0.8% of 2025 emissions; Cost effective

ES-1 Renewable Portfolio Standard

Assessment: High Priority. Bin B. 17 out of 22 votes.

A renewable portfolio standard (RPS) is a requirement that utilities must supply a certain, fixed percentage of electricity from an eligible renewable energy source. Currently 23 states and Washington D.C. have adopted Renewable Portfolio Standards, with Illinois considering RPS legislation in their current legislative sessions. Some states have expanded that notion to include an environmental portfolio standard (EPS) that allows energy efficiency as an eligible resource. In some cases, utilities can also meet their portfolio requirements by purchasing Renewable Energy Certificates (RECs) from eligible renewable energy projects. Utah has the potential to develop and import significant amounts of cost-effective renewable energy resources, which could result in significant economic development potential in Utah and surrounding states, increased energy security, and improved environmental quality. This issue will be explored in more detail in the Renewable Energy Initiative (REI) workgroup.

ES-2 Create Renewable Energy Development Zones

Assessment: High Priority. Bin B. 11 out of 22 votes.

The establishment of renewable energy development zones would serve two purposes. First, enhance renewable energy development through the reduction of zoning, siting and other regulatory barriers to renewable resources. This is applicable to transmission line capacity, which is one of the largest hurdles to renewable development. Second, provide economic incentives within the development zone, similar to “enterprise zones.”

ES-3 Green Power Purchases and Marketing

Assessment: High Priority. Bin A. 15 out of 22 votes.

Green Power refers to electricity from environmentally preferred sources, such as renewables. Green Power programs allow consumers to purchase "green tags" along with their electricity ensuring that a quantity of electricity equal to their purchase was produced from renewable resources. In addition, State government could use a green program to purchase a portion of their energy needs from renewable sources.

ES-4 Public Benefit Charge

Assessment: High Priority. Bin B. 9 out of 22 votes.

A public benefit charge is a fee on utility customers, based on their usage of energy. The revenue generated is to be spent on public goods such as energy efficiency. The funds collected are then provided to a third party to provide energy efficiency programming. Furthermore, the charge can be used to create programs such as a "Clean Energy Fund."

ES-5 Tax Credits and Incentives for Renewable Energy

Assessment: High Priority. Bin A. 18 out of 22 votes.

Tax credits and incentives are popular and effective policy mechanisms to advance certain technologies, especially those that do not currently benefit from other energy subsidies. Tax credits have been supported by Utah's legislature and can prove very effective for advancing renewable energy generation and efficiency with relatively minimal cost.

ES-6 Pricing and Metering Strategies

Assessment: High Priority. Bin B. 9 out of 22 votes.

The attractiveness of renewable energy projects to developers and to utilities depends, in part, upon the delivered price of the energy to the purchasing entity. The interconnection and/or net metering policies and processes also play an important role in renewable energy project development. Therefore, pricing and metering strategies must be considered as part of a renewable initiative.

ES-7 Research and Development

Assessment: High Priority. Bin B. 16 out of 22 votes.

Utah should consider providing support and/or funding for targeted R&D for renewable energy and energy storage. Such R &D may prove very helpful in reducing carbon emissions, while spurring economic development opportunities and technological innovation. As compared with other energy resources and technologies, there is currently very little R&D for renewables being undertaken in Utah. (see also CC-4).

ES-B: Encourage Carbon Capture and Sequestration Technologies

Benefit/Cost of Reducing CO_2e:

New Mexico: 22.7 MMt between 2007-2020; 4.2% of 2020 emissions; $29/ton
Montana: 11.1 MMt between 2007-2020; 5.6% of 2020 emissions; $30/ton

ES-8 Develop CO_2 Capture and Sequestration Policy

Assessment: High Priority. Bin B. 18 out of 22 votes.

Some of the key questions to be addressed in the development of a consistent regulatory framework for carbon capture and sequestration (CCS) are: immunity from potentially applicable criminal and civil environmental penalties; property rights, including the passage of title to CO_2 (including to the government) during transportation, injection and storage; government-mandated caps on long-term CO_2 liability; the licensing of CO_2 transportation and storage operators, intellectual property rights related to CCS, and monitoring of CO_2 storage facilities. Regulatory barriers may include revisiting the traditional least-cost/least risk regulatory standard or mitigating added risks and financing challenges of CCS projects with assured, timely cost-recovery.

ES-9 Issues for CO_2 Transmission

Assessment: High Priority. Bin B. 10 out of 22 votes.

Pipelines are required to transport CO_2 to sites that can provide storage. Identify permitting and licensing issues to expedite transmission pipelines. Identify incentives for pipelines, such as direct subsidies, assistance in securing financing and/or off-take agreements, or guaranteed cost recovery.

ES-10 Research and Development

Assessment: High Priority. Bin B. 20 out of 22 votes.

The State can help secure R&D funding toward sequestration technologies. A goal would be to build an industry around that technology in the state and to set the stage for adoption of the technology for use in the state.

ES-C: Develop and Deploy Advanced Generation Technology

Benefit/Cost of Reducing CO_2e:

N/A

ES-11 Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits

Assessment: High Priority. Bin B. 20 out of 22 votes.

Advanced fossil technologies produce lower CO_2 pounds per MWh as a result of more efficient generating technologies (i.e., integrated gasification combined cycle or oxy-combustion technologies) which may also be coupled with carbon capture and sequestration equipment (i.e., chilled ammonia scrubbing). Incentives may be in the form of direct subsidies such as tax incentives to help bridge the cost gap between advanced fossil technologies, compared to traditional technologies or assistance in securing financing. Addressing regulatory barriers may include revisiting the traditional utility least-cost/least risk regulatory standard or mitigating added risks and financing challenges of advanced fossil technologies with assured, timely cost-recovery.

ES-12 Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits

Assessment: Medium Priority. Bin A. 17 out of 22 votes.

Landfill Gas to Energy (LGE) is process by which gas is collected from Municipal Solid Waste landfills to generate energy, while reducing methane & CO_2 emissions. Currently in Utah there are three operational projects. LGE projects are "low hanging fruit" that create net benefits to owners, communities, and Utah's economy. This option could be structured as either a mandate or an incentive program.

ES-15 Nuclear Development

Assessment: Medium Priority. Bin C. 14 out of 22 votes.

Although there has been some renewed interest in nuclear because of its low carbon emissions, the questions about waste disposal and safety make it unlikely that nuclear energy development will result in near-term reductions in CO_2.

Nuclear energy has a potential to provide substantial carbon emission reductions. Nuclear energy should be evaluated as part of our long-term energy strategy (with due consideration of responsible waste disposal).

ES-D: Improve Efficiency and Reduce CO_2 at Existing Electricity Generation Plants

Benefit/Cost of Reducing CO_2e (GPS only):

New Mexico: 24.3 MMt between 2007-2020; 3.7% of 2020 emissions; $21/ton
Montana: 4.7 MMt between 2007-2020; 1.8% of 2020 emissions; $20/ton
Oregon: 7 MMt between 2007-2025; 7.3% of 2025 emssions; N/A

ES-16 Generation or Emissions Performance Standards

Assessment: High Priority. Bin B. 7 out of 22 votes.

A generation performance standard is a mandate that requires load serving entities (LSEs) to manage their electricity generation portfolio in such a way as to achieve an average annual pounds per megawatt-hour emissions rate limit. A CO_2 emissions performance standard is a resource procurement mandate that requires LSEs, when entering into new long-term financial commitments for electricity supply, to only acquire electricity from power plants that can demonstrate a maximum CO_2 pounds per megawatt-hour emission rate (for example, 1100 pounds of CO_2 per megawatt-hour). The maximum CO_2 emissions rate may also be based upon an average CO_2 emissions rate over a source's useful life. In both approaches, GHG offsets may be used to achieve compliance.

ES-17 Efficiency Improvements

Assessment: High Priority. Bin A. 18 out of 22 votes.

Efficiency improvements refer to increasing generation efficiency at power stations through incremental improvements at existing plants (e.g., more efficient boilers and turbines, improved control systems, or combined cycle technology).

ES-19 Retrofit Plants w/CO_2 Capture

Assessment: High Priority. Bin C. 15 out of 22 votes.

Technology is emerging for capturing CO_2 on existing power plants including chilled ammonia and other amine scrubbing technologies. These technologies have not been demonstrated at commercial scale, and the economics of such technologies are still being defined. See ES-B for further discussion on CO_2 sequestration.

ES-20 Retire Old Plant; Build New Low-Carbon Greenfield Plant

Assessment: High Priority. Bin B. 9 out of 22 votes.

New low carbon plants could be built to replace older/existing plants that consume high carbon fuels. Such plants could be constructed at sites that have never been used for industrial purposes (Greenfield), or could be constructed at former power plants or other industrial sites (Brownfield). Several regulatory issues need to be addressed, including cost recovery of stranded investment and least cost planning.

ES-E: Promote Combined Heat and Power (CHP)–Distributed Generation (DG)

Benefit/Cost of Reducing CO_2e:

New Mexico: 6.1 MMt between 2007-2020; 0.9% of 2020 emissions; $4/ton
Montana: 5 MMt between 2007-2020; 1.6% of 2020 emissions; $16/ton
Oregon: 0.5 MMt between 2007-2025; 0.6% of 2025 emissions; N/A

ES-21 Incentives and Barrier Reductions for CHP and DG

Assessment: High Priority. Bin B. 14 out of 22 votes.

Barriers to CHP and clean DG include inadequate information, institutional barriers, high transaction costs because of small projects, high financing costs because of lender unfamiliarity and perceived risk, "split incentives" between building owners and tenants, and utility-related policies like interconnection requirement, high standby rates, and exit fees. The lack of standard offer or long-term contracts, payment at avoided cost levels, and lack of recognition for emissions reduction value provided also creates obstacles.

Policies to remove these barriers include: improved interconnection policies; improved rates and fees policies; streamlined permitting; recognition of the emission reduction value provided by CHP and clean DG; financing packages and bonding programs; power procurement policies; education and outreach.

ES-F: Improve Efficiency of Electric Transmission and Distribution System

Benefit/Cost of Reducing CO_2e:

N/A

ES-22 Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation

Assessment: High Priority. Bin B. 16 out of 22 votes.

This is extremely important, especially for the development of clean energy. Improving the regulatory process for siting and permitting of new transmission lines and smart grid development (defined as an enhanced electric transmission or distribution network that provides smart metering, distributed generation management, and demand response, among other benefits) is critical to support the development of renewable energy, in that transmission and effective metering policies/technologies must be in place to move all energy to market.

ES-23 Transmission System Upgrading

Assessment: High Priority. Bin B. 19 out of 22 votes.

Upgrading the transmission system will improve overall system efficiency, reduce SF_6 emissions, and reduce line losses.

ES-H: Miscellaneous Energy Supply Options

Benefit/Cost of Reducing CO_2e:

N/A

ES-26 Research and Development

Assessment: High Priority. Bin A. 15 out of 22 votes.

Targeted R&D may be very helpful in ultimately reducing carbon emissions in such areas as renewables, advanced generation technologies, carbon sequestration, and energy storage (relates to CC-4).

ES-27 Remove Regulatory Barriers

Assessment: High Priority. Bin B. 18 out of 22 votes.

In some instances, specific regulatory challenges have been identified within other policy options. General regulatory barriers include insufficient resources or staffing to addressing emerging issues (i.e., permitting related to GHG emissions, analysis of geological sequestration, or renewables capacity potential). Others include revisiting the traditional least-cost/least risk regulatory standard or mitigating added risks and financing challenges of advanced energy supply technologies with assured, timely cost-recovery.

ES-28 Tax Credits and Incentives

Assessment: High Priority. Bin B. 19 out of 22 votes.

Tax credits and other incentives are tools that may be applied to encourage the reduction of CO_2 in the energy supply sector.

Goals

1. (ES-A) Develop significant amount of renewable energy resources using these tools:
    a. Renewable portfolio standard (ES-1)
    b. Create renewable energy development zones (ES-2)
    c. Green power purchase and marketing (ES-3)
    d. Public benefit charge (ES-4)
    e. Tax credits and incentives for renewable energy (ES-5)
    f. Pricing and metering strategies (ES-6)
    g. Research and development (ES-7)

2. (ES-B) Encourage carbon capturing and sequestration technologies by:
    a. Developing CO_2 capture and sequestration policy (ES-8)
    b. Addressing issues for CO_2 transmission (ES-9)
    c. Research and development (ES-10)

3. (ES-C) Develop and deploy advanced generation technology including:
    a. Incentives for advanced fossil fuel technologies that yield carbon reduction benefits (ES-11)
    b. Landfill gas/waste to energy that yield carbon reduction benefits (ES-12)
    c. Nuclear development

4. (ES-D) Improve energy efficiency and reduce CO_2 at existing electricity generation plants through:
    a. Generation or emissions performance standards (ES-16)
    b. Efficiency improvements (ES-17)
    c. Retrofit plants with CO_2 capture (ES-19)
    e. Retire old plant: build new low-carbon Greenfield plant (ES-20)

5. (ES-E) Promote Combined Heat and Power (CHP) Distributed Generation (DG) by:
    a. Incentives and barrier reductions for CHP and DG (ES-21)

6. (ES-F) Improve efficiency of electric transmission and distribution system by:
    a. Removing transmission/distribution system limitations and other infrastructure barriers for renewables and other clean distributed generation (ES-22)
    b. Transmission system upgrading (ES-23)

7. (ES-H) Adopt miscellaneous options including:
    a. Research and development (ES-26)
    b. Remove regulatory barriers (ES-27)
    c. Tax credits and incentives (ES-28)

Sorted by Priority:

The policy options were ranked first by priority and second by bin classification. Priority was assigned after consideration of the amount of CO_2 reduction potential, the criticality of the option to enable the related reduction pathway, the apparent cost/benefit, and the implementation time horizon (long-term vs. short-term). The bin ranking was assigned after consideration of cost (dollar amount, effort and benefits), and political and technical feasibility.

#	Policy Option	Priority	Bin	Vote
ES-10	Carbon Capture and Sequestration Research and Development	High	B	20
ES-11	Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits	High	B	20
ES-23	Transmission System Upgrading	High	B	19
ES-28	Tax Credits and Initiatives	High	B	19
ES-17	Efficiency Improvements	High	A	18
ES-5	Tax Credits and Incentives for Renewable Energy	High	A	18
ES-27	Remove Regulatory Barriers	High	B	18
ES-8	Develop CO2 Capture and Sequestration Policy	High	B	18
ES-1	Renewable Portfolio Standard	High	B	17
ES-22	Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation	High	B	16
ES-7	Renewable Energy and Energy Storage Research and Development	High	B	16
ES-26	Research and Development	High	A	15
ES-3	Green Power Purchase and Marketing	High	A	15
ES-19	Retrofit Plants w/CO2 Capture	High	C	15
ES-21	Incentives and Barrier Reductions for CHP and DG	High	B	14
ES-2	Create Renewable Energy Development Zones	High	B	11
ES-9	Issues for CO2 Transmission	High	B	10
ES-20	Retire Old Plant; Build New Low-Carbon Greenfield Plant	High	B	9
ES-4	Public Benefit Charge	High	B	9
ES-6	Pricing and Metering Strategies	High	B	9
ES-16	Generation or Emissions Performance Standards	High	B	7
ES-12	Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits	Medium	A	17
ES-15	Nuclear Development	Medium	C	14

Sorted by Votes:

#	Policy Option	Priority	Bin	Vote
ES-10	Carbon Capture and Sequestration Research and Development	High	B	20
ES-11	Incentives for Advanced Fossil Fuel Technologies that Yield Carbon Reduction Benefits	High	B	20
ES-23	Transmission System Upgrading	High	B	19
ES-28	Tax Credits and Initiatives	High	B	19
ES-17	Efficiency Improvements	High	A	18
ES-27	Remove Regulatory Barriers	High	B	18
ES-5	Tax Credits and Incentives for Renewable Energy	High	A	18
ES-8	Develop CO2 Capture and Sequestration Policy	High	B	18
ES-1	Renewable Portfolio Standard	High	B	17
ES-12	Landfill Gas/Waste to Energy that Yield Carbon Reduction Benefits	Medium	A	17
ES-22	Remove Transmission/Distribution System Limitations and Other Infrastructure Barriers for Renewables and Other Clean Distributed Generation	High	B	16
ES-7	Renewable Energy and Energy Storage Research and Development	High	B	16
ES-19	Retrofit Plants w/CO2 Capture	High	C	15
ES-26	Research and Development	High	A	15
ES-3	Green Power Purchase and Marketing	High	A	15
ES-15	Nuclear Development	Medium	C	14
ES-21	Incentives and Barrier Reductions for CHP and DG	High	B	14
ES-2	Create Renewable Energy Development Zones	High	B	11
ES-9	Issues for CO2 Transmission	High	B	10
ES-20	Retire Old Plant; Build New Low-Carbon Greenfield Plant	High	B	9
ES-4	Public Benefit Charge	High	B	9
ES-6	Pricing and Metering Strategies	High	B	9
ES-16	Generation or Emissions Performance Standards	High	B	7

Public Comment

Submitted by Kyle L. Davis, PacifiCorp, June 4, 2007

Utah Blue Ribbon Advisory Council on Climate Change - Energy Supply Catalog of State Actions

Proposed IGCC/CCS Incentives in Utah (ES Cat B and Cat C)

A. The Need for Clean Coal Technologies to Meet Emissions Reduction Targets.

On May 21, 2007, Governor Huntsman signed on to the Western Regional Climate Action Initiative.[2] The Initiative directs the states of Arizona, California, New Mexico, Oregon, Washington, and now Utah to develop a regional target for reducing greenhouse gases (GHG) by August 2007. By August 2008, they are expected to devise a market-based program, such as a load-based cap-and-trade program to reach the GHG target. The five states also have agreed to participate in a multi-state registry to track and manage greenhouse gas emissions in their region.

In addition to increased efficiency and renewable energy investment, the development and commercialization of advanced clean coal technology is a critical third component in the portfolio of GHG mitigation actions. The most viable of these technologies today appears to be Integrated Gasification Combined Cycle (IGCC) combined with carbon capture and storage (CCS) technology. There are also emerging CCS technologies that show promise for capturing carbon emissions from traditional pulverized coal fired boilers. These emerging technologies include chilled ammonia scrubbing and oxy-fuel combustion. Carbon capture technologies have the potential to remove approximately 90 percent of a coal plant's CO_2 emissions.[3]

IGCC plants generate electricity by gasifying coal and using clean "syn-gas" to fuel a combustion turbine in a combined cycle configuration. IGCC technologies have improved efficiencies compared to traditional pulverized coal plants. The overall efficiency of an IGCC plant depends on gasifier technology and coal type. Improvements in overall efficiency translate into reductions in CO_2 emissions; for every one percent of efficiency gain, a plant produces about 2 percent less CO_2 per kWh.[4] A generic IGCC plant has a CO_2 emissions rate of 1600-1760 lb/MWh as compared to a rate of 2000 lb/MWh for a traditional coal plant.[5] IGCC plants also have reduced air pollutant

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[2] See, http://gov.ca.gov/mp3/press/022607_WesternClimateAgreementFinal.pdf

[3] PacifiCorp's 2004 IRP at 23, located at http://www.pacificorp.com/File/File47422.

[4] U.S. Department of Energy Fact Sheet: Clean Coal Technology Ushers in New Era in Energy, located at http://www.state.gov/g/oes/rls/or/2006/77196.htm.

[5] "Exhibit 3-18, Emission Data from the Literature" page 3-29, from the Final Report, "Environmental Footprints and Costs of Coal-Based Integrated Gasification Combined Cycle and Pulverized Coal Technologies", EPA-430/R-06-006, United States Environmental Protection Agency, July 2006, located at http://www.epa.gov/airmarkets/resource/docs/IGCCreport.pdf.

emissions, such as sulfur dioxide (SO_2), nitrogen oxide (NO_X) and mercury,[6] compared to pulverized coal-fired plants. Additionally, using currently available commercial separation technologies, the cost of carbon capture from an IGCC plant is expected to be lower than the cost to capture carbon emissions from a traditional pulverized coal plant.

Both environmental and national security concerns support the accelerated development of advanced clean coal technologies. The North American Electricity Reliability Council recently reported that demand for electricity is increasing three times faster than new generating resources can be added.[7] Coal is the nation's most abundant fuel source.[8] Coal now accounts for 50 percent of the electricity generated in the U.S. and, as the lowest cost source of electricity generation, this percentage is expected to increase.[9]

The important role of advanced clean coal technology is recognized in the Western Public Utility Commissions' Joint Action Framework on Climate Change, signed on December 1, 2006 by the Washington, Oregon, California and New Mexico public utility commissions.[10] The Framework's Statement of Shared Principles includes five principles, the second of which is "Development and use of low carbon technologies in the energy sector." The third of six Action Items is: "Explore ways to remove barriers to development of advanced, low-carbon technologies for fossil fuel-powered generation capable of capturing and sequestering carbon dioxide emissions."

B. Removing Barriers and Providing Incentives to IGCC and CCS Technology Commercialization.

There are a number of barriers that stand in the way of large scale commercial development of IGCC and CCS technologies, particularly for investor-owned utilities (IOUs). Over the last several years, many states and the federal government have passed laws to address the most problematic of these. To promote Utah policies on climate change and sustainability, Utah should join these lawmakers in enacting clean coal legislation.

a. The Need for a Comprehensive Legal and Regulatory Framework for CCS.

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[6] PacifiCorp's 2004 Integrated Resource Plan (IRP) Update estimated IGCC reductions of 73% for SO_2, 85% for NO_X and 22% for mercury over a supercritical pulverized coal plant. PacifiCorp's 2004 IRP Update at 24, located at http://pacificorp.com/File/File57884.

[7] *Mixed Signals Leave Developers Wary of Building New Infrastructure*, 144 Pub Util Fort 4 (Nov 2006).
[8] *Financing Clean Coal*, 143 Pub Util Fort 73 (June 2005).
[9] U.S. Department of Energy Fact Sheet, supra note 3.
[10] Western Public Utility Commissions' Joint Action Framework on Climate Change (December 1, 2006), located at http://www.puc.state.or.us/PUC/news/2006/2006026jointaction.pdf.

CCS raises new legal and regulatory risks associated with siting and permitting projects, CO_2 transportation, injection and storage.[11] These risks are not yet fully understood, nor are uniform standards or government regimes in place to address and mitigate them.

Among the key questions to be addressed in the development of a consistent regulatory framework for CCS are: immunity from potentially applicable criminal and civil environmental penalties; property rights, including the passage of title to CO_2 (including to the government) during transportation, injection and storage; government-mandated caps on long-term CO_2 liability, insurance coverage for short-term CO_2 liability; the licensing of CO_2 transportation and storage operators, intellectual property rights related to CCS, and monitoring of CO_2 storage facilities.

California recently adopted AB 1925, directing the California Energy Commission to recommend standards to accelerate the adoption of long-term management of industrial CO_2.[12] Utah should similarly develop guidelines for addressing the emerging legal and regulatory issues associated with CCS. Among the options it should explore is that adopted by Texas, which transfers the title (and any liability post-capture) to CO_2 captured by CCS to the Railroads Commission of Texas.[13]

b. The Traditional Least-Cost/Least Risk Regulatory Standard Should Be Modified to Allow Development of CCS-Equipped IGCC and Pulverized Coal Resources.

IGCC plants have higher capital and operating costs than traditional coal plants. PacifiCorp's 2004 Integrated Resource Plan Update analyzed the costs of an IGCC plant equipped with CCS technology. This analysis demonstrated that a CCS-ready, IGCC plant costs at least 16.9% more than a supercritical pulverized coal plant.[14] Additionally, while reliable estimates for carbon geologic sequestration costs do not yet exist, the Department of Energy's research program goal is $10 per MWh.[15]

IOUs in Utah are subject to a least cost, least risk standard for new resources.[16] Additionally, Utah IOUs are required to implement their integrated resource plans through competitive bidding to ensure implementation of this least cost policy.[17] Because the costs of IGCC and CCS technologies are higher than uncontrolled traditional

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[11] Robertson, K., Findsen, J., Messner, S., Science Applications International Corporation. June 23, 2006. "International Carbon Capture and Storage Projects Overcoming Legal Barriers", prepared for the National Energy Technology Laboratory (see http://www.netl.doe.gov/energy-analyses/pubs/CCSregulatorypaperFinalReport.pdf)

[12] California AB 1925 (2006), located at http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1901-1950/ab_1925_bill_20060926_chaptered.pdf.

[13] Texas H.B. 149 (2006).

[14] PacifiCorp 2004 IRP Update at 24, supra note 5.

[15] *Id.*

[16] *See Energy Resource Procurement Act, Utah Code Ann. § 54-17-302(3)*

[17] *See Energy Resource Procurement Act, Utah Code Ann. § 54-17-101 et. seq. (for resources greater than 100 MW with a life or term of ten years or more.)*

pulverized coal, an IGCC or a CCS investment is difficult to justify under a least cost/least risk standard. For example, in 2003, the Wisconsin Public Service Commission rejected Wisconsin Electric's request for a certificate of need for an IGCC plant on the basis that the plant was not cost-effective.[18]

Utah should eliminate this barrier to IGCC and CCS technologies for IOUs by adopting a "reasonable and necessary" standard for IGCC and CCS technologies used to serve Utah customers, in place of a least cost/least risk standard. Indiana adopted a similar approach, requiring the Indiana Utility Regulatory Commission to encourage the development of IGCC and CCS as long as it concludes that the projects are reasonable and necessary.[19]

c. Utah Should Enact Tax Incentives to Help Bridge the Cost Gap Between IGCC and CCS Technologies and Traditional Uncontrolled Coal.

To bridge the cost gap between IGCC and CCS technologies and traditional coal, EPACT 2005 contained new investment tax credits for advanced coal technologies, including IGCC.[20] EPACT 2005's IGCC tax credits were heavily over-subscribed, however, with applications totaling $5 billion for only $1.6 billion in credits.[21]

Utah should enact tax incentives to encourage new IGCC and CCS development to serve Utah customers, adding to those already exhausted under EPACT 2005. The most effective combination of tax incentives for IOU development of IGCC and CCS technologies is a tax credit plus accelerated depreciation.

d. The Added Risks and Financing Challenges of IGCC and CCS Should Be Mitigated With Assured, Timely Cost-Recovery.

The developmental nature of IGCC and CCS technologies creates added risk and cost during the pre-construction phase, in construction of the plant and in the plant's performance. While engineering and construction designs for a traditional coal plant cost less than $1 million, an IGCC plant cannot be built without a Front End Engineering Design (FEED) study. Such a study costs $10-$20 million and requires 10-14 months for completion.[22] Because commercial-scale IGCC and CCS technologies are new, the risk of cost-overruns, construction delays and delays in achieving anticipated reliability levels are all higher than for a traditional coal plant.

This added risk and cost create financing challenges for an IGCC or CCS investment. Assured, timely cost recovery, typically achieved by "pay as you go"

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[18] *In re: Wisconsin Electric Power Company*, 05-CE-130 (Nov 10, 2003).
[19] IC 8-1-8.8-11(a), provides that "The Commission shall encourage clean coal and energy projects by creating the following financial incentives for clean coal and energy projects, if the projects are found to be reasonable and necessary."
[20] EPACT 2005, Title XIII, Subtitle A, Section 1307

[21] U.S. Department of Energy Fact Sheet, supra note 3.
[22] PacifiCorp 2004 IRP Update at 26, supra note 5.

proposals, is necessary for large IGCC or CCS projects to obtain financing and move forward. For example, the Ohio Public Utilities Commission recently allowed American Electric Power (AEP) to recover an estimated $23.7 million in first-phase IGCC pre-construction costs through a 12-month generation surcharge.[23] AEP proposed a second-phase of recovery during construction to cover financing costs, and a third-phase to recovery the costs of the plant after it becomes operational. Similarly, the Indiana Utility Regulatory Commission approved the requests of two utilities for deferral and recovery of IGCC pre-construction costs.[24]

Utah should adopt a full and timely cost-recovery standard for IOU investment in IGCC or CCS technologies used to serve Utah customers. Utah Code Ann. § 54-4-4(3) currently allows, but does not require, the Commission to use a future test period in setting retail rates.[25] To mandate "pay as you go" cost recovery for IGCC or CCS investments, Utah's clean coal legislation would need to create a limited exception to this statute for IGCC and CCS investments. Colorado, Indiana and Pennsylvania all provide full cost-recovery assurances for IGCC and CCS by statute; Colorado additionally includes recovery for replacement power costs associated with unplanned IGCC plant outages.[26]

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[23] *In re Columbus Southern Power Co. and Ohio Power Co.*, Case No. 05-376-EL-UNC (Ohio PUC April 10, 2006).

[24] *In re PSI Energy*, Cause 42894 (Indiana URC July 26, 2006).

[25] Utah Code Ann. § 54-4-4((3) (a) If in the commission's determination of just and reasonable rates the commission uses a test period, the commission shall select a test period that, on the basis of evidence, the commission finds best reflects the conditions that a public utility will encounter during the period when the rates determined by the commission will be in effect.

(b) In establishing the test period determined in Subsection (3)(a), the commission may use:

(i) a future test period that is determined on the basis of projected data not exceeding 20 months from the date a proposed rate increase or decrease is filed with the commission under Section 54 7 12;

(ii) a test period that is:

(A) determined on the basis of historic data; and

(B) adjusted for known and measurable changes; or

(iii) a test period that is determined on the basis of a combination of:

(A) future projections; and

(B) historic data..

[26] Colorado House Bill 06-1281; Indiana IC 8-1-8.8; Pennsylvania SB 1030.

Public Comment

Submitted by Hans Ehrbar, Utah Jobs with Justice, June 20, 2007

Utah has exceptional potential for solar and geothermal renewable energy. Since these technologies are in their infancy, they may still be less cost effective than other renewable sources. This note here discusses policies that would push them forward along their technological development path. Such policies not only have the advantage of providing Utahns with locally produced clean energy, but they also have the potential to develop Utah into a technology center for geothermal and solar energy.

Photovoltaic Solar Energy

One of the most important policies under consideration by the State of Utah is the requirement that Utah power companies provide a certain percentage of their power from renewable sources (RPS, renewable portfolio standards). This is a necessary step which deserves full support. But additional policies are needed to address Utah's special situation.

Experience from other states shows that RPS typically promotes the one presently cheapest clean energy, which is wind-generated electricity. Electricity generated by solar panels mounted on individual homes is still too expensive (although the costs are slowly falling), and it is difficult for homeowners to get favorable credit terms. Specific policies are needed to encourage the installation of solar panels. Germany's Feed-In Tariffs (FIT) are a possibility which proved successful: the utility companies have to write long term contracts (up to 20 years) in which they obligate themselves to photovoltaic electricity from the households at prices covering the producer's costs plus a little bit of profit. This cost structure is such that the distributed energy suppliers get a higher price from solar panels installed this year than if they wait and install slightly more efficient solar panels next year. This generates a predictable revenue stream which can be easily financed, thus encouraging early adoption of the technology. This again accelerates the process in which this technology matures and becomes cost effective. Data are available which say that this makes photovoltaic energy cheaper in the long run than other policies.

Utah is less densely populated than Germany and has much more sun. Therefore an adaptation of FIT to Utah might want to tie the capacity installed in a household to the average consumption of that household, in order to locally match the distributed generation of electricity with its consumption. There is also a good temporal match since PVC cells produce most at the times of peak demand from air conditioners. An obstacle to be overcome in Utah would be the requirements that power companies buy only the cheapest power. In the long term, the policies proposed here are cheaper than seeking the lowest price at the moment.

Geothermal Energy

Utah has the capacity to produce 30 percent of its electricity by geothermal means. Geothermal energy is the only renewable energy which can provide the base load without having to store energy. It uses little water and produces little noise. In addition, it can quickly and easily adapt its output to demand. Given these advantages, geothermal energy should be targeted as one of the backbones of the electricity supply in Utah. Since experience with geothermal as one of the main pillars of energy supply is rare, Utah can break new paths with carefully selected policies.

Geothermal facilities are small enough to be owned locally and clean enough to be situated near living areas. The technology is amenable to direct use of the heat; in some situations, geothermal energy must even be considered principally a source of heat, with electricity an additional bonus. Therefore policies are necessary to encourage direct use of the heat for space heating and greenhouses etc., in addition to the electricity use.

The main cost factor in geothermal energy is the location and drilling of the wells. Wells must be deep, which makes them expensive, and it is not certain whether they will be fruitful. Federal (DOE) or state programs for cost-shared drilling and the funding of the initial well for a small company might be considered. Geothermal drilling is a somewhat neglected sibling of oil drilling; there is high potential for efficiency improvements by targeted research. After the initial investment, operating costs are low; therefore low-cost loans would lower the threshold for private investment. The State government may also consider guaranteeing power purchase agreements between utilities and power companies in order to lower the interest costs.

Public Comment

Submitted by David Litvin, President of the Utah Mining Association and BRAC Member, via e-mail on July 17, 2007

TO: All Board Members

BRAC Draft Report

As requested by the July 12 e-mail, I offer the following three comments as we move closer to a final BRAC report:

1) Natural V.S. Manmade Greenhouse Gas Emissions:

The BRAC report should include a section setting forth the relative contributions of Greenhouse Gas Emissions (GHG) between natural and man-made sources, as well as Utah's contribution, as compared to total global emission levels. For each BRAC policy option. The expected amount of GHG emissions reduction should be quantified to the extent feasible. This information will assist Governor Huntsman and other readers of the BRAC report to put into proper context the level of Utah's man-made emission levels. I would hope that the technical BRAC staff are now compiling this information for the final BRAC report.

2) Guiding Principles:

Accompanying the individual policy option recommendation the BRAC will forward to Governor Huntsman in the final report should include a list of guiding principles that will provide Utah policymakers with an overall structure for helping to determine which policy options should be pursued. In this regard, I have provided below an initial list of guiding principles which should help initiate a dialogue on this important endeavor:

- Mankind's contribution to climate change GHG emissions is a global phenomenon that will require a comprehensive, long-term and worldwide response;
- The time frames for implementation of any climate change program to reduce GHG emission must be tied to technology availability, reliability and economic feasibility to avoid unnecessary impacts on Utah's citizens;
- Climate change programs designed to reduce GHG emissions should set achievable emission reduction targets with appropriate compliance periods without dictating specific required technologies or discriminating among different types of energy sources;
- Any GHG emissions reduction programs should not fall only on a portion of Utah's economy but include all sources of GHGs emissions;
- Any GHG emission reduction program should incorporate a fully-transparent cost-benefit analysis so that Utah consumers are aware of the potential economic impacts of policies prior to their implementation;

- Programs should be established which encourage the rapid research, development, demonstration and deployment, through public-private partnerships, of a broad spectrum of supply-side and demand-side technologies and practices, including energy efficiency, renewable technologies, fossil energy technologies and other appropriate energy technologies;
- Access to public lands for the development and transmission of domestic energy resources - such as renewables, oil-and-gas, oil shale and coal - that can be used in power generation technologies that can help Utah meet its growing energy demand while reducing its GHG emissions should be ensured.

3) Energy Technologies:

Throughout the policy option write-ups, specific energy technologies are given preferential treatment being described as "green power," "environmentally preferred," "clean energy" and so on. Such labels need to be removed in each policy option write-up in the final report. Why? Because such labels are incorrect and not defensible. For example, one may say that "wind" power is environmentally-preferred over other types of energy technologies. However, if you were a bird lover you probably would think not, since wind power is the largest source of bird kills in the U.S. Furthermore, if energy production reliability was your most important environmental criteria, solar or wind would not be environmentally-preferred since they are not dependable when it is cloudy or a calm day. Wood burning, a renewable energy source, is not environmentally healthy when burned in a confined area without proper combustion or emissions controls. Coal and nuclear have a very small land impact, in cases where land use values are a critically important factor. The point is, each energy technology offers certain benefits and challenges, and we should not, in this report, improperly label certain technologies being better than others. It is just wrong and not defensible. The fact is, we will need all available energy technologies to meet Utah's growing energy needs.

Best regards,

David Litvin
President
Utah Mining Association
office: 801-364-1874

Response submitted by Jordan Gates, Salt Lake City Mayor Rocky Anderson's Office, via e-mail on July 18, 2007

Good Morning David,

I was nice to meet you last Tuesday as I represented Mayor Anderson on the BRAC. I would like to respectfully add my 2 cents to your recommendations. While I would agree that studying the natural production of CO2 emissions is essential to fully

understand the complexity of global warming and climate change, I would caution that we do not do so at the expense of time that could be better spent exploring options to reduce the human contribution green house gases. Our primary Charge, as I understand it, is to study the potential effects of Climate Change on the state of Utah and develop policy recommendations for the Governor that will substantially reduce the CO2 emissions caused by anthropogenic sources, (i.e. energy production and changes in land use)

It's true that natural sources of CO2 emissions are globally larger than anthropogenic CO2 emissions. However, for the last 650,000 years the amount of carbon going into the atmosphere was steadied by a delicate balance. Since that time human beings, unknowingly, have upset this balance. On average humans produce about 26 billion tonnes of CO2 annually but, unlike nature, we are not removing any. Because of this imbalance atmospheric concentration of CO2 has now risen by over 35%, higher than any point in the last 800,000 years. It is imperative that we reduce this disastrous trend

I also have to disagree that the language used to describe renewable energy as clean, green and/or preferable is “indefensible.” While the issues you raise regarding these energy technologies are compelling, (I’m not familiar with wind turbines being the “largest source of bird kills in the U.S.” if you could provide a source for this information I would love to look into it) I would argue that the significant reduction in CO2 emissions that each of these technologies provides validate the use of said terms. If our charge is to examine policies to reduce CO2 emissions, then these technologies are indeed preferable. I believe this is the argument being used to further explore nuclear energy as an alternative to fossil fuels.

I look forward to further participation in this process

Regards,

Jordan Gates

Environmental Advisor to the Mayor
Salt Lake City Mayor's Office
451 South State Street #306
Salt Lake City, UT 84111
801.535.7939

Public Comment

Submitted by John R. Baza, Director of the Utah Division of Oil, Gas, and Mining on June 20, 2007 and handed out at BRAC meeting on July 10, 2007

James and Glade,

I've attached a Word document with language that I've drafted for the two policy options that I was assigned to address. I've collaborated with Mike Golas on the language, so we both feel comfortable with the statements.

The assignment of "medium priority", "Bin D" description is probably misstated and is somewhat based on a presumption that emissions from energy extraction operations are creating a large problem. I encourage additional and adequate study of current conditions, because both Mike G. and I sense that emissions risks are low in a majority of operations. In many cases where the emission risk is high, controls are mandatory Furthermore, especially with the value of natural gas, there are all kinds of controls in place to not release those dollars into the atmosphere. Therefore we suggest a low priority, Bin C designation as most appropriate. Such is indicated on the attached document.

Let me or Mike know if you have questions, otherwise we'll see you at next week's meeting.

John Baza

John R. Baza, P.E.
Director
State of Utah
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Attachment:

ES-19 GHG emissions reduction from fuel combustion in extraction operations

Assessment: Low Priority – Bin C

Fuel combustion in extraction operations can take several forms and must be addressed as separate components of any GHG emissions reduction strategy. In all phases of exploration and production, vehicles transport workers and material over long distances, and emissions reduction for this component should be tied to overall automotive

emissions reduction state-wide. In the case of various mined mineral commodities, long distance transportation is often accomplished by railway. Another component of the strategy could be to address railroad transportation emissions reduction.

All fuel combustion equipment that is utilized in energy extraction represents consumptive cost to a business venture and acts as a natural disincentive to unnecessary fuel utilization and the corresponding emissions. Thus, in order to reduce business expenses, many companies in the energy and minerals extraction industry have voluntarily worked toward higher efficiency engines, lower fuel consumption, or alternative fuels that result in lower combustion emissions.

Policies to encourage combustion-related GHG emissions reduction could include tax credits for mineral or petroleum producers or establishment of a state recognition program for voluntary efforts such as EPA's Natural Gas Star program.

Any policy for GHG emissions reduction will require determination of baseline performance and characterization of the subsequent effects of implementing new emission reduction strategies and technologies. The levels of such emissions are not well documented through current regulatory reporting channels, and available estimates or inventories may overstate the GHG emissions that are occurring. Even if some extraction and transportation companies have such information in detail or the means to obtain it, disclosure of such information should be constructively encouraged while avoiding the imposition of regulatory requirement. Companies should be rewarded for voluntary participation in GHG emissions reduction, but not penalized for non-participation.

ES-44 Leakage reduction program

Assessment: Low Priority – Bin C

Estimates of methane loss during production, processing and transportation of hydrocarbons vary greatly, leading to inaccurate characterization of such emissions. Because methane is a saleable commodity, there is an inherent value that promotes capture and retention of the material. This inherent value also drives regulations (federal and State) that are in place to prevent the waste of and require control of such emissions where there is known to be a risk of significant emissions occurring.

Many new emission control technologies have been implemented in recent years, and typical crude oils and natural gas produced in Utah oil and gas fields are of a type that would not lead to large emissions of methane if normal operational procedures are executed. Utah DEQ is nevertheless assembling a state-wide estimate of such emissions at oil and gas facilities. There is no comparable estimate being assembled state-wide for emissions during transmission all the way to the end user although there are EPA and international technical protocols for estimating such emissions.

Policies to encourage leakage reduction could include tax credits for mineral or petroleum producers or establishment of a state recognition program for voluntary efforts such as U.S. Environmental Protection Agency's Natural Gas Star program.

Any policy for leakage reduction will require determination of baseline performance and characterization of the subsequent effects of implementing new emission reduction strategies and technologies. The levels of such emissions are not well documented through current regulatory reporting channels, and available estimates or inventories may overstate the leakage quantities that are occurring. Even if some extraction and transportation companies have such information in detail or the means to obtain it, disclosure of such information should be constructively encouraged while avoiding the imposition of regulatory requirement. Companies should be rewarded for voluntary participation in leakage reduction, but not penalized for non-participation.

Public Comment

Submitted by James Holtkamp, Holland and Hart, for Questar on August 16, 2007

Re: Questar comments on BRAC report

Dear Dr. Nielson:

On behalf of Questar, we offer the following comment on the Climate Change Work Group's report to the Governor's Blue Ribbon Advisory Commission on Climate Change. In particular, Questar suggests amplifying ES-18 and TL-7 as follows:

> It will take time for demand-side conservation measures and renewable energy to make a significant dent in Utah's energy mix. Natural gas is an abundant and clean source of energy. The emissions of CO2 per BTU of natural gas burned are significantly less than for other types of fossil fuels. Natural gas is already widely used for residential and commercial heating, generation of electricity and a variety of manufacturing processes. Natural gas is also used as a transportation fuel, particularly in mass transit, and increasing numbers of passenger vehicles are converting to use natural gas as fuel. In addition, the technology and infrastructure for producing, transporting and delivering natural gas is well-developed. Therefore, natural gas can make an immediate impact as a "bridge fuel" to a carbon-constrained energy future as we move toward more renewable energy sources and better technology to reduce and even eliminate carbon dioxide emissions from energy generation and use..
>
> Recommendation: Encourage and incentivize environmentally responsible development, production and use of natural gas. (ES-18; TL-7

The foregoing recommendation was discussed at the Commission's August 14 meeting. We are submitting it in this letter for inclusion in the record of the Commission's deliberations.

Sincerely yours,

James A. Holtkamp
for Holland & Hart LLP

JAH:mf
cc: Thomas Jepperson
Ruland Gill

Public Comment

Submitted by HEAL Utah on August 29, 2007

Re: The Blue Ribbon Advisory Council on Climate Change (BRAC) Final Recommendations

Dear Governor Huntsman:

Greetings from HEAL Utah.

We write you today to share our concerns about the recommendation of the Blue Ribbon Advisory Council on Climate Change (BRAC) to consider nuclear power as a means of addressing global warming, and also to share concerns about legislation in the works that would virtually guarantee that a nuclear power plant would find its home in Utah.

As you know, HEAL Utah has historically focused its efforts on protecting Utah from nuclear and toxic waste. But because nuclear power and nuclear waste are inextricably linked, we have recently begun to engage the topic of nuclear power in several arenas.

Although our mission is not to fight global warming, as an organization and as individuals who care deeply about our environment, we recognize that human-caused climate change is possibly the greatest environmental threat facing our nation and our world.

But as we've educated ourselves about the issues, it turns out that protecting our land from nuclear waste and protecting our air from greenhouse gases are not mutually exclusive goals.

Nuclear—a "clean" option?

The nuclear industry has been very smart to paint itself as the only solution to global warming, since operating a nuclear power plant does not generate greenhouse gases. Some have even gone so far as to call nuclear power "clean" for this reason.

But as we both know, and as the mounds of contaminated rubble at EnergySolutions and the mounds of Private Fuel Storage's paperwork piling up in federal court attest, nuclear power is not clean. It creates a waste problem that virtually no one wants and that our collective global community has not been able to solve, in spite of 50 years and billions of dollars worth of research.

Your Blue Ribbon Commission looked at nuclear power as a means of addressing global warming, and we think that was an appropriate step. We need to cast a wide net and look at all means of addressing climate change if we're going to come up with serious and effective solutions.

But with all due respect to the BRAC members who voted otherwise, we disagree that nuclear power represents a sound and sensible path forward for Utah as a means of addressing global warming and the related important issues of air quality, sustainability, economics, and energy security.

Using nuclear power to combat global warming

The current thinking among many is that nuclear power is the only way to combat global warming while assuring adequate future energy supplies. But let's say every state and every country around the world decided to turn to nuclear power as the principle means of addressing climate change to achieve just the modest goal of year 2000 annual greenhouse gas emissions by 2050. The numbers are staggering:

- A new reactor would have to come online somewhere around the world every 6 days[27]
- A new Yucca Mountain-sized repository would be needed every 3 years[28]
- There'd be a greater than 90% probability of at least one nuclear accident happening somewhere in the world, even assuming that new nuclear power plants are *ten times safer* than the current U.S. fleet[29]

That's not a world we'd like to live in. Such a rapid expansion of nuclear power would necessarily trample community involvement in the decision-making process on the siting of reactors and disposal repositories. And besides inflicting economic devastation on the order of hundreds of billions of dollars, a catastrophic nuclear accident occurring anywhere in the world could turn public opinion so far away from nuclear power that the whole investment might be lost.

If this is not a world that you want to live in either, then as a state with virtually untapped renewable resources, we owe it to ourselves to try to strike a different path—non-Carbon emitting *and* non-nuclear.

Oh yeah, and the waste problem

Increasingly, nuclear power advocates claim the waste problem has been solved by reprocessing, or what they inaccurately call nuclear waste "recycling."

What they fail to mention is that only about 1% of the high-level waste from spent fuel rods can be re-used employing current technologies. This 1% figure represents the plutonium component of spent nuclear fuel.

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27 Brice Smith, *Insurmountable Risks: Can Nuclear Power Solve the Global Warming Problem?* (Takoma Park, MD: IEER Press, 2006), 96.

28 Ibid. at 291.

29 Brice Smith, "Insurmountable Risks: Can Nuclear Power Solve the Global Warming Problem?," *Science for Democratic Action* Vol. 14 Number 2 (2006): 5.

The vast majority of the spent fuel rod—around 95%—is low enriched uranium (LEU) that would likely be disposed at EnergySolutions in Utah's west desert. Radiologically, large quantities of LEU are most similar to transuranic waste, which by Federal law must be disposed in a deep geologic repository. And yet due to what we would describe as a classification loophole, the Department of Energy has targeted EnergySolutions' Clive site as one of two preferred disposal sites for large quantities of depleted uranium (DU), and LEU could follow. Therefore, any widespread reprocessing scheme could mean more long-lived and hazardous radioactive waste for Utah.

The remaining 4% of the spent fuel rod is called "fission products," and this waste would need to be disposed in a deep geologic repository like the one DOE hopes to build at Yucca Mountain.

It's hard to call something "recycling" if only 1% of the material can be recovered. And actually *reusing* that material presents a whole host of other technical and economic challenges.

The problem is that the world's current fleet of light water nuclear reactors was built to run on uranium-based fuels—*not* plutonium-based fuels.

France is instructive in this regard. It uses plutonium-based fuels in only about half of its 58 reactors. And to do so, it pays a heavy economic price. The French government spends an additional $1 billion annually just to supply 30% of the reactor fuel from plutonium for these 28 reactors.[30]

The poor economics of reprocessed plutonium fuel has no doubt contributed to France having to store, maintain, and protect an estimated 80 tons of separated commercial plutonium as of the year 1999.[31]

The reprocessing experience in the United Kingdom indicates just how difficult the process is to manage. The Thorp reprocessing plant had to shut down in 2005 when it was disclosed that 83,000 liters of acid containing 20 tons of uranium and 160 kg of plutonium had leaked out of a pipe and had remained undiscovered for a full *8 months* after the leak occurred.[32] The plant has been mostly shut down since that time, and the resulting lost revenues have totaled £112 million as of August of 2007.[33]

We've noticed among some legislators an interesting juxtaposition: they think of wind turbines as economically risky, but set great store by reprocessing as a practical and cost-

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30 Arjun Makhijani. *Plutonium end game: managing global stocks of separated weapons-usable commercial and surplus nuclear weapons plutonium.* (Takoma Park, MD: Institute for Energy and Environmental Research, 2001), 30.

31 Ibid. at 26.

32 "Sellafield firm fined over leak," *BBC News*, October 16, 2006, http://news.bbc.co.uk/2/hi/uk_news/england/cumbria/6055892.stm (accessed August 28, 2007).

33 Christine Buckley, "Losses from idle Sellafield plant hit £112m," *Times Online*, August 3, 2007, http://business.timesonline.co.uk/tol/business/industry_sectors/industrials/article2191431.ece (accessed August 28, 2007).

effective solution to the nuclear waste problem. We'd argue that the facts argue otherwise: wind power is economically competitive and rapidly growing, while commercial-scale reprocessing in the U.S. is non-existent.

Just to reprocess and burn the plutonium content of our existing nuclear waste would require a Herculean investment. A study by the National Research Council looked at what it would cost to use a reprocessing scheme to deal with the plutonium waste in all of the spent nuclear fuel accumulated around the U.S. through the year 2010. This report concluded that the cost would almost certainly top $50 billion and could easily exceed $100 billion.[34]

And spending that sum of money still wouldn't solve the waste problem. Even the nuclear industry doesn't make such grand claims about reprocessing, concluding in a 2006 Nuclear Energy Institute white paper on the subject that, "[r]egardless of time and infrastructure development, none of this [reprocessing technology] will substitute for the Yucca Mountain repository."[35]

Because of the sheer scale of a widespread reprocessing system and the poor economics, reprocessing would necessarily need to become the province of the Federal government. Are we really ready to start producing our own nuclear waste while blithely reassuring each other that "the Federal government will take care of it"? As a country, we've already made that mistake with the Yucca Mountain disposal facility, and that project remains stalled after around $9 billion in investments. The result is that 50,000 tons of high-level nuclear waste remain scattered around the country, most of it unsecured.

It simply does not make sense to resort to a form of energy production that has no readily achievable waste disposal solution—especially when that solution also carries such an exorbitant, though ultimately unknown, price tag. We're a community that places a high value on self-reliance, and as such, we should show the good sense to avoid problems that we don't have the infrastructure or desire to solve.

But even worse will be our own moral hypocrisy if we resort to nuclear power. If we don't want anyone else's nuclear waste in our state, then why would we assume that any other state would want our nuclear waste? What gives us the right to keep adding to this intractable nuclear waste burden? If we don't want nuclear waste, then we should not build and operate a nuclear power plant. It's as simple as that.

On the other hand, if those Utah legislators and others pushing nuclear power legislation (discussed later) intend for this state to permanently keep all of our resulting high- and low-level waste, that intention should be disclosed as part of the legislative process.

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[34] National Research Council, Committee on Separations Technology and Transmutation Systems, *Nuclear Wastes: Technologies for Separations and Transmutation, Executive Summary.* (Washington, DC: National Academy Press, 1996), 7.

[35] Nuclear Energy Institute. *Nuclear Waste Disposal for the Future: The Potential of Reprocessing and Recycling.* (Washington, DC: Nuclear Energy Institute, 2006), 5.

Mining and milling uranium

The recent coal mine tragedy in Utah has some commentators suggesting that a nuclear renaissance would be good for miners, since we wouldn't need to mine as much coal.[36]

The recent mine collapse has been absolutely devastating—for the miners, the fallen rescuers, their families, and indeed, an entire nation looking on and sharing silently in their grief.

As heart wrenching as this episode has been, we caution anyone who thinks that a uranium-energy economy is any better for our land, pocketbooks, or miners.

Taxpayers have shelled out an estimated $125 million to reclaim more than 5,000 abandoned uranium mines in Utah.[37] Around a billion dollars have been spent cleaning up only a handful of uranium mills in Utah alone.[38]

The Atomic Energy Commission's callous policies kept uranium millers, miners, and haulers in the dark about the potential health consequences of their exposure to radiation during the Utah uranium boom. As a result, compensation payments subsequently made to these miners, millers, and haulers or their surviving families have now exceeded $581 million dollars.[39] But as we both know, no amount of money can ever repay the true damage in lives lost, families broken, and communities scarred.

Although many would like to shrug off the past and blindly claim, "it'll be different next time," the science says otherwise.

It turns out that the uranium mining safety laws—on the books since 1971—are in drastic need of revision. A 1980 National Institute for Occupational Safety and Health (NIOSH) report detailing the findings of a scientific study group stated that the 1971 standard "does not provide an adequate degree of protection for underground miners exposed to radiation when it is evaluated over their exposure lifetime."[40] Subsequently, in 1987, a NIOSH scientist testified before Congress that the exposure limit be reduced by four-fold, and presented scientific analysis that the more protective standard would result in an

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36 Thomas Sowell, "2 recent tragedies have tax, energy implications," *Deseret Morning News*, August 16, 2007, http://deseretnews.com/article/content/mobile/0,5223,695201166,00.html (accessed August 29, 2007).

37 Jerry D. Spangler and Donna Kemp Spangler, "Uranium mining left a legacy of death," *Deseret Morning News*, February 13, 2001, http://www.deseretnews.com/dn/sview/1,3329,250010691,00.html (accessed August 29, 2007).

38 Jerry D. Spangler and Donna Kemp Spangler, "Toxic Utah: Paying the price," *Deseret Morning News*, February 11, 2001, http://www.deseretnews.com/dn/view/1,5143,250010204,00.html (accessed August 29, 2007).

39 Department of Justice, Radiation Exposure Compensation Program, http://www.usdoj.gov/civil/torts/const/reca/index.htm (accessed August 29, 2007).

40 Quoted in Gary E. Madsen and Susan Dawson. "Unfinished Business: Radiation Exposure Compensation Act (RECA) for Post-1971 U.S. Uranium Underground Miners," *Journal of Health & Social Policy* 19 (2004): 51.

accompanying four-fold decrease in the expected number of worker deaths caused by lung cancer over a 30-year career.[41]

Despite these advances in our understanding of the health effects of underground radiation exposures on mine workers, the official standard remains unchanged.

Whether it's the sudden collapse of a mountain overhead or a long, drawn out battle with lung cancer, underground mining for energy fuels entails substantial risk. It would be foolhardy to imagine that we're protecting miners by simply substituting one set of risks for the other.

Bringing a nuclear reactor to Utah

With all due respect to the legislative members of the BRAC who might feel otherwise, we do not feel that the state Legislature has made a good faith effort to adequately study the issue of nuclear power.

The 2006 Energy Policy Amendments included a provision added at the last minute by Senator Jenkins that suggested the state "promote the study of nuclear power." This suggestion did not emerge from the consensus-based approach adopted during the interim, in which legislators and representatives from industry and community groups participated.

Nearly two years later, that nuclear study has yet to be funded by the Legislature. And yet Public Utilities and Technology Committee co-Chairs Senator Jenkins and Representative Noel are drafting legislation that would all but guarantee a nuclear power plant in Utah.

Though the language has not yet been drafted, the new legislation will likely be modeled on the Florida Energy Act of 2006. If so, it would spur utilities to invest in a new nuclear reactor by shifting the risk of such a vast, complicated, and politically divisive enterprise from the utility to energy consumers.

Under this model, the utility would be able to recoup all of its expenditures on a new nuclear power plant *even if the plant never generated a single watt of electricity*.

The danger of this approach becomes clear when you realize that the history of nuclear power in this country is littered with abandoned nuclear projects. Utilities have cancelled at least 121 nuclear reactors on which they had spent some money—over half of which cost $50 million or more each.[42] Total expenditures on these highest cost cancellations amount to $35.3 billion.[43]

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41 Ibid.

42 Charles Komanoff and Cora Roelofs. *Fiscal Fission: The Economic Failure of Nuclear Power.* (New York, NY: Komanoff Energy Associates, 1992), 23.

43 Ibid.

Various factors contributed to these cancellations—including community activism, changing regulatory standards after the Three Mile Island (TMI) accident, extremely high interest rates, and poor project management.

The same factors that led to nuclear project cancellation also led to higher than anticipated costs for the electricity produced. A recent study estimated levelized (or average lifetime) costs for electricity produced from 99 U.S. nuclear reactors. While some of the reactors were very cost-effective, the most expensive 16% showed a cost of greater than 8 cents per kilowatt-hour (kWh)—more expensive than the 7.7 cents per kWh Utah residential power users actually paid last year. The most expensive 5% of the plants surveyed had costs exceeding 12 cents per kWh.[44] It's important to remember that the cost figures cited do not include a profit margin for the utility, so the prices paid by consumers for energy generated by these least cost-effective reactors would likely be even higher.

While you might be tempted to look at the 8-12 cents per kWh cost range as a worst-case estimate, a recent report adopts nearly identical figures for the *likely* cost of *new* nuclear power. The Keystone report was a collaborative fact-finding venture in which prominent industry policy groups, utilities, and nuclear firms participated—including representatives from the Electric Power Research Institute (EPRI), nuclear giant Areva, and Constellation Energy Generation Group. They concluded: "a reasonable range for the expected levelized cost of nuclear power is between 8 and 11 cents per kilowatt-hour (kWh) delivered to the grid."[45]

At the high-end of the range, 11 cents per kWh would represent a nearly 50% markup for residential energy consumers in Utah—without even providing a profit margin for the utility.

In the past, unanticipated delays have dramatically increased the actual cost of nuclear power. Have nuclear reactor construction schedules gotten any easier to predict?

An instructive example is Finland, where the only Western-type generation III+ reactor is being built anywhere in the world (generation III+ reactors rely more on passive safety features to prevent core damage accidents than their generation II counterparts).

Construction began on the new Finnish reactor in August of 2005. Less than a year later, in July 2006, amid reports of quality control problems, the Finnish utility stated that the project was more than a year off schedule. Then, in December, Areva, the French-German nuclear contractor, announced that the project was 18 months behind. Estimates are that the project is likely to be €700 million over budget. Areva's nuclear construction

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44 Nathan E. Hultman, Jonathan G. Koomey, and Daniel M. Kammen. "What History Can Teach Us about the Future Costs of U.S. Nuclear Power," *Environmental Science & Technology* 41 (2007): 2090.

45 The Keystone Center. *Nuclear Power Joint Fact-Finding.* (Keystone, CO: The Keystone Center, 2007), 11.

unit suffered, showing a decline of €300 million from the previous year's income due to problems with the Finnish project.[46]

Had the terms not been based on a "turnkey" or fixed-price contract, these delays and overruns would be impacting the utility's bottom-line, and thus the cost of the energy produced.

Now think about the Florida-style legislation being drafted in Utah, which would specifically require Utah ratepayers to shoulder all of the risk. Is it fair to ask energy consumers—who have absolutely no say in the choice of generating technology or control over the project management—to ultimately pay the price for an abandoned reactor, or to pay exorbitant prices for electricity from a reactor that takes longer to build than anyone predicted?

No. We view nuclear power as an inherently risky energy strategy, and if the utility wishes to go that route, it should bear responsibility for that risk.

Other paths forward

Combating global warming, improving air quality, increasing energy independence—these are all absolutely worthwhile goals that have awakened Utahns to the need for a change in energy policy.

And while 63% of Utahns in a recent poll—following the nuclear industry's clarion (but erroneous) slogan of "clean" energy—want to see increased development of nuclear power, around 95% of Utahns backed energy efficiency and conservation, 92% backed solar developments, and 90% wanted to see incentives for wind energy.[47]

This virtually unanimous level of enthusiasm for energy efficiency and renewable energy development represents our state's most important untapped resource in the fight against global warming—the human potential to transform how we use and generate electricity.

Our state's political leaders and utilities merely need to find more effective ways of tapping into this potential.

Our economy is strong. If asked to step up to the plate and invest in distributed solar, aggressive energy efficiency, and peak-load management strategies, we think the businesses and people of this state would do so, even if it meant proactively paying a little more for the energy we use now. The trick is to devise a series of effective programs that people can put their hearts and dollars behind, and then to reciprocate with openness and transparency in how those dollars are spent.

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46 Greenpeace International. *The economics of nuclear power.* (Amsterdam, The Netherlands: Greenpeace International, 2007), 4.

47 Joe Bauman, "Utahns back alternative fuels," *Deseret Morning News*, July 21, 2007.

Rocky Mountain Power's Blue Sky Program is an example of such a program, where residential and business consumers can voluntarily elect to buy blocks of wind power on top of their normal utility bill. These consumer-purchased blocks obligate the utility to purchase 100 kWh of 100% wind energy per block. Rocky Mountain Power makes any additional unspent money from the program available to community groups in the form of grants that support distributed power projects, like the recent photovoltaic solar panel installation at the Tracy Aviary.

The Blue Sky Program model brings up an interesting point of debate about consumer energy choice going forward. The Blue Sky Program allows consumers to pay a little more to put their dollars where their hearts are to support wind power. If nuclear power comes to Utah and ends up costing more, those higher costs will be borne by *everyone*—even though a significant portion of the population here opposes it. How is it equitable to make something like wind power, which enjoys almost universal support, *voluntary*, while making nuclear power, which nearly a third of the people already oppose, *compulsory*?

Will investing in renewable electricity generation and energy efficiency cost more than nuclear power? It's hard to say. But what seems absolutely certain is that *any* new electrical generation that isn't the run-of-the-mill coal plant will simply cost more—nuclear or otherwise.

It's difficult to compare the true, total cost of new nuclear generation vs. other generating strategies simply because the nuclear industry has successfully externalized much of the cost inherent in managing long-lived nuclear waste and insuring against the risk of a large nuclear accident. In other words, two significant drawbacks of nuclear generation—namely the waste problem and the risk of a meltdown—never show up as increased costs in the bottom line, since our nation's energy policy framework specifically excludes them.

Ultimately, no one really knows how much disposal is going to cost. U.S. taxpayers shoulder the liability for an open-ended and undefined financial commitment to manage the nation's high-level nuclear waste while utility executives can point to a relatively "low cost" of nuclear electricity.

On top of this already titled playing field, the US Energy Act of 2005 provided a whole host of additional incentives for nuclear power, including tax credits, loan guarantees, and risk insurance. Some might be inclined to view these incentives as essentially "free money." But it's important to keep some perspective that whether the dollars come out of one's utility bill or tax return, the true cost is the same.

Rather than chasing Federal incentives, we would urge you and the state Legislature to make a sober appraisal of the nuclear option, including the total lifetime costs borne by taxpayers, when attempting to compare the cost of nuclear to other options that might at first seem more expensive.

Finally, we want to highlight the opportunity costs of nuclear power—in other words, what possibilities we would likely have to sacrifice if we went nuclear.

Nuclear power plant construction is a massive and capital-intensive process. When the utility has to allocate all of its cash and credit to financing nuclear power plant construction, the dollars for other projects like energy efficiency and renewable energy will likely dry up.

And given that Pacificorp recently stated that the earliest it could bring a new nuclear reactor online is the year 2022[48], imagine what alternative technologies might be developed between now and then. Also imagine how the costs associated with various renewable and efficiency technologies might decrease in that timeframe as those industries mature. By committing ourselves to a nuclear power plant now, we might miss the boat on other energy systems that better reflect our values in the near- to mid-term.

In the end, we believe that renewable sources of energy like wind farms, photovoltaic solar panels, and solar thermal plants are more scalable and faster to deploy than nuclear power, and this is a strategic advantage. Investing in renewable generation and energy efficiency also keeps our options open, and at a more certain cost than nuclear. It gives us the opportunity to spread our energy eggs in many different baskets over time, rather than requiring us to commit all our eggs to nuclear. And it also allows us to move forward as one united community, since these approaches enjoy nearly unanimous support.

Conclusion

When our grandchildren look back on our generation, we don't want them to think that our highest ambition, and the pinnacle of our very best engineering and policy efforts was the most advanced nuclear waste dump the world had ever seen.

We want them to remember us for solving the energy problem, and doing so in a way that spared them the legacy of a warming planet and mountains of nuclear waste.

We hope you agree.

Thank you.

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[48] Pacificorp. *2007 Integrated Resource Plan.* (Portland, OR: Pacificorp, 2007), 93.

VII. Residential/Commercial/Industrial Options

The residential, commercial, and industrial fossil fuel combustion sector accounted for 18 percent of Utah's gross GHG emissions in 2005.[1] Options include:

RCI-1: Utility Demand Side Management 2
RCI-2: Voluntary Efficiency Targets 3
RCI-4: Green Power Purchasing 4
RCI-5: Rate Design 6
RCI-6: Distributed Generation with Combined Heat and Power Systems 7
RCI-7: Distributed Generation with Renewable Energy Applications 8
RCI-8: State Appliance Efficiency Standards 10
RCI-9: Solar Hot Water and Photovoltaic Codes for New Buildings 11
RCI-10: Energy Management Training/Training for Building Operators 12
RCI-11: Government Lead by Example with Mandatory Efficiency Targets 13
RCI-12: State Promotion and Tax or Other Incentives for Efficient Products 14
RCI-14: Fuel Switching to Less Carbon-Intensive Fuels 15
RCI-15: Reinvestment Fund 16
RCI-16: Focus on Small and Medium Enterprises (SMEs) 17
RCI-17: Participation in Voluntary Industry-Government Partnership 18
RCI-19: Water Pumping, Treatment, and Use Efficiency 19
RCI-20: Incentives for Improved Design and Construction 20
RCI-21: Improved Building Codes 21
RCI-23: Waste/Recycling 23
RCI Options Grouped by Goals 24
RCI Options by Priority 25
RCI Options by Vote 26

[1] Greenhouse Gas Inventory and Reference Case Projections, 1990-2020; Center for Climate Strategies, February 2007 http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_3-29-07.pdf

RCI-1 - Utility Demand Side Management

Benefit/Cost of Reducing CO_2e:

Arizona:	103 MMt between 2007-2020; 9.2% of 2020 emissions; $-36/ton
New Mexico:	6.5 MMt between 2007-2020; 1.17 % of 2020 emissions; $-23.54/ton
Colorado:	High reduction potential; Low cost
Montana:	6.6 MMt between 2007-2020; 2.57% of 2020 emissions; $-21/ton
Oregon:	4.18 MMt between 2007-2025; 4.4% of 2025 emissions; Cost effective
N. Carolina:	135 MMt between 2007-2020; 7.5% of 2020 emissions; $-24/ton

Assessment: High Priority. Bin A. 18 out of 22 votes.

This policy option has a substantial GHG emissions reduction potential and cost savings. Some utilities in Utah already offer demand side management (DSM) programs and have experience in their implementation.

This policy option involves the adoption of energy savings standards or targets for utility demand side management programs, the potential expansion of DSM programs to include all utilities, and the development of mechanisms for funding cost-effective energy efficiency programs.[2]

The goal of a utility DSM program is typically to secure additional investment in energy efficiency programs in order to secure cleaner energy at a lower or equivalent cost. DSM programs can cover a wide range of energy efficiency and conservation efforts. Performance based incentives, efficiency portfolio standards, energy trusts, decoupling of rates and revenues, and appropriate rate treatment for efficiency, are examples of policies to implement DSM programs.[3] [4]

A DSM program may be independently administered by a utility but typically is enacted by state legislation in the form of a Public Benefit Fund (PBF). A small charge – typically equivalent to a $0.27 to $2.50 - is placed on a consumer's electricity bill in order to secure funding for investment in energy efficiency programs. Non-profit organizations may also play a role in program administration. Flexibility in the administration of the program is important if the program is to be cost effective and have maximum effect. [5] [6] Examples of energy efficiency measures include lighting retrofits, weatherization[7], heating and cooling system improvements, and efficient building design.

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[2] Both Rocky Mountain Power and Questar currently have programs to fund DSM programs. In addition, Rocky Mountain released an assessment on DSM potential. See: http://www.pacificorp.com/Article/Article75535.html

[3] http://www.nmclimatechange.us/ewebeditpro/items/O117F10150.pdf

[4] http://www.epa.gov/cleanenergy/pdf/gta/guide_action_full.pdf

[5] See http://www.epa.gov/cleanenergy/pdf/gta/guide_action_full.pdf;

[6] http://www.swenergy.org/pubs/Natural_Gas_DSM_Programs_A_National_Survey.pdf;

[7] Including high efficiency windows and insulation

RCI-2 - Voluntary Efficiency Targets

Benefit/Cost of Reducing CO_2e:

New Mexico: 4.6 MMt between 2007-2020; 0.7% of 2020 emissions; N/A $/ton
Colorado: Low reduction potential; Low cost

Assessment: High Priority. Bin A. 19 out of 22 votes.

While efficiency targets do not offer direct GHG emissions reduction benefits, this policy option helps demonstrate State leadership on energy efficiency and can serve as a catalyst to implement energy efficiency initiatives.

This policy option could apply statewide. An example of such leadership is Governor Huntsman's goal of achieving a 20% increase in energy efficiency by 2015.

RCI-4 - Green Power Purchasing

Benefit/Cost of Reducing CO_2e:

New Mexico: 2.3 MMt between 2007-2020; 0.1% of 2020 emissions; $7/ton
Colorado: Low reduction potential; Medium cost
N. Carolina: 2 MMt between 2007-2020; 0.1% of 2020 emissions; $3/ton

Assessment: Medium Priority. Bin A. 16 out of 22 votes.

The GHG emissions reductions associated with green power purchasing are modest, these programs are being implemented by some of the state's utilities and are well-accepted by the public and business community.

Programs to promote the purchase of green power could include:

- Education to increase the level of consumer awareness of renewable energy benefits and options;
- Requiring utilities to provide information on fuel sources and their emissions to consumers;
- The formation of large customer buying groups or aggregation;
- The verification of the claims regarding a green energy product in order to protect the consumer; and
- States agencies can purchase green power to meet their own needs thus helping to form the renewable market

Green power offers customers the opportunity to buy electricity generated from sources that emit no CO_2. Typical examples include non-emitting nuclear generation, large hydroelectric facilities, and renewable resources such as wind, geothermal, biomass, and small hydro.[8]

EPA defines green power as those renewable energy sources with the highest environmental benefits, including solar, wind, geothermal, biogas, biomass, and low-impact hydroelectric.[9]

Green-e, a leading independent certification and verification program for renewable energy, has developed a national standard for the certification of renewable energy.[10]

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[8] See http://www.pge.com/about_us/environment/features/clean_energy.html.

[9] See www.epa.gov/greenpower/whatis/index.htm.

[10] See http://www.green-e.org/docs/Appendix_D-Green-e_National_Standard.pdf.

Rocky Mountain Power currently offers this option to its customers through its Blue Sky program. Blue Sky is sold in increments; each 100 KWh block represents about 10 percent of the average customer's monthly electricity usage. Payments go directly toward the purchase of renewable energy and renewable energy credits. Over 20,000 customers are currently participating.

RCI-5 - Rate Design

Benefit/Cost of Reducing CO_2e:

Arizona: 16 MMt between 2007-2020; 0.9% of 2020 emissions; $-63/ton
New Mexico: 3.6 MMt between 2007-2020; 0.3% of 2020 emissions; $-40/ton
Colorado: Medium reduction potential; Low cost
Montana: 0.2 MMt between 2007-2020; 0.1% of 2020 emissions; $-12/ton
Oregon: 0.16 MMt between 2007-2025; 0.2% of 2025 emissions; Cost effective

Assessment: High Priority. Bin A. 15 out of 22 votes.

Although GHG reductions from this policy option are modest, it sends an economic signal to consumers to use energy wisely and can result in cost savings. To avoid potential challenges in implementation, impacts on all parties need to be considered.

Rate design encourages energy efficiency and conservation through such tools as inverted block rates, smart meters, and peak time surcharge rates. This option is primarily aimed at the residential sector, although there may be some commercial sector applications. Regulatory barriers and impacts on all customer classes and utilities need to be considered.

RCI-6 - Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)

Benefit/Cost of Reducing CO_2e:

Arizona: 16 MMt between 2007-2020; 1.6% of 2020 emissions; $-25/ton
Colorado: High reduction potential; Low cost
Oregon: 0.54 MMt between 2007-2025; 0.6% of 2025 emissions; Cost effective
New Mexico: 6.4 MMt between 2007-2020; 0.9% of 2020 emissions; $4/ton

Assessment: High Priority. Bin B. 19 out of 22 votes.

Combined Heat and Power (CHP) systems can double the energy output per unit of energy input, but there are significant barriers to implementation. Utah-specific analysis will be required to identify and create a strategy to advance this option.

This option might include removing regulatory and other barriers to CHP and/or providing incentives to encourage CHP applications. The option has long-term GHG reduction potential. It is difficult to implement where infrastructure is already in place and much easier to do where it is not in place, such as at "greenfield" sites. Access to information and cost of a local system are also considerations.

Because virtually all industries require electricity in addition to thermal energy, combined heat and power (CHP) projects have become popular strategies for reducing energy consumption. CHP refers to the sequential production of thermal and electric energy from a single fuel source.

In the CHP process, heat is recovered that would normally be lost in the production of one form of energy. For example, in the case of an engine configured to produce electricity, heat could be recovered from the engine exhaust and used for processes or water heating, depending in part on the exhaust temperature. The recycling of waste heat differentiates CHP facilities from central station electric facilities. The overall fuel utilization efficiency of CHP plants is typically 70-80 percent versus 35-40 percent for utility power plants. The basic components of any CHP plant include a prime mover, a generator, a waste heat recovery system, and operating control systems. Typically, CHP systems are configured around three basic types of generators: 1) steam turbines; 2) combustion gas turbines; and 3) internal combustion engines.

RCI-7 - Distributed Generation with Renewable Energy Applications

Benefit/Cost of Reducing CO_2e:

Arizona: 10 MMt between 2007-2020; 1.28% of 2020 emissions; $31/ton
Colorado: Medium reduction potential; Medium cost
Oregon: 0.54 MMt between 2007-2025; 0.6% of 2025 emissions; Cost effective
N. Carolina: 29 MMt between 2007-2020; 1.4% of 2020 emissions; $1/ton
New Mexico: 1.6 MMt between 2007-2020; 0.4% of 2020 emissions; $105/ton

Assessment: High Priority. Bin B. 17 out of 22 votes.

Both the BRAC and the SWG felt that the level of difficulty would be higher than the Bin A originally recommended by the sector group. There was also a feeling that the cost/benefits needed more investigation.

Distributed renewable energy resources have the potential to cut GHG emissions. Although initial costs can be a barrier, they can be shared among many parties through utility rebates, tax incentives, and other measures. Importantly, there are no transmission and distribution losses associated with these resources.

This policy option consists of state and/or utility programs aimed at increasing the installation of distributed renewable energy, such as photovoltaic panels and small wind turbines. This option could include incentive programs and other measures that help make distributed renewables more competitive with conventional resources. The state could also decide to support research and development funding of promising renewable technologies.[11]

Net metering is a strategy for providing electric power generation from renewable sources. It uses a single meter to measure the difference between the total generation and total consumption of electricity by customers with small generating facilities by allowing the meter to turn backward. Net metering can increase the economic value of small renewable energy technologies for customers. It allows the customers to use the utility grid to "bank" their energy: producing electricity at one time and consuming it at another time. This form of energy exchange is particularly ideal for renewable energy technologies. In many states small-scale electricity generated from renewable energy sources is sold back to the electric utility at retail prices rather than cost.[12] Utilities in at least 41 states have net metering programs.

Utah enacted legislation in 2002 requiring all investor-owned electric and cooperative - but not municipal - utilities to offer net metering to their customers. Eligible generating systems include fuel cells, solar, wind and hydropower systems with a maximum capacity of 25 kilowatts (kW). Total participation in the program is limited to 0.1% of the cumulative generating capacity of each utility's peak demand in 2001.

[11] See: http://www.nmclimatechange.us/ewebeditpro/items/O117F10150.pdf
[12] 2000 Utah Office of Energy and Resource Planning (OERP) report

If a customer generates more electricity than he uses during a billing period, then the utility must credit him for the net excess generation (NEG) at a rate equal to the utility's avoided cost or higher. NEG is carried over to the customer's next monthly bill until the end of each calendar year, at which point any remaining NEG is granted to the utility. A utility may not levy additional charges or fees on net-metered customers, unless it is authorized to do so by the Utah Public Service Commission. Utilities may not require additional liability insurance for systems that meet applicable local and national standards regarding electrical and fire safety, power quality and interconnection requirements.

In February 2007, the Utah Division of Public Utilities published a report on the status of the state's net-metering program.[13] This publication included a discussion of best practices adopted by other states, program barriers, and recommendations for improvement. Rocky Mountain Power's interconnection agreement and application for net metering service is available online.[14]

[13] http://www.psc.state.ut.us/misc/06docs/0699903/NetMeteringReport.pdf
[14] http://www.utahpower.net/Navigation/Navigation552.html

RCI-8 - State Appliance Efficiency Standards

Benefit/Cost of Reducing CO_2e:

Arizona:	7 MMt between 2007-2020; 0.6% of 2020 emissions; $-66/ton
New Mexico:	2.1 MMt between 2007-2020; 0.3% of 2020 emissions; $-46/ton
Colorado:	Medium reduction potential; Low cost
Montana:	1.5 MMt between 2007-2020; 0.4% of 2020 emissions; $-36/ton
Oregon:	0.41 MMt between 2007-2025; 0.4% of 2025 emissions; Cost effective
N. Carolina:	5 MMt between 2007-2020; 0.4% of 2020 emissions; $-62/ton

Assessment: High Priority. Bin A. 17 out of 22 votes.

Although the reduction potential may be modest overall, this policy option is highly-cost effective and can be readily implemented.

This policy option could be based upon existing appliance standards in other states, or new, Utah-specific standards could be developed for applicances not covered by federal programs. The feasibility of this option would be driven by local energy costs and principle-driven decisions.

Some examples of state appliance efficiency standards are presented below.

California's Appliance Efficiency Regulations include standards for both federally-regulated appliances and non-federally-regulated appliances. Twenty-one categories of appliances are included in the scope of these regulations. The standards within these regulations apply to appliances that are sold or offered for sale in the state.[15]

Arizona law sets minimum energy efficiency standards for the following 12 products not covered by current federal standards: torchiere light fixtures, exit signs, commercial refrigerators and freezers, commercial clothes washers, large commercial air conditioning equipment, icemakers, spray nozzles used in commercial kitchens, low-voltage distribution transformers, metal-halide lamp fixtures, power supplies for electronic devices, unit heaters, and traffic signals. According to the Southwest Energy Efficiency Project (SWEEP), the standards will save Arizona consumers and business a total of $650 million on energy bills by 2030.[16]

[15] See http://www.energy.ca.gov/appliances/2006regulations/index.html
[16] See http://www.eere.energy.gov/state_energy_program/news_detail.cfm/news_id=9028

RCI-9 - Solar Hot Water and Photovoltaic Codes for New Buildings

Benefit/Cost of Reducing CO_2e:

N/A

Assessment: Medium Priority. Bin B. 15 out of 22 votes.

Although the GHG emissions reduction potential of this policy option is modest in the near-term, if distributed solar resources were widely-deployed, the emissions reductions could ultimately become significant. However, implementation of such a program could be potentially difficult.

Every new building without this option represents a lost opportunity to include renewable energy resources during the construction phase at a lower initial cost. New buildings could be required under certain conditions to be configured and wired for solar hot water heaters and photovoltaic panels. In addition, buildings with heavy use of heated water could be required to install solar water heaters.

RCI-10 - Energy Management Training / Training of Building Operators

Benefit/Cost of Reducing CO_2e:

Colorado: High reduction potential; Low cost

Assessment: Medium Priority. Bin B. 17 out of 22 votes.

This can be a low-cost option with important GHG reduction benefits, but training building operators can be difficult due to the complexity of building systems and skill requirements involved.

This policy option would involve the State taking an active role in supporting facility energy management training. In addition to building operator training, this option could also include benchmarking and tracking energy use to assist in identifying opportunities for savings. An energy profile evaluates a property's potential for energy savings. This information also helps determine baseline energy performance and can be used to benchmark a building's performance against comparable properties.

An energy accounting system records information from the energy profile over time. An energy accounting system is generally kept in a simple spreadsheet or tracked through computer software. Buildings equipped with an energy management system may be able to use this to automatically generate real-time information for an energy accounting system. Once these systems have been installed, this historical record enables energy mangers to later measure program results against baseline performance. It can also indicate when problems arise, such as through abnormally high energy costs related to equipment failure.

Added components of an energy accounting system may include monthly or more frequent energy-use and cost reports, changes in occupancy or facility usage, utility rate schedules, and performance tracking of major equipment systems.[17]

Building Operator Certification (BOC) is a professional development program in the energy efficient operation of building systems to qualify facility professionals for certification. BOC is a growing national program, now in 16 states including Washington, Oregon, California, Illinois, Ohio, New York, New Jersey, and Massachusetts.

[17] See: Fire Your Power: Commercial Office Buildings, Available at http://www.fypower.org/bpg/module.html?b=offices&m=Planning_an_Energy_Program&s=Energy_Profiles

RCI-11 - Government Lead by Example with Mandatory Efficiency Targets

Benefit/Cost of Reducing CO_2e:

Arizona: 3 MMt between 2007-2020; 0.2% of 2020 emissions; $-4/ton
New Mexico: 0.9 MMt between 2007-2020; 0.2% of 2020 emissions; $-20/ton
Colorado: Low reduction potential; Low cost
Montana: 1.7 MMt between 2007-2020; 0.6% of 2020 emissions; $-5/ton
Oregon: 0.117 MMt between 2007-2025; 0.1% of 2025 emissions; N/A on cost
N. Carolina: 7 MMt between 2007-2020; 0.5% of 2020 emissions; $-14/ton

Assessment: High Priority. Bin A. 19 out of 22 votes.

While the direct GHG emissions reduction potential of this option is modest due to the small emissions footprint of State facilities relative to that of Utah as a whole, efficiency improvements can be highly cost-effective and there is value in the State showing leadership on efficiency.

Governor Huntsman has called for a 20 percent increase in energy efficiency in Utah by 2015. On March 17, 2006, House Bill 80 was enacted, amending and updating state energy efficiency policy. Under this bill, the Division of Facilities Construction and Management is required to administer the State Building Energy Efficiency Program. The Division is responsible for developing guidelines and procedures for energy efficiency in state facilities, and assisting state agencies, commissions, divisions, boards, departments, and institutions of higher education in implementing these procedures into their facilities.

Additionally, the Division is charged with developing incentives that promote energy conservation and the reduction of energy costs in state buildings, procuring energy efficient products when practicable, analyzing state agencies' energy consumption, establishing an advisory group to assist with the development and implementation of the State Building Energy Efficiency program, and providing a yearly energy savings report, including long-term strategies and goals, to both the governor and the legislature.

The State Building Board is required to work in conjunction with the Division to establish design criteria, standards, and procedures for the planning, design, and construction of new state buildings and improvements to existing state facilities. Among other outcomes of a proposed building project, life-cycle costing of the most prudent cost of owning and operating the facility, in addition to other analyses, must address the expected energy efficiency of a given facility.

Each state entity must develop a program to manage energy efficiency and cost conservation and to appoint a staff member to coordinate the energy efficiency program. Agencies may enter into an energy savings agreement for a term of up to 20 years.[18]

[18] See http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=UT09R&state=UT&CurrentPageID=1&RE=1&EE=1

RCI-12 - State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)

Benefit/Cost of Reducing CO_2e:

Colorado: Medium reduction potential; Low cost
Oregon: Cost effective

Assessment: High Priority. Bin B. 19 out of 22 votes.

While these programs help reduce initial costs of energy efficiency and can lead to important GHG emissions reductions, there are costs associated with implementation.

This program could be modeled on the current Renewable Energy Tax Credit program. State tax or other incentives could be provided for the purchase of energy efficient products such as appliances. There are also federal energy efficiency incentives that could serve as an example for the development of such a policy option.

Because energy efficiency measures often pay for themselves over time, this type of program may require lower levels of support than are typically needed for renewable energy or clean vehicle incentive programs.

RCI-14 - Fuel Switching to Less Carbon-Intensive Fuels

Benefit/Cost of Reducing CO_2e:

Colorado: Medium reduction potential; Medium cost
Oregon: 0.1 MMt between 2007-2025; 0.1% of 2025 emissions; Cost effective

Assessment: Medium Priority. Bin D. 17 out of 22 votes.

This policy option is aimed primarily at the industrial sector. Fuel costs and regulatory requirements influence fuel choices in the industrial sector. More information is needed to evaluate this option.

RCI-15 - Reinvestment Fund

Benefit/Cost of Reducing CO_2e:

Colorado: Medium reduction potential; Low cost

Assessment: Medium Priority. Bin B. 11 out of 22 votes.

GHG emissions reduction potential is modest because public buildings represent a small fraction of total state emissions, but there is value in public sector leadership and these programs help remove financial barriers for energy efficiency projects.

This option recommends the expansion of the public schools revolving loan fund that was established during the 2007 Legislative General Session to cover all public buildings.

A revolving loan fund (RLF) is a funding mechanism that can provide needed capital for energy efficiency projects in the public sector. In Utah's 2007 legislative session, a $5 million RLF was established for energy efficiency projects implemented by school districts in K-12 schools. There are a number of other such funds around the United States, including funds in California, Idaho, Iowa, Missouri, Nebraska, Ohio, Oregon, and Texas. These funds typically feature below-market interest rates ranging from three to five percent, although zero interest loans also exist. When interest is charged it enables the fund to preserve its capital, thereby providing funding capacity over the long term.

Some states have established RLFs that are available to the public sector in its entirety. The Texas LoanSTAR (Saving Taxes And Resources) program was created in 1989 with $98.6 million in capital. Between 1989 and 2006, a total of 187 loans worth more than $234 million were made to state agencies, institutions of higher education, local governments, school districts, and county hospitals. This means the fund has "revolved" 2.3 times since 1989. Most loans are made at a 3% interest rate and must be repaid within 10 years. Cumulative energy savings from these projects now exceeds $180 million.[19]

The SWG recognized this option could have a high potential benefit to municipal government.

[19] Preliminary draft, Utah Energy Efficiency Strategy.

RCI-16 - Focus on Small and Medium Enterprises (SMEs)

Benefit/Cost of Reducing CO_2e:

Colorado: Low reduction potential; Low cost

Assessment: High Priority. Bin D. 9 out of 22 votes.

This policy option is aimed at providing technical assistance for small and medium commercial and industrial enterprises that may be underserved by current DSM programs. Typically this has been done through a university and/or State energy agency, but this support could be provided by utilities as well.

The Industrial Assessment Center (IAC) at Arizona State University provides free energy, waste and productivity analysis studies to qualified Arizona and Nevada Manufacturers, recommending methods to conserve resources, and reduce operating costs. Funding comes from the US Department of Energy. On average, implemented recommendations from assessments performed by the IAC at ASU saved each customer about $65,000 per year.[20]

In Arizona's Energy Advisor program, small to medium-sized businesses (those under 20,000 square feet) whose peak summer demand is less than 100 kilowatts can receive on on-site energy audit and computer analysis of cost-effective energy efficiency measure for $150 through SRP's Energy Advisor program.[21]

Although this policy option could be beneficial, it is difficult to determine the GHG emissions reduction potential of this option. More information about these programs and how one might be structured in Utah is needed to evaluate this policy option. (NOTE: This paragraph was originally the first paragraph.)

[20] See http://www.eas.asu.edu/~iac/index.html
[21] See http://www.swenergy.org/programs/arizona/utility.htm

RCI-17 - Participation in Voluntary Industry-Government Partnerships

Benefit/Cost of Reducing CO_2e:

Colorado: Low reduction potential; Low cost

Assessment: Medium Priority. Bin B. 7 out of 22 votes.

Although the GHG emissions reduction potential of this policy option is likely to be modest, industry-government partnerships are a low-cost measure.

Federal support for these measures can be leveraged to bolster state-level efforts.
Federal examples of industry-government partnerships include:

The Natural Gas STAR Program is a flexible, voluntary partnership between EPA and the oil and natural gas industry. Through the Program, EPA works with companies that produce, process, and transmit and distribute natural gas to identify and promote the implementation of cost-effective technologies and practices to reduce emissions of methane, a potent greenhouse gas. There is no upfront cost to joining the Natural Gas STAR Program and members have found significant economic benefits from participation. Some of the Best Management Practices (BMPs) have small incremental costs over standard technologies or processes, they are generally cost effective, and can be recouped in as little as 1-2 years.[22]

The SF_6 Emission Reduction Partnership for Electric Power Systems is a collaborative effort between EPA and the electric power industry to identify and implement cost-effective solutions to reduce sulfur hexafluoride (SF_6) emissions. SF_6 is a highly potent greenhouse gas used in the industry for insulation and current interruption in electric transmission and distribution equipment. Currently over 70 utilities participate in this voluntary program.[23]

There is also a new Energy Star program for refineries. Conoco-Phillips Billings, Montana refinery was recently recognized as the first operation to receive an Energy Star rating for superior performance.[24]

[22] See http://www.epa.gov/gasstar/
[23] http://www.epa.gov/electricpower-sf6/index.html
[24] http://yosemite.epa.gov/opa/admpress.nsf/4b779454038214c1852572a000651fe2/59ab6ae263da9895852572bb0047dedb!OpenDocument

RCI-19 - Water Pumping, Treatment, and Use Efficiency

Benefit/Cost of Reducing CO_2e:

Arizona: 6 MMt between 2007-2020; 0.5% of 2020 emissions

Assessment: Medium Priority. Bin B. 14 out of 22 votes.
This option offers GHG emissions reductions and has important water conservation co-benefits. Additional work is required to determine how such programs might be structured in Utah.

At the residential level, water pumping and treatment efficiency is typically confined to improvements homeowners can make.

Programs for treatment efficiency are tailored to specific industry types. Examples of previously implemented strategies can be found for electronics, semi-conductor, cleanroom, fume hood, pulp & paper, stone, glass and clay products, and food products industries.[25]

The Agricultural Pumping Efficiency Program (APEP) is a multi-level program addressing the resource management problems in California. Eligibility extends to all owners or users of a non-residential, PG&E electric or natural gas account that is primarily used for pumping water for the following: Production agriculture; landscape or turf irrigation; municipal purposes, including potable and tertiary-treated (reclaimed) water but excluding pumps used for industrial processes, raw sewage, or secondary-treated sewage. APEP goals include:

- Getting highly efficient hardware in the field, including pumping plants, irrigation systems, and water distribution systems.

- Ensuring that this hardware is managed correctly.

APEP has operated with funding from a variety of sources including the California Energy Commission, the California Public Utilities Commission, and the Federal Environmental Protection Agency. It works with agriculturalists and municipal and private water companies. [26]

In Utah, approximately 70% of developed water is used in agriculture.[27] However, the Farm Bureau points out that, for the farmer, the saving potential from water pumping efficiency is relatively small, given current commodity prices.

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[25] http://www.energy.ca.gov/process/industry/industry_intro.html
[26] http://www.pumpefficiency.org
[27] Utah Water Supply/Facts brochure published by Utah Division of Water Resources. Available at: www.water.utah.gov/brochures/default.asp

RCI-20 - Incentives for Improved Design and Construction (e.g. Energy Star, LEED, green buildings, expedited permitting)

Benefit/Cost of Reducing CO_2e:

Arizona: 18 MMt between 2007-2020; 1.9% of 2020 emissions; $-17/ton
New Mexico: 7.4 MMt between 2007-2020; 1.3% of 2020 emissions; $-2/ton
Colorado: Medium reduction potential; Low cost
N. Carolina: 10 MMt between 2007-2020; 0.6% of 2020 emissions; $-14/ton

Assessment: High Priority. Bin A. 21 out of 22 votes.

This policy option can offer significant GHG emissions reduction benefits and potential cost savings. In addition, such incentive programs can be readily implemented.

Improved design and construction incentives can include tax credits, preferential permitting, enhanced utility incentives, education, and training.

Utah currently has an Energy Star program. Energy Star® labeled homes incorporate energy savings in design and construction and use 15 percent less energy.[28]
Rocky Mountain Power and Questar offers incentives to contractors who build energy-efficient homes. Energy efficient mortgages are available to purchase these homes and to remodel existing homes.[29]

Rocky Mountain Power's Energy FinAnswer provides cash incentives to help commercial and industrial customers improve their heating, cooling, refrigeration, compressed air, lighting, or industrial process. New construction and retrofit projects for all industrial facilities can participate as well as new commercial projects and retrofits in facilities larger than 20,000 square feet.[30]

[28] http://www.energystar.gov
[29] http://www.utahenergystar.org/financial_bnefits.html
[30] http://www.rockymtnpower.net/Navigation/Navigation71490.html

RCI-21 - Improved Building Codes

Benefit/Cost of Reducing CO_2e:

Arizona:	14 MMt between 2007-2020; 1.3% of 2020 emissions; $-18/ton
New Mexico:	16.6 MMt between 2007-2020; 2.3% of 2020 emissions; $-12/ton
Colorado:	High reduction potential; Low cost
Montana:	1.6 MMt between 2007-2020; 0.7% of 2020 emissions; $-9/ton
Oregon:	0.61 MMt between 2007-2025; 0.6% of 2025 emissions; Cost effective
N. Carolina:	29 MMt between 2007-2020; 1.6% of 2020 emissions; $-17/ton

Assessment: High Priority. Bin A. 20 out of 22 votes.

This option offers significant GHG emissions reduction benefits and cost savings. Improved codes can be readily implemented.

Building codes set the minimum standards to which homes and other buildings must be constructed. Improved building codes could increase building energy efficiency requirements. In addition to setting new standards, training for contractors and others and enforcement of standards is critical.

New Mexico is considering requiring buildings to cut energy use by 50 Percent per sq ft by 2010.

Improved building codes require new buildings to meet minimum energy efficiency requirements and could also be applied to existing buildings undergoing renovations. Codes usually address improvements in "thermal resistance" in the exterior and windows, air leakage, and heating and cooling efficiencies.[31]

The Arizona Climate Change Advisory Group recommended that Arizona adopt a statewide code or strongly encourage municipalities to adopt and maintain improved building codes. The CCAG also recommends that Arizona or the municipalities adopt the 2004 International Energy Conservation Code (IECC), and consider adopting innovative features from California's latest Title 24 Building Energy Codes, such as lighting efficiency requirements in new homes. In addition, the CCAG recommends that Arizona and local jurisdictions should update energy codes regularly, such as a three-year cycle of review based on the national model codes release.[32]

Arizona is a "home-rule state" meaning that the municipalities are able to adopt and enforce their residential and commercial building energy codes. According to the Southwest Energy Efficiency Project (SWEEP), Arizona passed legislation encouraging local governments to voluntarily adopt of the 2000 International Energy Code (IECC) and ASHRAE Standard 90.1-1999. State government buildings must comply with ASHRAE Standard 90.1-1999, the most recent and model standard for energy efficiency in commercial buildings.[33]

In California, Energy Efficiency Standards for Residential and Nonresidential Buildings were established in 1978 in response to a legislative mandate to reduce energy consumption. California

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[31] See http://www.epa.gov/cleanenergy/pdf/gta/guide_action_full.pdf
[32] See http://www.azclimatechange.us/ewebeditpro/items/O40F9347.pdf
[33] See Southwest Energy Efficiency Project (SWEEP)http://www.swenergy.org/

Title 24 is updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods. Currently in the process of being updated, the first phase of the development process will include a series of public workshops. The second phase will present draft language for the 2008 Standards based on the discussions in the first phase and will offer opportunities for further public input. The third phase will be the formal rulemaking. California's building efficiency standards (along with those for energy efficient appliances) have saved more than $56 billion in electricity and natural gas costs since 1978. It is estimated the standards will save an additional $23 billion by 2013.[34]

[34] http://www.energy.ca.gov/title24/index.html

RCI-23 - Waste/Recycling

Benefit/Cost of Reducing CO_2e:

Arizona: 36 MMt between 2007-2020; 2.3% of 2020 emissions
New Mexico: 8.4 MMt between 2007-2020; 1.1% of 2020 emissions
Oregon: 6.61 MMt between 2007-2025; 6.9% of 2025 emissions

Assessment: High Priority. Bin A. 19 out of 22 votes.

This policy option can have significant GHG emissions reduction benefits and has important co-benefits. Recycling programs are already in place in much of Utah and can be readily implemented.

In most cases, the energy input for recycling is less than the energy required to manufacture new products from raw materials.

This option should be coordinated with the cross-cutting sector.

Goals

1. Reduce energy consumption by:

    a. Implementing appliance efficiency measures including:
        i. Utility demand side management programs (RCI-1)
        ii. State appliance efficiency standards (RCI 8)
        iii. State promotion and tax or other incentives for efficient products (RCI-12)

    b. Implementing building efficiency measures including:
        i. Utility demand side management programs (RCI-1)
        ii. Energy management and building operator training (RCI-10)
        iii. Reinvestment Fund (RCI-15)
        iv. Incentives for improved design and construction of buildings (RCI-20)
        v. Improved building codes (RCI-21)

    c. Implementing other efficiency measures including:
        i. Utility demand side management programs (RCI-1)
        ii. Rate design programs (RCI-5)
        iii. Distributed generation with combined heat and power systems (RCI-6)
        iv. Water pumping, treatment and use efficiency (RCI-19)
        v. Waste/recycling (RCI-23)

2. Reduce CO_2 emissions per unit of energy consumed by:

    a. Green Power Purchasing (RCI-4)
    b. Distributed generation with renewable energy aplications (RCI-7)
    c. Solar hot water and photovoltatic codes for new buildings (RCI-9)
    d. Fuel switching to less carbon-intensive fuels (RCI-14)

3. Adopt the following program enablers:

    a. Voluntary efficiency targets (RCI-2)
    b. Government lead-by-example with mandatory efficiency targets (RCI-11)
    c. Focus on small and medium enterprises (RCI-16)
    d. Participation in voluntary industry-government partnerships (RCI-17)

Sorted By Priority:

#	Policy Option	Priority	Bin	Vote
RCI-20	Incentives for Improved Design and Construction (e.g. EnergyStar, green buildings, expedited permitting)	High	A	21
RCI-21	Improved Building Codes	High	A	20
RCI-11	Government Lead by Example w/Mandatory Efficiency Targets	High	A	19
RCI-2	Voluntary Efficiency Targets	High	A	19
RCI-23	Waste/Recycling	High	A	19
RCI-12	State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)	High	B	19
RCI-6	Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)	High	B	19
RCI-1	Utility Demand Side Management	High	A	18
RCI-8	State Appliance Efficiency Standards	High	A	17
RCI-7	Distributed Generation with Renewable Energy Applications	High	B	17
RCI-5	Rate Design	High	A	15
RCI-16	Focus on Small and Medium Enterprises (SMEs)	High	D	9
RCI-10	Energy Management Training/ Training of Building Operators	Medium	B	17
RCI-14	Fuel Switching to Less Carbon-Intensive Fuels	Medium	D	17
RCI-4	Green Power Purchasing	Medium	A	16
RCI-9	Solar Hot Water and Photovoltaic Codes for New Buildings	Medium	B	15
RCI-19	Water Pumping, Treatment, and Use Efficiency	Medium	B	14
RCI-15	Reinvestment Fund	Medium	B	11
RCI-17	Participation in Voluntary Industry-Government Partnerships	Medium	B	7

Sorted By Vote:

#	Policy Option	Priority	Bin	Vote
RCI-20	Incentives for Improved Design and Construction (e.g. EnergyStar, green buildings, expedited permitting)	High	A	21
RCI-21	Improved Building Codes	High	A	20
RCI-11	Government Lead by Example w/Mandatory Efficiency Targets	High	A	19
RCI-12	State Promotion and Tax or Other Incentives for Efficient Products (e.g. EnergyStar)	High	B	19
RCI-2	Voluntary Efficiency Targets	High	A	19
RCI-23	Waste/Recycling	High	A	19
RCI-6	Distributed Generation with Combined Heat and Power Systems (including Reducing Barriers)	High	B	19
RCI-1	Utility Demand Side Management	High	A	18
RCI-10	Energy Management Training/ Training of Building Operators	Medium	B	17
RCI-14	Fuel Switching to Less Carbon-Intensive Fuels	Medium	D	17
RCI-7	Distributed Generation with Renewable Energy Applications	High	B	17
RCI-8	State Appliance Efficiency Standards	High	A	17
RCI-4	Green Power Purchasing	Medium	A	16
RCI-5	Rate Design	High	A	15
RCI-9	Solar Hot Water and Photovoltaic Codes for New Buildings	Medium	B	15
RCI-19	Water Pumping, Treatment, and Use Efficiency	Medium	B	14
RCI-15	Reinvestment Fund	Medium	B	11
RCI-16	Focus on Small and Medium Enterprises (SMEs)	High	D	9
RCI-17	Participation in Voluntary Industry-Government Partnerships	Medium	B	7

VIII. Transportation-Land Use Options

The second largest source of Utah's gross GHG emissions is the transportation sector, accounting for 25 percent in 2005.[1]

Options include:

TL-1: Develop and Implement Aggressive Mass Transit Strategy 2

TL-2: Quality Growth Program 3

TL-4: Trip Reduction, Rideshare, Vanpool, and Telecommuting 4

TL-6: "Buy Local" Program 5

TL-7: Promote Low –Carbon Fuels and Vehicle Technologies 6

TL-8: State Fleet Lead By Example 7

TL-9: Clean Car Program 8

TL-10: Idle-Reduction Program 10

TL-11: Vehicle Speed Reduction 12

TL-13: Education Program 13

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Bill Tibbits, Anti- Hunger Committee

Jerry Costley, Disabled Rights Action Committee

Response by Senator Greg Bell

Dr. Richard Kanner, University of Utah Hospital

Jim Holtkamp for Questar

[1] Greenhouse Gas Inventory and Reference Case Projections, 1990-2020; Center for Climate Strategies, February 2007 http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_3-29-07.pdf

TL-1 – Develop and Implement Aggressive Mass Transit Strategy

Benefit/Cost of Reducing CO_2e:

New Mexico: 13.4 MMt between 2007-2020; 1.3% of 2020 emissions; $0 cost or net savings
N. Carolina: 31.3 MMt between 2007-2020; 1.1% of 2020 emissions; $0 cost or net savings

Assessment: High Priority. Bin B. 19 out of 22 votes.

This policy option has the potential to significantly reduce GHG emissions and provide important co-benefits, but will require a concerted, long-term effort to implement.

Mass transit is included in long-range planning for the Wasatch Front. However the plans should be more aggressive and need to be fully-integrated and supported with adequate funding. Transit also offers important co-benefits such as improving air quality and congestion mitigation. Public support of the 2006 transit initiatives was high.

This is a long-term strategy needs to be developed in conjunction with quality growth land-use planning principles. To ensure success, mass transit options need to be convenient, reliable, and affordable. The strategy should consider the following program options:

- Methods for expanding government programs such as the UTA Eco-pass
- Educating the general public about transit options
- State and local incentives for increased utilization of mass transit.
- Optimized fares and enhanced subsidies are needed to encourage an optimal ridership rate; a detailed analysis should be undertaken to determine the optimum rates for daily fare and monthly passes.[2]
- The State could assist with obtaining rights-of-way, park and ride lots, and traffic signal priority.
- Options that compliment mass transit, including shared ownership vehicles (e.g. Zipcars/Freedom cars), bike carriers, and pedestrian-friendly city planning, should be evaluated in long range plans.

[2] Current fare rates can create barriers to transit ridership. For example, it costs $12.00 for a family of four to take a round trip downtown by bus, remaining cheaper to drive an automobile. Approximately 16 percent of UTA operating expenses come from passengers fares.

TL-2 - Quality Growth Program

Benefit/Cost of Reducing CO_2e:

Arizona: 26.7 MMt between 2007-2020; 2.4% of 2020 emissions; $0 cost
New Mexico: 13.4 MMt between 2007-2020; 1.3% of 2020 emissions; $0 cost
Montana: 0.26 MMt between 2007-2020; 0.1% of 2020 emissions; N/A
Oregon: 0.4 MMt between 2007-2025; 0.4% of 2025 emissions; Cost effective
N. Carolina: 50.3 MMt between 2007-2020; 3% of 2020 emissions; net savings

Assessment: High Priority. Bin A. 17 out of 22 votes.

This policy option could substantially reduce GHG emissions in the State, but is a longer-term option that will require significant effort to implement. BRAC members noted the State could help facilitate these collaborative processes with resources and funding.

In Utah, 80% of the population lives along the rapidly growing Wasatch Front region. Smart growth is a vital component to any strategy that seeks to reduce CO_2 emissions from transportation. The State of Utah should promote smart growth, including such community and transportation planning measures as compact, transit-oriented, walkable, bicycle-friendly planning, as well as mixed-use development with a range of housing choices. Such measures help reduce GHG emissions through a reduction in vehicle miles traveled (VMT). Congestion management is also important. Envision Utah and the Wasatch Front Regional Council should be consulted as guides for this policy option. An effective strategy should also include public education and could include incentives to ensure the uptake of these measures.

Envision Utah recently released the findings of its Wasatch Choices 2040 Project, including a Vision Scenario that reflects the preferences of participants in a visioning process that involved 1,000 area residents. The Vision Scenario steers 13% of new development (compared with 4% in a business-as-usual scenario) into walkable, mixed-use districts,[3] like those under development in Kennecott Land's new Daybreak community. Envision Utah's modeling results show a modest but measurable reduction in VMT in the Vision Scenario relative to business-as-usual.

[3] Envision Utah, *Wasatch Choices 2040*. 2007

TL-4 - Trip Reduction, Rideshare, Vanpool, Telecommuting

Benefit/Cost of Reducing CO_2e:

N/A

Assessment: High Priority. Bin A. 20 out of 22 votes.

The current Commuter Trip Reduction Program could be enhanced to provide larger GHC and air quality benefits over the longer run. The challenge with these types of programs is the ability to meet employees' diverse and changeable needs. Additional information is required to determine the GHC emissions reductions of this option.

UTA Rideshare currently provides marketing and promotion to eligible public and private enterprises for the following programs: teleworking, vanpool, guaranteed ride home, commuter choice, discount pass programs, carpool, bicycle, alternative work hours. These travel demand management measures are aimed at reducing commuter vehicle miles traveled during the peak travel periods, thereby reducing fuel consumption and GHG emissions. Enhancement of the existing program could achieve greater GHG emissions reduction benefits. In addition, the rapid and ongoing expansion and adoption of internet and telecommunications technologies may enhance opportunities for telecommuting over the longer run. Efforts taken by the State to help accelerate the deployment and acceptance of these technologies may yield additional GHG reduction benefits.

TL-6 – "Buy Local" Program

Benefit/Cost of Reducing CO_2e:

New Mexico: 5.9 MMt between 2007-2020; 1.1% of 2020 emissions; $0.2/ton

Assessment: Medium Priority. Bin B. 10 out of 22 votes.

This policy option could yield GHG emissions benefits and could help support Utah's economy. However, additional research is required to determine the optimal form of such a policy and to assess its cost effectiveness. There may be a point where such a program is counterproductive – for example, tomatoes from a local hothouse may be more energy consumptive than trucking tomatoes from Arizona. Also, there may be the unintended consequence: If every state implements a "buy local" program, what happens to the economic sectors where Utah most exports goods?

The goal of "buy local" programs is to reduce vehicle miles traveled and associated GHG emissions through the encouragement of consumers to buy locally-produced goods. Such programs can include both incentives and consumer education. An important co-benefit of a "buy local" program is the support it lends the statewide economy.

TL-7 - Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)

Benefit/Cost of reducing CO_2e:

Arizona: 6.2 MMt between 2007-2020; 0.7% of 2020 emissions; $0 cost
New Mexico: 9.1 MMt between 2007-2020; 1.7% of 2020 emissions; $-13/ton
Oregon: 1 MMt between 2007-2025; 1% of 2025 emissions; Cost effective
N. Carolina: 25.8 MMt between 2007-2020; 1.2% of 2020 emissions; N/A

Assessment: High Priority. Bin A. 20 out of 22 votes.

This policy option could result in significant GHG reduction benefits. Some incentive programs are already in place in Utah, although they should be refined and expanded to extend GHG reduction and other benefits.

The State of Utah should promote low-carbon fuels and vehicle technologies. Examples could include low-carbon biofuels and other alternative fuels, hybrid, and plug-in vehicles. Incentives could include tax credits, HOV lane access, and parking advantages. Right sizing vehicles and vehicle fleets are also important methods to reduce carbon emissions from the automobile fleet statewide. For biofuels, fuel quality and related vehicle warranty issues should be addressed.

Currently in Utah, a tax credit and grant loan program exists for vehicles that utilize alternative fuels. This program provides incentives for natural gas and flex-fuel vehicles, but does not provide an incentive for off-the-shelf, market-ready high efficiency technology. Incentives should be fuel and technology neutral. Readily available technologies reduce GHG emissions through improved fuel efficiency through variable valve timing, cylinder deactivation, efficient transmissions, as well as hybrid drives and natural gas and cleaner diesel fuels.

A similar example being proposed on the national level is the OILSAVE Act recently proposed by Utah Senator Robert Bennett. The OILSAVE Act takes a technology-neutral approach and allows any vehicle with superior fuel efficiency to qualify for a credit, whether it uses hybrid or conventional technologies. Vehicles that are at least 25 percent more fuel efficient than the applicable CAFÉ standard for cars, trucks and SUVs, will get a tax credit of at least $630 and as much as $1860 for the most fuel efficient models. The consumer could claim the tax credit on his or her tax return or transfer it to an auto dealer – providing a “cash back” option to consumers at the time of purchase.

TL-8 - State Fleet Lead by Example

Benefit/Cost of reducing CO_2e:

Arizona: 0.4 MMt between 2007-2020; $0 cost
Oregon: Cost effective

Assessment: High Priority. Bin A. 19 out of 22 votes.

Although direct GHG reduction benefits are limited due to the small size of the State fleet relative to the total number of vehicles in Utah, this policy option demonstrates leadership by the State and can be readily implemented.

The State should lead by example in the purchase of low-carbon fuels and vehicle technologies. School district bus fleets offer an immediate opportunity to utilize these fuels and technologies, and implementation would have important air quality co-benefits for school children.

Refueling infrastructure limitations have made existing alternative fuel requirements for State fleets difficult to implement. Such limitations need to be addressed in concert with vehicle purchase decisions.

In addition to purchasing vehicles that use low-carbon fuels, the State should prioritize the purchase of vehicles with high efficiency technologies such as variable valve timing, efficient transmissions, and hybrid technologies. State fleets should "right-size" their vehicles, ensuring that the most fuel efficient vehicle is used for the task required.

In the 2007 Legislative session, HB110 created a set of state fleet efficiency requirements. This legislation is results-oriented, while being non-prescriptive in how departments and divisions achieve efficiency improvements. The options would include right-sizing, efficiency technologies, and alternative fuels.

TL-9 - Clean Car Program

Benefit/Cost of reducing CO_2e:

Arizona:	32.5 MMt between 2007-2020; 3.4% of 2020 emissions; -$90/ton
New Mexico:	10.4 MMt between 2007-2020; 1.9% of 2020 emissions; -$117/ton
Colorado:	14% reduction potential; -$100/ton
Montana:	5.2 MMt between 2007-2020; 2% of 2020 emissions; -$100/ton
Oregon:	6.24 MMt between 2007-2025; 6.5% of 2025 emissions; Cost effective
N. Carolina:	44.5 MMt between 2007-2020; 3% of 2020 emissions; -$100/ton

Assessment: High Priority. Bin B. 16 out of 22 votes.

This policy option could substantially reduce GHG emissions in the State and result in a cost savings to consumers. However, this is a longer-term option that will require significant effort to implement.
Central to this policy option is the adoption of clean car standards already recognized by California and 12 other states.[4] Doing so would mean that new vehicles sold in Utah by each manufacturer would need to, on average, be 30 percent more efficient by 2016.

There is a high CO_2 reduction potential, cost savings, and associated energy security and air quality benefits. Due to legal proceedings associated with this option, implementation may not be straightforward. However, in April 2007, the Supreme Court ruled that the EPA has the authority to regulate CO_2 emissions from automobiles. The waiver for this program implementation is currently being decided.

In studies conducted in several western states, the adoption of a clean car program[5] has consistently been ranked as one of the most cost-effective GHG emissions reduction strategies. This option was also found to have a large impact on total emissions, with projections ranging from 1.9 to 6.5 percent of total statewide emissions.

In the preliminary Utah Energy Efficiency Strategy analysis, this option is highly cost effective and yields very significant CO_2 reductions. The study found that savings in fuel costs over the lifetime of the projected eligible vehicles sold in Utah would equal about $1.41 billion (present value).[6] Assuming 2006 price levels, this gives a net economic benefit of $1.16 billion (2006 dollars) over the life of the vehicles purchased in 2009-2015.[7] There may be other important economic factors that are not reflected in these numbers. The study also found that if efficiency accounted entirely for the GHG emissions reductions, new vehicles would consume on average 22 percent less fuel in

[4] These states are: California, Connecticut, Maine, Maryland Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington. States in which this program is being considered include Arizona, New Mexico, Minnesota, Nevada, Tennessee, and Texas.
[5] This program sets mandatory GHG emissions standards for light-duty vehicles and was enabled by California's AB1493
[6] This assumes an average15 year vehicle life, and that gasoline prices remain at their 2006 levels. This cost savings figure is likely conservative due to the likelihood of increasing fuel costs.
[7] The fuel savings exclude state gasoline tax (24.5 cents per gallon).

2012, and 30 percent less fuel in 2016, than the average vehicle consumed in 2002. In addition, emissions of CO_2 could be reduced by 841,000 short tons in 2015 and by 1.86 million short tons in 2020, with additional upstream reductions.[8]

[8] Utah Energy Efficiency Strategy, preliminary results from review draft, June 2007

TL-10 - Idle-Reduction Program

Benefit/Cost of reducing CO_2e:
Arizona: 11.8 MMt between 2007-2020; 0.8% of 2020 emissions; -$22/ton
New Mexico: 6.3 MMt between 2007-2020; 0.7% of 2020 emissions; $4/ton
Montana: 0.093 MMt between 2007-2020
N. Carolina: 1.9 MMt between 2007-2020; 0.1% of 2020 emissions; -$22/ton

Assessment: High Priority. Bin B. 18 out of 22 votes.

This policy option can result in GHG emissions reductions and has important air quality co-benefits, particularly for school-aged children. Although some components of this policy option, such as an educational campaign, can be readily implemented, other components such as truck stop electrification systems will require greater effort over a longer period of time. The Farm Bureau cautioned of potential "unintended consequences" for farming due to the possibility of few or no options for truck stop electrification in rural areas.

School buses, developing no-idle programs for public-sector buildings, and strategies for heavy-duty trucks should be the target for idle reduction programs. A school and school disctict program should be the priority due to the low cost, ease of implementation through district networks, high visibility, large impact, and significant co-benefits. Specific methods to reduce idling in the trucking industruy and at truck stops should be studied further due to varied settings and scenarios. Most of the idling for trucking occurs overnnight and at the loading/unloading point.

Preliminary results from a heavy-duty truck efficiency and idle reduction program and other efficiency measures analysed in the Utah Energy Efficiency Strategy found significant reductions of CO_2 (547,000 tons in 2020).[9]

Currently, Utah Clean Cities is working with the National Energy Foundation to develop an idle reduction education and training pilot program for bus drivers. Ten school districts in Utah and Nevada are currently participating in the program that will launch with the 2007-2008 school year. Utah Clean Cities is also working to introduce the program through national networks.

Other idle reduction resources include:

- The Utah Transit Authority (UTA), which uses block heaters and requires drivers to shut buses off after 10 minutes of idling.

- The Argonne National Laboratory Transportation Technology R&D Center, which has a program to help reduce vehicle idling, including an idle reduction calculator.[10]

[9] Utah Energy Efficiency Strategy, preliminary results from review draft, June 2007

• The Wasatch Front Regional Council, which has also allocated funding for idle reduction.

• Salt Lake City, Salt Lake County, and Park City, which have introduced anti-idling initiatives.[11]

[10] http://www.transportation.anl.gov/research/technology_analysis/idling.html, http://www.transportation.anl.gov/downloads/idling_worksheet.xls

[11] See http://www.epa.gov/smartway/documents/420b06004.pdf, http://www.slvhealth.org/eh/pdf/rg/Regulation%2028%20H.D.pdf, http://www.slcgreen.com/pdf/signed%20Idling%20EO%208-7-07.pdf.

TL-11 - Vehicle Speed Reduction

Benefit/Cost of reducing CO_2e:

Arizona: 5.2 MMt between 2007-2020; 0.3% of 2020 emissions; $35/ton
New Mexico: 2.8 MMt between 2007-2020; 0.3% of 2020 emissions

Assessment: High Priority. Bin B. 9 out of 22 votes.

While this policy option could result in GHG emissions reductions due to greater fuel efficiency, it is likely to be politically and technically difficult to implement. The cost of implementing this policy option could range from revenue neutral to high, depending on the policy components selected.

Due largely to aerodynamic drag, as vehicle speed increases, fuel efficiency is reduced. The speed at which fuel economy is highest varies, but is typically below 60 miles per hour for a light-duty vehicle.[12] Federal Highway Administration tests of nine vehicles in 1997 found that fuel economy declined on average by 3.1 percent when speed increased from 55 mph to 60 mph and by 8.2 percent increasing from 65 to 70 mph.[13]

A vehicle speed reduction policy option could include any of a handful of components, including, but not limited to enhanced enforcement of speed limits, reduced speed limits for commercial trucks, and other reduced speed limits. Recognizing the value of such strategies, the American Trucking Association supports a mandated national 68 mph speed limit for safety and fuel economy reasons.

The Utah Energy Efficiency Strategy analyzed the fuel saving potential associated with better enforcement of Utah's speed limits and found that CO_2 would be reduced by 198,000 short tons per year in 2015 and 218,000 short tons in 2020. The cost of this program would be wholly or largely paid for by increased revenue from speeding fines. Co-benefits resulting from enhanced enforcement of speed limits include: reduced likelihood that an accident will be fatal due to reduced speeds. NO_x emissions are also expected to decline with better enforcement of speed limits.

[12] "Drive more efficiently," U.S.DOE and U.S. EPA, http://www.fueleconomy.gov/feg/driveHabits.shtml.
[13] *Transportation Energy Data Book*, 2006. Oak Ridge National Laboratory.

TL-13 - Education Program

Benefit/Cost of reducing CO_2e:

N/A

Assessment: High Priority. Bin A. 18 out of 22 votes.

Education is a critical enabling component to the entire suite of transportation and land use policy options listed in this section. Many educational programs exist and other can be implemented to improve awareness and efficacy of transportation options in Utah.

The State of Utah should develop and adequately fund education programs focusing on transportation, including, but not limted to vehicle choice, transit options, vehicle maintenance, driving habits/speeding/idling, and proper tire inflation.

TL-14 – Explore Funding Options for the Suite of Transportation and Land Use Options

Benefit/Cost of reducing CO_2e:

N/A

Assessment: High Priority. Bin B. 9 out of 22 votes.

Adequate funding is a critical enabler to several of the transportation/land use policy options. Resolving funding issues will require a sustained and concerted effort by political leaders and stakeholders.

TL-15 – Develop Congestion Pricing Programs

Benefit/Cost of reducing CO_2e:

N/A

Assessment: Medium Priority. Bin A. 19 out of 22 votes.

This policy option involves establishing congestion pricing to discourage vehicle use during peak times or along constrained transportation routes. Examples of such programs include toll roads, toll bridges, and high-occupancy toll (HOT) lanes.

In September 2006, the Utah Department of Transportation (UDOT) began operation of the Utah Express Lanes program, a HOT lane congestion pricing program allowed by the passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005. Express Lanes program customers pay a monthly fee in exchange for HOT lane privileges. In the near future, this payment scheme will be replaced by a more sophisticated system that will provide customers real-time prices based on the level of congestion along the Express Lanes route. Those who opt to use the Express Lanes facility will be charged via a transponder device onboard their vehicle. UDOT estimates that it cost approximately $12.5 to initiate this program. Ongoing program expenses are offset with program revenues.

While such a program will likely yield peak and route congestion benefits, it is unclear whether it would result in robust GHG emissions reduction benefits. For example, drivers may simply opt to shift their travel to off-peak periods or may choose alternate routes. In either scenario, vehicle miles traveled would not necessarily decrease, and – as a result – GHG emissions would not be reduced. However, these programs could result in greater efficiency of the highway system and associated carbon benefits. As a result, careful program design is critical to the successful implementation of a congestion pricing program aimed at reducing GHG emissions.

Goals

The options discussed in this section include the following goals related to reducing GHG emissions through tranportation planning and effective land use.

1. Reduce distance traveled by:

a. Developing and implementing aggressive mass transit strategy (TL-1)
b. Quality growth programs (TL-2)
c. Trip reduction, rideshare, vanpool, telecommuting (TL-4)
d. "Buy local" programs (TL-6)
e. Congestion pricing (TL-15)

2. Improve energy efficiency of travel by:

a. Developing and implementing aggressive mass transit strategy (TL-1)
b. Promoting low-carbon fuels and vehicle technologies (TL-7)
c. State fleet lead by example (TL-8)
d. Adopting a Clean Car program (TL-9)
e. Idle-reduction program (TL-10)
f. Vehicle speed reduction (TL-11)
g. Congestion pricing (TL-15)

3. Reduce CO_2 emissions per unit of fuel consumed by:

a. Promoting low-carbon fuels and vehicle technologies (TL-7)
b. State fleet lead by example (TL-8)

4. Adopt the following program enablers:

a. Education program (TL-13)
b. Funding for suite of options (TL-14)

Sorted by Priority:

#	Policy Option	Priority	Bin	Vote
TL-4	Trip Reduction, Rideshare, Vanpool, and Telecommuting	High	A	20
TL-7	Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)	High	A	20
TL-8	State Fleet Lead by Example	High	A	19
TL-1	Develop and Implement Aggressive Mass Transit Strategy	High	B	19
TL-13	Education Program	High	A	18
TL-10	Idle-Reduction Program	High	B	18
TL-2	Quality Growth Program	High	A	17
TL-9	Clean Car Program	High	B	16
TL-11	Vehicle Speed Reduction	High	B	9
TL-14	Explore Funding Options for the Suite of Transportation and Land Use Options	High	B	9
TL-15	Congestion Pricing	Medium	A	19
TL-6	"Buy Local" Program	Medium	B	10

Sorted by Vote:

#	Policy Option	Priority	Bin	Vote
TL-4	Trip Reduction, Rideshare, Vanpool, and Telecommuting	High	A	20
TL-7	Promote Low-Carbon Fuels and Vehicle Technologies (Statewide)	High	A	20
TL-1	Develop and Implement Aggressive Mass Transit Strategy	High	B	19
TL-15	Congestion Pricing	Medium	A	19
TL-8	State Fleet Lead by Example	High	A	19
TL-10	Idle-Reduction Program	High	B	18
TL-13	Education Program	High	A	18
TL-2	Quality Growth Program	High	A	17
TL-9	Clean Car Program	High	B	16
TL-6	"Buy Local" Program	Medium	B	10
TL-11	Vehicle Speed Reduction	High	B	9
TL-14	Explore Funding Options for the Suite of Transportation and Land Use Options	High	B	9

Public Comment

Submitted by Bill Tibbitts, Anti-Hunger Action Committee on June 12, 2007

Dear Blue Ribbon Council on Climate Change:

The time is approaching when you will be asked to vote on final recommendations for initiatives to reduce carbon emissions in Utah. As the director of an organization that includes a large number of bus riders, it is very exciting to see that one of the recommendations coming from the Transportation Stakeholder Working Group is to Develop Mass Transit. It is important to develop the basic public transportation infrastructure to enable as many people as possible to leave their cars at home and use public transportation to get to work, school and other appointments. It is also a very positive thing to see that fare reduction is mentioned explicitly in that recommendation. It is my belief that the current price structure is a major barrier to participation in public transportation for many Utah families. For families that are larger than one or two people it is cheaper to buy and maintain a car than purchase monthly bus passes. A large family can spend over $20 to ride the bus to and from a movie. This discourages use of public transportation.

It seems to me that the recommendation for fare reduction needs to be made more explicit. I would suggest that the Council propose that price for bus service be reduced from the current rate of $1.50 to $1 and that the price of a monthly pass be reduced from $50 to $30. The number of passengers on UTA buses has been declining for several years.

The UTA Board recently voted to raise the price for bus fare to $2 over the next 19 months. If that increase is necessary to meet UTA's budget goals then it seems like the state could help them to make up the difference. Fare box revenue is a small part of UTA's total budget and so the costs for doing this would be cheaper than some of the other proposals being put before the Council. I believe that a significantly decreased price on a monthly pass would actually increase UTA's revenue. Right now you need to use a bus pass 34 times in a month to break even. This means only the most devoted users of public transportation purchase the pass. If a pass cost something closer to the price of riding 10-15 times then customers who currently ride 1-6 times to month would suddenly be tempted to purchase a monthly pass in a way that they currently are not.

Be that as it may, it is likely that the price increases that the UTA Board recently approved are not being driven by budget needs but are instead being driven by the belief of some some UTA Board members that people who ride the bus and TRAX should pay as much as possible for the costs of that service. The problem with that belief is that it assumes UTA's share of the transportation market is fixed. Right now over 19 people in Salt Lake County drive to work in a car alone for every one person who uses public transportation to get to work. With rising gas prices and all the current interest around local air quality and climate change. Many of those people would be more open to using public transportation if they were approached in the right way and the costs for public transportation were not also increasing.

Given the above, I would like to further suggest that you consider splitting the goal to "Develop mass transit" into two parts. The first part would be related to infrastructure, and could still be called "Develop mass transit". The second goal would deal with eliminating barriers people have to using public transportation and conducting the kind of social marketing necessary to convince people to give public transportation a chance. I guess this goal could be called, "Eliminate barriers and increase use

of existing mass transit." According to 2005 data from the Census Bureau, 17,500 people in Salt Lake County use public transportation to get to work. The state could play a very significant role in doubling that number by: a) promoting use of public transportation by state employees and firms that contract with the state, b) helping to decrease prices, as discussed above, and c) taking a leadership role in promoting the benefits of public transportation with the public.

Thank you for taking the time to serve on this important Council and thank you for taking the time to read through this overly wordy email. If you have any questions about any of the points that I have made please call me about them at 364-7765 ex 131.

Bill Tibbitts
Anti-Hunger Action Committee Director
347 South 400 East
Salt Lake City, UT 84111
(801)-364-7765 ex 131

Public Comment

Submitted by Jerry Costley, Executive Director of Disabled Rights Action Committee on July 6, 2007 via e-mail

I have received a copy of an email that Bill Tibbitts sent to you all encouraging you to look at specific reductions in UTA fares, and in particular the monthly passes as a means of encouraging individuals to use public transportation. I am writing in support of Mr. Tibbits statement. In Europe and other countries the use of public transportation is the norm. With lower fares and high costs of operating individual vehicles, most people commute via public transit. It is a great equalizer of transportation in that everyone, from the upper manager to the store clerk uses public transit. If we could create this kind of culture here we could cut back on a great number of emissions and greatly improve the quality of our air. Given the tremendous heat we have in the summer and the inversions we experience in the winter we are in desperate need of improved air quality. As it stands now, only those who are better off financially will be able to afford consistent bus ridership. Instead of trying to entice these and other individuals with slick ad campaigns, lets give them a financial offer they can't resist. Cutting fares to $1.00 a ride or $30.00 for a monthly pass would be much more irresistible than TV spots. In addition, it would have the added benefit of opening up transportation opportunities to a great many individuals who cannot now afford to leave their home.

On behalf of my many friends with the Disabled Rights Action Committee, I would like to request a reply and to know if you would support a significant UTA fare decrease such as Mr. Tibbits proposed as a means of encouraging increased ridership. Thank you for your work on behalf of a cleaner, healthier Utah. I look forward to hearing from you.

Jerry Costley
Executive Director
Disabled Rights Action Committee

Response by Senator Greg Bell on July 7, 2007, via e-mail:

Jerry, as you know the UTA Board makes these policy decisions. Elected officials certainly give input, but the board has the final say. This issue has certainly received a thorough airing, with wide public input and even protest. The ultimate changes were made in response to the public's frustration.

You and Bill raise a strategic issue--who is the market for bus ridership? Are we moving to a white collar commuter system, or are we seeking a broadly-based, affordable system? I have not had this dialogue with the UTA Board, but would be interested in hearing their perspective and will ask them to explain it to you, Bill, me and others interested. Thanks for your message. I look forward to more discussion on this important issue.

Greg Bell
Utah State Senate, District 22
gbell@utahsenate.org

Public Comment

Submitted by Dr. Richard Kanner, University of Utah Hospital and Clincs, via e-mail on July 11, 2007

My comment is that we need to make mass transit as acceptable as driving an automobile with only the driver in the car. We have a right of way for rail in Davis County but developers are now building the area up with low density housing, a situation that is bound to make mass transit a failure. Can something be done to ensure that we have high density housing, shopping malls and office buildings near the stations for the future mass transit lines? That will help convince people to use mass transit. Eastern cities, that are much more crowded than the Wasatch front all rely on mass transit and people use it even though it has to be subsidized by tax dollars. Here we say automobile traffic will double by 2020 and talk about building more roads so more cars can pollute more. We should be trying to reduce automobile traffic not double it. Auto exhaust adds to global warming, air pollution (both ozone and PM 2.5) and consumes a precious product. Mass transit, if convenient and affordable might entice people to get out of their cars. This requires long term planning, something that has been an anathema to the legislature. Thus, BRAC needs to try to convince the public and their elected representatives that we need long term planning that emphasizes mass transit with a decrease in automobile miles traveled. Thank you.

--

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Public Comment

Submitted by James Holtkamp, Holland and Hart, for Questar on August 16, 2007

Re: Questar comments on BRAC report

Dear Dr. Nielson:

On behalf of Questar, we offer the following comment on the Climate Change Work Group's report to the Governor's Blue Ribbon Advisory Commission on Climate Change. In particular, Questar suggests amplifying ES-18 and TL-7 as follows:

> It will take time for demand-side conservation measures and renewable energy to make a significant dent in Utah's energy mix. Natural gas is an abundant and clean source of energy. The emissions of CO2 per BTU of natural gas burned are significantly less than for other types of fossil fuels. Natural gas is already widely used for residential and commercial heating, generation of electricity and a variety of manufacturing processes. Natural gas is also used as a transportation fuel, particularly in mass transit, and increasing numbers of passenger vehicles are converting to use natural gas as fuel. In addition, the technology and infrastructure for producing, transporting and delivering natural gas is well-developed. Therefore, natural gas can make an immediate impact as a "bridge fuel" to a carbon-constrained energy future as we move toward more renewable energy sources and better technology to reduce and even eliminate carbon dioxide emissions from energy generation and use..
>
> Recommendation: Encourage and incentivize environmentally responsible development, production and use of natural gas. (ES-18; TL-7)

The foregoing recommendation was discussed at the Commission's August 14 meeting. We are submitting it in this letter for inclusion in the record of the Commission's deliberations.

Sincerely yours,

James A. Holtkamp
for Holland & Hart LLP

JAH:mf

cc: Thomas Jepperson
Ruland Gill

Climate Change and Utah: The Scientific Consensus
September 2007

Executive Summary

As directed by Governor Jon Huntsman's Blue Ribbon Advisory Council on Climate Change (BRAC), this report summarizes present scientific understanding of climate change and its potential impacts on Utah and the western United States. Prepared by scientists from the University of Utah, Utah State University, Brigham Young University, and the United States Department of Agriculture, the report emphasizes the consensus view of the national and international scientific community, with discussion of confidence and uncertainty as defined by the BRAC.

There is no longer any scientific doubt that the Earth's average surface temperature is increasing and that changes in ocean temperature, ice and snow cover, and sea level are consistent with this global warming. In the past 100 years, the Earth's average surface temperature has increased by about 1.3°F, with the rate of warming accelerating in recent decades. Eleven of the last 12 years have been the warmest since 1850 (the start of reliable weather records). Cold days, cold nights, and frost have become less frequent, while heat waves have become more common. Mountain glaciers, seasonal snow cover, and the Greenland and Antarctic ice sheets are decreasing in size, global ocean temperatures have increased, and sea level has risen about 7 inches since 1900 and about 1 inch in the past decade.

Based on extensive scientific research, there is very high confidence that human-generated increases in greenhouse gas concentrations are responsible for most of the global warming observed during the past 50 years. It is very unlikely that natural climate variations alone, such as changes in the brightness of the sun or carbon dioxide emissions from volcanoes, have produced this recent warming. Carbon dioxide concentrations are now more than 35% higher than pre-industrial levels and exceed the highest natural concentrations over at least the last several hundred thousand years.

It is likely that increases in greenhouse gas concentrations are contributing to several significant climate trends that have been observed over most of the western United States during the past 50 years. These trends are: (1) a several day increase in the frost-free growing season, (2) an earlier and warmer spring, (3) earlier flower blooms and tree leaf out for many plant

species, (4) an earlier spring snowmelt and run off, and (5) a greater fraction of spring precipitation falling as rain instead of snow.

In Utah, the average temperature during the past decade was higher than observed during any comparable period of the past century and roughly 2°F higher than the 100 year average. Precipitation in our state during the 20th century was unusually high; droughts during other centuries have been more severe, prolonged, and widespread. Declines in low-elevation mountain snowpack have been observed over the past several decades in the Pacific Northwest and California. However, clear and robust long-term snowpack trends have yet to emerge in Utah's mountains.

Climate models estimate an increase in the Earth's average surface temperature of about 0.8°F over the next 20 years. For the next 100 years, the projected increase is between 3 and 7°F, depending on a range of credible estimates of future greenhouse gas emissions. These projections, combined with extensive scientific research on the climate system, indicate that continued warming will take place over the next several decades as a result of prior greenhouse gas emissions. *Ongoing greenhouse gas emissions at or above current levels will further alter the Earth's climate and very likely produce global temperature, sea level, and snow and ice changes greater than those observed during the 20th century.*

What does this mean for Utah? *Utah is projected to warm more than the average for the entire globe and more than coastal regions of the contiguous United States. The expected consequences of this warming are fewer frost days, longer growing seasons, and more heat waves*. Studies of precipitation and runoff over the past several centuries and climate model projections for the next century indicate that *ongoing greenhouse gas emissions at or above current levels will likely result in a decline in Utah's mountain snowpack and the threat of severe and prolonged episodic drought in Utah is real*. Preparation for the future impacts of climate variability and change on Utah requires enhanced monitoring and knowledge of Utah's climate, as well as better understanding of the impacts of weather and climate on the state's water availability, agriculture, industry, and natural resources.

1 Introduction

What do we know about climate change and its impacts on Utah and the West? As directed by Governor Jon Huntsman's Blue Ribbon Advisory Council on Climate Change (BRAC), this report summarizes our current understanding of climate change, trends and projections for the future, and possible impacts for Utah and the western United States. Prepared by a team of scientists and engineers from the University of Utah, Utah State University, Brigham Young University, and the United States Department of Agriculture (Appendix A), this understanding is consistent with the consensus view of the national and world scientific community. Scientific confidence and uncertainty are addressed throughout the report as directed by the BRAC and summarized in Appendix B.

2 The consensus view of global climate change

2.1 Evidence of a warming Earth

There is no longer any scientific doubt that the Earth's average surface temperature[1] *is increasing and that changes in ocean temperature, ice and snow cover, and sea level are consistent with this global warming*. In the past 100 years, the Earth's average surface temperature has increased by about 1.3°F (Fig. 1). There is very high confidence in this estimate because it is based on data that have been carefully scrutinized by the scientific community. The rate of warming has accelerated in recent decades and 11 of the last 12 years have been the warmest since 1850 (the start of reliable weather records).

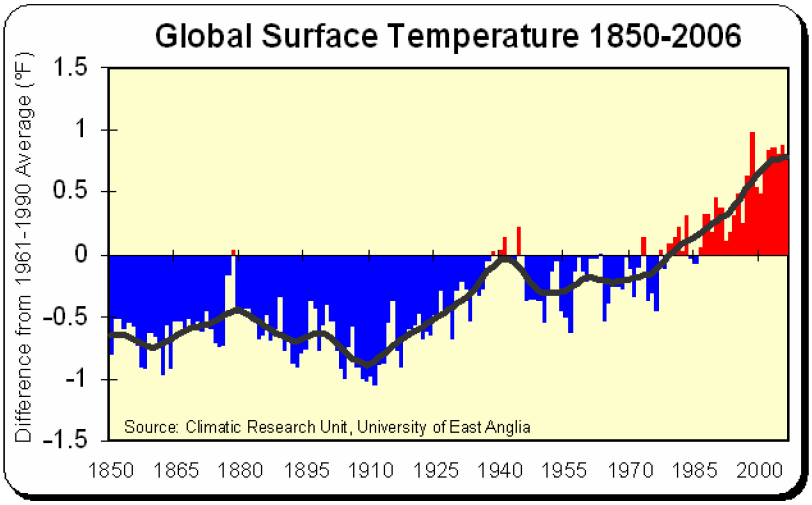


Figure 1

Temperatures inferred from ice cores, tree rings and other sources provide a longer-term perspective on this

[1] Based on near-surface air temperature over land and sea surface temperature.

warming. Based on these reconstructions, *there is very high confidence that the past few decades were warmer than any comparable period in the last 400 years*. Temperature during the late-20th century appears to be higher than for any comparable period in the last 1000 years at many (but not all) locations, but because of uncertainties in temperature reconstructions beyond several hundred years before present, we are less confident about how today's average temperature compares with that prior to 1600 AD.

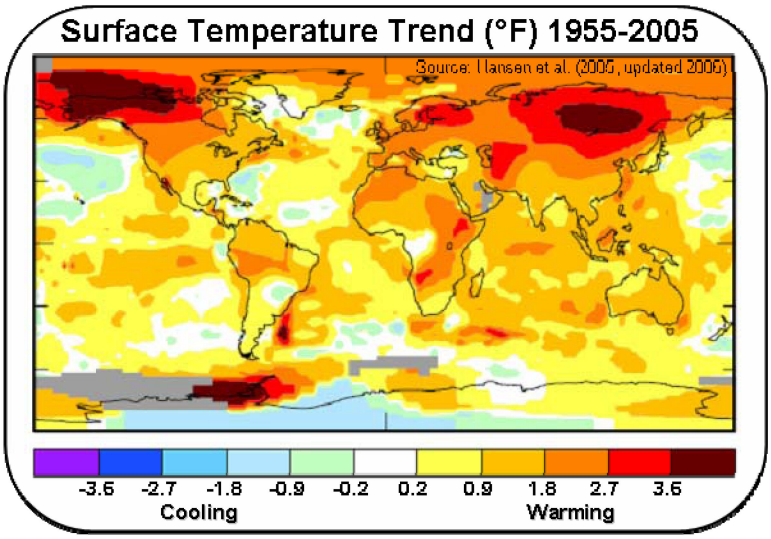


Figure 2

Temperature changes have not occurred uniformly around the globe and vary regionally (Fig. 2). Although most of the Earth has warmed, with greater warming over land than oceans, a few regions have cooled. The most rapid change is in the Arctic, which is warming twice as fast as the global average. *Most of the western United States is warming faster than the global average*.

Observed changes in ocean temperature, sea level, mountain glaciers, seasonal snow cover, Arctic sea ice, and the Greenland and Antarctic ice sheets are consistent with what is expected from global warming. The sea surface and upper-layers of the ocean have warmed. Sea level has risen about 7 inches since 1900 and about 1 inch in the past decade, nearly all mountain glaciers are receding, sea ice in the Arctic is declining, and the Greenland ice sheet is shrinking.

2.2 Is recent warming natural or human caused?

Without carbon dioxide and other greenhouse gases, the atmosphere would be very cold, almost 60°F colder than presently observed. Although there are natural sources of greenhouse gases, *the amount of carbon dioxide in the atmosphere (381 parts per million) is now more than 35% higher than pre-industrial levels (280 parts per million) and very likely exceeds the highest natural concentrations over at least the last several hundred thousand years* (Fig. 3). The added

carbon dioxide enhances the Earth's natural greenhouse effect and comes primarily from fossil fuel burning, with forest clearing playing a secondary role. Half of the post-industrial increase in carbon dioxide concentration has occurred since the mid 1970s.

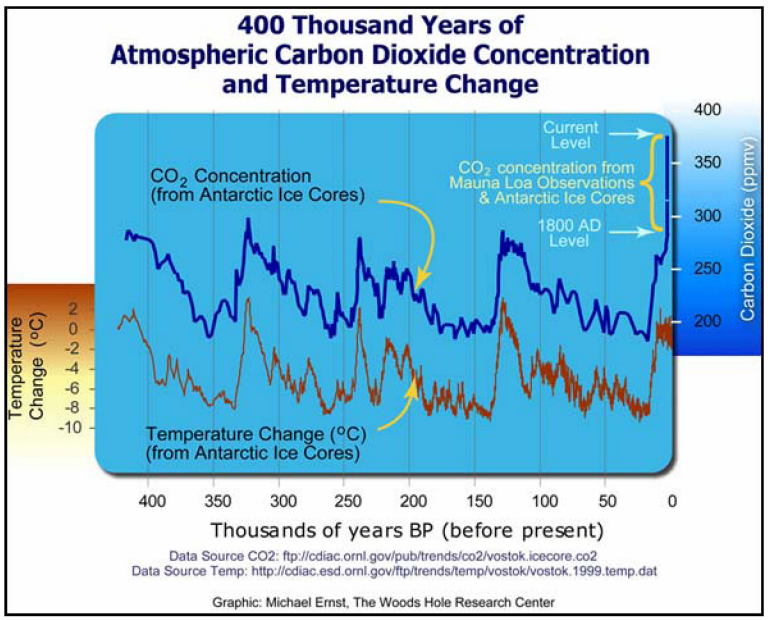


Figure 3

Climate has changed dramatically during the Earth's history, sometimes abruptly. Changes in the Earth's tilt and distance from the sun, the brightness of the sun, and volcanic eruptions are known to affect climate. Air bubbles in Antarctic ice cores provide estimates of temperature and carbon dioxide in the distant past. Temperature and carbon dioxide levels show consistent large swings between 180 and 300 parts per million over the past several hundred thousand years with low carbon dioxide during cool periods (ice ages) and high carbon dioxide during warm periods (Fig. 3). Although ice ages and the intervening warm periods are caused by gradual changes in the Earth's tilt and distance from the sun, temperature can change more abruptly due to a complicated interplay between greenhouse gases and temperature. These "feedbacks" in the climate system are not completely understood and remain an important scientific issue to resolve.

Humans affect the climate system through the production of particulate pollution, changes to the land surface, and greenhouse gas emissions. *Based on extensive scientific research, there is very high confidence that human-generated increases in greenhouse gas concentrations are responsible for most of the global warming observed during the past 50 years*. It is very unlikely that natural climate variations alone, such as changes in the brightness of the sun or carbon dioxide emissions from volcanoes, have produced this recent warming. Further, the Earth's climate is just beginning to respond to the rapid rise in greenhouse gas concentrations evident in Fig. 3, as discussed in section 4.

2.3 Other recent climate trends

2.3.1 Droughts and rainfall

Although estimating precipitation around the globe is difficult, observations do reveal regional changes in the distribution, intensity, and amount of precipitation. The peripheries of the deserts of North Africa have become increasingly arid during the last 100 years and drought has become more intense, widespread, and persistent in many regions since 1970. On the other hand, the frequency of heavy precipitation has increased. For example, over the contiguous United States, the average precipitation has increased by just over 10%, with over half of this increase produced by the most extreme heavy precipitation events. Although it may seem contradictory that droughts are becoming more prevalent in many regions while episodes of heavy precipitation are generally increasing, such changes are consistent with our understanding of how global warming influences the regional distribution and intensity of precipitation.

2.3.2 Sea level rise

Mean sea level rose almost 7 inches in the 20th century and about 1 inch in the past decade (Fig. 4). Expansion of the water as ocean temperature increases is the leading contributor to sea level rise with additional contributions from melting glacers, ice caps, and ice sheets. The melting of sea ice does not appreciably influence sea level.

2.3.3 Glaciers, ice caps and sheets, and sea ice

Mountain glaciers, ice caps, and the Greenland ice sheet are shrinking and are responsible for 35-40% of the recent (1993-2003) sea level rise. The thickness and coverage of Arctic sea ice is also declining (Fig. 5), as is the extent of snow cover in the winter.

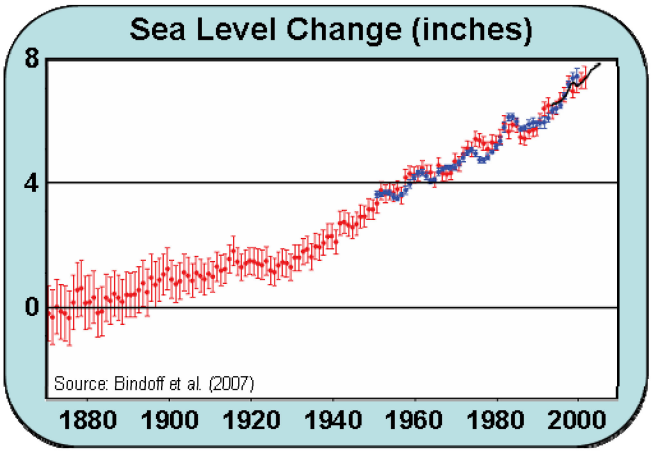


Figure 4

The large Greenland ice sheet is particularly vulnerable to warming. If fully melted, it contains enough ice to raise sea level by 22 feet. (About 130,000 years ago when the climate was warmer than it is now, the Greenland ice sheet was much smaller and sea level was at least 10 feet higher than today). From 2003-2005, the loss of ice from the Greenland ice sheet was roughly equivalent to the amount of water that flows through the Colorado River over a 12 year period.

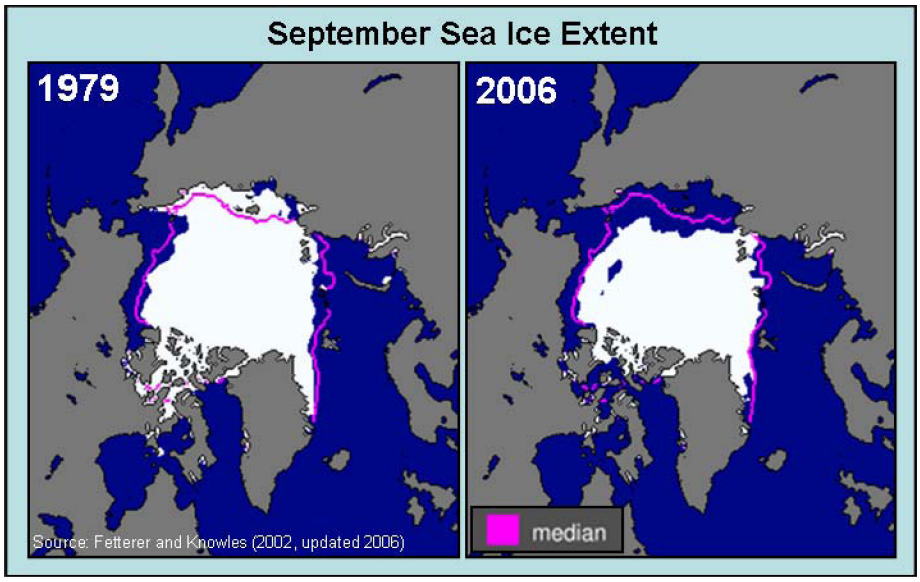


Figure 5

Antarctica has the largest floating ice shelves in the world, one of which is nearly the size Utah and is 1000 feet thick. The disintegration and melting of floating ice shelves does not contribute appreciably to sea level rise. The floating ice sheets are maintained, however, by glaciers that flow seaward from the higher elevation continental regions. The loss of the floating ice shelves can accelerate the flow of continental ice into the ocean, which does raise sea level. In 2000, the 10,000 year old, 700 foot thick Larsen 'B' Ice Shelf collapsed, contributing to accelerated ice flow from land to ocean. A smaller ice shelf collapse has also been observed in the Arctic. Further ice shelf breakups will increase sea level. Our understanding of the mechanisms that lead to ice shelf collapse is incomplete, however, so the future of ice sheets in a warming world is presently uncertain.

Satellite observations show that the area of the Arctic ice cap has decreased (about 7.5% per decade during the past 25 summers). The average thickness of Arctic sea ice has also declined.

2.3.4 Hurricanes and tropical cyclones

Hurricane is the common name for a *tropical cyclone* in the western hemisphere. Elsewhere they are known as *typhoons* or just cyclones. The active 2005 hurricane season underscores the vulnerability of the southern and eastern sections of the United States to these weather events.

Knowledge of tropical cyclone trends is based on long-term datasets that are imperfect, particularly before the widespread use of satellite imagery in the 1970s. With consideration of the limitations of the existing datasets, we summarize the current understanding as follows:

- There has been little or no long-term trend in the average *number* of tropical cyclones that occur across the entire globe each year.
- It is likely that *intense hurricane activity* has increased over the Atlantic Ocean since 1970.
- Although global warming may affect the frequency of intense hurricanes, direct attribution for the creation of individual hurricanes to global warming is not possible.

There is no doubt that the ever-growing concentration of population and development in vulnerable coastal regions is the primary driver of the increasing financial losses produced by hurricanes. If present development trends continue in these regions, we can expect even larger human and economic losses from hurricane disasters.

2.3.5 Species and habitats

Plants and animals respond not only to changes in climate, but also to changes in their habitat caused by fires, insect outbreaks, invasion of non-native species, human land use patterns, etc. While it is a challenge to attribute plant and animal responses solely to a change in climate in the presence of these other factors, about 90% of documented changes to plant and animal species across the globe are consistent with recent climate change.

It is very likely that earlier warming in the spring is strongly affecting plants, animals, and insects. Events that are occurring earlier in the spring include the greening of grasses and

trees, flowering of plants, migration of birds and insects, and laying of eggs. For example, the average date of first bloom for lilacs and honeysuckles has advanced more than a week over the last 40 years in the western United States. Recent climate change has led to mismatches between bird migration timing and their insect food sources, between insects and plant food sources, and between plants and the birds and insects that help them reproduce. For example, marmots at one location in Colorado are now emerging from hibernation before the emergence of plants that they depend on for food.

There is very high confidence that the ranges of some plants and animals have moved towards the poles or towards higher elevations. Treeline in the Canadian Rockies has advanced upward and the distribution of high mountain plants in the Alps has shifted to higher elevations. Butterfly ranges have expanded northward all over Europe. The range of shrubs in northern Alaska, Canada, and Russia has moved northward into tundra regions. Hummingbirds that formerly wintered in Mexico are now found regularly in the Gulf Coast states.

3 Climate Change in the Western United States and Utah

It is likely that increases in greenhouse gas concentrations are contributing to several significant climate trends that have been observed over most of the western United States during the past 50 years. These trends are: (1) a several day increase in the frost-free growing season, (2) an earlier and warmer spring, (3) earlier flower blooms and tree leaf out for many plant species, (4) an earlier spring snowmelt and run off, and (5) a greater fraction of spring precipitation falling as rain instead of snow. *In Utah, the average temperature during the past decade was higher than that observed during any comparable period of the past century and roughly 2°F higher than the 100 year average* (Fig. 6).

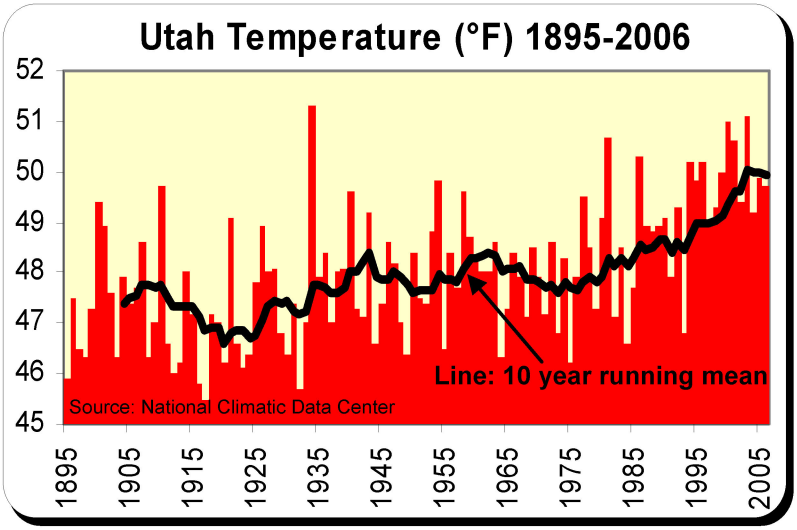


Figure 6

Most of Utah's water resources originate in

mountainous areas above 6500 feet in elevation, which cover about 19% of the state. The primary source of this water is snowpack. Snow accumulates in these mountainous areas during winter and then melts in spring and early summer releasing months of stored precipitation in typically 4 to 8 weeks time. The release of this stored water over a short time generates the majority of streamflow across the state.

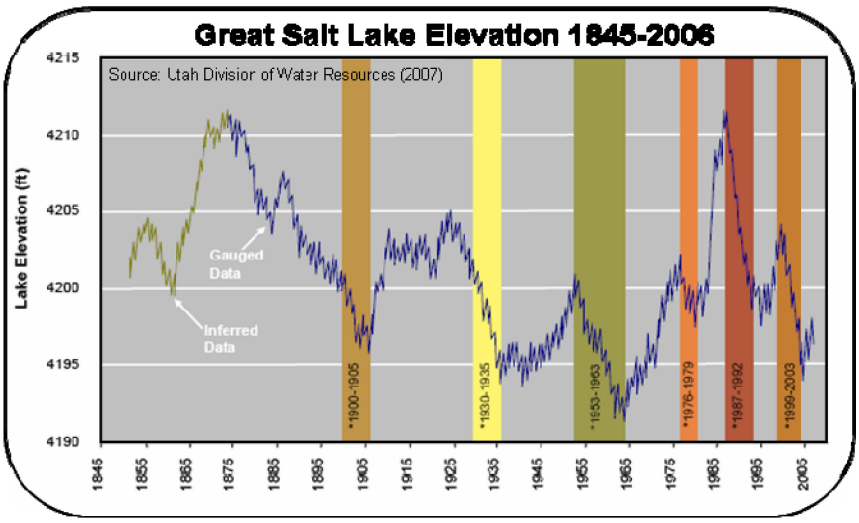


Figure 7. Great Salt Lake elevation with drought periods indicated by colored bars.

Precipitation fluctuates dramatically in Utah from year to year, complicating the identification of long term trends. Using geologic records and tree rings, however, scientists have produced estimates of river flow and precipitation in the Colorado River Basin dating back several hundred years. These estimates show that *sustained droughts are a defining feature of the upper Colorado River Basin, which has experienced far more prolonged and severe drought than observed during the comparatively wet 20th century.* Persistent drought occurred in the late 16th century, with river flows during this period much lower than for any period in the 20th century. The drought of 1999-2004 was a severe event, but there have been even longer and more severe droughts in the past.

Declines in low-elevation mountain snowpack have been observed over the past several decades in the Pacific Northwest and California. However, *in Utah, careful analysis of long-term (80 year) snow surveys shows no evidence for a clear long-term trend in mountain snowpack*. In addition, recent temperature increases in the state appear to have had little impact on snowpack in the high mountains of the Intermountain West. Streamflows in Utah and the Intermountain West also do not show clear trends over the past 50 years.

The level of the Great Salt Lake reflects to a large degree the total precipitation received over much of northern Utah. Several wet years led to high lake levels in the mid 1980's, while

the 1999-2004 drought led to falling lake levels (Fig. 7). The causes for these swings in basin precipitation are not completely understood, and, at this time, there is no clear linkage between recent global warming and precipitation within the basin of the Great Salt Lake.

4 Projections for future global climate change

4.1 Overview of climate models

The Earth's climate is too complex to assess and predict by physical reasoning or laboratory experiments alone (Fig. 8). Therefore, scientists use well-established physical principles to build sophisticated computer codes, or climate models, which simulate the past, present, and future climate. These models can be used, for example, to understand how the build-up of greenhouse gases or a volcanic eruption might modify temperature, rainfall, snow cover, winds, soil moisture, sea ice, and ocean circulations.

4.2 Strengths and limitations of climate models

Unlike weather forecast models, climate models are not intended to forecast what will happen on a particular day in the future. Rather, climate models are designed to estimate the average conditions over many years. There is considerable confidence that today's climate models provide credible estimates of future climate for the Earth as a whole and for large regions like entire continents. This confidence is derived from the ability of climate models to reproduce many observed features of recent and past climate. In addition, confidence is improved by

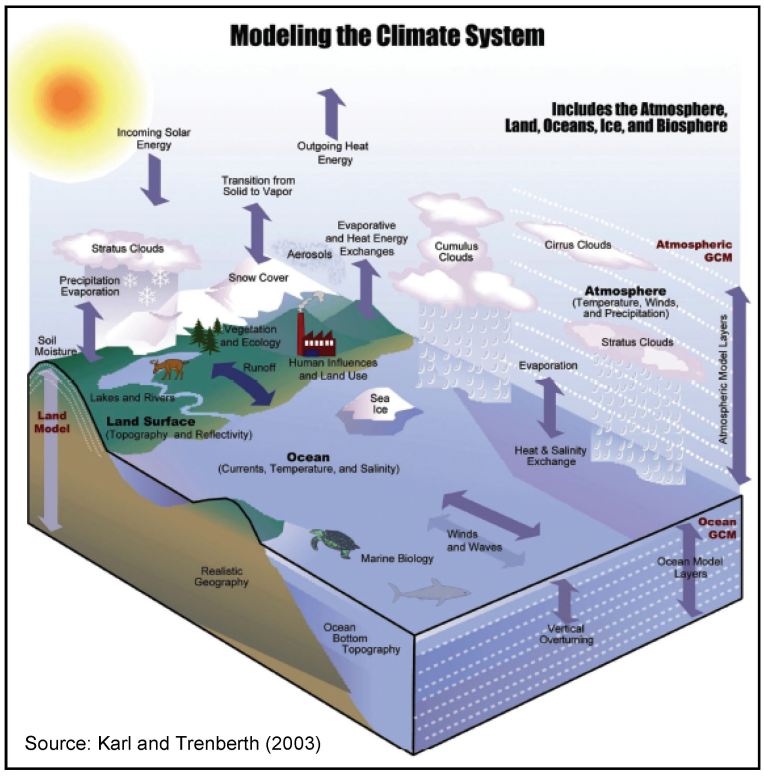


Figure 8

evaluating the results from a number of different models.

Since climate models are simplified versions of the Earth's climate system, they cannot capture its full complexity, especially in mountainous regions such as Utah. For example, current climate models divide the globe into a mosaic of squares that are too big to directly simulate the impact of individual mountain ranges in Utah. For this and other reasons, climate model projections become less reliable for particular regions, states, or locations.

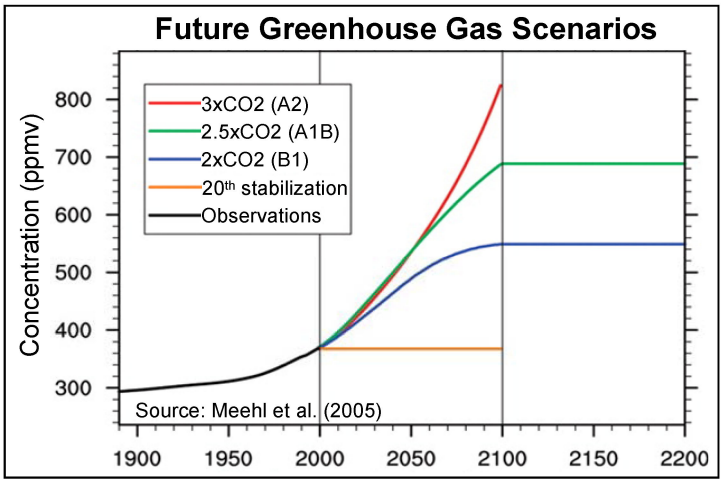


Figure 9

4.3 Future greenhouse gas scenarios

Estimates of future greenhouse gas concentrations, called scenarios, are used to produce different projections for future climate (Fig. 9). Three commonly used scenarios are:

- 2xCO2, which projects that greenhouse gas concentrations stabilize by the end of the 21st century at double their pre-industrial levels.
- 2.5xCO2, which projects that greenhouse gas concentrations reach 2.5 times their pre-industrial levels by the end of the century.
- 3xC02, which projects that greenhouse gas concentrations reach three times their pre-industrial levels by the end of the century[2].

A fourth hypothetical scenario, 20th century stabilization, assumes greenhouse gas concentrations remain at year 2000 levels. Since greenhouse gas concentrations are already above year 2000 levels and climbing, this scenario illustrates the anticipated response of the Earth's climate to emissions that have already occurred.

[2] The Intergovernmental Panel on Climate Change (IPCC) refers to the 2xCO2, 2.5xCO2 and 3xCO2 scenarios as B1, A1B, and A2, respectively.

4.4 Projected changes

Climate model projections, when combined with other research on the climate system, indicate that *(1) continued climate change will take place over the next several decades as a result of prior greenhouse gas emissions and (2) ongoing greenhouse gas emissions at or above current levels will very likely produce global temperature, sea level, and snow and ice changes greater than those observed during the 20th century.*

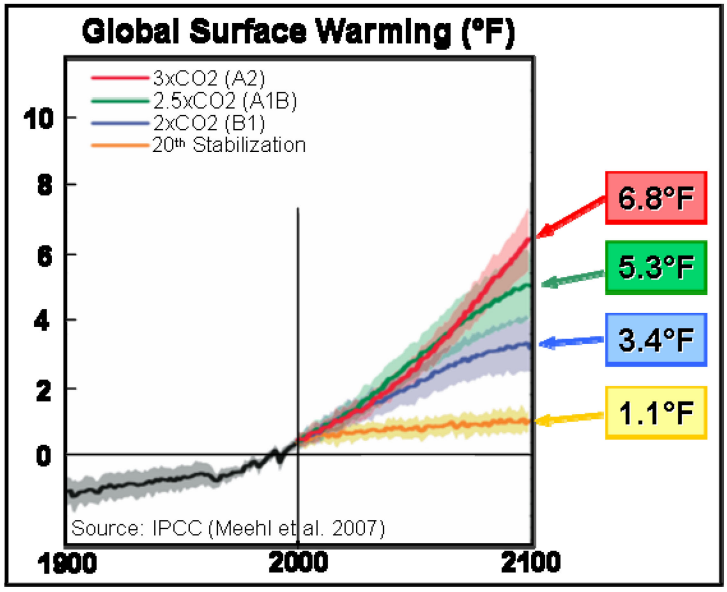


Figure 10

4.4.1 Temperature

Climate models project an increase in the Earth's average surface temperature of about 0.8°F over the next 20 years. This projected warming is largely independent of future emission scenarios (2xCO2, 2.5xCO2, or 3xCO2) and is primarily the result of prior and current greenhouse gas emissions. By 2100, climate models project an increase in global mean surface temperature of between 3 and 7°F, with greater warming for larger projected increases in carbon dioxide (Fig. 10). For each scenario, the projected warming differs between climate models, but these differences are small compared to the size of the overall warming. Because the Earth's climate takes time to respond, warming (as well as ice melt and sea level rise) continues for centuries after greenhouse gas concentrations stabilize, as illustrated by the 1.1°F of warming projected by the hypothetical 20th century stabilization scenario by 2100.

Some general statements about the expected spatial distribution of the warming (Fig. 11) are:

- Areas that have experienced the most warming during the past few decades will experience the most warming in the future;

- Warming will be greater over land than over oceans;
- Warming will be greater over the interiors of the continents than at the coasts;
- Warming will be greatest in the Arctic;
- Warming will be larger in winter than in summer.

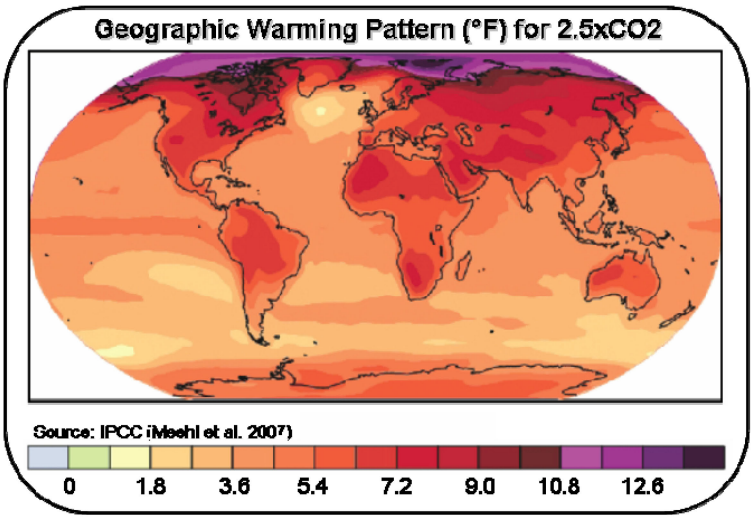


Figure 11. Projected surface temperature change from the late 20th century to the late 21st century.

Utah is projected to warm more than the average for the entire globe and more than coastal regions of the contiguous United States. The expected consequences of this warming are fewer frost days, longer growing seasons, and more heat waves. For Utah, the projected change in annual mean temperature under the 2.5xCO2 scenario by the end of this century is about 8°F, which is comparable to the present difference in annual mean temperature between Park City (44°F) and Salt Lake City (52°F).

4.4.2 Rainfall, storms, and Weather

In contrast to temperature, which is projected to increase everywhere, changes in precipitation vary regionally and there is greater uncertainty about the model projections. The climate models project more precipitation

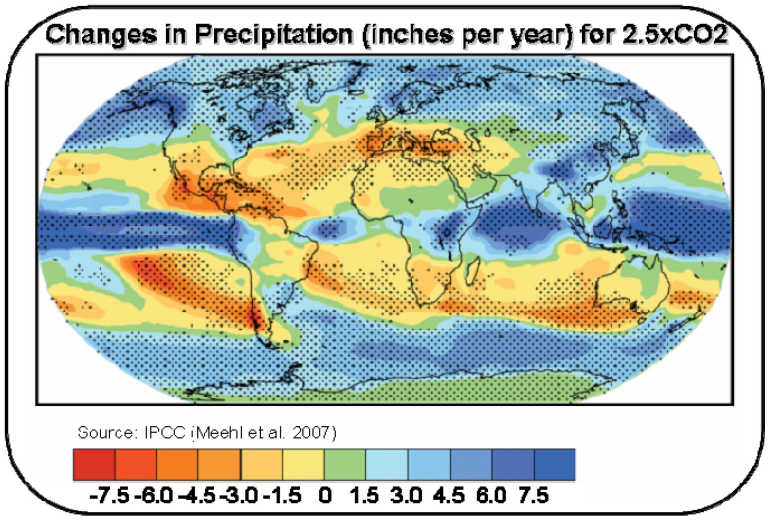


Figure 12. Projected change in precipitation from the late 20th century to the late 21st century.

for the mid and high latitudes and drying across most of the subtropics including southwest North America, Mexico, North Africa, and southern Europe. There is a general tendency among the models for more frequent heavy precipitation events, separated by longer dry spells, especially in Utah and the western United States.

4.4.3 Sea level

It is likely that sea level will continue to rise at rates at or above those observed in the 20th century. There are two major contributors to sea level rise. The first is that water expands as it warms, called thermal expansion. The second is water flowing into the oceans from melting glaciers, ice caps, and ice sheets.

Current climate models project a sea level rise due only to thermal expansion of 7 to 23 inches by the end of the 21st century, depending on which emissions scenario and model is considered. Any shrinking of the Antarctic and Greenland ice sheets, which is not included in current climate model projections, will lead to additional sea level rise. Due to the slow response of the Earth's climate, sea level rise will continue for many centuries after greenhouse gas concentrations are stabilized.

4.5 Projected impacts

4.5.1 Projections for human health and diseases

Negative health effects associated with climate change are expected to outweigh positive ones, particularly for those in developing countries. The consequences for society will be strongly regional, with people in poor regions expected to be most vulnerable as they have less capacity to adapt and depend generally on locally produced food and water. These consequences include increases in deaths, disease, and injuries due to heat waves, extreme weather events, malnutrition (caused by crop failure), intestinal disease, and allergy-causing pollen. Cold exposure deaths are expected to decline. Climate change will also alter the transmission of infectious diseases such as cholera, malaria, and bubonic plague. The production of near-surface ozone and associated cardio-respiratory diseases is expected to increase.

4.5.2 Projections for agriculture and food production

At mid- to high latitudes where increased precipitation and a longer growing season are expected, crop productivity will likely increase slightly for local temperature increases of 2-5°F (depending on the crop), above which productivity will decline in some regions. At lower latitudes, crop productivity is projected to decrease even for small temperature increases. Where susceptible, increases in the frequency of droughts will affect agricultural production. Changes in the distribution and population of insects and animals will likely have positive and negative effects on crops through changes in the magnitude, location, and timing of insect damage and pollination.

4.5.3 Projections for biodiversity

The biodiversity of plants, animals and other organisms on the earth is decreasing dramatically, representing the sixth major extinction event in the history of life. While climate change is a factor in decreasing biodiversity, other modifications of the environment are primarily responsible, including human land use, agricultural and hunting/fishing practices, pollution, and introduction of non-native species.

Estimates of the influence of climate change on biodiversity suggest that 20-30% of all known plant and animal species will be more vulnerable to extinction during the next century. Climate change will probably not influence biodiversity by itself; instead, pressures from land use change or the other factors listed above will be increased by climate change. Depending on the projection scenario, more than half of plant species in Europe could be vulnerable or threatened by the late 21st century. Twelve percent of all known bird species are estimated to be threatened currently with extinction, and this is expected to be larger with global warming. Species whose home range is restricted by cold temperatures at high latitudes or altitudes, or whose habitat is limited by land use change, are at higher risk.

4.6 Feedbacks, tipping points, and the threat of catastrophic climate change

Climate feedbacks are important for future climate change because the warming produced by increased greenhouse gas concentrations can be amplified (or reduced) by other indirect effects. For example, as greenhouse gas warming melts arctic sea ice, sunlight that was

previously reflected back to space by the ice is now absorbed by the dark ocean. This is a "positive feedback" that results in additional warming. These feedbacks are very important, since they can increase or reduce the initial temperature change by large amounts. Uncertainties in feedbacks are partly responsible for the fact that different climate models produce different amounts of warming in the 21st century.

"Tipping point" has been used to describe the crossing of a threshold greenhouse gas concentration beyond which we cannot avoid catastrophic climate change. What constitutes catastrophic climate change is somewhat arbitrary, but the inability to maintain sea level near current levels is a common definition. For example, as greenhouse gas concentrations increase, a threshold may be reached whereby we are committed to a slow but major rise in sea level. It is likely that tipping points exist in the Earth's climate, as indicated by dramatic climate shifts over the past several hundred thousand years (e.g., Fig. 3). At the current level of scientific understanding, it is unclear where these tipping points are or if they have already been passed. *Identifying these tipping points represents an important scientific problem since catastrophic, abrupt climate change represents the greatest potential risk from rising greenhouse gas concentrations.*

5 Climate change and impacts on Utah

Climate change is expected to vary regionally, but estimates of future regional climate change and its impacts on specific states are less certain than global estimates. It is with this in mind that the following discussion considers the potential impacts of projected future climate change on Utah and the Intermountain West.

5.1 Impacts on snowpack, water supply, and drought potential

Ongoing greenhouse gas emissions at or above current levels will likely result in a decline in Utah's mountain snowpack and associated changes to spring runoff. Year-to-year variations in snowfall will continue to dominate mountain snowpack, streamflow, and water supply during the next couple of decades. As temperature increases through the century, it is likely that a greater fraction of precipitation will fall as rain instead of snow, the length of the

snow accumulation season will decrease, and snowpack loss due to evaporation will increase. Trends that are likely to emerge as the climate warms during the 21st century include:

- A reduction in natural snowpack and snowfall in the early and late winter for the winter recreation industry, particularly in lower-to-mid elevation mountain areas (trends in high elevation areas are unclear).
- An earlier and less intense average spring runoff for reservoir recharge.
- Increased demand for agricultural and residential irrigation due to more rapid drying of soils.
- Warming of lakes and rivers with associated changes on aquatic life, including increased algal abundance and upstream shifts of fish habitat.

Future water supplies are strongly dependent on long-term trends in precipitation. If average precipitation remains similar to that of the 20th century, the changes noted above will result in a declining water supply. This decline will be exacerbated if the region becomes more arid. An increase in precipitation is required to offset the changes noted above. Current climate models project a decline in summer precipitation across all of Utah. During the winter, projections indicate a decrease in precipitation over the southwest United States and an increase in the northwest. Utah is located in the transition zone between these regimes where there is low confidence in future precipitation trends. Although a shift to a wetter climate cannot be ruled out, *it is more likely than not that water supplies in Utah and the Colorado River Basin will decline during the 21st century*. In addition, since precipitation will continue to fluctuate from year to year, *the threat of severe and prolonged episodic drought is real and ongoing*.

5.2 Impacts on the Great Salt Lake

Year-to-year variations in mountain snowfall will continue to drive runoff in the Great Salt Lake Basin and the level of the Lake (temperature and evaporation of lake water plays a secondary role). There is limited ability to predict these variations and associated changes in lake level under current climate conditions. *As temperature increases, however, expected declines in mountain snowpack will likely lead to lower average lake levels and increased*

average salinity unless average winter precipitation increases. These changes will affect wetland habitat and wildlife, as well as commercial and recreation activities that rely on the Lake. How soon these changes will occur remains unclear.

5.3 Impacts on agriculture

Agriculture in Utah produces over $1 billion in cash receipts annually, with livestock and related products accounting for about 80% of this figure. Agricultural irrigation covers about 1.5 million acres and is the primary use of developed water in the state. Future agricultural productivity is affected not only by climate change, but also factors such as agricultural research and practices, expansion of urban development into farmland, etc. Based solely on climate change, *per-acre crop yields in Utah will likely increase on irrigated fields provided (1) water remains available for irrigation and (2) temperatures do not increase beyond crop tolerance levels. Pasture yields and livestock forage will likely decline on non-irrigated fields.* Climate change may also have indirect effects on crop yields through changes in the distribution and population of insects and animals, which affects pollination and crop damage.

5.4 Impacts on human health

Impacts on human health are difficult to discern because they are also dependent on technological adaptation and other non-climatic factors. For example, human mortality during heat waves is strongly influenced by the availability of residential air conditioning. If non-climatic factors do not change, expected impacts on human health include:

- Increased heat-related illness and mortality.
- Decreased hypothermia related deaths.
- Increased ground-level ozone concentrations and associated cardio-respiratory diseases.
- Changes in the distribution and morbidity of diseases that are transmitted by insects and animals.

5.5 Impacts on forests, wildlands, and wildfire

Forests and wildlands are adapted to recent climatic conditions and variability, but the rate of temperature change expected during the next century will greatly exceed that produced naturally over the past several thousand years. Forests, wildlands, and wildfires will also be affected by management practices, and other factors such as land-use change. In isolation, future climate change is likely to contribute to:

- Drier conditions and increased wildfire intensity.
- More insect outbreaks and reduced forest health.
- Movement of tree and plant species ranges to higher elevations.

5.6 Impacts on soils

Because of increasing temperature, soils are expected to dry more rapidly, which will likely increase soil vulnerability to wind erosion. This will increase dust transport during high wind events, particularly from salt flats and dry lake beds such as Sevier Lake. Dust deposited on mountain snowpack also accelerates spring snowmelt.

6 Improving assessments of climate change impacts

Preparation for the future impacts of climate variability and change on Utah requires improved monitoring and knowledge of Utah's climate, as well as better understanding of the impacts of weather and climate on the state's water availability, agriculture, industry, and wildlife. While considerable progress has been made over the past decade to understand and project the consequences of increasing greenhouse gas concentrations globally, much work remains to improve understanding of the consequences for Utah. Advances in our understanding and predictive abilities will enable the most effective adaptation to and mitigation of future climate change for Utah's citizens, economy, and natural resources.

For More Information

Climate Change 2007: The Physical Science Basis

Summary for Policymakers: http://www.ipcc.ch/WG1_SPM_17Apr07.pdf
Frequently Asked Questions: http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_FAQs.pdf
Full Report: http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

Climate Change 2007: Impacts, Adaptation, and Vulnerability

Summary for Policymakers: http://www.ipcc.ch/SPM13apr07.pdf
Full Report: http://www.gtp89.dial.pipex.com/chpt.htm

Drought in Utah: Learning from the Past – Preparing for the Future

Full Report: http://www.water.utah.gov/DroughtReport/binder2A.pdf

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Appendix B: Scientific Confidence and Uncertainty

As directed by the BRAC this report addresses issues of confidence and uncertainty. The report follows the guidelines used by the Intergovernmental Panel on Climate Change (IPCC) for their Four Assessment Report (available in full at http://www.ipcc.ch/activity/uncertaintyguidancenote.pdf). Both level of confidence and likelihood based on quantitative analysis or expert judgment are used and reflect definitions as outlined in the tables below.

Table 1. Levels of confidence

Terminology	Degree of confidence in being correct
Very high confidence	At least 9 out of 10
High confidence	About 8 out of 10
Medium confidence	About 5 out of 10
Low confidence	About 2 out of 10
Very low confidence	Less than 1 out of 10

Table 2. Likelihood

Terminology	Likelihood of the occurance/outcome
Virtually certain	Greater than 99%
Very likely	Greater than 90%
Likely	Greater than 66%
About as likely as not	33 to 66%
Very unlikely	Less than 10%
Exceptionally unlikely	Less than 1%

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Section 4.6

Hansen, J., and coauthors, 2007: Dangerous human-made interference with climate: A GISS modelE study. *Atmospheric Chemistry and Physics*, **7**, 2287-2312

Schellnhuber, and coeditors, 2006: Avoiding Dangerous Climate Change, Cambridge Univ. Press, 392 pp. [Available online at http://www.defra.gov.uk/environment/climatechange/research/dangerous-cc/pdf/avoid-dangercc.pdf].

Schneider, S. H., 2004: Abrupt non-linear climate change, irreversibility, and surprise. *Global Environmental Change*, **14**, 245-258.

Section 5.1

Christensen, J. H., and coauthors, 2007: Regional Climate Projections. *Climate Change 2007: The Physical Science Basis*. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, eds. Cambridge University Press, Cambridge, United Kingdom and New York, NY. [Available at http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Ch11.pdf].

Christensen, N., and D. P. Lettenmaier, 2006: A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River basin. *Hydrol. Earth Syst. Sci. Discuss*., **3**, 3727-3770.

Utah Division of Water Resources, 2007: Drought in Utah: Learning from the Past – Preparing for the Future. *Utah State Water Plan*, 124 pp. [Available at http://www.water.utah.gov/DroughtReport/binder2A.pdf].

Section 5.2

Lall, U., and M. Mann, 1995: The Great Salt Lake: A barometer of low-frequency climatic variability. *Water Resources Research*, **31**, 2503-2515.

Section 5.3

USDA, 2006: 2006 Annual Bulletin, p. 37. [Available at http://www.nass.usda.gov/Statistics_by_State/Utah/Publications/Annual_Statistical_Bulletin/Pdf/ab06/pg3706.pdf].

Utah Division of Water Resources, 2001: Utah's Water Resources: Planning for the Future, 73 pp. [Available at http://www.water.utah.gov/planning/SWP/SWP2001/SWP_pff.pdf].

8/8/07

Curriculum Vita

W. James Steenburgh

Professor and Chair
Department of Meteorology
University of Utah
135 South 1460 East, Room 819
Salt Lake City, UT 84112-0110
(801) 581-6136
http://www.met.utah.edu/people/faculty/department/jimsteenburgh/index_html
jim.steenburgh@utah.edu

Research Interests

Mountain weather and climate, orographic and lake-effect precipitation, urban and arid-land meteorology, weather analysis and forecasting

Professional Experience

2005 – present	Chair, Dept. of Meteorology, University of Utah
2001 – present	Associate Professor, Dept. of Meteorology, University of Utah
2002	Visiting Professor, University at Albany, State University of New York
2002	Head, Mesoscale Modeling Group, 2002 Olympic Winter Games
1995 – 2001	Assistant Professor, Dept. of Meteorology, University of Utah
1995	Research Associate, Dept. of Atmospheric Sciences, University of Washington
1989 – 1995	Research Assistant, Dept. of Atmospheric Sciences, University of Washington
1988	Intern Meteorologist, National Weather Service, Albany, NY

Education

1995	Ph. D.	Atmospheric Sciences, University of Washington Doctoral Thesis: "An Investigation of the Interaction of Extratropical Cyclones with the Complex Terrain of Western North America," C. F. Mass, advisor.
1989	B.S.	Meteorology, The Pennsylvania State University, with high distinction

Peer-Reviewed Publications

Shafer, J. C., and W. J. Steenburgh, 2007: Climatology of strong Intermountain cold fronts. *Mon. Wea. Rev.*, in review.

Cheng, W. Y. Y., and W. J. Steenburgh, 2007: Strengths and weaknesses of MOS, running-mean bias removal, and Kalman filter techniques for improving model forecasts over the western U. S. *Wea. Forecasting*, in press.

Orf, L., G. Lackman, C. Herbster, A. Krueger, E. Cutrim, T. Whitaker, J. Steenburgh, and M. Voss, 2007: Models as educational tools. *Bull. Amer. Meteor. Soc.*, **88**, 1101-1104.

West, G. L., W. J. Steenburgh, and W. Y.-Y. Cheng, 2007: Spurious grid-scale precipitation in the North American Regional Reanalysis. *Mon. Wea. Rev.*, **135**, 2168-2184.

Shafer, J. C., W. J. Steenburgh, J. A. W. Cox, and J. P. Monteverdi, 2006: Terrain influences on synoptic storm structure and mesoscale precipitation distribution during IPEX IOP3. *Mon. Wea. Rev.*, **134**, 478-497.

Cheng, W. Y. Y., and W. J. Steenburgh, 2005: Evaluation of surface sensible weather forecasts by the WRF and Eta models over the western United States. *Wea. Forecasting*, **20**, 812-821.

Colle, B. A., J. B. Wolfe, W. J. Steenburgh, D. E. Kingsmill, J. A. W. Cox, and J. C. Shafer, 2005: High resolution simulations and microphysical validation of an orographic precipitation event over the Wasatch Mountains during IPEX IOP3. *Mon. Wea. Rev.*, **133**, 2947-2971.

Hart, K. A., W. J. Steenburgh, and D. J. Onton, 2005: Model forecast improvements with decreased horizontal grid spacing over fine-scale Intermountain orography during the 2002 Olympic Winter Games. *Wea. Forecasting*, **20**, 558-576.

Cox, J. A. W., W. J. Steenburgh, D. E. Kingsmill, J. C. Shafer, B. A. Colle, O. Bousquet, B. F. Smull, and H. Cai, 2005: The kinematic structure of a Wasatch Mountain winter storm during IPEX IOP3. *Mon. Wea. Rev.*, **133**, 521-542.

Pataki, D. E., B. J. Tyler, R. E. Peterson, A. P. Nair, W. J. Steenburgh, and E. R. Pardyjak, 2005: Can carbon dioxide be used as a tracer of urban atmospheric transport? *J. Geophys. Res.*, **110**, D15, D15102.

Steenburgh, W. J., 2004: One hundred inches in one hundred hours – the complex evolution of an Intermountain winter storm cycle. *Bull. Amer. Meteor. Soc.*, **85**, 16-20.

Steenburgh, J., and E. Greene, 2004: Intermountain winter storm evolution during a 100-inch storm cycle. *The Avalanche Review*, **22(4)**, 13-16.

Hart, K. A., W. J. Steenburgh, D. J. Onton, and A. J. Siffert, 2004: An evaluation of mesoscale-model based model output statistics (MOS) during the 2002 Olympic and Paralympic Winter Games. *Wea. Forecasting*, **19**, 200-218.

Steenburgh, W. J., 2003: One hundred inches in one hundred hours – evolution of a Wasatch Mountain winter storm cycle. *Wea. Forecasting*, **18**, 1018-1036.

Steenburgh, W. J., 2002: Using real-time mesoscale modeling in undergraduate education. *Bull. Amer. Meteor. Soc.*, **83**, 1447-1451.

Horel, J., T. Potter, L. Dunn, W. J. Steenburgh, M. Eubank, M. Splitt, and D. J. Onton, 2002: Weather support for the 2002 Winter Olympic and Paralympic Games. *Bull. Amer. Meteor. Soc.*, **83**, 227-240.

Schultz, D. M., W. J. Steenburgh, R. J. Trapp, J. Horel, D. E. Kingsmill, L. B. Dunn, W. D. Rust, L. Cheng, A. Bansemer, J. Cox, J. Daugherty, D. P. Jorgensen, J. Meitin, L. Showell, B. F. Smull, K. Tarp, and M. Trainor, 2002: Understanding Utah Winter Storms: The Intermountain Precipitation Experiment. *Bull. Amer. Meteor. Soc.*, **83**, 189-210.

Stewart, J. Q., C. D. Whiteman, W. J. Steenburgh, and X. Bian, 2002: A climatological study of thermally driven wind systems of the U. S. Intermountain West. *Bull. Amer. Meteor. Soc.*, **83**, 699-708.

Steenburgh, W. J., and T. R. Blazek, 2001: Topographic distortion of a cold front over the Snake River Plain and central Idaho Mountains. *Wea. Forecasting*, **16**, 301-314.

Steenburgh, W. J., and D. J. Onton, 2001: Multiscale analysis of the 7 December 1998 Great Salt Lake-effect snowstorm. *Mon. Wea. Rev.*, **129**, 1296-1317.

Onton, D. J., and W. J. Steenburgh, 2001: Diagnostic and sensitivity studies of the 7 December 1998 Great Salt Lake-effect snowstorm. *Mon. Wea. Rev.* **129**, 1318-1338.

Steenburgh, W. J., S. F. Halvorson, and D. J. Onton, 2000: Climatology of lake-effect snowstorms of the Great Salt Lake. *Mon. Wea. Rev.,* **128**, 709-727.

Mass, C. F., and W. J. Steenburgh, 2000: An observational and numerical study of an orographically trapped wind reversal along the west coast of the U.S. *Mon. Wea. Rev.,* **128**, 2363-2396.

Schultz, D. M., and W. J. Steenburgh, 1999: The formation of a forward-tilting cold front with multiple cloud bands during Superstorm 1993. *Mon. Wea. Rev.*, **127**, 1108-1124.

White, B. G., J. Paegle, W. J. Steenburgh, J. D. Horel, R. T. Swanson, L. K. Cook, D. J. Onton, and J. G. Miles, 1999: Short-term forecast validation of six models. *Wea. Forecasting*, **14**, 84-108.

Steenburgh, W. J., D. M. Schultz, and B. A. Colle, 1998: The structure and evolution of gap outflow over the Gulf of Tehuantepec, Mexico. *Mon. Wea. Rev.*, **126**, 2673-2691.

Steenburgh, W. J., C. F. Mass, and S. A. Ferguson, 1997: The influence of terrain-induced circulations on wintertime temperature and snow level in the Washington Cascades. *Wea. Forecasting,* **12**, 208-227.

Steenburgh, W. J., and C. F. Mass, 1996: Interaction of an intense extratropical cyclone with the coastal orography of western North America. *Mon. Wea. Rev.,* **124**, 1329-1352.

Steenburgh, W. J., and C. F. Mass, 1994: The structure and evolution of a simulated Rocky Mountain lee trough. *Mon. Wea. Rev.*, **122**, 2740-2761.

Steenburgh, W. J., and J. R. Holton, 1993: On the interpretation of geopotential height tendency equations. *Mon. Wea. Rev.*, **121**, 2642-2645.

Mass, C. F., W. J. Steenburgh, and D. M. Schultz, 1991: Diurnal surface pressure variations over the continental U.S. and the influence of sea level reduction. *Mon. Wea. Rev.*, **119**, 2814-2830.

E-Publications

Steenburgh, W. J., 2004: Dynamics and microphysics of cool-season orographic storms. COMET Meteorological Education & Training (MetEd) Program Webcast. http://deved.meted.ucar.edu/norlat/orographic/index.htm.

Technical Reports

SHARE: Sierra Hydrometeorology and Atmospheric River Experiment Master Planning Document. SHARE Scientific Steering Committee. D. Kingsmill and S. Yuter, co-chairs.

Steenburgh, W. J., and D. J. Onton, 2001: Meteorological modeling for the 2002 particulate matter (PM10) State Implementation Plan for Salt Lake and Utah Counties. Report to the Utah Department of Environmental Quality, Division of Air Quality, 21 pp.

Steenburgh, W. J., 1998: Weather support at the 1998 Nagano Winter Olympics: Summary and Recommendations. Report to the Salt Lake Organizing Committee for the Olympic Winter Games of 2002.

MAP: Mesoscale Alpine Programme U. S. Overview Document 1996, National Science Foundation Field Program Proposal. R. Houze, J. Kuettner, and R. Smith, eds.

Steenburgh, W. J., and C. F. Mass, 1996: Synoptic and mesoscale circulations during high ozone episodes over western Washington: An evaluation of the Penn State/NCAR Mesoscale Model (MM5). Report to the Puget Sound Air Pollution Control Agency, 67 pp.

Steenburgh, W. J., and C. F. Mass, 1996: Numerical Simulations of the PM-10 Episode of 3-4 January 1995. Report to the Puget Sound Air Pollution Control Agency, 28 pp.

Research and Educational Funding

Current

Mechanisms of Intermountain Cold Front Evolution (PI), National Science Foundation, **$387.5K**, 1/07-12/09.

Structure and Evolution of Intermountain Cyclones (PI), National Science Foundation, **$344.3K**, 1/04-12/07.

Past

NOAA Cooperative Institute for Regional Prediction: 2004-2007 (co-PI), NOAA, **$375.0K**, 7/04-6/07.

Evaluation of NCEP Regional Reanalyses over Complex Terrain (co-PI), NOAA, **$220.0K**, 7/04-6/07.

Improving the Gridded Forecast Process Using Statistically Post-Processed Model Guidance Based on High-Density Mesonet Observations (PI), University Corporation for Atmospheric Research/COMET, **$81.0K**, 6/04-11/06.

Orographic Precipitation Processes over the Wasatch Mountains during IPEX (PI), National Science Foundation, **$231.5K**, 1/01-12/03.

Cooperative Institute for Regional Prediction Contribution to CSTAR (co-PI), NOAA, **$375.0K**, 1/01-12/03.

Planning Weather Support for the 2002 Winter Olympics (co-PI), NOAA, **$588.7K**, 4/01-3/02.

Regional Coupled Atmospheric/Land–Surface Modeling for GAPP (PI), University of Utah Seed Grant Committee, **$30.7K**, 3/02-2/03.

Cooperative Institute for Regional Prediction: 2000 (co-PI), NOAA, **$125.0K**, 1/00-12/00.

Planning Weather Support for the 2002 Winter Olympics (co-PI), NOAA, **$216.0K**, 1/99-12/ 99.

Collaboration for Improved Meteorological Modeling (PI), Utah Division of Air Quality, **$56.7K**. 10/99-9/01.

Planning Weather Support for the 2002 Winter Olympics (co-PI), NOAA, **$97.0K**, 6/98-6/99.

Development of a Meteorological Computation and Visualization Laboratory: A Unidata Equipment Proposal (PI), National Science Foundation, **$19.4K**, 9/97-9/98.

Mesoscale Modeling Studies of Warm Season Rainfall in the PACS Domain (co-PI), NOAA-OGP, **$171.7K**, 3/98-2/00.

Observational and Numerical Investigations of the Interaction of Synoptic Weather Systems with the Orography of the Western United States (PI), National Science Foundation, **$206.5K**, 2/97-1/00.

Workshop on Weather Prediction in the Intermountain West (PI), University Corporation for Atmospheric Research//COMET, **$3.8K**, 4/ 98-3/99.

Real-Time Numerical Weather Prediction for the Wasatch Front and Adjoining Region (PI), University of Utah Research Committee, **$5.8K**, 2/96-2/98.

Field Program Participation

IMPROVE (2001)	Lead forecaster
IPEX (2000)	Co-lead scientist, mission coordinator, lead forecaster
VTMX (2000)	Lead forecaster
COAST (1993)	Airborne scientist, field-phase forecasting and planning

Teaching

I regularly teach a year-long sequence in synoptic meteorology covering synoptic-dynamic meteorology, extratropical cyclones and fronts, and weather analysis and forecasting. I have also co-developed an advanced course in Mountain Meteorology (Meteo 5550/6550) in collaboration with Dr. John Horel. In 2001 I received the *College of Mines and Earth Sciences Outstanding Teaching Award.* I also served as the Department Undergraduate Advisor from 1996-2005.

Synoptic Meteorology I (Meteo 5530/6530)
Synoptic Meteorology II (Meteo 5540/6540)
Mountain Meteorology (Meteo 5550/6540)
Mountain Weather and Climate (ATM 619, University at Albany, Fall 2002)
Fundamental Applications of Dynamic Meteorology (Meteo 551, quarter system)
Weather Discussion (Meteo 5580/6580)
Undergraduate Seminar (Meteo 2810)
Graduate Seminar (Meteo 7810)
Undergraduate Advisor (1996-2005)

Student Mentoring

Doctoral Students Supervised

Cox, J. A. W., 2006: The Sensitivity of thermally driven mountain flows to land-cover change. Present Employment: Research Meteorologist, AIR Worldwide, Boston, MA.

Shafer, J. C., 2005: Topographic and diabatic influences on baroclinic storm evolution over the Intermountain West. Present employment: Assistant Professor, Lyndon State College, VT.

Hart, K. A., 2004: An evaluation of high-resolution modeling and statistical forecast techniques over complex terrain. Present employment: Professor, U.S. Air Force Academy and Lt. Col., U.S. Air Force, Colorado Springs, CO.

Onton, D. J., 2000: An observational and numerical modeling investigation of Great Salt Lake-effect snow. Present employment: Meteorologist, National Weather Service.

Masters Students Supervised

West, G. L., 2005: Spurious grid-scale convection in the North American Regional Reanalysis (NARR). Present employment: Ph. D. student, University of Utah

Shafer, J. C., 2002: Synoptic and mesoscale structure of a Wasatch Mountain winter storm. Present employment: Assistant Professor, Lyndon State College, VT.

Cox, J. A. W., 2002: Kinematic structure of a Wasatch Mountain Snowstorm. Research Meteorologist, AIR Worldwide, Boston, MA.

Grandy, R. J., 2001: Case studies of ozone transport processes along the Wasatch Front. Present employment: Permit Engineer, State of Utah Division of Air Quality, UT.

Siffert, A. J., 2001: Point-specific MOS forecasts for the 2002 Winter Games. Present employment: Meteorologist, ACE-INA, Philadelphia, PA.

Blazek, T. R., 2000: Analysis of a Great Basin cyclone and attendant mesoscale features. Present employment: Major, U. S. Air Force, Offut AFB, NE.

Halvorson, S. F., 1999: Climatology of lake-effect snowstorms of the Great Salt Lake. Present employment: Meteorologist, U. S. Army Dugway Proving Grounds, UT.

Cook, L. K., 1998: An evaluation of mesoscale model performance over the western United States. Present employment: Meteorologist, National Weather Service, Salt Lake City, UT.

Current Research Assistants
Greg West, Ph. D.
Colby Neuman, M. S.

Graduate Committees
Erik Crosman, Ph.D. (enrolled)
Phoebe McNeally, Ph.D., Dept. of Geography (enrolled)
Scott Hynek, Ph. D., Dept. of Geology and Geophysics (enrolled)
Luis Blacutt, M.S. 2006
David Myrick, Ph.D. 2006
Mario Majcen, M.S. 2005
Eric Crosman, M.S. 2005
Eric Stone, M.S. 2004
Dan Zumpfe, M.S. 2004
Jennifer Roman, Ph.D. 2004
Robert Rice, Ph.D., Dept. of Civil Engineering, 2003
Linda Cheng, M.S. 2001
Gonzalo Miguez-Macho, Ph.D. 2000
Robert Swanson, Ph.D. 1998
Jonathan Slemmer, M.S. 1998
Brett McDonald, Ph.D. 1998
Bryan White, M.S. 1997
Christopher Stiff, M.S. 1997
Mark Braby, MS 1997

Current and Past Undergraduate Research Assistants
Eric Grimit
Jebb Stewart
Dave Strohm

Matt Maserik
Todd Foisy
Christine McCue
Marissa Orgill
Colby Neuman

Invited Lectures and Seminars

Steenburgh, W. J., 2006: *Everything you wanted to know about the Great Salt Lake effect but were afraid to ask*, Utah State University.

Steenburgh, W. J., 2005: *Improved performance measures for NWS gridded forecasts*, NWS-WR SOO/DOH Workshop.

Steenburgh, W. J., 2004: *Using the MesoWest cooperative networks for environmental analysis and prediction*, NOAA National Severe Storms Laboratory.

Steenburgh, W. J., 2004: *Mountains of snow: Orographic storms of the western United States*. American Avalanche Association Fall Weather Seminar, Snowbird, UT.

Steenburgh, W. J., 2003: *Dynamics and microphysics of orographic storms*, MSC/COMET Winter Weather Course.

Steenburgh, W. J., 2002: Numerical *weather prediction: The ultimate test of supercomputing*. University of Utah High School Computing Institute.

Steenburgh, W. J., 2002: *Weather support for the 2002 Olympic and Paralympic Winter Games*, Marine Sciences Research Center, State University of New York, Stony Brook.

Steenburgh, W. J., 2002: *ADAS, MesoWest, and IFPS challenges, tools, and strategies*, NWS-WR SOO/DOH Workshop.

Steenburgh, W. J., 2002: *Cool-season orographic precipitation processes and prediction*, MSC/COMET Winter Weather Course.

Steenburgh, W. J., 2001: *Weather research and forecasting advances for the 2002 Olympic Winter Games*, University of Innsbruck, Austria.

Steenburgh, W. J., 2000: *Educational applications of mesoscale modeling*, UCAR/UNIDATA Summer Workshop.

Steenburgh, W. J., 1999: *Orographic cyclogenesis*, UCAR/COMET Mesoscale Analysis and Prediction Course.

Steenburgh, W. J., 1997: *Mesoscale modeling over western North America: Model-aided studies and real-time applications*, UCAR/COMET Mesoscale Analysis and Prediction Course.

Professional Service

1996 – present	Fellow, NOAA Cooperative Institute for Regional Prediction
2006 – present	3TIER Environmental Forecast Group Science Advisory Board
1994 – present	Member, American Meteorolgical Society
2003 – 2006	Chair, UCAR/Unidata User Committee
2003 – 2006	User Committee Representative, UCAR/Unidata Policy Committee
1998 – 2006	UCAR/Unidata User Committee
2001 – 2006	Associate Editor, *Weather and Forecasting*
2005	Utah Sci. Center Avalanche, Weather, Mountains and Risk Discussion Panel
2004	Chair, Workshop on Weather Prediction in the Intermountain West
2000 – 2003	AMS Mountain Meteorology Committee

1996 – 2002	Head, Mesoscale Modeling Team for the 2002 Olympic Winter Games
2002	Co-chair (with Louisa Nance), AMS Mountain Meteorology Conference
1999 – 2001	PM10 SIP Modeling Workgroup, State of Utah Dept. of Environmental Quality
2000	Chair, Workshop on Weather Prediction in the Intermountain West
1999	Chair, Workshop on Weather Prediction in the Intermountain West
1998	Chair, Workshop on Weather Prediction in the Intermountain West
1997	Chair, Workshop on Weather Prediction in the Intermountain West
1994 – 1996	Manager, Workstation MM5 Users' Group
1994 – 1996	Advisory Committee for the PSU/NCAR Mesoscale Model
1994 – 1996	Puget Sound Regional Modeling Committee

University Service

2005 – present	Chair, Department of Meteorology
2005 – present	College of Mines and Earth Sciences College Council
2005 – present	College of Mines and Earth Sciences Executive and Space Committee
2004 – 2006	College of Mines and Earth Sciences Distinguished Lecture Series Committee
1996 – 2005	Department of Meteorology Undergraduate Advisor
2003 – 2004	Chair, College of Mines and Earth Sciences Faculty Relations Committee
2001 – 2004	Center for High Performance Computing Faculty Advisory Board
1998 – 2004	Department of Meteorology Curriculum Committee
2001 – 2002	Chiar, College of Mines and Earth Sciences Teaching Committee
1996 – 2002	College of Mines and Earth Sciences Teaching Committee
1999 – 2001	Chair, College of Mines and Earth Sciences Computer Committee
1997 – 2001	College of Mines and Earth Sciences Computer Committee
2000	College of Science Day Lecturer
1999	College of Science Day Lecturer
1996 – 1998	Leader, Department of Meteorology Semester Conversion
1997 – 1998	Academic Computing and Library Information Systems Advisory Committee
1998	Center for High Performance Computing Visualization Task Force
1998	College of Science Day Lecturer
1997	College of Science Day Lecturer
1996	College of Science Day Lecturer
1996	Featured Instructor, Commercials promoting use of technology in the classroom

Awards

Outstanding Service Award (2002), National Weather Service Western Region, "for outstanding service to the weather support group for the 2002 Olympic Winter Games"

Outstanding Teaching Award (2001), College of Mines and Earth Sciences, University of Utah

Graduate Fellowship (1994), American Meteorological Society, to attend International Symposium on the Life Cycles of Extratropical Cyclones, Bergen, Norway

Elizabeth Holmes Teas' Undergraduate Scholarship for Academic Excellence (1987-1989)

Curriculum Vita

David R. Bowling

8/15/07

Assistant Professor
Department of Biology, University of Utah
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bowling@biology.utah.edu

Research Interests

Ecosystem ecology, biosphere-atmosphere interactions, carbon and water cycling

Academic Positions

2003 – present	Assistant Professor, Dept. of Biology, University of Utah
2006 – present	Adjunct Assistant Professor, Dept. of Meteorology, University of Utah
2001 – 2002	Research Assistant Professor, Biology, University of Utah
1999 – 2001	Postdoctoral Scientist, Biology, U. of Utah, with J. Ehleringer

Education

1999	Ph.D.	Biology	University of Colorado, Boulder, with R. Monson
1994	M.S.	Electrical Engineering	University of Colorado, Boulder, with D. Etter
1991	B.S.	Electrical Engineering	New Mexico State University

Peer-Reviewed Publications

(graduate students underlined)

Number of times cited (published papers listed in Web of Science as of Aug. 2007)

- senior-authored papers: 304 times cited (avg 27.6/paper)
- co-authored papers: 232 times cited (avg 15.5/paper)

in review:

Zobitz JM, Moore D, Sacks WJ, Monson RK, Bowling DR, Schimel DS, Integration of process-based soil respiration models with whole-ecosystem CO_2 measurements, submitted 6/07 to *Ecosystems*.

Schaeffer SM, Anderson DE, Burns SP, Monson RK, Sun J, Bowling DR, Canopy structure and atmospheric flows in relation to the $\delta^{13}C$ of respired CO_2 in a subalpine coniferous forest, submitted 6/07 to *Agricultural and Forest Meteorology*.

Zobitz JM, Burns SP, Reichstein M, Bowling DR, Partitioning net ecosystem carbon exchange and the carbon isotopic disequilibrium between whole-ecosystem photosynthesis and respiration in a subalpine forest, submitted 5/07 to *Global Change Biology*.

Schwinning S, Bowling D, Ehleringer J, Belnap J, Sensitivity of the Colorado Plateau to change: climate, ecosystems, and society, submitted 5/07 to *BioScience*.

in press:

Zobitz JM, Burns SP, Ogee J, Reichstein M, Bowling DR, Partitioning net ecosystem exchange of CO_2 in a high-elevation subalpine forest: comparison of a

Bayesian/isotope approach to environmental regression methods, submitted 8/06 to *Journal of Geophysical Research.*

published:

32. Fuentes JD, Wang D, Bowling D, Potosnak M, Monson RK, Delany AC, Stockwell WR, Goliff WS (2007) Biogenic hydrocarbon chemistry within and above a mixed deciduous forest, *Journal of Atmospheric Chemistry.*, DOI 10.1007/s10874-006-9048-4.
31. Zobitz JM, Keener JP, Schnyder H, Bowling DR (2006) Sensitivity analysis and quantification of uncertainty for isotopic mixing relationships in carbon cycle research, *Agricultural and Forest Meteorology*, 136:56-75.
30. Wahl EH, and 12 others (2006) Applications of cavity ring-down spectroscopy to high precision isotope ratio measurement of $^{13}C/^{12}C$ in carbon dioxide, *Isotopes in Environmental and Health Studies*, 42:21-35, doi:10.1080/10256010500502934.
29. Pataki DE, Bowling DR, Ehleringer JR, Zobitz JM (2006) High resolution atmospheric monitoring of urban carbon dioxide sources, Geophys. Res. Lett., 33, L03813, doi:10.1029/2005GL024822.
28. Bowling DR, Burns SP, Conway T, Monson R, White JWC (2005) Extensive observations of CO_2 carbon isotope content in and above a high-elevation subalpine forest, *Global Biogeochemical Cycles*, 19, GB3023, doi:10.1029/2004GB002394.
27. Roden JS, Bowling DR, McDowell NG, Bond B, Ehleringer JR (2005) Carbon and oxygen isotope ratios of tree ring cellulose along a precipitation transect in Oregon, USA, *Journal of Geophysical Research*, 110, G02003, doi:10.1029/2005JG000033.
26. Baldocchi DD, and Bowling DR (2005) Theoretical examination of Keeling-plot relationships for carbon dioxide in a temperate broadleaved forest with a biophysical model, CANISOTOPE, in, Flanagan LB, Ehleringer JR, Pataki DE, Eds. *Stable Isotopes and Biosphere-Atmosphere Interactions: Processes and Biological Controls*, Elsevier, Amsterdam, pp 109-124.
25. McDowell NG, Bowling DR, Schauer A, Irvine J, Bond BJ, Law BE, Ehleringer JR (2004) Associations between carbon isotope ratios of ecosystem respiration, water availability and canopy conductance, *Global Change Biology*, 10, 1767–1784, doi: 10.1111/j.1365-2486.2004.00837.x
24. McDowell NG, Bowling DR, Bond BJ, Irvine J, Law BE, Anthoni P, Ehleringer JR (2004) Response of the carbon isotopic content of ecosystem, leaf and soil respiration to meteorological and physiological driving factors in a *Pinus ponderosa* ecosystem, *Global Biogeochemical Cycles,* 18, GB1013, doi:10.1029/2003GB002049.
22. Bowling DR, McDowell NG, Welker JM, Bond BJ, Law BE, Ehleringer JR (2003) Oxygen isotope content of CO_2 in nocturnal ecosystem respiration: 1: Observations in forests along a precipitation transect in Oregon, USA, *Global Biogeochemical Cycles*, 17(4), 1120, doi:10.1029/2003GB002081.
21. Bowling DR, McDowell NG, Welker JM, Bond BJ, Law BE, Ehleringer JR (2003) Oxygen isotope content of CO_2 in nocturnal ecosystem respiration: 2: Short-term dynamics of foliar and soil component fluxes in an old-growth ponderosa pine forest, *Global Biogeochemical Cycles*, 17(4), 1124, doi:10.1029/2003GB002082.
20. Pataki DE, Bowling DR, Ehleringer JR (2003) The seasonal cycle of carbon dioxide and its isotopic composition in an urban atmosphere: anthropogenic and biogenic effects, *Journal of Geophysical Research*, 108(D23), 4735, doi:10.1029/2003JD003865.

19. Bowling DR, Sargent SD, Tanner BD, and Ehleringer JR (2003) Tunable diode laser absorption spectroscopy for stable isotope studies of ecosystem-atmosphere CO_2 exchange, *Agricultural and Forest Meteorology*, 118, 1-19.
18. Schauer AJ, Lai C-T, Bowling DR, Ehleringer JR (2003) An automated sampler for collection of atmospheric trace gas samples for stable isotope analyses, *Agricultural and Forest Meteorology,* 118, 113-124.
17. Bowling DR, Pataki DE, and Ehleringer JR (2003), Critical evaluation of micrometeorological methods for measuring ecosystem-atmosphere isotopic exchange of CO_2, *Agricultural and Forest Meteorology*, 116, 159-179.
16. Pataki DE, Ehleringer JR, Flanagan LB, Yakir D, Bowling DR, Still CJ, Buchmann N, Kaplan JO, and Berry J (2003) The application and interpretation of Keeling plots in terrestrial carbon cycle research, *Global Biogeochemical Cycles*. 17(1), 1022, doi:10.1029/2001GB001850.
15. Baldocchi DD, and Bowling DR (2003) Modelling the discrimination of $^{13}CO_2$ above and within a temperate broad-leaved forest canopy on hourly to seasonal time scales, *Plant, Cell, and Environment*, 26:231-244.
14. Ehleringer JR, Bowling DR, Flanagan LB, Fessenden J, Helliker B, Martinelli LA, Ometto JP (2002) Stable isotopes and carbon cycle processes in forests and grasslands, *Plant Biology*, 4:181-189.
13. Bowling D, McDowell N, Bond B, Law B, and Ehleringer J (2002) ^{13}C content of ecosystem respiration is linked to precipitation and vapor pressure deficit, *Oecologia*, 131:113-124.
12. Bowling DR, Cook CS, and Ehleringer JR (2001) Technique to measure CO_2 mixing ratio in small flasks with a bellows/IRGA system, *Agricultural and Forest Meteorology,* 109, 61-65.
11. Bowling DR, Tans PP, and Monson RK (2001) Partitioning net ecosystem carbon exchange with isotopic fluxes of CO_2, *Global Change Biology*, 7:127-145.
10. Bowling DR, Baldocchi DD, and Monson RK (1999) Dynamics of isotopic exchange of carbon dioxide in a Tennessee deciduous forest, *Global Biogeochemical Cycles*, 13:903-922.
9. Bowling DR, Delany AC, Turnipseed AA, Baldocchi DD, and Monson RK (1999) Modification of the relaxed eddy accumulation technique to maximize measured scalar mixing ratio differences in updrafts and downdrafts, *Journal of Geophysical Research*, 104:9121-9133.
8. Baldocchi D, Fuentes J, Bowling D, Turnipseed A, and Monson R (1999) Scaling isoprene fluxes from leaves to canopies: test cases over a boreal aspen and a mixed species temperate forest, *Journal of Applied Meteorology*, 38:885-898.
7. Katul G, Hsieh C-I, Bowling D, Clark K, Shurpali N, Turnipseed A, Albertson J, Tu K, Hollinger D, Evans B, Offerle B, Anderson D, Ellsworth D, Vogel C, and Oren R (1999) Spatial variability of turbulent fluxes in the roughness sublayer of an even-aged pine forest, *Boundary-Layer Meteorology,* 93:1-28.
6. Singsaas E, Laporte M, Shi J, Monson R, Bowling D, Johnson K, Lerdau M, Jasentuliytana A, and Sharkey T. (1999) Kinetics of leaf temperature fluctuation affects isoprene emission from red oak (*Quercus rubra* L.) leaves, *Tree Physiology*, 19:917-924.
5. Bowling DR, Turnipseed AA, Delany AC, Baldocchi DD, Greenberg JP, and Monson RK (1998) The use of relaxed eddy accumulation to measure biosphere-atmosphere exchange of isoprene and other trace gases, *Oecologia*, 116:306-315.
4. Demmig-Adams B, Adams III WW, Barker DH, Logan BA, Bowling DR, and Verhoeven AS (1996) Using chlorophyll fluorescence to assess the fraction of

absorbed light allocated to thermal dissipation of excess excitation, *Physiologia Plantarum* 98:253-264.

technical reports:

23. American Institute of Biological Sciences. (2004) Ecological Aspects of Biogeochemical Cycles: Report from a NEON Science Workshop. Washington, DC: AIBS.
3. Durand S and Bowling D (1990) *Data Acquisition for Photovoltaic Power Plants*, EPRI Publication GS-7082, Electric Power Research Institute.
2. Durand S, Bowling D, and Risser V (1990) Lessons Learned From Testing Utility Connected PV Systems, *Proc. 21st IEEE PV Specialists Conference*, 909-913.
1. Rosenthal A, Lane C, and Bowling D (1990) *Photovoltaic System Performance Assessment for 1988*, EPRI Publication GS-6696, Electric Power Research Institute.

Grant Support

Present:

Long-term assessment of isotopic exchange of carbon dioxide in a subalpine forest (Niwot Ridge AmeriFlux site), U. S. Department of Energy, DE-FG02-04ER63904, **$649.8k**, PI: Bowling, 9/04-9/07.

Isotope Ratio Mass Spectrometers for Environmental Research, NSF Major Research Instrumentation, **$405k**, PIs: Ehleringer, Cerling, Bowling, 7/07-6/09.

Past:

Development of a novel real-time method to measure the stable isotope content of carbon dioxide respired from soil, University of Utah Funding Incentive Seed Grant Program, **$27k**, PI: Bowling, 7/06-6/07.

Field-deployable gas analyzer for MMV applications (Phase I), U. S. Department of Energy, SBIR program, PI: Anthony O'Keefe, Los Gatos Research, Bowling subcontract **$14.8k**, 2/07-3/07.

Technical proposal for the development of a Fourier-transform infrared gas analyzer to measure carbon isotopes of CO_2, U.S. Department of Energy, SBIR program, PI: Larry Jacobsen, Campbell Scientific, Inc., Bowling subcontract **$15.2k**, 8/05-7/06. (this grant was awarded but the company did not make enough progress to merit testing the instrument, so we never saw the money at Utah)

System upgrade for Biology's shared tunable diode laser absorption spectrometer, Research Instrumentation Fund Award, University of Utah, **$7.1k**, PI: Bowling, 7/05.

Instrumentation purchase for a shared tunable diode laser absorption spectrometer, Research Instrumentation Fund Award, University of Utah, **$77.6k**, PI: Bowling, 6/03.

Ecosystem carbon cycling in a desert grassland, University Research Committee Faculty Research and Creative Grant, University of Utah, **$5.4k**, PI: Bowling, 5/03-5/04.

Ultra-sensitive portable isotope ratio analyzer, US Department of Energy, SBIR DE-FG03-01ER83250-A002, PI: Dmitri Permogorov, Picarro, Inc., Bowling subcontract **$122k**, 5/02-5/04.

Pending:

A Regional Atmospheric Continuous CO_2 Observing Network in the Rocky Mountains (Rocky RACCOON): Operation and Synthesis with Remote Sensing Products to Produce Regional Carbon Flux Estimates, NASA Carbon Cycle Science, PI Britt Stephens, National Center for Atmospheric Research, Bowling subcontract **$168.3k**, 1/08-12/10.

Field-deployable gas analyzer for MMV applications (Phase II), U. S. Department of Energy, SBIR program, PI: Anthony O'Keefe, Los Gatos Research, Bowling subcontract **$63.6k**, 1/08-1/09.

Environmental controls on the isotopic content of plant, soil, and ecosystem respiration, US Department of Energy Terrestrial Carbon Processes Program, **$721k**, PI: Bowling, 9/06-8/09 (still in review, very delayed by the agency)

Graduate student fellowships (I contributed as Ph.D. advisor):

Comparison and assessment of methods to partition net ecosystem exchange of CO_2 in heterogeneous environments, US Department of Energy Global Change Education Program, Graduate Research Environmental Fellowship, **$54k**, (2005-2008), (awarded to John Zobitz)

Teaching

Ecosystem Ecology (new course Fall 2004, Fall 2006, Biology 5490): This lecture course for 50-70 upper division or graduate students examines the biological, physical, and chemical factors that control storage and cycling of the major elements (carbon, nitrogen, and phosphorus) within terrestrial ecosystems.

Biophysical Ecology (new course Fall 2005, Fall 2007, Biology/Meteorology/Geology 5495): This lecture and laboratory course for 25 upper division or graduate students examine the physical environment in which plants, animals, and soil organisms live, how the physical environment affects their physiological function, and how organisms in turn affect their physical environment.

Water and Ecology of Western Ecosystems (new course Fall 2003, Biology 7406): This graduate core seminar examines the importance of water to animals, plants, insects, and microbes in ecosystems of the western U.S.

Biological Responses to Climate Change (new course Spring 2005, Biology 7406): This graduate core seminar examines observed responses of biological systems to climate change, such as increased growing season length, altered migration patterns, changes in species abundance, etc.

Stable Isotope Ecology (existing course, team-taught Summers 2003-2007, Biology 7473/7475): This summer 2-week course attracts top-notch graduate students, postdocs, and faculty from around the world. The course focuses on environmental science applications of stable isotope theory, methods, instrumentation, experimental design, lab and fieldwork.

University Service

University Committees

College of Science Representative to International Requirement Committee, since 8/05

Department of Biology Committees

2002-2003 Graduate Admission

2003-2004 Graduate Admission, Communication, BioURP Steering, Red Butte Canyon
2004-2005 Graduate Admission, BioURP Steering, Red Butte Canyon
2005-2006 Graduate Admission, Curriculum and Teaching, Red Butte Canyon, Riser Award
2006-2007 Graduate Admission, Curriculum and Teaching, Red Butte Canyon
2007-2008 pending

Science Overnight Orientation, Faculty Volunteer, 6/05 and 6/06

Professional Service

Associate Editor, Journal of Geophysical Research – Biogeosciences, since 12/04.

AmeriFlux Steering Committee member, which oversees a national flux tower CO_2 monitoring network, since 10/04.

Manuscript reviews:
Agricultural and Forest Meteorology, Analytical Chemistry, Applied Geochemistry, Applied Spectroscopy, Atmospheric Environment, Australian Journal of Plant Physiology, Chemical Geology, Ecological Applications, European Journal of Soil Biology, Geochimica et Cosmochimica Acta, Global Biogeochemical Cycles, Global Change Biology, Isotopes in Environmental and Health Studies, Journal of Applied Meteorology, Oecologia, Plant, Cell, and Environment, Tellus, Tree Physiology

Grant proposal review panels:
- NSF June 2007

Grant proposal reviews:
- NSF Directorate for Biological Sciences, Division of Environmental Biology
  - Ecosystem Science cluster
  - Instrumentation and Instrumentation Development
  - Major Research Instrumentation
- NSF Directorate for Geosciences, Division of Atmospheric Sciences
- USDOE National Institute for Global Environmental Change
  - Northeast Regional Center
  - Southeast Regional Center
  - Great Plains Regional Center
- USDOE National Institute for Climatic Change Research
  - Northeast Regional Center
  - Southeast Regional Center
- USDOE Small Business Innovation Research
- Kearney Foundation for Soil Science (U. California system)
- NOAA Climate and Global Change Program
- Natural Environment Research Council (United Kingdom)
- Israel Science Foundation (Israel)
- Swiss National Science Foundation (Switzerland)

External dissertation reviews:

- Australian National University, Research School of Biological Sciences (Australia)

Active in developmental meetings for National Ecological Observatory Network (NEON, http://www.neoninc.org/)

- Site evaluation visit to Onaqui-Benmore area in Utah for Great Basin Domain 15 Core Site, 4/07.
- Rocky Mountain Ecological Observatory Network (ROMEOnet) Regional Meetings, Ft. Collins, CO, 11/04, Boulder, CO, 4/04.
- Invited participant, NEON Workshop, Boulder, CO, 7/04 – co-authored an associated publication (in list above)

Active in developmental meetings for Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI, http://www.cuahsi.org/)

- collaboration on a vision paper regarding Watersheds and Urbanization
- development of the Great Salt Lake Basin as a Long-Term Hydrologic Observatory

Interaction with local media

- global change public discussion panel for KCPW radio, 6/16/06
- KCPW radio article, 3/16/06
- Newspaper article, Salt Lake Tribune, 8/7/06
- Newspaper article, Daily Utah Chronicle, 4/11/06
- Op-ed article, Daily Utah Chronicle, 9/17/04

Students and Employees Supervised

Graduate Students

- Primary PhD Advisor for:
  Seth Arens: beginning Fall 2007.
  Greg Maurer: beginning Fall 2007.
  Andrew Moyes: Expected to finish his Ph.D. sometime in 2008.
  John Zobitz: Awarded Ph.D. at end of summer 2007, accepted a tenure-track faculty position at Augsburg College.

- Served on Supervisory Committee for:
  - Biology: Susan Bush, Tomas Domingues, Sylvia Englund, Erin Hanlon, Anthony Macharia, Jessica Pearce, Christy Turnbull, Adam West
  - Mathematics: Molly Kelton
  - Geology and Geophysics: Mike Davis

Postdoctoral Scientists: Sean Schaeffer

Undergraduates: Susan Bush, Sarah Gaines, Zach James, Tina Jensen, Stephanie Plummer, Sarah Reed

Technicians: Suzanne Bethers, David Galvez, Shashi Kalaskar, Shannon Kincaid, Claire Lunch, Andy Schauer

Invited Lectures and Seminars

international:

Bowling D, Stable Isotopes of CO_2 and Forest Carbon Cycling, Wissenschaftszentrum Weihenstephan, Technische Universität München, Freising, Germany, 1/07.

Bowling D, Zobitz J, Burns S, Monson R, and Turnipseed A, Partitioning assimilation and respiration in a subalpine forest using isofluxes, International Symposium: "Partitioning of fluxes between the biosphere and atmosphere across spatial scales", ESF Scientific Programme, Stable Isotopes in Biospheric-Atmospheric Exchange (SIBAE), Interlaken, Switzerland, 4/04.

Bowling D, Burns S, Monson R, Turnipseed A, Photosynthetic and respiratory fluxes and their isotopic content in a Colorado subalpine forest, International Symposium: "Stable isotopic signals of the terrestrial biosphere: Linking ecosystem C fluxes to isotopic signals of plant components", ESF Scientific Programme, Stable Isotopes in Biospheric-Atmospheric Exchange (SIBAE), Orvieto, Italy, 11/03.

Bowling D, Partitioning NEE using ecosystem fluxes of $^{13}CO_2$, Fluxnet Synthesis Workshop, Orvieto, Italy, 06/02.

Bowling D, Lai C-T, McDowell N, Short-term environmental effects on $\delta^{13}C$ of ecosystem respiration, Stable Isotopes and Biosphere-Atmosphere Interactions International Workshop, Banff, Alberta, 5/02.

within U.S.:

Bowling D, Stable isotopes of CO_2 and forest carbon cycling, School of Biological Sciences, Washington State University, 2/07.

Bowling D, Stable isotopes of CO_2 and forest carbon cycling, Department of Ecology and Evolutionary Biology, University of Arizona, 4/06.

Bowling D, Stable isotopes and carbon exchange between terrestrial ecosystems and the atmosphere, American Society of Agronomy Annual Meeting, Salt Lake City, 11/05.

Bowling D, Stable isotopes and carbon exchange between terrestrial ecosystems and the atmosphere, Department of Geography, University of Utah, 4/05.

Bowling D, Partitioning net ecosystem carbon exchange with fluxes of $^{13}CO_2$, Department of Environmental Sciences, University of Virginia, 2/05.

Bowling D, The oxygen isotope composition of nocturnal ecosystem respiration, International Symposium: "Oxygen isotopes as a tracer linking global O_2, CO_2, and H_2O cycles", Biosphere-Atmosphere Stable Isotope Network, Marshall, California, 9/04.

Bowling D, Stable isotopes and carbon exchange between terrestrial ecosystem and the atmosphere, Bowdoin College, Department of Biology. 2/04.

Bowling D, Yakir D, Interpreting ecosystem respiration fluxes using stable isotopes, in symposium "Respiratory control of the global C cycle in a changing environment", Ecological Society of America Annual Meeting, Savanna, GA, 8/03.

Bowling D, Stable isotopes of atmospheric CO_2 and ecosystem-scale biological processes, Columbia University's Biosphere2 Center, 10/01.

Bowling D, Partitioning Biosphere-Atmosphere Exchange of CO_2 into Photosynthesis and Respiration using Tower Measurements, University of Utah, Dept. of Geology and Geophysics, 9/01.

Bowling D,The Math Behind Eddy Covariance: Studying Biological Processes with Atmospheric Measurements, University of Utah, Mathematical Biology Seminar Series, 3/01.

Bowling D and Monson R, Forest-Atmosphere Fluxes of $^{13}CO_2$, American Geophysical Union Fall Meeting, San Francisco, CA, 12/99.

Bowling D, Flux measurement using relaxed eddy accumulation, AmeriFlux Network Annual Meeting, St. Louis, MO, 10/97.

Other Lectures and Seminars

(graduate students underlined)

Moyes AB, Bowling DR, Causes of seasonal and temporal variability in soil respiration along a Rocky Mountain riparian-meadow ecotone, Ecological Society of America annual meeting, San Jose, CA, 8/07.

Schaeffer SM, Monson RK, Burns SP, Bowling DR, Temporal and spatial effects on the isotopic composition of ecosystem-respired CO_2 in a high-elevation subalpine forest, Ecological Society of America annual meeting, San Jose, CA, 8/07.

Bowling DR, Schaeffer SS, Miller JM, Stephens B, CO_2 and $\delta^{13}C$ of CO_2 at three spatial scales over the Rocky Mountains, American Geophysical Union Fall Meeting, San Francisco, 12/06.

Moyes AB, Bowling DR, Seasonality of temperature, moisture, and substrate controls on soil carbon dioxide in a Rocky Mountain meadow, American Geophysical Union Fall Meeting, San Francisco, 12/06.

Schaeffer SM, Anderson DE, Burns SP, Monson RK, Sun J, Yi C, Bowling DR, Environmental controls on the stable isotopic composition of forest respired carbon dioxide across a vertical canopy profile in a subalpine coniferous forest, American Geophysical Union Fall Meeting, San Francisco, 12/06.

Zobitz JM, Ogee J, Monson RK, Bowling DR, High-resolution stable-isotope partitioning of net ecosystem exchange into respiration and photosynthesis, American Geophysical Union Fall Meeting, San Francisco, 12/05.

Pataki DE, Bowling DR, Ehleringer JR, Zobitz JM (presenter), High resolution atmospheric monitoring of urban carbon dioxide sources, US. Dept. of Energy Global Change Education Program Summer Orientation Workshop, Portland, Oregon, 6/06.

Roden JS, Bowling DR, Ehleringer JR, Stable oxygen and carbon isotope ratios of tree ring cellulose along a precipitation transect in Oregon, 2005 Annual Meeting of the American Society of Plant Biologists, 7/05.

Crosson E, Rella C, Richman B, Kachanov A, Wahl E, Tan S, Pham H, Koulikov S, Kharlamov B, Fidric B, Sanders S, Bowling D, and Paldus B, Applications of cavity ring-down spectroscopy to high precision isotope ratio: measurements of $^{12}C/^{13}C$ in carbon dioxide, SIRIS 2004, International Workshop on Stable Isotope Ratio Infrared Spectrometry: New Developments and Applications, Vienna, Austria, 9/04.

McDowell NG, Bowling D, Schauer A, Irvine J, Bond BJ, Law B, Ehleringer JR, Seasonal variation in the carbon isotope ratio of ecosystem respiration in two coniferous forests, American Geophysical Union Fall Meeting, San Francisco, CA, 12/03.

Baldocchi D, Bowling D, Interpreting carbon isotope ($^{13}CO_2$) fluxes and profiles over and under a temperate broadleaved forest with a biophysical model, *CANOAK*, Stable Isotopes and Biosphere-Atmosphere Interactions International Workshop, Banff, Alberta, 5/02.

Bowling DR, McDowell NG, Anthoni PM, Law BE, Bond BJ, and Ehleringer J, Isotopic (^{13}C) response of ponderosa pine ecosystem respiration to atmospheric stress events, American Geophysical Union Fall Meeting, San Francisco, CA, 12/01.

Baldocchi DD, and Bowling DR, Modeling carbon isotope fluxes and concentration profiles over a temperate deciduous forest across a spectrum of time scales with

a biophysical model, CANOAK, American Geophysical Union Fall Meeting, San Francisco, CA, 12/01.

McDowell NG, Bowling DR, Lunch CK, Welker J, Anthoni P, Law B, Bond BJ, and Ehleringer JR, Oxygen-18 content of ecosystem respiration across a climatic gradient in Oregon, American Geophysical Union Fall Meeting, San Francisco, CA, 12/01.

McDowell N, Bowling D, Bond B, and Ehleringer J, Seasonal variation of $\delta^{18}O$ of ecosystem respiration across a precipitation gradient in Oregon, USA, IUFRO Canopy Processes Workshop, 7/01.

Bowling D, McDowell N, Bond B, Anthoni P, Irvine J, Law B, and Ehleringer J, Seasonal and interannual variation in the carbon isotopic composition of ecosystem respiration along an Oregon precipitation gradient, American Geophysical Union Fall Meeting, San Francisco, CA, 12/00.

Poster Presentations

(graduate students and junior researchers underlined)

Ehleringer JR, Bramble D, Hultine K, Bowling D, Dearing MD, Entrada Field Station: a new opportunity for desert ecology and riparian ecology research in southeastern Utah, , Ecological Society of America annual meeting, San Jose, CA, 8/07.

Schaeffer S, Miller J, Stephens B, Bowling D, Carbon dioxide and $\delta^{13}C$ of CO_2 at multiple spatial scales over the Rocky Mountains, US North American Carbon Program Investigators Meeting, Colorado Springs, CO, 1/07.

Moyes AB, Bowling DR, Carbon dioxide, temperature, and moisture under a Rocky Mountain meadow, AmeriFlux Network annual meeting, Boulder, CO, 10/06.

Zobitz J, Bowling D, Adler F, Keener J, Dobson D, Estimating respiratory and photosynthetic fluxes in a heterogeneous conifer forest, IGERT Project Meeting, Washington DC, 5/05.

Zobitz JM, Keener JP, Bowling DR, Sensitivity analysis and quantification of uncertainty for isotopic mixing relationships in carbon cycle research, American Geophysical Union Fall Meeting, San Francisco, CA, 12/04.

Zobitz JM, Keener JP, Bowling DR, Analysis of Linear Regression Techniques to Determine $\delta^{18}O_R$ and $\delta^{13}C_R$: Implications and Applications, International Symposium: "Oxygen isotopes as a tracer linking global O_2, CO_2, and H_2O cycles", Biosphere-Atmosphere Stable Isotope Network, Marshall, California, 9/04.

Pataki DE, Bush SE, Bowling DR, Ehleringer JR, Ecosystem respiration in an urban atmosphere: an isotopic approach, Carbon Respiration from Terrestrial Ecosystems: Reducing Uncertainties in the Role Played by Respiration in the Global Carbon Cycle (workshop), Laguna Beach, CA, 01/04.

Zobitz JM, Bowling DR, Process based belowground carbon dioxide modeling in a desert ecosystem, American Geophysical Union Fall Meeting, San Francisco, CA, 12/03.

Reed SE, Bond BJ, Bowling DR, McDowell NG, Ehleringer JR, Stable isotopic variation across a precipitation gradient in Oregon, DOE Global Change Education SURE Program, 8/03.

Lunch CK, Bowling DR, Difficulties of measuring eddy covariance fluxes of carbon dioxide at arid sites, Ecological Society of America Annual Meeting, Savanna GA, 8/03.

Bethers S, Bowling DR, Evapotranspiration of a semi-arid Utah grassland during the summer monsoon, Ecological Society of America Annual Meeting, Savanna GA, 8/03.

McDowell NG, Bowling D, Lunch CK, Welker J, Irvine J, Law BE, Bond BJ, Ehleringer JR, Relationships between precipitation, vapor pressure deficit, and $\delta^{18}O$ of ecosystem respiration across a steep climatic transect, Stable Isotopes and Biosphere-Atmosphere Interactions International Workshop, Banff, Alberta, 5/02.

McDowell N, Bowling D, Ecosystem respired $\delta^{18}O$ and $\delta^{13}C$: calculation via slopes vs. intercepts, Stable Isotopes and Biosphere-Atmosphere Interactions International Workshop, Banff, Alberta, 5/02.

Wever L, Flanagan LB, and Bowling DR, Seasonal and interannual variation in oxygen isotope discrimination in a temperate grassland ecosystem, American Geophysical Union Fall Meeting, San Francisco, CA, 12/01.

Pataki DE, Ehleringer JR, Flanagan LB, Yakir D, Bowling DR, Still C, Buchmann N, and Berry JA, The carbon isotope composition of ecosystem respiration in North and South America, American Geophysical Union Fall Meeting, San Francisco, CA, 12/01.

Bowling D, McDowell N, Bond B, Law B, and Ehleringer J, ^{13}C content of ecosystem respiration is linked to precipitation and vapor pressure deficit, International Union of Forestry Research Organizations (IUFRO) "Linking the Complexity of Forest Canopies to Ecosystem and Landscape Function" Workshop, 7/01.

Flanagan LB, Carlson PJ, Wever LA, and Bowling DR, Interannual variation in precipitation and its consequences for ecosystem carbon dioxide exchange and carbon isotope discrimination in a northern grassland, American Geophysical Union Fall Meeting, San Francisco, CA, 12/00.

1999 ESA Best Student Poster in Physiological Ecology:

Bowling D, Baldocchi D, and Monson R, Partitioning net ecosystem exchange in a Tennessee deciduous forest using stable isotopes of carbon dioxide, Ecological Society of America, Spokane, WA, 8/99.

Bowling D, Delany A, Turnipseed A, Baldocchi D, and Monson R, Modifying the REA technique to collect CO_2 for stable isotope analysis: hyperbolic relaxed eddy accumulation, FluxNet Conference, Polson, MT, 6/98.

Bowling D, Turnipseed A, Delany A, Baldocchi D, Greenberg J, and Monson R, Relaxed eddy accumulation of isoprene above a mixed deciduous forest, Ecological Society of America, Albuquerque, NM, 8/97.

Bowling D, Carbon cycling in a Colorado subalpine forest, EPA Star Graduate Conference, Raleigh-Durham, NC, 6/97.

Timothy J. Garrett

Education

University of Washington, Ph.D., Atmospheric Sciences, 2000 (*Advisor: P. V. Hobbs*)
University of Washington, M.S. Atmospheric Sciences, 1995 (*Advisor: P. V. Hobbs*).
University of Waterloo, B.Sc. Honours Physics, 1992

Academic Positions

Assistant Professor, Meteorology Department, University of Utah, 2002 - present
Huber Fellow, Princeton Environmental Institute, Princeton University, 2000 - 2002

Refereed Publications

Zhao, C. and **T. J. Garrett**, 2007: Ground-based remote-sensing of low-level cloud properties in the Arctic. *J. Geophys. Res.*, (submitted)

Zhao, C. and **T. J. Garrett**, 2007: Ground-based remote-sensing of precipitation in the Arctic. *J. Geophys. Res.*, (submitted)

Schultz, D.M., K.M. Kanak, J.M. Straka, A.J. Durant, and **T. J. Garrett,** 2007: Reply. *J. Atmos. Sci.* (accepted)

Garrett, T. J. Observational quantification of the optical properties of cirrus cloud. Chapter in *Light Scattering Reviews, Vol. 3,* A. Kokhanovsky, ed. (accepted), 2007

Liu, C., E. Zipser, **T. J. Garrett**, J. Jiang, and H. Su, 2007: How do the water vapor and carbon monoxide "tape recorders" start near the tropical tropopause? *Geophys. Res. Lett.*, 34, L09804, doi:10.1029/2006GL029234, 2007

Garrett, T. J. and L. Verzella, 2007: Hazy perspectives of Early Arctic Explorers. *Bull. Amer. Meteorol. Soc.* (in review)

Garrett, T. J., M. B. Kimball, G. G. Mace, D. G. Baumgardner, 2007: Observing cirrus halos to constrain in-situ measurements of ice crystal size *Atmos. Chem. Phys. Discuss,* **7,** 1295-1325

Noel, V., D. M. Winker, **T. J. Garrett**, and M. McGill, 2007: Extinction coefficients retrieved in deep tropical ice clouds from lidar observations using a CALIPSO-like algorithm compared to in-situ measurements from the Cloud Integrated Nephelometer during CRYSTAL-FACE. *Atmos. Chem. Phys.* **7,** 1415-1422

T. J. Garrett, 2007: Comments on "Effective radius of ice cloud particle populations derived from aircraft probes" *J. Atmos. Oceanic. Technol.* **24,** 1492-1503.

Avey, L., **T. J. Garrett**, A. Stohl, 2007: Evaluation of the aerosol indirect effect using satellite, tracer transport model, and aircraft data from ICARTT, *J. Geophys. Res.* 112, D10S33, doi:10.1029/2006JD007581

Garrett, T. J., L. Avey, P. I. Palmer, A. Stohl, J. A. Neuman, C. A. Brock, T. B. Ryerson, and J. S. Holloway, 2006: Quantifying wet scavenging processes in aircraft observations of Nitric Acid and CCN. *J. Geophys. Res.* 111, D23S51, doi:10.1029/2006JD007416

Garrett, T. J., M. A. Zulauf, and S. K. Krueger, 2006: Effects of cirrus near the tropopause on anvil cirrus dynamics, *Geophys. Res. Lett,* 33, L17804, doi:10.1029/2006GL027071

Garrett, T. J. and C. Zhao, 2006: Increased Arctic cloud longwave emissivity associated with pollution from mid-latitudes. *Nature,* 440, 10.1038/nature04636, 787-789

Garrett, T. J., J. Dean-Day, C. Liu, B. K. Barnett, G. G. Mace, D. B. Baumgardner, C. R. Webster, T. P. Bui, W. B. Read, and P. Minnis 2006: Convective formation of pileus cloud near the tropopause *Atmos. Chem. Phys.* **6,** 1185-1200

Schultz, D. M., K. M. Kanak, J. M. Straka, R. J. Trapp, B. A. Gordon, D. S. Zrnic, G. H. Bryan, A. J. Durant, **T. J. Garrett**, P. M. Klein, and D. K. Lilly, 2006: The mysteries of mammatus clouds: Observations and formation mechanisms. *J. Atmos. Sci.*, **63,** 2409-2435.

Garrett, T. J., B. C. Navarro, C. H. Twohy, E. J. Jensen, D. G. Baumgardner, T. P Bui, H. Gerber, R. L. Herman, A. J. Heymsfield, P. Lawson, P. Minnis, L. Nguyen, M. Poellot, S. K. Pope, F. P. J. Valero, and E. Weinstock 2005: Evolution of a Florida cirrus anvil, *J. Atmos. Sci.,* **62,** 2352-2372.

Roskovensky, J. K., K.-N. Liou, **T. J. Garrett**, D. G., Baumgardner, 2004: Simultaneous Retrieval of Aerosol and Thin Cirrus Optical Depths using MODIS Airborne Simulator Data during CRYSTAL-FACE and CLAMS. *Geophys. Res. Lett.* Vol. **31,** No. 18, 10.1029/2004GL020457

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Wendisch, M., **T. J. Garrett,** and W. Strapp, 2002: PVM-100A liquid water content probe response to large droplets. *J. Atmos. Ocean. Tech.,* **19,** 1577-1584.

Garrett, T.J., P.V. Hobbs, and H. Gerber, 2001: Shortwave, single-scattering properties of arctic ice clouds, *J. Geophys. Res.*, **106,** 15,155-15,172.

Curry, J. A, P. V. Hobbs, M. D. King, D. A. Randall, P. Minnis, G. A. Isaac, J. O. Pinto, T. Uttal, A. Bucholtz, D. G. Cripe, H. Gerber, C. W. Fairall, **T. J. Garrett,** J. Hudson, J. M., Intrieri, C. Jakob, T. Jensen, P. Lawson, D. Marcotte, L. Nguyen, P. Pilewskie, A. Rangno, D. C. Rogers, K. B Strawbridge, F. P. J. Valero, A. G. Williams, D. Wylie, 2000: FIRE Arctic Clouds Experiment. *Bull. Amer. Meteor. Soc.,* **81,** 5-29.

Durkee, P. and co authors, 2000: The impact of ship-produced aerosols on the microstructure and albedo of warm marine stratocumulus clouds: A test of MAST hypotheses 1i and 1ii. *J. Atmos. Sci.,* **57,** 2554-2569.

Ferek, R.J., **T.J. Garrett** and co-authors, 2000: Drizzle suppression in ship tracks. *J. Atmos. Sci.,* **57,** 2707-2728.

Hobbs, P.V., **T.J. Garrett**, and co-authors, 2000: Emissions from ships with respect to their effects on clouds, *J. Atmos. Sci.,* **57,** 2570-2590.

Hudson, J.G., **T.J. Garrett,** P.V. Hobbs, S.R. Strader, Y. Xie, and S.S. Yum, 2000: Cloud condensation nuclei and ship tracks. *J. Atmos. Sci.,* **57,** 2696-2706.

Noone K. J., D. W. Johnson, J. P. Taylor, R. J. Ferek, **T. Garrett,** P. V. Hobbs, P. A. Durkee, K. Nielsen, E. Öström, C. O'Dowd, M. H. Smith, L. M. Russell, R. C. Flagan, J. H. Seinfeld, L. De Bock, R. E. Van Grieken, J. G. Hudson, I. Brooks, R. F. Gasparovic, and R. A. Pockalny, 2000: A Case Study of Ship Track Formation in a Polluted Marine Boundary Layer. *J. Atmos. Sci.,* **57,** 2748-2764.

Noone, K. J., D. W. Johnson, J. P., Taylor, R. J. Ferek, **T. Garrett,** P. V. Hobbs, P. A. Durkee, K. Nielsen, E. Oestrom, C. O'Dowd, M. H. Smith, L. M. Russell, R. C. Flagan, J. H. Seinfeld, L. DeBock, R. E. Van Grieken, J. G. Hudson, I. Brooks, R. F. Gasparovic, I. Brooks, 2000: A case of ships forming and not forming tracks in moderately polluted clouds, *J. Atmos. Sci.,* **57,** 2729-2747.

Gerber, H., Y. Takano, **T. J. Garrett,** and P. V. Hobbs, 2000: Nephelometer measurements of the asymmetry parameter, volume extinction coefficient, and backscatter ratio in clouds. *J. Atmos. Sci.,* **57,** 3021-3034.

Garrett, T.J. and P.V. Hobbs, 1995: Long-range transport of continental aerosols over the Atlantic Ocean and their effects on cloud structures. *J. Atmos. Sci.,* **52,** 2977-2984.

Other Publications

Kimball, M. B. and **T. J. Garrett,** *Constraining cirrus ice crystal size through observation of halos.* 12th Conference on Cloud Physics and Radiation, Madison, Wisconsin, 2006

Avey, L., **T. J. Garrett,** and A. Stohl, *Evaluation of the aerosol indirect effect using satellite, chemical transport model, and aircraft data from ICARTT,* 12th Conference on Cloud Physics and Radiation, Madison, Wisconsin, 2006

Zhao, C. and **T. J. Garrett**, *Ground-based retrieval of seasonal cloud an precipitation properties in the Arctic,* 12th Conference on Cloud Physics and Radiation, Madison, Wisconsin, 2006

Garrett, T. J., H. Gerber, D. G. Baumgardner, M. Poellot, C. H. Twohy, and E. M. Weinstock, *Microphysical relationships in CRYSTAL-FACE anvil cirrus*. International Conference on Clouds and Precipitation, Bologna, Italy, 2004

Garrett, T. J., X. Dong, G. G. Mace, C. Zhao: *Effects of arctic haze on clouds and the surface radiation balance*. Seventh Conf. on Polar Meteorology and Oceanography and Joint Symposium on High Latitude Climate Variations, , Hyannis Mass.,16-23 May 2003.

Garrett, T. J.: *Radiative Properties of Arctic Clouds*. Ph. D. Dissertation, University of Washington, 2000.

Garrett, T. J. and P. V. Hobbs, 1999: *Calibration of liquid water probes form the University of Washington's CV-580 aircraft at the Canadian NRC wind tunnel.*

Garrett, T. J. in collaboration with the Curriculum Development Unit of Tonga: *Form 3: Weather and the Sea.* Ministry of Education, Kingdom of Tonga, 1997.

Garrett, T. J.: *Ship Tracks: An Example of Aerosol-Cloud Interactions.* Masters Thesis, University of Washington, 1995.

Recent Invited Presentations

Is Arctic sea-ice melting stimulated by aerosol-cloud-radiative interactions? Gordon Conference on Radiation and Climate, July, 2007.

Is the Cloud System Homeostatic? Dalhousie University, Canada, May, 2007

Arctic Haze and Winter Warming Arctic Climate Workshop sponsored by Clean Air Task Force, NASA GISS, January, 2007

Pollution and the Arctic: 200 years of Man-Made Climate Change, Wallace Stegner Center, University of Utah, October 2006

Exploring Pollution-Cloud-Climate Interactions in the Arctic, State University of New York, September 2006

Exploring Pollution-Cloud-Climate Interactions in the Arctic, Brookhaven National Laboratories, September 2006

Teaching

Courses

Undergraduate *Physical Meteorology*, *Meteorological Analysis*

Graduate *Radiative Transfer and Climate*; *Advanced Cloud Physics*; *Physical Meteorology*

Graduate Students Advised

Bradley Navarro. M. S. 2003
Nathaniel Mullins M. S. 2005
Margaret Kimball M. S. 2006
Lance Avey M. S. 2006
Chuanfeng Zhao Ph. D. 2007
Stina Söström, M. S. Uppsala University, 2007
Kyle Tietze, 2007 - present
Clint Schmidt, 2007 - present

Graduate Student Committees

Eric Vernon, M.S., 2002
Yuying Zhang M.S., 2002
Yaping Li, M.S. 2002
Haiyan Jiang, Ph.D. 2004

Kristen Dowd, M. S. 2004
Yuying Zhang, Ph. D. 2006
Ryan Riveland, M. S. 2006
Helena Schlueter, M. S. 2006
Daniel Hartsock, M.S. 2006
Jennifer Esker, M. S. 2006
Scott Robertson, M. S. 2007

Service

Editor, 2007, - *Atmospheric Chemistry and Physics*
Associate Editor, 2003-2007, *Journal of Atmospheric Sciences*
Panel Review Committee for NOAA Office of Global Programs, October, 2004
Journal article reviewer for AMS, AGU, EGU and IEEE journals, *Nature* and Science
Proposal reviewer for NASA, NSF, DOE, and NOAA
Member ISDAC Science Team (2006-present)

Awards

Honors

New Investigator Award, NASA, 2006
Huber Fellowship, Princeton Environmental Institute, Princeton University, 2000 - 2002
Atmospheric Chemistry Colloquium for Emerging Senior Scientists (ACCESS), Invited participant, 2002
Outstanding Student Paper Award, AGU Fall Meeting, 1999

Externally Awarded Research Proposals

(Total $1,683,644)

1. **NASA** *Optical Properties of Tropical Cirrus Clouds.* P. I. T. J. Garrett, Co-P.I. H. Gerber. $136,389. 01/2002 - 01/2004.

2. **NSF** *Aerosol-Cloud-Radiation Interactions in the Arctic.* P.I. T. Garrett, co-P.I. Xiquan Dong, Gerald G. Mace. $339,503. 04/2003 - 04/2006.

3. **NSF** *New Approaches for the Measurement of Microphysics in Extratropical Hurricanes.* P.I. T. J. Garrett. $19,946, 07/2003 - 07/2004.

4. **NOAA** 2003 *Aerosol-cloud-climate interactions downwind of North Eastern North America.* P.I. T. J. Garrett. $351,234. 03/03 - 03/06.

5. **NASA** *Airborne Studies of Middle and Low-Latitude Cirrus.* P. I. T. J. Garrett. $86,882. 01/04-01/05.

6. **NSF** *Formation and evolution of pileus cloud near the tropopause.* P. I. T. J. Garrett $35,693. 1/1/06 - 12/31/06.

7. **NASA** (New Investigator Program Award) *Interaction between microphysics, radiation and dynamics in terrestrial cirrus.* P. I. T. J. Garrett $339,976. 8/1/06 - 7/31/09.

8. **NSF** *Evaluation of Aerosol-Cloud-Radiation Processes and Feedbacks in the Alaskan Arctic.* P.I. T. J. Garrett $324,121 6/1/07-5/30/10.

9. **Clean Air Task Force** *Quantifying the significance of mid-latitude pollution plumes to clouds and sea-ice melting in the Arctic,* $50,000 6/1/07-5/30/08.

Field Work

NASA CRYSTAL-FACE, Summer 2002: Integrated Cloud Integrating Nephelometer (CIN) onto the NASA WB-57 aircraft for the study of Florida anvil cirrus.
CNRC ETHEX, Fall, 2003: Integrated CIN onto Canadian National Research Council CV-580 Airborne Facility for flight into mid-latitude Hurricane systems.
NASA MidCiX, Spring, 2004: Integrated CIN onto the the NASA WB-57 for the study of mid-latitude and sub-tropical anvil cirrus.
NOAA ICARTT, Summer, 2004: Integrated CIN, FSSP-100 and OAP 2D-C onto NOAA and CNRC aircraft for the study of the effects of North American pollution on cloud radiative properties.

Professional Memberships

American Meteorological Society. 2000 - present
American Geophysical Union 1998 - present

Curriculum Vitae

Robert Robertson Gillies

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EDUCATION

M.A. with Honors (Geography; 2:1), University of Glasgow, U.K. (1984)
(Advisor: A. Morrison)
M.S. (Meteorology), The Pennsylvania State University
(Advisor: T.N. Carlson).
Course Requirement Ph.D.
Ph.D. (Meteorology and Remote Sensing), University of Newcastle, U.K. (1994)
(Advisor: T.N. Carlson, The Pennsylvania State University)

ACADEMIC AND PROFESSIONAL EXPERIENCE

2006 – Present	Director of the Utah Climate Center / State Climatologist (Utah), Associate Professor, Utah Climate Center (Dept. Plants, Soils and Climate), Utah State University
2002 - 2006	Associate Professor (tenured) Departments of Watershed Sciences, Plants, Soils and Climate, Utah State University
1996 - 2002	Assistant Professor Departments of Geography and Earth Resources & Plants, Soils and Biometeorology, Utah State University
1990 - 1996	Research Associate / Support Scientist Earth System Science Center and Department of Meteorology, The Pennsylvania State University
1987 - 1990	Research Associate and Teaching Assistant, Collaborative Position The School of Architecture, University of Newcastle and Department of Meteorology, The Pennsylvania State University
1987	Scientific Programmer Department of Meteorology, The Pennsylvania State University
1985 - 1987	Research Associate, Building Science, The School of Architecture, University of Newcastle, U.K.

1982 - 1983 President, University of Glasgow Athletic Club, U.K.

PUBLICATIONS

Peer-Reviewed:

Carlson, T.N., Belles, J.E and **Gillies, R.R**.., 1991: Transient water stress in a vegetation canopy; simulations and measurements. *Remote Sensing of the Environment*., **35**, 175-186.

Carlson, T.N., **Gillies. R. R** and Perry, E.M., 1993: A method to make use of thermal infrared temperature and NDVI measurements to infer surface soil water content and fractional vegetation cover. *Remote Sensing Reviews.*, **52**, 45-59. Special Issue on Recent Advances in Remote Sensing Science.

Gillies, R.R. and Carlson, T.N., 1994: A physically based modeling approach for including remotely derived measurements in the study of land use change. *In Effects of Human-Induced Changes on Hydrological Systems, for American Water Resources Association, Annual Summer Symposium*, Technical Publication Series (TPS-94-3), (Bethesda, Maryland: American Water Resources Association) pp. 27-34.

Carlson, T.N., **Gillies R.R.** and Schmugge T.J., 1995: An interpretation of NDVI and radiant surface temperature as measures of surface soil water content and fractional vegetation cover. *Agricultural and Forest Meteorology*., 77, 191-205.

Carlson, T.N., Capehart, W.J. and **Gillies, R.R.**, 1995: A new look at the simplified method for remote sensing of daily evapotranspiration. *Remote Sensing of the Environment*., **54**, 161-167.

Carlson, T.N., Taconet, O., Vidal, A., **Gillies, R.R.**, Olioso, A. and Humes, K., 1995: An overview of the workshop on thermal remote sensing held at La Londe les Maures, France, September 20-24, 1993. *Remote Sensing Reviews,*. **12**, 147-158.

Carlson, T.N., Taconet, O., Vidal, A., **Gillies, R.R.**, Olioso, A. and Humes, K., 1995: An overview of the workshop on thermal remote sensing held at La Londe les Maures, France, September 20-24, 1993 *Agricultural and Forest Meteorology*., **77**, 141-151.

Gillies, R.R. and Carlson, T.N., 1995: Thermal remote sensing of surface soil water content with partial vegetation cover for incorporation into climate models. *Journal of Applied Meteorology.*, **34**, 745-756.

Gillies, R.R., Cui, J., Carlson, T.N., Kustas, W.P., and Humes, K.S., 1997: Verification of a method for obtaining surface soil water content and energy fluxes from remote measurements of NDVI and surface radiant temperature. *International Journal of Remote Sensing.*, **18**, 3145-3166.

Owen, T.W., Carlson, T.N. and **Gillies, R.R.**, 1998: An assessment of satellite remotely sensed land cover parameters in quantitatively describing the climate effect of urbanization. *International Journal of Remote Sensing.*, **19**, 1663-1681.

Crombie, M.K., **Gillies R.R.**, Arvidson R.E., Brookmeyer P., Weil G.J., Sultan M., and Harb M. 1999: An application of remotely derived climatological fields for risk assessment of

vector-borne diseases – A spatial study of filariasis prevalence in the Nile delta, Egypt. *Photogrammetric Engineering and Remote Sensing*., **65**, 1401-1409.

Brunsell, N., **Gillies, R.R**. 2000 The effect of emissivity on evaporation. Remote Sensing and Hydrology 2000 (Proceedings of a symposium held at Santa Fe, New Mexico, USA, April 2000). IAHS Publ. No **267**, 2001, 276-280.

Gottschalk, J., **Gillies, R.R.** and Carlson T.N. 2001: The simulation of canopy transpiration under doubled CO_2: The evidence and impact of negative feedbacks on transpiration in two 1-D soil-vegetation-atmosphere-transfer (SVAT) models. *Agricultural and Forest Meteorology*., **106**, 1-21.

Gottschalk, J. and **Gillies, R.R.** 2001: Implications of feedback processes in plant water usage and resulting climate change. *Journal of the American Water Resources Association*., **37**, 305-314.

Brunsell, N., **Gillies, R.R.** 2002. Incorporating surface emissivity into a thermal atmospheric correction. *Photogrammetric Engineering and Remote Sensing*., **68** (12): 1263-1269.

Brunsell, N., **Gillies, R. R**. 2003: Determination of scaling characteristics of AVHRR data with wavelets: application to SGP97. *International Journal of Remote Sensing*, **24** (14), 2945-2957.

Brunsell, N., **Gillies, R.R**. 2003. Scale issues in land-atmosphere interactions: implications for remote sensing of the surface energy balance. *Agricultural and Forest Meteorology*., **117**, 203-221.

Brunsell, N., **Gillies, R.R**. 2003. Length scale analysis of surface energy fluxes derived from remote sensing. *Journal of Hydrometeorology*. **4**, 1212-1219.

Gillies, R.R., Brim-Box, J., Symanzik, J. and E.J. Rodemaker. 2003. Effects of urbanization on the aquatic fauna of the Line Creek watershed, Atlanta – A satellite perspective., *Remote Sensing of the Environment*, **86**, 441-422.

Rieke Arentsen, **Gillies, R.R** and Mesner, N. 2004: Satellite derived impervious surface area as an indicator for water resource impacts in a semi-arid environment, Utah, USA. In Management Information Systems 2004: Incorporating GIS and Remote Sensing, WIT Press. ISBN: 1-85312-728-0

Y.-J. Sun, J.-F Wang, R-H.Zhang, **R. R. Gillies**, Y-Xue, and Y-C. Bo. 2005: Air temperature retrieval from remote sensing data based on thermodynamics. Theoretical and Applied Climatology, **80**, 37-48.

Book Chapters

Chapter (*Coupling Thermal Infrared and Visible Satellite Measurements to Infer Biophysical Variables at the Land Surface*) in "Thermal Infrared Remote Sensing and Land Surface Processes". Dale A. Quattrochi, Jeffery C. Luvall (Eds). Taylor & Francis, ISBN 0415302242. January 2004

Book Chapter Co-author – (*Documenting Dynamics of Human Dynamics*) in "The Manual of Remote Sensing, 3rd Edition (A Series): Volume 5: Remote Sensing of Human

Settlements", Andrew B. Rencz, Editor-in-Chief; Volume Editors: Merrill K. Ridd & James D. Hipple. ISBN 1-57083-077-0. 2006.

Paper (*On the Appreciation of Constant Pressure Surfaces*) – in "Aviation Meteorology Unscrambled: For VFR and IFR Operations, Certificates and Ratings, 9th Edition. Chapter 18 – Contributed Papers on Various Aviation Weather Topics" Kenneth B. McCool, ISBN 978-0-9621387-2-0. 2006.

e-Book – *Scale-dependent approaches to modeling spatial epidemiology of chronic wasting disease*. Conner, Mary M., Gross, John E., Cross, Paul C., Ebinger, Michael R., **Gillies, Robert R.** and Miller, Michael M. Utah Division of Wildlife Resources, United States Geological Survey and, the International Association of Fish and Wildlife Agencies, Special Report 2007.

Book Chapter (*The Growth of Impervious Surface Coverage and Aquatic Fauna*) in Remote Sensing of Impervious Surfaces. Taylor and Francis Group. 2007.

Non-Peer-Reviewed:

M.K. Crombie, **R.R. Gillies**, G. Weil, R.E. Arvidson, P. Brookmeyer, M. Sultan, and M. Harb: Remote Sensing as a Tool for Assessing Environmental Risk Factors for Filariasis. Preprint volume of 10th Conference on Applied Meteorology, 20-23 October 1997, Reno, NV, by the *American Meteorological Soc*iety, Boston, MA.

Jiangsu Academy of Agricultural Sciences, Nanjing, P. R. China. International Symposium on Modeling for Crop-Climate-Soil-Pest System and Its Application in Sustainable Crop Production. 06/22-26/98.

Gillies, R.R., Gottschalk, J. and Carlson, T.N.: The Simulation of Canopy Transpiration Under Doubled CO_2: The Evidence and Impact of Feedbacks on Transpiration in Two 1-D Soil-Vegetation-Atmosphere-Transfer (SVAT) Models. *American Water Resources Association*, Specialty Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States, 10-12 May 1999, Atlanta, GA.

Gillies, R.R., Gottschalk, J: The Impacts of Regional Scale Transpiration Across North America in a Doubled CO_2 Environment Via Simulations with the GENESIS Global Climate Model. *American Water Resources Association*, Specialty Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States, 10-12 May 1999, Atlanta, GA.

Gillies, R.R. and Griffiths, L.: The Seasonal Energy Signature of the City of Atlanta, Georgia. *The Association of American Geographers*, 95th Annual Meeting, 23-27 March 1999, Honolulu, Hawaii.

Symanzik, J., Griffiths, L., **Gillies, R.R.**: Visual Exploration of Satellite Images, 2000 *Proceedings of the Section on Statistical Graphics*, American Statistical Association, Indianapolis, Indiana, August 13-17, 2000, pp10 -19.

Brunsell, N.A and **Gillies, R.R.**: *Proceedings 25th Agricultural and Forest Meteorology Meeting*. 20-24 may, 2002, Norfolk, Virginia. Length Scales of Remotely Sensed Vegetation, Surface Radiometric Temperature, and Derived Surface Energy Fluxes.

Brunsell, N.A and **Gillies, R.R.**, Lapenta, B. and Dembeck S.: *83rd American Meteorological Society Annual Meeting*. Symposium on Observing and Understanding the Variability of

Water in Weather and Climate. 9 – 13 February, 2003, Long Beach, California. Aggregation of Remotely Sensed Vegetation and Derived Latent Heat Flux.

John H. Prueger, USDA, Ames, IA; and W. P. Kustas, L. E. Hipps, J. L. Hatfield, A. Cahill, C. A. Williams, J. D. Albertson, W. E. Eichinger, D. I. Cooper, N. Brunsell, and **R. Gillies**. *83rd American Meteorological Society Annual Meeting*. Symposium on Observing and Understanding the Variability of Water in Weather and Climate. 9 – 13 February, 2003, Long Beach, California. 17th Conference on Hydrology. Spatial Variability of Turbulent Fluxes Across a Corn/Soybean Production Region in Central Iowa.

Symanzik, J., Gebreab, S., **Gillies, R**. Wilson, J. 2003: Visualizing the Spread of West Nile Virus, 2003 Proceedings, American Statistical Association, Alexandria, Virginia, CD.

SCHOLARLY PRESENTATIONS

Carlson, T.N. and **Gillies, R.R.**, 1991: Remote sensing of soil moisture over vegetation. Sensitivity and limitations of the infrared temperature method. *Proceedings 20th Conference on Agricultural and Forest Meteorology*. Salt Lake City, UT, September 10-13, 1991.

Carlson, T.N. and **Gillies, R.R.**, 1993: A physical approach for inverting vegetation index with surface radiometric temperature to estimate surface soil water content. *Proceedings Thermal Remote Sensing of the Energy and Water Balance over Vegetation in Conjunction with Other Sensors*, La Londe Les Maures, France, 20-23 September 1993.

Gillies, R.R. and Carlson, T.N., 1993: Translation of satellite measurements to land surface parameters. *Proceedings, ERDAS Northern Regional User's Group Meeting*, Indiana University, 4-5 August 1993.

Gillies, R.R., Olioso, A. and Humes, K., (Ed's): *Symposium Proceedings, Thermal remote sensing of the energy and water balance over vegetation in conjunction with other sensors*, La Londe Les Maures, France, 20-23 September 1993.

Miller, D.A., **Gillies, R.R.**, T.N. Carlson, E.M. Perry, D.A.J. Ripley and R.A. White, 1993: Scale similarities in the pattern of soil moisture as determined using visible and thermal infrared measurements over vegetation. *Proceedings American Meteorological Society Annual Meeting, Session on Climatology and Hydrology*, Pasadena, CA, 18-22 January 1993.

Gillies, R.R. and Carlson, T.N., 1994: An efficient method for incorporating remote multi-spectral measurements in land-surface models. *AGU*, Baltimore, MD, 23-27 May 1994.

Gillies, R.R., Cui J., Carlson, T.N., Kustas, W.P. and Humes K.S., 1995: Implications of the NDVI and the surface radiant temperature relationship. *AMS* Conf. on Hydrology, Dallas, TX. January, 1995.

Gillies, R.R., Rangeland Resources (CNR, Utah State University) - Sensitivity of Transpiration of Doubled Atmospheric CO_2 Concentration. 11/04/96.

Gillies, R.R., Department of Earth and Planetary Science, Washington University, St. Louis, MO - Sensitivity of Transpiration of Doubled CO_2. 04/04/97.

Gillies, R.R., Department of Earth and Planetary Science, Washington University, St. Louis, MO - Aspects of Multi-Spectral Remote Sensing - Applied to Land Surface Processes. 04/04/97.

Crombie M.K., **Gillies R.R.**, Weil G., Arvidson R.E., Brookmeyer P., Sultan M., and Harb M.: Tenth Conference on Applied Climatology - American Meteorological Society - Remote Sensing as a Tool for Assessing Environmental Risk Factors for Filariasis. 10/19/97.

Gillies, R.R., Gottschalk, J. and Carlson, T.N.: Model Simulation of Canopy Transpiration under Doubled CO_2 Atmospheric Conditions. Jiangsu Academy of Agricultural Sciences, Nanjing, P. R. China. International Symposium on Modeling for Crop-Climate-Soil-Pest System and Its Application in Sustainable Crop Production. 06/22-26/98.

Gillies, R.R., Second Biennial Conference on Higher Education in Natural Resources: Utah State University. A Graphical Surface-Vegetation-Atmosphere Transfer Model As a Pedagogical and Research Tool. 03/7-10/98.

Gillies, R.R., Utah Geographical Society, 16th Annual Fall Meeting, 2 October 1998, Weber State University. Remote Sensing As a Tool for Assessing Environmental Risk Factors for Filariasis.

Quattrochi, D.A., J. C.Luvall, M. G. Estes,Jr, C. P. Lo, S. Q. Kidder, J. Hafner, H.Taha, R.D. Bornstein, **R.R.Gillies**, and K. P. Gallo. Project ATLANTA (ATlanta Land use ANalysis:Temperature and Air quality): A study of how the urban landscape affects meteorology and air quality through time. *American Meteorological Society*, 104-107,1998.

Gillies, R.R., Gottschalk, J. and Carlson, T.N.: The Simulation of Canopy Transpiration under Doubled CO_2: The Evidence and Impact of Feedbacks on Transpiration in Two 1-D Soil-Vegetation-Atmosphere-Transfer (SVAT) Models. *American Water Resources Association*, Specialty Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States, 10-12 May 1999, Atlanta, GA.

Gillies, R.R., Gottschalk, J.: The Impacts of Regional Scale Transpiration Across North America in a Doubled CO_2 Environment Via Simulations with the GENESIS Global Climate Model. *American Water Resources Association*, Specialty Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States, 10-12 May 1999, Atlanta, GA.

Gillies, R.R. and Griffiths, L.: The Seasonal Energy Signature of the City of Atlanta, Georgia. *The Association of American Geographers*, 95th Annual Meeting, 23-27 March 1999, Honolulu, Hawaii.

Boettinger, J.L., **Gillies R.R.**, Broderson W., Kienast S., and Jaros R.: Developing a multi-scale, open-ended soil inventory of the Grand Staircase - Escalante National Monument. International Conference on Soil Resources, June 1999, Minneapolis, MN.

Gillies, R.R. and Griffiths, L.: The Energy Signature of the City of Atlanta, Georgia. *International Symposium on Special Sensing Research*, Las Vegas, Nevada, October 31 – November 4, 1999.

Crombie M.K., **Gillies R.R.**, Weil G., Arvidson R.E., Brookmeyer P., Sultan M., and Harb M.: Remote Sensing as a Tool for Assessing Environmental Risk Factors for Filariasis.

International Symposium on Special Sensing Research, Las Vegas, Nevada, October 31 – November 4, 1999.

Gillies, R.R.: The determination of surface climatological fields from AVHRR. Department of Geography, University of Georgia, Athens, Georgia. May 13, 1999. **Invited.**

Gillies, R.R.: American Society of Photogrammetry and Remote Sensing, Intermountain Region Fall Technical Meeting. September 29, 2000. Worldwide Spread of Vector-borne Disease – Can Remote Sensing Help? **Invited.**

Gillies, R.R., Qiming Qin, and Rongjian Lu College of Natural Resources. 11/29/00, College Seminar Series. Wavelet Analysis and Neural Networks in Radar Imagery Classification.

Gillies, R.R.: *The Association of American Geographers*, 97th Annual Meeting, February 27 - March 3, 2001, New York, New York. Radar Image Classification Using Wavelet Analysis and a Neural Network Configuration.

Gillies, R.R., Brim Box, J. and Symanzik, J.: College of Natural Resources. 10/03/01, College Seminar Series. Effects of urbanization on the aquatic fauna of Line Creek, Atlanta – A Satellite Perspective.

Brunsell, N.A and **Gillies, R.R**: *25th Agricultural and Forest Meteorology Meeting.* 20-24 May, 2002, Norfolk, Virginia. Length Scales of Remotely Sensed Vegetation, Surface Radiometric Temperature, and Derived Surface Energy Fluxes.

Gillies, R. R., 13th March 2003: Detection of Vector Bourne Diseases: A Satellite Perspective. The National Space Science and Technology Center, Marshall Space Flight Center, Huntsville, Alabama. **Invited**

Gillies, R. R., Jürgen Symanzik, Samson Gebreab and James Wilson, 16-17 September 2003, McLean, Virginia: *Mathematical Modeling of the Spread of Agricultural Bioterrorism Agents*: Statistical and GIS Visualization of Vector-Borne Disease. **Invited**

Symazik, J., **Gillies, R. R.**, Gebraeb, S., Krishna, G., Ma, Peter and Wilson, J. Visualization, Web-Access, and Simulation of West Nile Virus Data – From the Regional to the National Level. Interface 2004, 36th Symposium on the Interface of Statistics, Computer Science, and Applications. May 28-31, 2004. Baltimore, Maryland. **Invited**

P. Rieke-Arentsen, **R. R. Gillies**, and N. Mesner, 13- 15 September 2004, Malaga, Spain. *Fourth International Conference on Management Information Systems: Incorporating GIS and Remote Sensing*: Satellite Derived Impervious Surface Area as an Indicator for Water Resource Impacts in a Semi-arid Environment, Utah, USA.

Gillies, R. R., September 27 – 29, 2004, Park City, Utah. Spatial Epidemiology Tools for Chronic Wasting Disease Research and Management: Visualization of Geographically Referenced Statistical Epidemiological Summaries. **Invited**

Symanzik, J., **Gillies, R.**, Lee, H., and Ma, P. NDVI Data Reduction for Fuzzy Statistical Evaluation. *Interface 2006, 38ih Symposium on the Interface of Statistics, Computer Science, and Applications*. May 24-27, 2006. Pasadena, California.

Gazal, R., White, M., **Gillies R.**, Sparrow, E., and Gordon, L. 2006. Urbanization Effects on Leaf Phenology Across a Multi-continent Bioclimatic Gradient. Organized Oral

Session on "Climate Change and Timing in Ecological Communities", 91st *Ecological Society of America Annual Meeting*, August 6-11, 2006. Memphis, Tennessee.

Gillies, R.R., Gazal, R., White, M., and Rodemaker E. J. 2006. The Urban Heat Island Effect – Implications for Leaf Phenology. Session on "Thermal Remote Sensing Data for Earth Science Research", *AGU Fall Meeting*, 11-15 December 2006, San Francisco, California.

Gillies, R. R. 2007. Towards Integrating and Interpreting Climate Data for Agriculture. (Poster) Protecting The Homeland. A University Science and Education Exhibition and Reception of Capitol Hill. *National Association of State Universities and Land-Grant Colleges (NASULGC)*, February 28, 2007. Washington D.C.

Lawerence Hipps and **Robert Gillies**. 2007. Investigating the Wet Dry Cycles in Utah. (Poster). Spring Runoff Conference – Utah State University. April 5-6, 2007. Logan, Utah.

Gebreab Y. Samson, **Robert R. Gillies**, Symanzik Jürgen and Ronald G. Munger. 2007. Bayesian approach to mapping the spatial distribution of Oral Clefts in Utah. Session on " URISA GIS in Public Health", *Urban and Regional Information Systems Association (URISA) Conference*. May 20-23, 2007, New Orleans, Louisiana.

Gebreab Y. Samson, **Robert R. Gillies**, Symanzik Jürgen and Ronald G. Munger. 2007. Visualization of Birth Defects Data Using Linked Micromap Plots. Session on " URISA GIS in Public Health", *Urban and Regional Information Systems Association (URISA) Conference*. May 20-23, 2007, New Orleans, Louisiana.

Robert R. Gillies. 2007. Climate Change – Its Impact on Precipitation and Water Supply in Utah's Major Drainage Basins: The Colorado and the Great Basin. Featured Presentation "Utah Water Law, Water Rights and Water Quality: Stay Up to Date!" *15th Annual Superconference, Water Law Institute CLE International*. October 1-2, 2007, Marriott Downtown, Salt Lake City, Utah.

AWARDS AND HONORS FOR TEACHING AND RESEARCH

Walton Memorial Prize for Work in Physical Geography (Scottish Geographical Society), Thesis presented as Glasgow University's submission, (1984).

May 25, 2000 ASPRS 2000 Annual Conference. **ERDAS Award for Best Scientific Paper in Remote Sensing** (American Society of Photogrammetry and Remote Sensing). Third Place for " An Application of remotely derived climatological fields for risk assessment of vector-borne diseases – A spatial study of filariasis prevalence in the Nile delta, Egypt, " M.K. Crombie, R.R. Gillies, R.E. Arvidson, P. Brookmeyer, G.J. Weil, M. Sultan, and M. Harb (*PE&RS.*,65-12, 1401-1409).

May 7, 2003 ASPRS 2003 Annual Conference. **Leica Geosystems Award for Best Scientific Paper in Remote Sensing** (American Society of Photogrammetry and Remote Sensing). Second Place for "Incorporating surface emissivity into a thermal atmospheric correction, " Nathaniel A. Brunsell and Robert R. Gillies (PE&RS., 68-12, pp. 1263-1269)

Golden Mouse Award (Utah State University) 2003. For outstanding innovation in technology, teaching and learning.

EXTERNAL FUNDING

July 1985 - July 1987 **S.E.R.C** (Science and Engineering Research Council), Contract GR/D/11395. Thermal Mapping of Urban Developments using Remote Sensing Techniques.

August 1987 - September 1990 **S.E.R.C**, Contract GR/E/20080. Numerical Modeling of the Urban Environment.

January 1995 **NASA** Proposal # 9401011 Forest/Rangeland/Crop/Aquatic Ecosystems Program (National Research Initiative Competitive Grants Program). The Effect on Transpiration of Doubling Atmospheric Carbon Dioxide Concentration.

September 1994 **NASA** Proposal # 94-5 Networking Infrastructure for Education. Earth System Science Community Testbed. Participant with Consortium for International Research, Collaboration, and Learning about the Earth System.

NASA Office of Mission to Planet Earth (Physical Climate Branch). 11/94 - 10/97. $341,755. "A Remotely Sensed Index of Deforestation / Urbanization for Use in Climate Models." (Co-Principal Investigator).

NASA Office of Mission to Planet Earth (Physical Climate Branch). 10/96 - 09/99. $183,983. "Remote Sensing and modeling of temporal changes in urban landcover." (Principal Investigator).

NASA Office of Mission to Planet Earth. 12/97 - 12/98. Enhancement of Remote Sensing Analysis Capabilities at Utah State University. $398,000. (Principal Investigator).

National Science Foundation. (Division of Atmospheric Sciences). 11/97 - 12/97. "Start-up Equipment for UNIDATA at Utah State University." $35,264 (Principal Investigator).

NOAA/NASA Joint GEWEX/GCIP Research Announcement. 12/97 - 12/2000. $479,663. Analysis of Spatial and Temporal Variability of the Warm Season Land Surface Energy Budget Using GOES Assimilation Techniques and Surface Flux Sites. (Co-Principal Investigator).

NASA 08/01/00 – 08/01/01. Extension of Atlanta/Houston Urban Heat Island Studies Using ASTER Imagery. $52,073.00. (Principal Investigator).

SUN Microsystems 05/12/00 Sun Microsystems Matching Equipment Grant Initiative. $66,000. (Principal Investigator).

Mineral Lease Internal Competitive. Advancement of Soil Survey for the Grand Staircase – Escalante National Monument Through Application of Landsat and EOS Platform Sensor Data. $35,000 (Co-Investigator with Dr. Janis Boettinger (PSB)).

Agricultural Experiment Station Internal non-competitive $10,000 per annum. Analysis of Spatial and Temporal Variability of the Warm Season Land Surface Energy Budget. Termination Date 06/30/2002.

Agricultural Experiment Station Internal non-competitive $10,000 per annum. Examination of Spatial Scale Effects in Land Atmosphere Interactions. Termination Date 06/30/2005.

National Science Foundation 09/06/02 – 09/06/06. Integrated Phenology Research and Education. $492,674 (Co-Principal Investigator with Dr. Michael White)

Community / University Research Initiative 06/01/02 – 06/01/03 Urban Planning and Satellite Remote Sensing: A Pilot Program for Planners. $25,000

DOD 09/01/02 – 08/31/04 Medical Vanguard Disease Surveillance. $103,574 (Principal Investigator)

Post-Doctoral Fellowship – Lee Hee Il – **Korea Science and Engineering Foundation** (KOSEF). $20,115 (Co-Investigator)

Community / University Research Initiative 06/01/05 – 06/01/06 Web-based Micromap Capabilities. $20,000

ACADEMIC AND RESEARCH ADVISING

Graduate Students:

Student	Degree (Major)	Status	Professor's Role
Pennsylvania State University			
Timothy Owen	M.S. (Meteorology)	Graduated 1995	Committee Member
Cui Jui	M.S. (Meteorology)	Graduated 1996	Major Professor
Jon Gottschalck	M.S. (Meteorology)	Graduated 1997	Major Professor
Utah State University			
Nathaniel Brunsell	Ph.D (Biometeorology)	Graduated 2002	Major Professor
Jerry Tagestad	M.S. (Geography)	Graduated 1998	Directed Thesis
Joshua Campbell	M.S. (Biometeorology)	Graduated 2006	Major Professor
Louise Griffiths	M.S. (Geography)	Graduated 2006	Major Professor
Eli Rodemaker	M.S. (Geography)	Graduated 2006	Major Professor
Bekele Temesgen	Ph.D (Biometeorology)	Graduated 2006	Directed Thesis
Penny Rieke Artentsen	M.S. (Watershed Science)	Graduated 2005	Co-advisor
Gopi Krishna Chapala	M.S. (Computer Science)	Graduated 2004	Directed Thesis
Samson Gebreab	Ph.D (Ecology)	Ongoing	Major Professor
Peter Ma	M.S. (Geography)	Graduated 2006	Major Professor
Ravi Kiran	M.S. (Computer Science)	Graduated 2006	Directed Thesis
Vineela Valllabhaneni	M.S. (Computer Science)	Ongoing	Thesis Advisor

Graduate Committees (excluding above):

3 Ph.D. (Civil & Environmental Engineering; Plants, Soils and Climate)

9 M.S. (Geography and Earth Resources, Forest Resources, Plants, Soils and Climate, Civil & Environmental Engineering, Computer Science, Watershed Sciences)

Visiting Professors / Scholars:

Dr. Hee Lee from the Republic of Korea, Fall 2001 – Spring 2002. Attending Utah State University by virtue of a competitive overseas research fellowship awarded by the Korean government. Dr. Lee is a medical entomologist whose interests lie in detecting Malaria breeding habitats using remote sensing and GIS.

Samson Yikealo Gebreab from Eritrea, August 2002 – January 2003. Studying MSc in Geographic Information Sciences at Wageningen. Fulfilling his thesis Master's research at Utah State University with Dr. Gillies.

Dr. Hee Lee from the Republic of Korea, Spring 2004 – Fall 2006. Attending Utah State University by virtue of a competitive overseas research fellowship awarded by the Korean government.

TEACHING

Courses Taught:

Pennsylvania State University

METEO 02	*Weather and Society*
METEO 03	*Lab supplement for Meteo 02*
METEO 472	*Climatology*
METEO 467E / Earth 497E	*Investigation of the Earth System Biosphere Atmosphere Interactions (Land Surface Processes)*
METEO 567C	
METEO 454	*Micrometeorology*
METEO 421	*Dynamic Meteorology I*

Utah State University

GEOG / BMET 3280	*Global Climatology*	97 – 00
GEOG 4750	*Fundamentals of Remote Sensing*	98 – 05
BMET 3250	*Aviation Weather*	97 –
BMET / BIE 5250/6250	*Remote Sensing of Land Surfaces*	99 – 03
GEOG 6980 - 2	*Imagine Toolkit*	Spring 2001
GEOG 6900	*Programming for Remote Sensing and GIS Environments*	Spring 2002

Teaching Activities / Development:

Selected participant (by review) in the 1997 Summer Workshop "Using Instructional Technological and Satellite Data for College-Level Education in the Atmospheric and Earth Sciences," sponsored by the National Science Foundation and COMET.

Participant in "Shaping the Future, Unidata Users as Leaders". June 19-23, 2000. Sponsored workshop by the National Science Foundation. **Invited**

Participant in a workshop on ***Accelerated Learning Training Methods*** with Dave Meier (from The Center for Accelerated Learning). **Invited**

Mentoring Activities / Development

September 12, 2002 Annual MGE@MSA Faculty Doctoral Mentoring Institute Mentor for Underrepresented Minority Doctoral Students. **Invited**

PROFESSIONAL ACTIVITIES

Society Memberships:

American Meteorological Society
Association of American Geographers
American Geophysical Union
International Association of Hydrological Sciences
American Society of Photogrammetry and Remote Sensing

Manuscript, Book and Proposal Reviews:

The Journal of Forestry
The International Journal of Remote Sensing
Natural Environmental Research Council, U.K.
Urban Ecosystems
California Department of Food and Agriculture
Remote Sensing of Environment
International Journal of Remote Sensing
Theoretical and Applied Climatology
American Water Resources Association (AWRA)
Utah Agricultural Experiment Station at Utah State University
Cooperative State Research, Education, and Extension Program

Weather and climate: cause, course, effect, animation. Harald Frater (ed.), Springer-Verlag, 1999, ISBN, 3-540-14667-9. **Gillies, R.R.**, *Agricultural and Forest Meteorology.*, **2823** (2000) 1-2.

Workshops / Conference:

Invited team-member of Thermal Inertia Mapping Experiment (TIMEX) satellite science team. Proposed thermal IR satellite concept being developed at JPL for submission as an Earth System Science Pathfinder project.

Remote Sensing and Image Processing Workshop, Tuscon, Arizona, April 13 – 15, 1999. Sponsored by NASA **(Invited)**

International assessor for "the midterm presentation of the programme Earth Observation" 28 – 29 October 1999 at the Sorø Strorko, Denmark.

International participant (**invited**) of the GEWEX workshop on status of SVAT modeling. Sponsored by World Meteorological Organization.

Human Health, Urbanization, and Remote Sensing Workshop (**invited**) April 10, 2001. The Rollins School of Public Health, Emory University, Atlanta, Georgia, USA.

Observer (**invited**) WHO meeting on the Prevention of Craniofacial Anomalies, 24-26 May 2001, Utah, USA

Integrated Research Team: The Role of Indications and Warnings for Prediction and Surveillance of Catastrophic Biological Events. 28 – 30 June, 2004 (**invited**)

OTHER AWARDS & HONORS

Chi Epsilon Pi -- The Pennsylvania State University, Meteorological Honors Society, (1989).

Catherine Clarke Trophy for Outstanding Contribution to University Sport, University of Glasgow, (1984).

John D. Horel
Professor
Department of Meteorology
University of Utah
Office: 486 INSCC
Mail: 135 South 1460 East Rm 819
Salt Lake City 84112
Phone: (801) 581-7091
Fax: (801) 581-4362
Email: john.horel@utah.edu

EDUCATION

- Ph.D. 1982, Atmospheric Sciences, University of Washington
- B.S. 1977, Meteorology, San Jose State University

PROFESSIONAL EXPERIENCE

- 1996-present, Professor, Meteorology, University of Utah
- 2002-2006, Director, NOAA Cooperative Institute for Regional Prediction, University of Utah
- 1996-1998, Acting Director, NOAA Cooperative Institute for Regional Prediction, University of Utah
- 1990-1996, Associate Professor, Meteorology, University of Utah
- 1986-1990, Assistant Professor, Meteorology, University of Utah
- 1982-1986, Assistant Research Professor, Scripps Institution of Oceanography

RESEARCH ACTIVITIES

My research is centered on the observation and analysis of weather and climate processes in mountainous regions. Building on a decade of applied research within the framework of the NOAA Cooperative Institute for Regional Prediction, the Mountain Meteorology Group has now been established as a center of excellence within the Department of Meteorology. My current research activities include further development of MesoWest (see http://www.met.utah.edu), which provides access to surface weather observations for operational, research, and educational applications. MesoWest has evolved since 1996 from providing weather information at a few dozen weather stations in northern Utah to the current availability of weather conditions at thousands of stations around the nation using a state-of-the-art database and dozens of tabular and graphical displays. The MesoWest observations also provide a foundation from which to conduct research to improve data assimilation techniques over complex terrain. I participate in a National Weather Service effort to develop a mesoscale Analysis of Record and its prototype the Real Time Mesoscale Analysis. I also am involved in research related to the Great Salt Lake, including the causes and impacts of interannual variations in the level, salinity, and temperature of the Lake.

AWARDS

- Fellow of the American Meteorological Society 2002
- Outstanding Service Award, National Weather Service Western Region, "For outstanding service to the weather support group for the 2002 Olympic Winter Games" 2002
- College of Mines and Earth Sciences Outstanding Teacher Award 1993-94

COURSES TAUGHT DURING THE PAST TEN YEARS

- Meteorology 1010: Severe and Unusual Weather
- Meteorology 1020: Climate Change: An Atmospheric Perspective (course developer)
- Meteorology 2810: Undergraduate Seminar
- Meteorology 3000/Geography 3280: Mountain Weather and Climate (course developer)
- Meteorology 3410: Weather Analysis and Prediction I (course developer)
- Meteorology 3510: Weather Analysis and Prediction II (course developer)
- Meteorology 5120/6120: Applied Mathematics and Statistics for Environmental Scientists
- Meteorology 5140/6140: Mesoscale and Radar Meteorology
- Meteorology 5540: Synoptic Meteorology II
- Meteorology 5550: Mountain Meteorology (co-course developer)
- Meteorology 6010: Fundamentals of Dynamic Meteorology
- Math 6790: Case Studies in Computational Engineering and Science

REFEREED PUBLICATIONS

Texts and Book Chapters

Horel, J. D., and J. E. Geisler, 1996: Global Environmental Change: An Atmospheric Perspective. 165 pp. John Wiley and Son.

Horel, J., 2003: Terrain-forced mesoscale circulations. Handbook of Weather, Climate, and Water: Dynamics, Climate, Physical Meteorology, Weather Systems, and Measurements. Edited by T. Potter and B. Colman. Wiley and Sons. 562-573.

Journal Publications

Myrick, D., and J. Horel 2007: Sensitivity of surface analyses over the western United States to RAWS observations. *Wea. Forecasting*. Accepted.

Zumpfe, D., J. Horel, 2007: Lake-breeze fronts in the Salt Lake Valley.J. Appl. Meteor., 46- 196-211.

Myrick, D., J. Horel, 2006: Verification over the Western United States of Surface Temperature Forecasts from the National Digital Forecast Database. Wea. Forecasting, 21, 869-892.

Horel, J., B. Colman, 2005: Meeting Summary: A Community Meeting on Real-Time and Retrospective Mesoscale Objective Analysis: An Analysis of Record Summit. *Bull. Amer. Meteor. Soc.,* 86, 1477–1480.

Myrick, D., J. Horel, S. Lazarus, 2005: Local Adjustment of the Background Error Correlation for Surface Analyses over Complex Terrain. *Wea. Forecasting,* 20, 149-160.

Ludwig, F., J. Horel, C. D. Whiteman, 2004: Using EOF analysis to identify important surface wind patterns in mountain valleys. J. Appl. Meteor., 7, 969-983.

Clements, C. B., C. D. Whiteman, J. D. Horel, 2003: Cold air pool structure and evolution in a mountain basin. J. Appl. Meteor. 42, 752-768.

Doran, C., J. Fast, J. Horel, 2002: The VTMX 2000 Campaign. Bull. Amer. Meteor. Soc., 83, 537- 551.

Lazarus, S., C. Ciliberti, J. Horel, K. Brewster, 2002: Near-real-time Applications of a Mesoscale Analysis System to Complex Terrain. Wea. Forecasting, 17, 971-1000.

Horel, J., T. Potter, L. Dunn, W. J. Steenburgh, M. Eubank, M. Splitt, and D. J. Onton, 2002: Weather support for the 2002 Winter Olympic and Paralympic Games. Bull. Amer. Meteor. Soc., 83, 227-240

Horel, J., M. Splitt, L. Dunn, J. Pechmann, B. White, C. Ciliberti, S. Lazarus, J. Slemmer, D. Zaff, J. Burks, 2002: MesoWest: Cooperative Mesonets in the Western United States. Bull. Amer. Meteor. Soc., 83, 211-226.

Schultz, D. M., W. J. Steenburgh, R. J. Trapp, J. Horel, D. E. Kingsmill, L. B. Dunn, W. D. Rust, L. Cheng, A. Bansemer, J. Cox, J. Daugherty, D. P. Jorgensen, J. Meitin, L. Sho well, B. F. Smull, K. Tarp, and M. Trainor, 2002: Understanding Utah winter storms: The Intermountain Precipitation Experiment. Bull. Amer. Meteor. Soc., 83, 189-210.

White, Bryan G., Paegle, Jan, Steenburgh, W. James, Horel, John D., Swanson, Robert T., Cook, Louis K., Onton, Daryl J., Miles,John G. 1999: Short-Term Forecast Validation of Six Models.Wea. Forecasting. 14, 84-108.

Waldron, Kim M., Paegle, Jan, Horel, John D. 1996: Sensitivity of a Spectrally Filtered and Nudged Limited-Area Model to Outer Model Options. Mon. Wea. Rev., 124, 529-552.

Dunn, Lawrence B., Horel, John D. 1994: Prediction of Central Arizona Convection. Part II: Further Examination of the Eta Model Forecasts.Wea. Forecasting, 9, 508-521.

Dunn, Lawrence B., Horel, John D. 1994: Prediction of Central Arizona Convection. Part I: Evaluation of the NGM and Eta Model Precipitation Forecasts.Wea. Forecasting, 9, 495-507.

Horel, John D., Gibson, Chris V. 1994: Analysis and Simulation of a Winter Storm over Utah. Wea.Forecasting. 9, 479- 494.

Horel, John D., Pechmann, Judith B., Geisler, John E., Hahmann, Andrea N. 1994: Simulations of the Amazon Basin Circulation with a Regional Model.J. Climate. 7, 56-71.

Berbery, Ernesto H., Nogues-Paegle, Julia, Horel, John D. 1992: Wavelike Southern Hemisphere Extratropical Teleconnections.J. Atmos. Sci., 49, 155-177.

Sassen, Kenneth, Horel, John D. 1990: Polarization Lidar and Synoptic Analyses of an Unusual Volcanic Aerosol Cloud. J. Atmos. Sci. 47, 2881-2889.

Barker, Timothy W., Horel, John D. 1989: The Impact of Climatology and Systematic Errors upon the Skill of DERF Forecasts. Mon. Wea. Rev., 117, 2835-2842.

Horel, John D., Hahmann, Andrea N., Geisler, John E. 1989: An investigation of the Annual Cycle of Convective Activity over the Tropical Americas. J. Climate, 2, 1388-1403.

Horel, John D., Staley, Lloyd R., Barker, Timothy W. 1988: The University of Utah Interactive Dynamics Program- One Approach to Interactive Access and Storage of Meteorological Data. Bull. Amer. Meteor. Soc., 69, 1321-1327.

Horel, John D., Mechoso, Carlos R. 1988: Observed and Simulated Intraseasonal Variability of the Wintertime Planetary Circulation.J. Climate, 1, 582-599.

Barker, Timothy W., Horel, John D. 1988: Quasi-Stationary Regimes in the Northern Hemisphere of the NCAR Community Climate Model.J. Climate, 1, 406- 417.

Horel, John D., Cornejo-Garrido, Angel G. 1986: *Convection along the Coast of Northern Peru during 1983: Spatial and Temporal Variation of Clouds and Rainfall. Mon. Wea. Rev., 114, 2091-2105.

Horel, John D. 1985: Persistence of Wintertime 500 mb Height Anomalies over the Central Pacific. Mon. Wea. Rev., 113, 2043-2048.

Horel, John D. 1985: Persistence of the 500 mb Height Field during Northern Hemisphere Winter. Mon. Wea. Rev., 113, 2030-2042.

Horel, J. D. 1984: Complex Principal Component Analysis: Theory and Examples.J. Appl. Meteor., 23, 1660-1673.

Van Den Dool, H.M., Horel, J.D. 1984: An Attempt to Estimate the Thermal Resistance of the Upper Ocean to Climatic Change. J. Atmos. Sci., 41, 1601-1612.

Horel, John D. 1982: On the Annual Cycle of the Tropical Pacific Atmosphere and Ocean. Mon. Wea. Rev., 110, 1863-1878.

Horel, John D., Wallace, John M. 1982: Reply. Mon. Wea. Rev., 10, 1497-1497.

Horel, John D. 1981: A Rotated Principal Component Analysis of the Interannual Variability of the Northern Hemisphere 500 mb Height Field. Mon. Wea. Rev., 109, 2080-2092.

Horel, John D., Wallace, John M. 1981: Planetary-Scale Atmospheric Phenomena Associated with the Southern Oscillation. Mon. Wea. Rev., 109, 813-829.

GRADUATE STUDENTS (area of employment)

- Current: E. Crosman, L. Jones, B. Olsen, D. Tyndall
- D. Myrick, 2006, Ph.D. (NWS)
- E. Crosman, 2005, M.S. (student)
- D. Zumpfe, 2004. M.S. (NWS)
- D. Myrick, 2003. M.S. (NWS)
- L. Holland, 2002. M.S. (NCAR)
- L. Cheng, 2002. M.S. (NWS)
- C. Clements, 2001. M.S. (Faculty SJSU)
- R. Swanson, 1998. Ph.D. (Air Force)
- J. Slemmer, 1998. M.S (NWS)
- A. Haynes, 1998. M.S. (NWS)
- B. McDonald, 1998. Ph.D. (NWS)
- J. Stiff, 1997. M.S. (Broadcasting)
- M. Braby, 1997. M.S. (Commercial firm)
- J. Mittelstadt, 1995. Ph.D. (NWS)
- R. Swanson, 1995. M.S. (Air Force)
- C. Gibson, 1993. M.S. (NWS)
- L. Dunn, 1993. Ph.D. (NWS)
- A. Hahmann, 1992. Ph.D. (NCAR)
- T. Barker, 1991. Ph.D. (NWS)
- C. Jones, 1990. M.S. (Research Faculty UCSB)

SELECTED PROFESSIONAL ACTIVITIES

- Co-chair. WAF/NWP AMS Conference. June 2007
- Member. WAF/NWP statement writing team. 2007
- Covenor. Thirteenth Workshop on Weather Prediction in the Intermountain West. Nov. 2006

- Clarus Quality Checking Task Force. Federal Highway Administration. May 2006.
- Department Review Panel. Department of Atmospheric and Environmental Science. Creighton University. April 2005.
- Co-Chair. Mesoscale Analysis Committee. National Weather Service Office of Science and Technology. 2004-present.
- Member of NSF LEAD external advisory panel 2004-present (Chair 2006-present)
- Member of the Scripps Experimental Climate Prediction Center advisory panel 1999-present
- Covenor and Co-Covenor of First-Ninth Workshops on Weather Prediction in the Intermountain West (1994-2002)
- Member of external 10-year institutional review panel for the Desert Research Institute 2002
- Contributor to Olympic Weather Support Team for the 2002 Winter Olympic and Paralympic Games (1996-2002)
- Member of the U.S. CLIVAR Pan American Climate Studies Panel. 1999-2000
- Member of the Scientific Steering Group for the Pan American Climate Systems Program of the NOAA Office of Global Programs: 1994-1999
- Co-Lead Instructor UCAR/COMET COMAP Course. Summer 1997
- Member of the American Meteorological Society Panel on Climate Variations 1994-1997
- Member of the NCEP EMC review panel 1996
- Member of College of Mines and Earth Sciences committees (e.g., computer 1988-1993, committee chair 1991-1993; curriculum 2000-present; retention and promotion 1996-1998, 2001-2002, 2005-present)

RECENT INVITED PRESENTATIONS

- April 2007. National Weather Service SOO/DOH Workshop. Salt Lake City UT
- December & March 2006. COMET Olympic Winter Weather Training Course. Boulder CO
- July 2006. Instructor for COMET faculty course on instructional uses of multimedia. Boulder CO.
- July 2006. Empirical Models and Data Assimilation. Unidata Users Workshop. Boulder CO.
- March 2006. National Weather Service Western Region Climate Services Workshop. Salt Lake City, UT.
- February 2006: National Weather Service S591 Fire Meteorologist Training Course. Boise, ID
- October 2005: Department of Atmospheric Sciences. University of Washington
- March 2005: Department of Geography. University of Utah
- March 2005: Western Region National Weather Service. Meteorologist in Charge Workshop. Portland OR
- March 2005: Department of Atmospheric Sciences. Texas A&M

- February 2005: Western Region National Weather Service. Science and Operations Officer Workshop. Salt Lake City UT
- September 2004: University of Oklahoma. College of Meteorology
- June 2004: NWS/UCAR COMET course on boundary layer meteorology
- March 2004: National Fire Weather Course- S591
- March 2004: Incident Meteorologist Workshop
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FEDERAL AND OTHER RESEARCH SUPPORT DURING THE PAST TEN YEARS

Cooperative Institute for Regional Prediction. Agency: NOAA. Total amount: $375,000. Period covered: July 2007-June2010. (Co-PIs J. Steenburgh, D. Whiteman).

Cooperative Institute for Regional Prediction. Agency: NOAA. Total amount: $375,000. Period covered: July 2004-June 2007. (Co-PI J. Steenburgh)

Development of a Nationwide, Weather Observation Monitor for Fire Weather Applications. Agency: BLM. Total amount: $720,000. Period covered: July 2002-Sep 2007

CIRP Consortium: Contributions from government and private sources.

Climate Applications of MesoWest. U/Utah VP for Research Seed funding. $33,500. 1/06-12/06

Weather and Climate Variations Associated with the Great Salt Lake, NASA, $72000, 9/07-8/10

Utilization of MesoWest Data in the DHS Biological Warning Incident Program. $30000, 3/06-2/08

Improved Integration and Coordination between UDOT RWIS Program and the University of Utah MesoWest Program. Utah Department of Transportation, $50,000, 7/05-6/07.

Evaluation of the NCEP Regional Reanalyses over Complex Terrain. Agency: NOAA Office of Global Programs. Total amount: $245,897. Period covered: March 2004-February 2007. (Co-PI J. Steenburgh, W. Cheng)

Cooperative Institute for Regional Prediction. Agency: NOAA. Total amount: $500,000. Period covered: January 2000-June 2004. (Co-PI T. Potter, J. Steenburgh)

Analysis of the Planetary Boundary Layer in an Urban Valley. Agency: DOE. Total amount: $378,000. Period covered: Nov. 1999-Oct. 2004. (Co-PI S. Lazarus)

Planning Weather Support for the 2002 Winter Olympics. Agency: NOAA. Total amount: $380,000. 4/00-3/02. (Co-PI T. Potter, J. Steenburgh)

Mesoscale Modeling Studies of Warm Season Rainfall in the PACS Domain. Agency: NOAA OGP. Total amount: $171,686. Period covered: March 1998-March 2000. (Co-PI J. Steenburgh)

Evaluation and Application of the Eta Adjoint Model. Agency: NSF. Total amount: $105,900. Period covered: June 1996-May 1998.

Regional Climate Simulations over the Tropical Americas. Agency: NOAA. Award amount: $171,000. Award dates: May 1995-April 1997. (Co-PI J. Pechmann)

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Randall P. Julander

Education

1976 – 1979 Utah State University - Logan, Utah
BS Watershed Management
1983 – 1984 Utah State University - Logan, Utah
MS Forest Watershed Management

Professional experience

1979 – 1980 - Hydrologic Technician, Bureau of Land Management, Glenwood Springs Colorado
1980 – 1981 - Hydrologic Technician, US Forest Service, Boise Idaho
1981 – 1982 - Hydrologist, Bureau Of Land Management, Denver Colorado
1982 – 1983 - Hydrologist, Agricultural Research Service, Sydney Montana
1984 – 1991 - Hydrologist, Colorado Basin River Forecast Center
1991 – Current - Hydrologist, Snow Survey Supervisor, Natural Resources Conservation Service, USDA
1999 – Current Adjunct Professor, University of Utah, Teaching Snow Hydrology

- As Snow Survey Supervisor, I am responsible for the collection, processing and archival of snow and hydrometerological data from Utah, Nevada and parts of California. These data are used in water management functions by local, state and federal governments as well as private organizations and individuals. We produce water supply forecasts, in order to more effectively manage water resources for agriculture, hydroelectric, reservoir operations, municipal supplies, droughts, floods and all manner of water related problems. We provide accurate and timely information on snowmelt and runoff. We also provide consultation and training on data monitoring systems, data collection, processing, archival, application and use. Expert in the use of historical data relative to climate applications. In previous experience: expert in hydrologic modeling: SRM, DamBreak, Snow17, Sacramento and others.

Publications

Frequency and Temperature Analysis of the 1983 Wasatch Front Floods.

Improvements in Developing Water Supply Forecasts

Drop Former vs Ponding Ring Infiltrometers, a Comparison.

Water, Salt and Sediment yields from 3 Mancos Shale soils in Eastern Utah

Flooding and the SNOTEL System

The Franklin Basin Problem and Solution

Soil Moisture and Water Supply

Soil Moisture and Water Supply, the Sequel

A Historical Comparison of Snowpack Averages in Utah

Soil Moisture and Water Supply Forecasting

An analysis of the timing of snow course measurement and the potential error compared to April 1 measurements in Utah

The impacts of soil type and sensor location on soil moisture data

An examination of external influences embedded in the historical snowpack data of Utah

Floods, droughts and extremes in Utah Snowpack

The SNOTEL temperature dataset

Soil surface temperature difference between steel and hypalon pillows

Professional memberships

Western Snow Conference

Languages

English and German

David G. Long, Ph.D.

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Education:

1989 **Ph.D. University of Southern California**. Electrical Engineering. Advisor: Prof. Jerry Mendel, Chair EE-Systems Dept.

1983 **M.S. Brigham Young University**. Electrical Engineering. Cum Laude.

1982 **B.S. Brigham Young University**. Electrical Engineering. Summa Cum Laude.

Experience:

1990- **Brigham Young University.** Provo, Utah

Professor of Electrical and Computer Engineering. (1999-) Teach undergraduate and graduate courses in electrical engineering. Conduct research in spaceborne scatterometry, synthetic aperture radar, and microwave remote sensing. Mentor undergraduate and graduate students. Mentor new faculty. University, college, and department committee assignments.

Associate Professor of Electrical and Computer Engineering. (1994-99)

Assistant Professor of Electrical and Computer Engineering. (1990-94)

***Director*, BYU Center for Remote Sensing**. (2000-) Coordinate, promote, and direct BYU interdisciplinary remote sensing activities across the University. Manage support staff. Develop academic support program.
http://www.cers.byu.edu/

***Head*, Microwave Earth Remote Sensing (MERS) Laboratory**. (1991-) Direct research in microwave remote sensing. Coordinate research and laboratory resources among faculty and students. Manage the acquisition and maintenance of laboratory computer and microwave test equipment. Manage support staff.
http://www.mers.byu.edu/

Principal Investigator. (1990-) NASA, NSF, NOAA, and DoD sponsored research projects. Selected titles include "Boundary Layer Modeling of Surface Winds Using NSCAT Data," "Model-Based Wind Retrieval of Wind Fields Using Seasat Scatterometer Data," "High Resolution Imaging of Land and Ice Using SASS Data," "Research in Oceanic Air/Sea Interaction," "Geologic Applications of Small SAR," "Scatterometer Climate Record Pathfinder," "Application and Extension of the Scatterometer Climate Record Pathfinder," "MicroSAR for small UAV." Member of a number of NASA and international science teams.

Instructor, BYU Education Week. (1995-2005) Give1-3 public lectures per year

1990- **Consultant**. Technical expertise in scatterometer performance and design analysis, radar resolution enhancement, and radar remote sensing. Teach short courses.

1983-1990 **Jet Propulsion Laboratory, California Institute of Technology (JPL).** Pasadena, California.

***Experiment Manager*, SCANSCAT Project.** (1989-90) Senior manager responsible for all technical and programmatic aspects of the SCANSCAT Project in the development and proposal phase. Eventually known as *SeaWinds*, this highly successful $250 M project resulted in two successful launches and one extended mission (*SeaWinds-on-QuikSCAT*: 1999-present). Managed and coordinated all JPL design and development efforts among staff spread over multiple disciplines at JPL. Prepared and negotiated budgets and technical requirements between JPL, NASA headquarters, other NASA centers, and contractors.

***Project Engineer*, Spaceborne Scatterometer Projects Office.** (1988-90) Senior technical manager for the JPL scatterometer projects office. Responsible for the high level design, analysis, and technical management of the scatterometer projects including instrument design and fabrication, algorithm development and coding for the ground processing system, mission operations, calibration data analysis, system performance analysis, and development and maintenance of system and low-level requirements. Supervised Project Engineering staff. Managed large multi-disciplinary design team. Functioned as interface between scientists, engineering support teams, and upper management.

***Group Leader*, Radar Systems Engineering.** (1988-90) Supervised a staff of 5 radar system engineers involved in the design and performance analysis of JPL flight projects in spaceborne radar remote sensing including the SIR-C and Magellan synthetic aperture radars and the NSCAT, NUSCAT, and SCANSCAT scatterometer missions. Responsibilities included personnel hiring, task assignment, project reporting, and managing and negotiating budgets.

***Principal Investigator*.** (1989-90) NASA-sponsored research project "Model-Based Wind Retrieval of Wind Fields Using Seasat Scatterometer Data."

***Member Technical Staff*.** (1983-1987) Developed requirements and the high-level design for the NASA Scatterometer (NSCAT) project as the NSCAT Instrument Systems Engineer. Developed performance analysis tools and performed tradeoffs in developing the onboard signal processor design and the ground processing system. Managed technical development in supporting disciplines.

1982 **ESL, Inc.** Sunnyvale, California (summer hire)

***Member Technical Staff*.** Studied the effects of bit errors in digital communication channels on the intelligibility of LPC-coded speech.

1980-1981 **Timet Corp.** Henderson, Nevada (summer hire)

***Engineer*.** Designed custom analog and digital control systems for high-power vacuum arc furnaces and molten salt electrolytic cells.

Publications:

Seventy-on refereed journal papers and three book chapters. Over 250 conference papers and technical conference presentations. Co-authors include distinguished scientists, faculty members, and students.

Awards:

2005 **IEEE *Best Paper of the Year, Trans. Geoscience and Remote Sensing.*** With David W. Draper.

2004 **BYU *Sponsored Research Award.*** For outstanding achievement in scholarly activities funded by external sponsors.

2004 **Utah County Sheriff *Citizen Service Award.*** For contributions to search and rescue activities.

2002 **BYU *Karl G. Maeser Excellence in Research and Creative Arts Award.*** For outstanding research and creative accomplishments.

2001 **BYU *Martha Jane Knowlton Coray Professorship.*** To acknowledge senior faculty who are outstanding scholars, teachers, and university citizens.

2000 **NASA *Group Achievement Award.*** For outstanding performance in the development, launch and operations of the Quick Scatterometer spacecraft.

1997 **NASA *Team Recognition.*** In recognition of proficient advice on scientific requirements during the development of the mission, successful development of methods for optimal data retrieval and outstanding early demonstration of scientific application of NSCAT observations.

1986,'88,'91,'91,'92 NASA *Certificate of Recognition.* For technical papers on scatterometer instrument design, analysis, and data processing.

1986,'88 **NASA *Certificate of Recognition.*** For the development of a sophisticated computer graphics package which was commercially distributed by NASA's Computer Software Management and Information Center (COSMIC). The package was among the center's most popular program packages for several years.

Research Interests:

Microwave remote sensing, spaceborne scatterometry, synthetic aperture radar, speech and signal processing, radar theory, estimation theory, computer graphics, resolution enhancement, scattering theory, polar ice, and mesoscale atmospheric dynamics.

Society Memberships:

Senior Member IEEE (nominated for Fellow), American Geophysical Union, and Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, and Sigma Xi honor societies. Currently faculty advisor for Eta Kappa Nu. Past faculty advisor for Tau Beta Pi.

NASA Science Teams:

Past or current member of science teams: *NASA Scatterometer, SeaWinds, Ocean Vector Winds, TRMM, JASON-1, and ESA ERS-2.* Chair of the NSCAT model function subcommittee. Chair of the QuikSCAT/Seawinds Committee on Model Functions.

Students:

One post-doc, eight Ph.D. students completed with five currently in progress, 25 Masters students completed with five in progress. Completed students work in academia, in industry and for government laboratories. Numerous undergraduate students were also mentored as research students.

Major Research Grants:

Over 30 externally funded research grants totaling approximately $7M. Sponsors include NASA, NSF, DoD, and NOAA.

Selected Journal Publications (* denotes student authors)

J.Piepmeir, E.G. Njoku, and D.G. Long "Stokes Antenna Temperatures," to appear, *IEEE Transactions on Geoscience and Remote Sensing*, 2007.

H. Stephen and D.G. Long, "Spatial and Temporal Behavior of Microwave Backscatter Directional Modulation Over the Saharan Ergs," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 45, No. 5, pp. 1164-1173, 2007.

C. Nie and D.G. Long, "A C-band Wind/Rain Backscatter Model," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 45, No. 3, 621-631, 2007.

I.S. Ashcraft and D.G. Long, "Comparison of Methods for Melt Detection over Greenland using Active and Passive Microwave Measurements," *International Journal of Remote Sensing*, Vol. 27, No. 12, pp. 2569-2488, 2006.

I.S. Ashcraft and D.G. Long, "Relating Microwave Backscatter Azimuth Modulation to Surface Properties of the Greenland Ice Sheet," *Journal of Glaciology*, Vol. 52, No. 177, pp. 257-266, 2006.

L.B. Kunz and D.G. Long, "Melt Detection in Antarctic Ice-Shelves Using Spaceborne Scatterometers and Radiometers," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 44, No. 9, pp. 2461-2469, 2006.

J.R. Allen and D.G. Long, "Microwave Observations of Daily Antarctic Sea-Ice Edge Expansion and Contraction Rates," *Geoscience and Remote Sensing Letters*, Vol. 3, No. 1, pp. 54-58, 2006.

H. Stephen and D.G. Long, "Modeling Microwave Emissions of Erg Surfaces in the Sahara Desert," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 12, pp. 2822-2830, 2005.

J.R. Allen and D.G. Long, "An Analysis of SeaWinds-Based Rain Retrieval in Severe Weather Events," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 12, pp. 2870-2878, 2005.

L.B. Kunz and D.G. Long, "Calibrating SeaWinds and QuikSCAT Scatterometers Using Natural Land Targets," *Geoscience and Remote Sensing Letters*, Vol. 2, No. 2, pp. 182-186, 2005.

I.S. Ashcraft and D.G. Long, "Differentiation Between Melt and Freeze Stages of the Melt Cycle Using SSM/I Channel Ratios," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 6, pp. 1317-1323, 2005.

H.S. Anderson and D.G. Long, "Sea Ice Mapping Method for SeaWinds," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 3, pp. 647-657, 2005.

I.S. Ashcraft and D.G. Long, "Observation and Characterization of Radar Backscatter over Greenland," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 2, pp 237-246, 2005.

I.S. Ashcraft* and D.G. Long, "Observation and Characterization of Radar Backscatter over Greenland," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 2, pp 237-246, 2005.

H. Stephen* and D.G. Long, "Microwave Backscatter Modeling of Erg Surfaces in the Sahara Desert," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 2, pp. 238-247, 2005.

D.G. Long, M.W. Spencer, and E.G. Njoku, "Spatial Resolution and Processing Tradeoffs for HYDROS: Application of Reconstruction and Resolution Enhancement Techniques," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 43, No. 1, pp. 3-12, 2005.

J. Etcheto, E.Dinnat, J. Boutin, A. Camps, J. Miller, S. Contardo, J. Wesson, J.Font, and D.G. Long, "Wind Speed Effect on L-band Brightness Temperature Inferred from EuroSTARRS and WISE 2001 Field Experiments," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 42, No. 10, 2004.

J. Haarpainter, R.T. Tonboe, D.G. Long and M. L. VanWoert, "Automatic Detection and Validity of the Sea Ice Edge: An Application of Enhanced Resolution QuikScat/SeaWinds Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 42, No. 7, pp. 1433-1443, 2004.

P.K. Yoho* and D.G. Long, "Correlation and Covariance of Satellite Scatterometer Measurements," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 42, No. 6, pp. 1176-1187, 2004.

D.W. Draper* and D.G. Long, "Simultaneous Wind and Rain Retrieval Using SeaWinds Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 42, No. 7, pp. 1411-1423, 2004.

D.W. Draper* and D.G. Long, "Assessing the Quality of SeaWinds Rain Measurements," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 42, No. 7, pp. 1424-1432, 2004.

D.W. Draper* and D.G. Long, "Evaluating the Effect of Rain on SeaWinds Scatterometer Measurements," *Journal of Geophysical Research*, Vol. 109, No. C02005, doi:10.1029/2002JC001741, 2003.

P.K. Yoho* and D.G. Long, "An Improved Scatterometer Simulation Model for Spaceborne Scatterometer Measurements," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 41, No. 11, pp. 2692-2695, 2003.

Q.P. Remund* and D.G. Long, "Large-scale Inverse Ku-band Backscatter Modeling of Sea Ice," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 41, No. 8, pp. 1821-1833, 2003.

D.W. Draper* and D.G. Long, "An Advanced Ambiguity Selection Algorithm for SeaWinds," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 41, No. 3, pp. 538-547, 2003.

M.W. Spencer*, W-Y Tsai, and D.G. Long, "High Resolution Measurements with a Spaceborne Pencil-Beam Scatterometer Using Combined Range/Doppler Discrimination Techniques," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 41, No. 3, pp. 567-581, 2003.

D.W. Draper* and D.G. Long, "An Assessment of SeaWinds on QuikSCAT Wind Retrieval," *Journal of Geophysical Research*, Vol. 107, No. C12, pp. 3212-3226, Dec. 2002.

D.G. Long, Jarom Ballantyne*, and C. Bertoia, "Is the Number of Icebergs Really Increasing?" *EOS, Transactions of the American Geophysical Union*, Vol. 83, No. 42, pp 469 & 474, 15 Oct. 2002.

Y. Zhao, A.K. Liu, and D.G. Long, "Validation of Sea Ice Motion from QuikSCAT with Those from SSM/I and Buoy," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 40, No. 6, pp. 1241-1246, 2002.

B.E. Barrowes* and D.G. Long, "Evaluation of a Compound Probability Model with Tower-Mounted Scatterometer Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 40, No.1, pp. 42-49, 2002.

D.G. Long, M.R. Drinkwater, B. Holt, S. Saatchi, and C. Bertoia, "Global Ice and Land Climate Studies Using Scatterometer Image Data," *EOS, Transaction of the American Geophysical Union*, Vol. 82, No. 43, pg. 503, 23 Oct. 2001. Includes *EOS* Electronic Supplement: http://www.agu.org/eos_elec/010126e.html

R.R. Forster, D.G. Long, K.C. Jezek, S.D. Drobot, and M.R. Anderson, "The Onset of Arctic Sea-Ice Snowmelt as Detected with Passive- and Active-microwave Remote Sensing," *Annals of Glaciology*, Vol. 33, pp. 85-93, 2001.

M.R. Drinkwater, D.G. Long, and A.W. Bingham, "Greenland Snow Accumulation Estimates from Scatterometer Data," *Journal of Geophysical Research*, PARCA Special Issue, Vol. 106, No. D24, pp. 33935-33950, 2001.

D.S. Early* and D.G. Long, "Image Reconstruction and Enhanced Resolution Imaging from Irregular Samples," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 39, No. 2, pp. 291-302, 2001.

Q.P. Remund*, D.G. Long, and M.R. Drinkwater, "An Iterative Approach to Multisensor Sea Ice Classification," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 38, No. 4, pp. 1843-1856, 2000.

D.G. Long and M.R. Drinkwater, "Azimuth Variation in Microwave Scatterometer and Radiometer Data Over Antarctica," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 38, No. 4, pp. 1857-1870, 2000.

M.W. Spencer*, C. Wu, and D.G. Long, "Improved Resolution Backscatter Measurements with the SeaWinds Pencil-Beam Scatterometer," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 38, No. 1, pp.89-104, 2000.

J. Zec*, W.L. Jones, and D.G. Long, "NSCAT Normalized Radar Backscattering Coefficient Biases Using Homogenous Land Targets," *Journal of Geophysical Research*, Vol. 184, No. C5, pp. 11557-11568, 1999.

T. Oliphant* and D.G. Long, "Accuracy of Scatterometer-Derived Winds Using the Cramer-Rao Bound," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 37, No. 6, pp. 2642-2652, 1999.

Q.P. Remund* and D.G. Long, "Sea Ice Extent Mapping Using Ku-Band Scatterometer Data," *Journal of Geophysical Research*, Vol. 104, No. C5, pp. 11515-11527, 1999.

A.E. Gonzales* and D.G. Long, "An Assessment of NSCAT Ambiguity Removal," *Journal of Geophysical Research*, Vol. 104, No. C5, pp. 11449-11457, 1999.

D.G. Long and M.R. Drinkwater, "Cryosphere Applications of NSCAT Data," *IEEE Transactions Geoscience and Remote Sensing*, Vol. 37, No. 3, pp. 1671-1684, 1999.

W-Y Tsai, J.E. Graf, C. Winn, J.N. Huddleston, S. Dunbar, M.H. Freilich, F.J. Wentz, D.G. Long, and W.L. Jones, "Post-launch Sensor Verification and Calibration of the NASA Scatterometer," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 37, No. 3, pp. 1517-1542, 1999.

P.J. Johnson* and D.G. Long, "The Probability Density of Spectral Estimates Based on Modified Periodogram Averages," *IEEE Transactions on Signal Processing*, Vol. 47, No. 5, pp. 1255-1261, 1999.

D.G. Long, Q.P. Remund*, and D.L. Daum*, "A Cloud-Removal Algorithm for SSM/I Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 37, No. 1, pp. 54-62, 1999.

J. Graf, C. Sasaki, C. Winn, W.T. Liu, W. Tsai, M. Freilich and D. Long, "NASA Scatterometer Experiment," *Acta Astronautica*, Vol. 43, No. 7-8, pp. 377-407, 1998.

D.G. Long, and D.L. Daum, "Spatial Resolution Enhancement of SSM/I Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 35, No. 2, pp. 407-417, 1998.

D. S. Early* and D.G. Long, "Azimuth Modulation of C-band Scatterometer sigma-0 Over Southern Ocean Sea Ice," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 35, No. 5, pp. 1201-1209, Sept. 1997.

M.W. Spencer*, C. Wu, and D.G. Long, "Tradeoffs in the Design of a Spaceborne Scanning Pencil-beam Scatterometer," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 35, No. 1, pp. 115-126, Jan. 1997.

D.G. Long and M.W. Spencer, "Radar Backscatter Measurement Accuracy for a Spaceborne Pencil-Beam Wind Scatterometer with Transmit Modulation," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 35, No. 1, pp. 102-114, Jan. 1997.

D.G. Long, R.S. Collyer*, R. Reed*, and D.V. Arnold, "Dependence of the Normalized Radar Cross Section of Water Waves on Bragg Wavelength--Wind Speed Sensitivity," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 34, No. 3, pp. 656-666, May 1996.

D.G. Long and G.B. Skouson*, "Calibration of Spaceborne Scatterometers Using Tropical Rainforests," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 34, No. 2, pp. 413-424, Mar. 1996.

P. J. Hardin and D. G. Long, "Integrating Reconstructed Scatterometer and Advanced Very High Resolution Radiometer Data for Tropical Forest Inventory," *Optical Engineering*, Vol. 34, No. 11, pp. 3146-3153, Nov. 1995.

D. G. Long and M.R. Drinkwater, "Greenland Observed at High Resolution by the Seasat-A Scatterometer," *Journal of Glaciology*, Vol. 32, No. 2, pp. 213-230, 1994.

D. G. Long and P. Hardin, "Vegetation Studies of the Amazon Basin Using Enhanced Resolution Seasat Scatterometer Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 32, No. 2, pp. 449-460, Mar. 1994.

D. G. Long, "Wind Field Model-Based Estimation of SEASAT Scatterometer Winds," *Journal of Geophysical Research*, Vol. 98, No. C8, pp. 14,651-14,668, 1993.

D. G. Long, P. Hardin, and P. Whiting*, "Resolution Enhancement of Spaceborne Scatterometer Data," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 31, No. 3, pp. 700-715, May 1993.

D. G. Long and D. Arnold, "Observational Research in Air/Sea Interaction," Invited Paper, *Remote Sensing Reviews*, Vol. 8, pp. 189-194, 1993.

F. Naderi, M. H. Freilich, and D. G. Long, "Spaceborne Radar Measurement of Wind Velocity Over the Ocean--An Overview of the NSCAT Scatterometer System," invited paper, *Proceedings of the IEEE*, pp. 850-866, Vol. 79, No. 6, June 1991.

D. G. Long and J. M. Mendel, "Identifiability in Wind Estimation from Wind Scatterometer Measurements," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 29, No. 2, pp. 268-276, 1991.

S. J. Shaffer, R.S. Dunbar, S. V. Hsiao, and D.G. Long, "A Median-Filter-Based Ambiguity Removal Algorithm for NSCAT," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 29, No. 1, pp. 167-174, Jan. 1991.

D. G. Long and J. M. Mendel, "Model-Based Estimation of Wind Fields over the Ocean From Scatterometer Measurements Part I: The Wind Field Model," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 28. No. 2, pp. 349-360, May 1990.

D. G. Long and J. M. Mendel, "Model-Based Estimation of Wind Fields over the Ocean From Scatterometer Measurements Part II: Estimation of the Model Parameters," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 28. No. 2, pp. 361-373, May 1990.

D. G. Long, "Exact Computation of the Unwrapped Phase of a Finite-Length Time Series," *IEEE Transactions on Acoustics, Speech, and Signal Processing*, Vol. 36, No. 11, pp. 1787-1790, Nov. 1988.

D. G. Long, C-Y Chi, and F. K. Li, "The Design of an Onboard Digital Doppler Processor for a Spaceborne Scatterometer," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 26, No. 6, pp. 869-878, Nov. 1988.

C-Y Chi, D. G. Long, and F. K. Li, "Roundoff Noise Analysis for Digital Signal Power Processors Using Welch's Spectrum Estimation," *IEEE Transactions on Acoustics, Speech, and Signal Processing*, Vol. ASSP-35, No. 6, June 1987.

C-Y Chi, D. G. Long and F. K. Li, "Radar Backscatter Measurement Accuracies Using Digital Doppler Processors in Spaceborne Scatterometers," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. GE-24, No. 3, May 1986.

Book Chapters

D.G. Long, "Reconstruction and Resolution Enhancement Techniques for Microwave Sensors," in C.H. Chen (ed.), *Frontiers of Remote Sensing Information Processing*, World Scientific Publishing Co., 2003.

D.P. Winebrenner, D. G. Long, and B. Holt, "Automatable Observation of Seasonal Transitions on Arctic Sea Ice Using Synthetic Aperture Radar," in C. Tsatsoulis and R. Kwok (eds), *Recent Advances in the Analysis of SAR for Studies in the Polar Oceans*, Springer-Verlager, pgs. 129-144, 1998.

D.W. Parry, D.V. Arnold, D.G. Long, S.R. Woodward, "The Dead Sea Scrolls and New Technological Advances: DNA, Electronic Database, and Imaging Radar," for P.W. Flint and J.C. Vanderkam (eds.), *The Dead Sea Scrolls Jubilee Collection*, E.J. Brill, Vol. 1, pg. 496-515, 1998.

Curriculum Vitae

Thomas Reichler

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September 18, 2007

PROFESSIONAL EXPERIENCE

2004-date	Assistant Professor, Department of Meteorology, University of Utah, UT.
2003-2004	Visiting Scientist, Geophysical Fluid Dynamics Laboratory, Princeton, NJ.
1997-2003	Research Assistant, Scripps Institution of Oceanography, La Jolla, CA.
1996-1997	Research Assistant, Department of Atmospheric Sciences, Univ. of Illinois, IL.
1995-1996	Research Assistant, Institute for Atmospheric Physics, German Aerospace Center (DLR), Germany.
1993	Intern, German Remote Sensing Center (DFD), Oberpfaffenhofen, Germany.
1992	Intern, German Weather Service (DWD), Munich, Germany.

EDUCATION

2003	Ph.D. Oceanography, Scripps Institution of Oceanography, University of California, San Diego.
1996	M.S. (equivalent), Meteorology, University of Munich; Physical Geography, University of Augsburg, Germany.

TEACHING

2005-2007	Earth Climate System (METEO 6030), University of Utah.
2004-2007	Atmospheric Dynamics (METEO 6010), University of Utah.
2006	Case Studies in Computational Engineering (MATH 6790), "Numerical modeling of geophysical flow", University of Utah.
2008	Advanced Large Scale Dynamics (METEO 6210), planned.
2006	Graduate Seminar (METEO 7810).
2004-date	Graduate Coordinator, University of Utah.
1998	Teaching Assistant, Introduction to Atmospheric Sciences (ES20), University of California.

STUDENT MENTORING

Graduate Students Supervised

Junsu Kim, Ph.D. candidate (2004-date)
Byoung-Cheol Kim, M.S. candidate (2005)
Paul Staten, Ph.D. candidate (2006-date)
Chris Pennell, Ph.D. candidate (2006-date)

Graduate Committees

Kantave Green, M.S. (2005-2006).

PROFESSIONAL SERVICE AND ACTIVITIES

Reviewer for

National Science Foundation
National Oceanic and Atmospheric Administration
Journal of Climate
Journal of the Atmospheric Sciences
Quarterly Journal of the Royal Meteorological Society
Journal of Geophysical Research
Geophysical Research Letters
Tellus-A
Atmospheric Science Letter

Member of

American Meteorological Society (1997-date)
American Geophysical Union (1997-date)
Royal Meteorological Society (2003-date)

UNIVERSITY SERVICE AND ACTIVITIES

2004-date	Department of Meteorology Graduate Coordinator.
2004-date	Department of Meteorology Representative to University's Graduate Director's meetings.
2005-2006	Department of Meteorology Member Representative to the University Corporation for Atmospheric Research.
2005-date	Computational, Engineering and Science (CES) Steering Committee.
2004-2006	College of Mines and Earth Sciences McGregor Library Committee.
2005-date	College of Mines and Earth Sciences Computer Committee.
2005-date	University of Utah Credits and Admissions Committee.

RESEARCH AND EDUCATIONAL SUPPORT

Current

"Structural changes in the tropical Hadley circulation: Past and future trends ", Thomas Reichler (Sole PI), NSF, $173,453, 12/05-11/07.

"Predictability of the Arctic oscillation from stratospheric coupling", Thomas Reichler (PI) and Arun Kumar (NCEP/NOAA), NOAA, $376,076 (Univ. of Utah portion $376,076), 6/06-5/09.

"Purchase of a rotating tank for classroom demonstrations", Thomas Reichler (Sole PI), University of Utah Teaching Grant, $3,000, 1/07-4/07.

"Measuring the global tropopause by satellite: uncertainties, structure, and variability", Thomas Reichler (PI), NASA Earth and Space Science Fellowship for Paul Staten, $24,000, 9/07-8/08.

HONORS AND AWARDS

2003-2004	Visiting scientist fellowship, GFDL, Princeton, NJ.
1998, 1997	AMS graduate student fellowship, annual AMS meeting.
1996	Thesis award, University of Augsburg, Germany (DM 3,000.-)
1978	Stiftung Jugend forscht (youth science foundation), 1st prize awarded.

PUBLICATIONS

Articles in preparation

Reichler, T., I. Held, and. K. Rosenlof (2007): Direct observational evidence for a widening of the tropical Hadley cell. *J. Clim.*

Reichler, T. and J. Kim (2007): Validating the present-day mean climate simulated by the IPCC AR4 models. *J. Clim.*

Submitted Articles

Seidel, D., Q. Fu, R. Randel, and T. Reichler (2007): Getting wider around the middle: Tropical belt is expanding as climate changes, *Nature-Geosciences*, (sub judice).

Reichler, T. and J. Kim (2007): How well do coupled models simulate present-day climate? A comparison of three generations of coupled models. *Bull. Amer. Meteor. Soc.*, (sub judice).

Reichler, T. and J. Kim (2007): Uncertainties in the climate mean state of global observations, reanalyses, and a modern climate model, *J. Geophys. Res.* (sub judice).

Refereed Articles

Lu, J., G. Vecchi, and T. Reichler (2007): Correction to "Expansion of the Hadley cell under global warming". *Geophys. Res. Lett.*, **34** (14), L14808.

Lu, J., G. Vecchi, and T. Reichler (2007): Expansion of the Hadley cell under global warming. *Geophys. Res. Lett.*, **34**, L06805.

Fu, Q., C. Johanson, J. Wallace, and T. Reichler (2006): Enhanced midlatitude tropospheric warming in satellite measurements. *Science,* **312**, 1179.

Reichler, T. and J. O. Roads (2005): Long-range predictability in the tropics. Part I: monthly averages. *J. Climate,* **18**, 619-633.

Reichler, T. and J. O. Roads (2005): Long-range predictability in the tropics. Part II: 30-60 days variability, *J. Climate*, **18**, 634-650.

Reichler, T., P. J. Kushner, and L. M. Polvani (2005): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, *J. Atmos. Sci.*, **62** (9), 3337–3352.

Reichler, T. and J. O. Roads (2004): Time-space distribution of long-range atmospheric predictability. *J. Atmos. Sci.*, **61**, 249-263.

Reichler, T., M. Dameris, and R. Sausen (2003): Determination of tropopause heights from gridded data. *Geophys. Res. Lett.*, **30**, No. 20, 2042, doi: 10.1029/2003GL018240.

Roads, J., R. Lawford, E. Bainto, H. Berbery, B. Fekete, K. Gallo, A. Grundstein, W. Higgins, J. Janowiak, M. Kanamitsu, V. Lakshmi, D. Leathers, D. Lettenmaier, Q. Li, L. Luo, E. Maurer, T. Meyers, D. Miller, K. Mitchell, T. Mote, R. Pinker, T. Reichler, D. Robinson, A. Robock, J. Smith, G. Srinivasan, K. Vinnikov, T. von der Haar, C. Vorosmarty, S. Williams, and E. Yarosh (2002): GCIP Water and Energy Budget Synthesis (WEBS). *J. Geophys. Res.*, **108**, No. D16, 8609, doi:10.1029/2002JD002583.

Reichler, T. J. and J. O. Roads (2002): The role of boundary and initial conditions for dynamical seasonal predictability. *Nonlinear Processes in Geophysics,* **10**, 211.

Reports

Roads, J., R. Lawford, E. Bainto, H. Berbery, B. Fekete, K. Gallo, A. Grundstein, W. Higgins, J. Janowiak, M. Kanamitsu, V. Lakshmi, D. Leathers, D. Lettenmaier, Q. Li, L. Luo, E. Maurer, T. Meyers, D. Miller, K. Mitchell, T. Mote, R. Pinker, T. Reichler, D. Robinson, A. Robock, J. Smith, G. Srinivasan, K. Vinnikov, T. von der Haar, C. Vorosmarty, S. Williams, E. Yarosh, 2002: GCIP Water and Energy Budget Synthesis (WEBS). CD-ROM (available from GAPP program office).

Reichler, T. J., and J. O. Roads (2002): The Impact of Initial Conditions on the Time-Space Distribution of Long-Term Atmospheric Predictability, *Maui High Performance Computing Center, Application Briefs 2001*, Kihei, Hawaii.

Reichler, T. J., and J. O. Roads (2001): The Role of Initial and Boundary Conditions for Dynamical Seasonal Forecasting, *Maui High Performance Computing Center, Application Briefs 2001*, Kihei, Hawaii.

Schlesinger, M. E., N. G. Andronova, A. Ghanem, S. Malyshev, T. J. Reichler, E. Rozanov, W. Wang, and F. Yang (1997): Geographical Scenarios of Greenhouse-Gas and Anthropogenic-Sulfate-Aerosol Induced Climate Changes.

Reichler, T. J., M. Dameris, R. Sausen and D. Nodorp (1996): A global climatology of the tropopause height based on ECMWF-analyses, DLR Oberpfaffenhofen, Institute of Atmospheric Physics, 57, ISSN 0943-4771, 23 pp.

Proceedings and Talks

Reichler, T., J. Kim, and A. Kumar (2007): Short-term climate predictability associated with stratospheric influences in operational forecast systems. AGU Chapman conference on The Role of the Stratosphere in Climate and Climate Change, Santorini, Greece, September 24-28, 2007, (invited talk).

Reichler, T. and J. Kim (2007): How well do coupled models simulate present-day climate? *3rd WGNE Workshop on Systematic Errors in Climate and NWP Models*, San Francisco (CA), February 12-16, 2007, (poster).

Reichler, T., J. Lu, G. A. Vecchi, Q. Fu (2006): Expansion of the Hadley Cell: A Possible New Driver for Droughts? *American Geophysical Union Fall Meeting*, San Francisco (CA), December 14, (poster).

Reichler, T. and J. Kim (2006): How well do coupled models simulate present-day climate? *American Geophysical Union Fall Meeting*, San Francisco (CA), December 14, (poster).

Lu, J., G. Vecchi, and T. Reichler (2006): Expansion of the Hadley cell under global warming. *NOAA 31st Climate Diagnostics & Prediction Workshop*, Boulder (CO), October 25, (poster).

Reichler, T. and J. Kim (2006): How well do coupled models simulate present-day climate? *National Center for Atmospheric Research*, Boulder (CO), October 12, (seminar).

Reichler, T. and J. Kim (2006): How well do coupled models simulate present-day climate? *National Oceanographic & Atmospheric Association - Earth System Research Laboratory*, Boulder (CO), October 12, (seminar).

Reichler, T. and J. Kim (2006): How well do coupled models simulate present-day climate? A comparison of three generations of models. *Geophysical Fluid Dynamics Laboratory*, Princeton (NJ), August 14, (invited seminar).

Reichler, T. and J. Kim (2006): How well do coupled models simulate present-day climate? A comparison of three generations of models. *Goddard Institute for Space Studies*, New York (NY), August 15, (seminar).

Reichler, T. (2006): Climate change: Theory – Facts – Uncertainties. Invited guest lecture at the *University of Utah*, Department of Philosophy, April 11.

Reichler, T., and I. Held (2005): A possible widening of the tropical Hadley cell over the past decades, *AGU fall meeting*, Global Environmental Change session, December, (talk).

Kim, J., and T. Reichler (2005): A Performance Index for the Evaluation of Coupled Climate Models, *AGU fall meeting*, Global Environmental Change session, December, (poster).

Kim, J., and T. Reichler (2005): How well do models simulate observations? A critical appraisal of the latest generation of coupled climate models, *Department of Meteorology, University of Utah*, Salt Lake City, November, (seminar).

Reichler, T. (2005): An introduction to three-dimensional climate modeling, *Scientific Computing and Imaging Institute, University of Utah*, Salt Lake City, November, (invited seminar).

Reichler, T., and I. Held (2005): Widening trend of the Hadley cell Over the Past 40 Years, *Conference on Climate Variability and Change*, Cambridge, MA, June, (talk).

Reichler, T., P. J. Kushner, and L. M. Polvani (2005): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, Conference on Middle Atmosphere, Cambridge, MA, June, (poster).

Kushner, P. J., T. Reichler, and L. M. Polvani (2005): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, Canadian CLIVAR network meeting, Montreal, February, (talk).

Kushner, P. J., L. M. Polvani, and T. Reichler (2004): Extratropical stratosphere-troposphere dynamical coupling: Perspectives from a simple GCM, *AGU fall meeting*, December, (talk).

Reichler, T., I. Held (2004): Evidence for a Widening of the Hadley cell over the past 40 years, *Global Circulation of the Atmosphere*, Pasadena, CA, November, (poster).

Reichler, T. (2004): Long-range atmospheric predictability, *Department of Meteorology, University of Utah*, Salt Lake City, September, (seminar talk).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, *SPARC general assembly*, Victoria, CA, August, (poster).

Reichler, T., M. Dameris, R. Sausen (2004): Determination of tropopause heights from gridded data, *SPARC general assembly*, Victoria, CA, August, (poster).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, *Climate Prediction Center, NCEP-NOAA*, Camp Springs, MD, May, (invited seminar).

Reichler, T. (2004): The role of initial and boundary conditions for sub-seasonal predictability, *Global Modeling and Assimilation Office, Goddard Space Flight Center GSFC-NASA*, Greenbelt, MD, May, (invited seminar).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, *Global Modeling and Assimilation Office, Goddard Space Flight Center GSFC-NASA*, Greenbelt, MD, May, (invited seminar).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): The coupled stratosphere-troposphere response to impulsive forcing from the troposphere, *IGERT Joint Program in Applied Mathematics and the Earth & Environmental Sciences, Columbia University*, NY, May, (invited seminar).

Reichler, T. (2004): The role of initial and boundary conditions for sub-seasonal predictability, *Center for Ocean-Land-Atmosphere Studies COLA*, Calverton, MD, May, (invited seminar).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): Response of the stratosphere-troposphere system to impulsive topographic forcing, *EGU 1st General Assembly*, Dynamics of the Middle Atmosphere, Nice, April, (talk).

Reichler, T., and J. O. Roads (2004): The role of initial and boundary conditions for long-range atmospheric predictability, *Lamont-Doherty Earth Observatory*, Palisades, April, (invited seminar).

Reichler, T., P. J. Kushner, and L. M. Polvani (2004): Response of the stratosphere-troposphere system to impulsive forcing, *Atmospherics Physics Group, University of Toronto*, Toronto, March, (invited seminar).

Reichler, T. , P. J. Kushner, and L. M. Polvani (2003): Response of the stratosphere-troposphere system to impulsive forcing, *Geophysical Fluid Dynamics Laboratory*, Princeton, December, (seminar).

Reichler, T. , P. J. Kushner, and L. M. Polvani (2003): The response of the stratosphere-troposphere system to impulsive forcing, *Department of Meteorology, University of Utah*, Salt Lake City, October, (invited seminar).

Reichler, T. J., and J. O. Roads (2003): Predictability of the MJO, *EGS/AGU Joint Assembly*, Intraseasonal and seasonal climate predictability, Nice, April, (talk).

Reichler, T. J., and J. O. Roads (2003): Predictability and sensitivity of monthly means in the tropics, *EGS/AGU Joint Assembly*, Intraseasonal and seasonal climate predictability, Nice, April, (poster).

Reichler, T. J. (2002): Atmospheric Long-Range Predictability, *NOAA/Geophysical Fluid Dynamics Laboratory*, Princeton, NJ, June, (invited seminar).

Reichler, T. J., and J. O. Roads (2002): Atmospheric Long-Range Predictability, *National Institute for Water and Atmosphere*, Wellington, New Zealand, May, (invited seminar).

Reichler, T. J., and J. O. Roads (2002): The role of atmospheric initial conditions for long-range predictability. *Workshop on Prospects for improved Forecasts of Weather and Short-term Climate Variability on Subseasonal Time Scales, NASA/GSFC*, Greenbelt, MD, April, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2002): Dynamical Seasonal Predictions: Sensitivity to soil moisture and initial conditions. *82nd AMS annual meeting, 13th symposium on global climate change and climate variations*, Orlando, FL, January, (poster).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2001): Dynamical Seasonal Predictability. *ECPC meeting, Scripps Institution of Oceanography*, La Jolla, CA, December, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2001): The Role of Initial and Boundary Conditions for Dynamical Seasonal Forecasting. *26th Annual Climate Diagnostics and Prediction Workshop, Scripps Institution of Oceanography*, La Jolla, CA, October, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2001): The Role of Initial and Boundary Conditions for Dynamical Seasonal Forecasting. *ARCs network meeting, Scripps Institution of Oceanography*, La Jolla, CA, October, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2001): Seasonal Climate Predictability in a General Circulation Model. *European Geophysical Society XXVI General Assembly*, Nice, France, March, (talk).

Gershunov, A., T. J. Reichler and J. O. Roads (2001): Sources of Seasonal Predictability for Daily Precipitation Extreme Statistics Over the Eastern US, *AAG meeting 2001* (Association of American Geographers), NY March 3, (poster).

Gershunov, A., D. Cayan, T. J. Reichler and J. O. Roads (2001): Seasonal Predictability of Regional Hydrometeorology, *European Geophysical Society XXVI General Assembly*, Nice, France, (poster).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2001): The Role of Ocean Boundary Conditions for Seasonal Predictability, *Proceedings to the Symposium on Climate Variability, the Oceans and Societal Impacts*, Albuquerque, New Mexico, (poster).

Gershunov, A., T. J. Reichler, and J. O. Roads (2001): Sources of Seasonal Predictability for Daily Precipitation Extreme Statistics Over the Eastern US, *Proceedings to the Symposium on Climate Variability, the Oceans and Societal Impacts*, Albuquerque, New Mexico, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2000): Seasonal Predictability Studies with the NCEP Global Spectral Model. *ECPC meeting, Scripps Institution of Oceanography*, La Jolla, CA, December, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (2000): Validation of the NCEP Global Spectral Model. *2nd international RSM workshop*, Maui, HI, July, (talk).

Reichler, T. J., J. O. Roads and S. Chen (2000): Seasonal predictions with the NCEP reanalysis-2 model: Initial value or boundary forced?" *ARCs/IRI meeting, Lamont-Doherty Earth Observatory*, Palisades, NY, March, (talk).

Roads, J. O., T. J. Reichler, S. Chen, M. Kanamitsu, and W. Ebisuzaki (1999): Surface water characteristics and influences in NCEP/DOE Reanalysis II. *Proceedings of the 2nd International Conference on Reanalysis*, Wokefield Park, United Kingdom, Aug. 23-27, (talk).

Chen, S., T. J. Reichler, and J. O. Roads, (1999): The NCEP reanalysis II model: Surface forcing characteristics and SST-sensitivity. *CORC Pacific Meeting, Scripps Institution of Oceanography*, La Jolla, CA, August, (talk).

Reichler, T. J., J. O. Roads, and M. Kanamitsu (1999): The NCEP reanalysis II model: Climatology, variability and SST sensitivity. *Workshop on extratropical SST anomalies, Climate Diagnostics Center*, Boulder, CO, June, (talk).

Reichler, T. J., J. O. Roads, M. Kanamitsu, S. Chen, and D. Cayan (1998): Surface fluxes in the NCEP/NCAR reanalysis GSM climate model and COADS. *CORC Pacific Meeting, University of California – San Diego*, La Jolla, CA, October, (talk).

Final Utah Greenhouse Gas Inventory and Reference Case Projections, 1990-2020

Center for Climate Strategies
July 2007

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Executive Summary

The Center for Climate Strategies (CCS) prepared this report for the Utah Department of Environmental Quality (UDEQ) under an agreement with the Western Governors' Association. The report contains an inventory and forecast of the State's greenhouse gas (GHG) emissions from 1990 to 2020.

Utah's anthropogenic GHG emissions and sinks (carbon storage) were estimated for the period from 1990 to 2020. Historical GHG emission estimates (1990 through 2005, or most recent historical year) were developed using a set of generally-accepted principles and guidelines for state GHG emission estimates, with adjustments by CCS to provide Utah-specific data and inputs when it was possible to do so. The initial reference case emission projections (2006-2020) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of transparent assumptions.

Table ES-1 provides a summary of historical (1990, 2000 and 2005) and reference case projection (2010 and 2020) GHG emissions for Utah. Activities in Utah accounted for approximately 69 million metric tons (MMt) of *gross*[1] carbon dioxide equivalent (CO_2e) emissions in 2005, an amount equal to about 1% of total U.S. gross GHG emissions. Utah's gross GHG emissions are rising at a faster rate than those of the nation as a whole (gross emissions exclude carbon sinks, such as forests). Utah's gross GHG emissions increased 40% from 1990 to 2005, while national emissions rose by only 16% during this period.

Figure ES-1 illustrates the State's emissions per capita and per unit of economic output. On a per capita basis, Utahns emits about 27 metric tons (Mt) of CO_2e annually, slightly higher than the national average of 25 $MtCO_2e$/yr. As in the nation as a whole, per capita emissions in Utah have changed relatively little (with a slight decrease in the post-2000 period), while economic growth exceeded emissions growth throughout the 1990-2005 period (leading to declining estimates of GHG emissions per unit of state product). During the 1990s, emissions per unit of gross product dropped by 40% nationally, and by 52% in Utah.

The principal source of Utah's GHG emissions is electricity use (electricity production netting out electricity exports), accounting for 37% of total State gross GHG emissions in 2005 (see Table ES-1). The next largest contributors to total gross GHG emissions are the transportation sector (25%) and the residential, commercial, and industrial fossil fuel combustion sector (18%).

As illustrated in Figure 2 and shown numerically in Table ES-1, under the reference case projections, Utah's gross GHG emissions continue to grow, and are projected to climb to 96.1 $MMtCO_2e$ per year by 2020, 95% above 1990 levels. As shown in Figure ES-3, emissions associated with electricity generated to meet Utah's demands is projected to be the largest contributor to future emissions growth, followed by emissions from the transportation sector. The figure shows that electricity generation will add more than 10 $MMtCO_2e$ to Utah's emissions by 2020, while the transportation sector will add almost 6 $MMtCO_2e$.

[1] Excluding GHG emissions removed due to forestry and other land uses and excluding GHG emissions associated with exported electricity.

Some data gaps exist in this analysis, particularly for the reference case projections. Key tasks include review and revision of key emissions drivers (such as electricity, fossil fuel production, and transportation fuel use growth rates) that will be major determinants of Utah's future GHG emissions. We expect that Utah's ongoing climate change action planning process will shed light on these issues.

Estimates of carbon sinks within Utah's forests and agricultural soils have also been included in this report. For forests, the current estimates are based on data from the U.S Forest Service and indicate that about 12.3 $MMtCO_2e$ are sequestered annually in Utah forest biomass. As described in Appendix H however, there is a significant degree of uncertainty in the size of the forest sink in Utah. The estimates presented here are believed to be at the high end of the possible range of sequestration estimates.

Emissions of aerosols, particularly "black carbon" (BC) from fossil fuel combustion, could have significant climate impacts through their effects on radiative forcing. Estimates of these aerosol emissions on a CO_2e basis were developed for Utah based on 2002 and 2018 data from the WRAP. Estimated BC emissions for the year 2002 were a total of 4.9 $MMtCO_2e$, which is the mid-point of a range of estimated emissions (3.1 – 6.6 $MMtCO_2e$). Based on an assessment of the primary contributors, it is estimated that BC emissions will decrease substantially by 2018 after new engine and fuel standards take effect in the onroad and nonroad diesel engine sectors. Details of this analysis are presented in Appendix I to this report. These estimates are not incorporated into the totals shown in Table ES-1 below because a global warming potential for BC has not yet been assigned by the Intergovernmental Panel on Climate Change (IPCC).

Table ES-1. Utah Historical and Reference Case GHG Emissions, by Sector[a]

(Million Metric Tons CO_2e)	1990	2000	2005	2010	2020	Explanatory Notes for Projections
Electricity Production	**15.3**	**22.5**	**25.6**	**27.6**	**36.6**	
Coal	28.8	31.7	33.6	33.6	39.7	See electric sector assumptions
Natural Gas	0.05	0.6	0.4	2.3	3.1	in Appendix A
Oil	0.04	0.04	0.02	0.02	0.03	
Net Exported Electricity	-13.6	-9.9	-8.4	-8.4	-6.3	
Res/Comm/Non-Fossil Ind (RCI)	**14.1**	**15.7**	**12.2**	**13.7**	**16.3**	
Coal	5.1	5.1	1.4	1.5	1.6	Based on USDOE regional projections
Natural Gas	6.5	8.3	7.7	8.7	10.7	Based on USDOE regional projections
Oil	2.4	2.3	3.0	3.4	4.0	Based on USDOE regional projections
Wood (CH_4 and N_2O)	0.02	0.03	0.02	0.02	0.02	Based on USDOE regional projections
Transportation	**10.9**	**16.1**	**16.9**	**18.4**	**22.4**	
Motor Gasoline	6.5	9.1	9.4	9.8	12.0	VMT projections from UDOT
Diesel	2.1	3.5	4.3	5.2	7.1	VMT projections from UDOT
Natural Gas, LPG, other	0.1	0.3	0.4	0.5	0.7	Projected based on historical data
Jet Fuel and Aviation Gas	2.2	3.1	2.9	2.9	3.0	Aircraft operations projections from FAA
Fossil Fuel Industry	**2.5**	**3.1**	**4.1**	**4.4**	**4.6**	
Natural Gas Industry	0.8	1.8	1.9	2.1	2.4	Historical trends and USDOE regional
Oil Industry	0.2	0.1	0.1	0.1	0.1	projections
Coal Mining (Methane)	1.4	1.1	2.1	2.1	2.1	Held flat at 2004 levels
Industrial Processes	**2.2**	**2.8**	**3.7**	**4.3**	**5.8**	
Cement Manufacture	0.5	0.8	0.9	0.9	1.1	Utah manufacturing employment growth
Lime Manufacture	0.3	0.5	0.6	0.7	0.8	Utah manufacturing employment growth
Limestone and Dolomite Use	0.04	0.1	0.1	0.1	0.1	Utah manufacturing employment growth
Nitric Acid Production	0.2	0.1	0.1	0.1	0.1	Utah manufacturing employment growth
ODS Substitutes	0.002	0.6	1.1	1.6	2.7	EPA 2004 ODS cost study report
Semiconductor Manufacture	0.002	0.005	0.003	0.002	0.001	Based on national projections (USEPA)
Magnesium Production	1.0	0.7	0.9	0.9	1.1	Utah manufacturing employment growth
SF_6 from Electric Utilities	0.2	0.1	0.1	0.1	0.04	Based on national projections (USEPA)
Waste Management	**1.1**	**1.7**	**2.0**	**2.7**	**4.7**	
Solid Waste Management	0.9	1.4	1.7	2.3	4.2	Projected based on 1996-2005 trend
Wastewater Management	0.2	0.3	0.3	0.4	0.5	Projected based on population
Agriculture	**3.1**	**4.0**	**4.2**	**4.6**	**5.8**	
Manure Management	1.2	1.4	1.5	1.6	1.9	USDA livestock projections
Enteric Fermentation	0.3	0.6	0.7	0.9	1.5	USDA livestock projections
Agricultural Soils	1.6	1.8	1.7	1.8	1.9	Projected based on historical trend
Agricultural Residue Burning	0.001	0.001	0.001	0.001	0.001	No growth assumed
Total Gross Emissions	**49.3**	**65.6**	**68.8**	**75.6**	**96.1**	
increase relative to 1990		*34%*	*40%*	*54%*	*95%*	
Forestry and Land Use	**-12.3**	**-12.3**	**-12.3**	**-12.3**	**-12.3**	Historical and projected flux held at 2004 levels (excludes soil carbon flux)
Agricultural Soils	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	Historical and projected emissions held at 1997 level
Net Emissions (including sinks)	**37.0**	**53.6**	**56.5**	**63.4**	**83.8**	
increase relative to 1990		*45%*	*53%*	*72%*	*127%*	

[a] Totals may not equal exact sum of subtotals shown in this table due to independent rounding. NA = not available.

Figure ES-1. Historical Utah and U.S. GHG Emissions, Per Capita and Per Unit Gross Product, 1990-2005

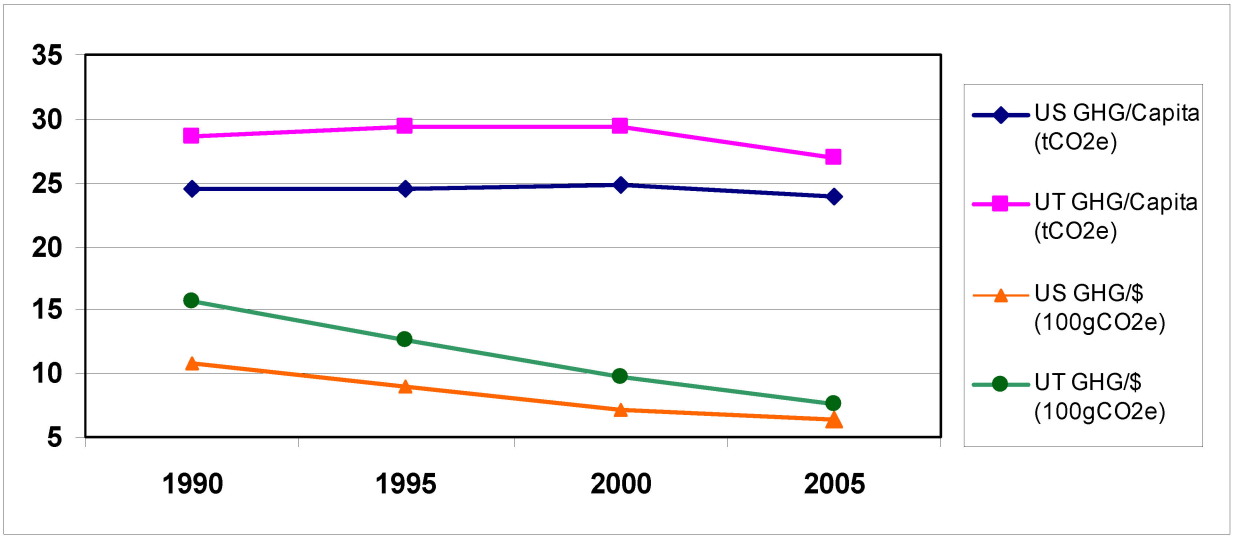


Figure ES-2. Utah Gross GHG Emissions by Sector, 1990-2020: Historical and Projected

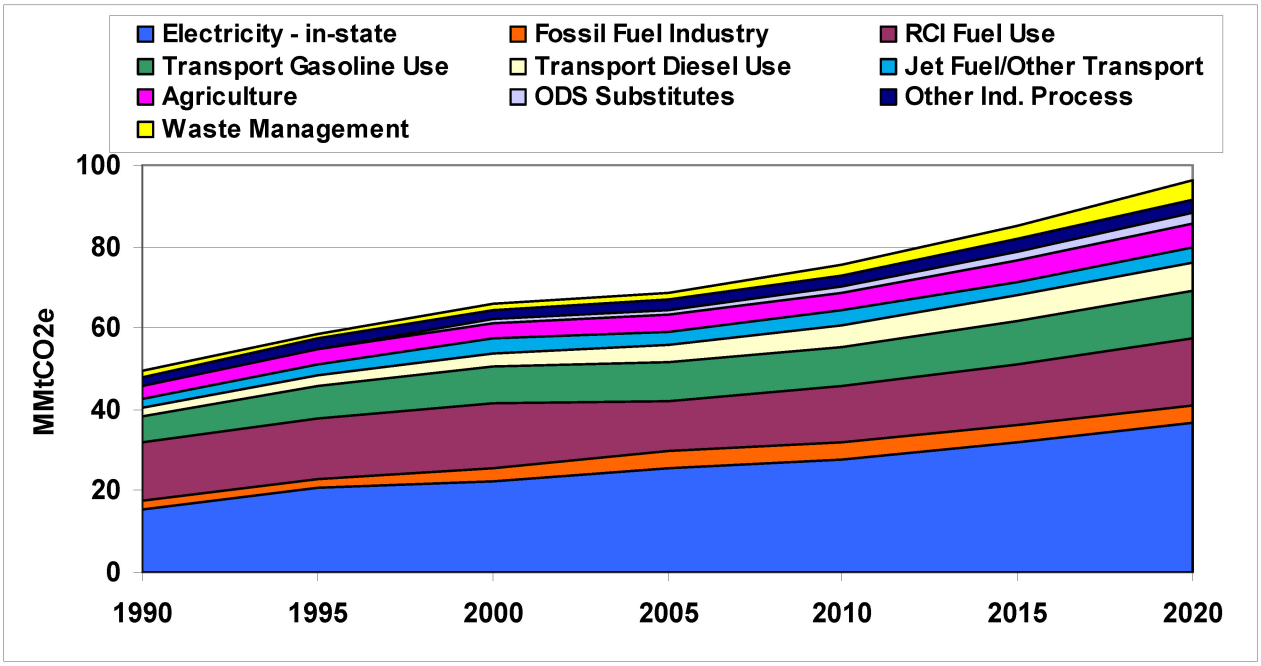


Figure ES-3. Sector Contributions to Emissions Growth in Utah, 1990-2020: Reference Case Projections

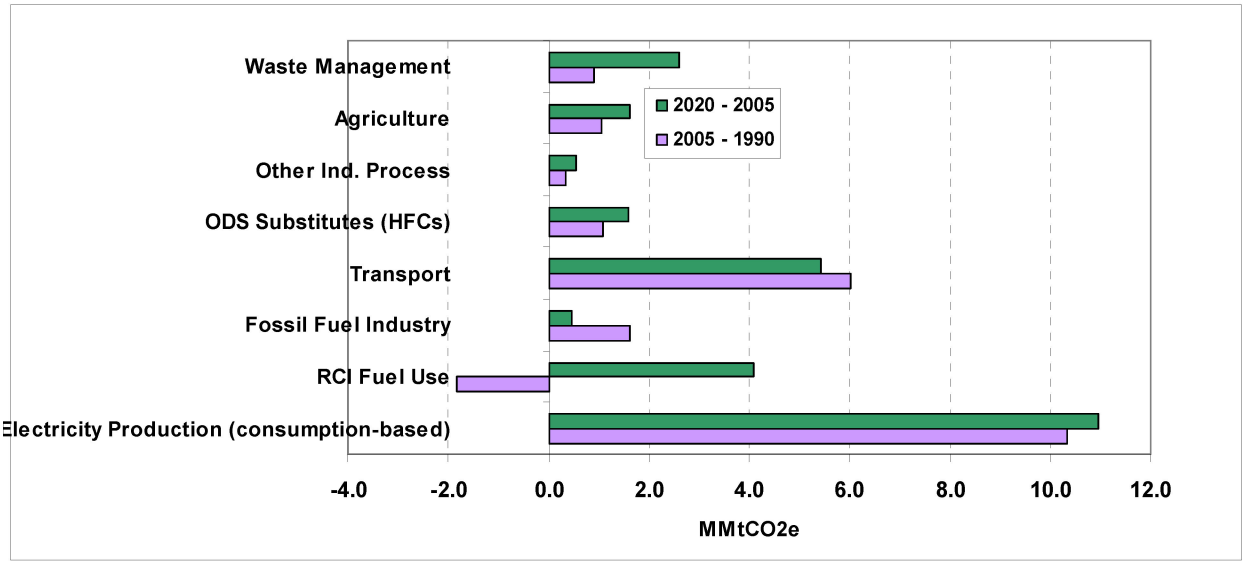


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Acronyms and Key Terms

AEO – *Annual Energy Outlook, EIA*

Ag – Agriculture

bbls – Barrels

BC – Black Carbon

Bcf – Billion Cubic Feet

BLM – United States Bureau of Land Management

BOC – Bureau of Census

BTU – British Thermal Unit

C – Carbon

$CaCO_3$ – Calcium Carbonate

CBM – Coal Bed Methane

CCS – Center for Climate Strategies

CFCs – Chlorofluorocarbons

CH_4 – Methane*

CO_2 – Carbon Dioxide*

CO_2e – Carbon Dioxide Equivalent*

CRP – Federal Conservation Reserve Program

EC – Elemental Carbon

eGRID – U.S. EPA's Emissions & Generation Resource Integrated Database

EIA – U.S. DOE Energy Information Administration

EIIP – Emissions Inventory Improvement Project (US EPA)

FIA – Forest Inventory Analysis

GHG – Greenhouse Gases*

GSP – Gross State Product

GWh – Gigawatt-hour

GWP - Global Warming Potential*

HFCs – Hydrofluorocarbons*

HNO_3 – Nitric Acid

HWP – Harvested Wood Products

IPCC – Intergovernmental Panel on Climate Change*

kWh – Kilowatt-hour

LFGTE – Landfill Gas Collection System and Landfill-Gas-to-Energy

LMOP – Landfill Methane Outreach Program

LNG – Liquefied Natural Gas

LPG – Liquefied Petroleum Gas

Mg – Megagrams (equivalent to one metric ton)

Mt - Metric Ton (equivalent to 1.102 short tons)

MMt – Million Metric Tons

MPO – Metropolitan Planning Organization

MSW – Municipal Solid Waste

MW – Megawatt

N – Nitrogen

N_2O – Nitrous Oxide*

NO_2 – Nitrogen Dioxide*

NAICS – North American Industry Classification System

NASS – National Agricultural Statistics Service

NO_x – Nitrogen Oxides

NSCR – Non-selective Catalytic Reduction

ODS – Ozone-Depleting Substances

OM – Organic Matter

PADD – Petroleum Administration for Defense Districts

PFCs – Perfluorocarbons*

PM – Particulate Matter

ppb – parts per billion

ppm – parts per million

ppt – parts per trillion

PSCo – Public Service Company of Utah

PV – Photovoltaic

RCI – Residential, Commercial, and Industrial

RPA – Resources Planning Act Assessment

RPS – Renewable Portfolio Standard

SAR – Second Assessment Report

SCR- Selective Catalytic Reduction

SED – State Energy Data

SF_6 – Sulfur Hexafluoride*

SGIT – State Greenhouse Gas Inventory Tool

Sinks – Removals of carbon from the atmosphere, with the carbon stored in forests, soils, landfills, wood structures, or other biomass-related products.

TAR – Third Assessment Report

T&D – Transmission and Distribution

TWh – Terawatt-hours

UDOT – Utah Department of Transportation

UGS – Utah Geological Survey

UNFCCC – United Nations Framework Convention on Climate Change

U.S. EPA – United States Environmental Protection Agency

U.S. DOE – United States Department of Energy

USDA – United States Department of Agriculture

USFS – United States Forest Service

USGS – United States Geological Survey

UDEQ – Utah Department of Environmental Quality

UT - Utah

VMT – Vehicle-Miles Traveled

WAPA – Western Area Power Administration

WECC – Western Electricity Coordinating Council

W/m^2 – Watts per Square Meter

WMO – World Meteorological Organization*

WRAP – Western Regional Air Partnership

* - See Appendix J for more information.

Acknowledgements

CCS appreciates all of the time and assistance provided by numerous contacts throughout Utah, as well as in neighboring states, and at federal agencies. Thanks go to the many staff at several Utah state agencies for their inputs, and in particular to Michael Vanden Berg of the Utah Department of Natural Resources, Utah Geological Survey and to Patrick Barickman, Scott Hanks, Brock LeBaron, Ran MacDonald, Deborah McMurtrie, Carol Nielsen, Glade Sowards, Richard Sprott, and Peter Verschoor of the Utah Department of Environmental Quality, Division of Air Quality, who provided key guidance and review for this analytical effort.

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Summary of Preliminary Findings

Introduction

The Center for Climate Strategies (CCS) prepared this report for the Utah Department of Environmental Quality (UDEQ) under an agreement with the Western Governors' Association. This report presents initial estimates of base year and projected Utah anthropogenic greenhouse gas (GHG) emissions and sinks for the period from 1990 to 2020. These estimates are intended to assist the State with an initial, comprehensive understanding of current and possible future GHG emissions for Utah, and, thereby, to inform future analysis and design of GHG mitigation strategies.

Historical GHG emissions estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emissions inventories, as described in Section 2, relying to the extent possible on Utah-specific data and inputs. The initial reference case projections (2006-2020) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the appendices of this report.

This report covers the six types of gases included in the U.S. Greenhouse Gas Inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas to global average radiative forcing on a Global Warming Potential- (GWP-) weighted basis. The final appendix to this report provides a more complete discussion of GHGs and GWPs. Emissions of black carbon were also estimated. Black carbon (BC) is an aerosol species with a positive climate forcing potential (that is, the potential to warm the atmosphere, as GHGs do); however, black carbon currently does not have a GWP defined by the IPCC due to uncertainties in both the direct and indirect effects of BC on atmospheric processes (see Appendices I and J for more details).

It is important to note that the preliminary emission estimates reflect the *GHG emissions associated with the electricity sources used to meet Utah's demands,* corresponding to a *consumption-based* approach to emissions accounting (see Approach Section below). Another way to look at electricity emissions is to consider the *GHG emissions produced by electricity generation facilities in the State.* For many years, Utah power plants have tended to produce more electricity than is consumed in the State; emissions associated with exported electricity are excluded from the consumption-based emissions. This report covers both methods of accounting for emissions, but for consistency, all total results are reported as *consumption-based.*

[2] The last year of available historical data varies by sector; ranging from 2000 to 2005.

Utah Greenhouse Gas Emissions: Sources and Trends

Table 1 provides a summary of GHG emissions estimated for Utah by sector for the years 1990, 2000, 2005, 2010, and 2020. In the sections below, we discuss GHG emission sources (positive, or *gross*, emissions) and sinks (negative emissions) separately in order to identify trends, projections and uncertainties for each.

This next section of the report provides a summary of the historical emissions (1990 through 2005) followed by a summary of the forecasted reference-case projection-year emissions (2006 through 2020), key uncertainties, and suggested next steps. CCS also provides an overview of the general methodology, principles, and guidelines followed for preparing the inventories. Appendices A through H provide the detailed methods, data sources, and assumptions for each GHG sector.

Appendix I provides information on 2002 and 2018 BC estimates for Utah. CCS estimated that BC emissions in 2002 ranged from 3.1 – 6.6 $MMtCO_2e$ with a mid-point of 4.9 $MMtCO_2e$. A range is estimated based on the uncertainty in the global modeling analyses that serve as the basis for converting BC mass emissions into their carbon dioxide equivalents (see Appendix I for more details). Since the IPCC has not yet assigned a global warming potential for BC, CCS has excluded these estimates from the GHG summary shown in Table 1 below. Based on an assessment of 2018 forecasted emissions for the primary BC contributors from the Western Regional Air Partnership (WRAP), it is estimated that BC emissions will decrease significantly by 2018 after new engine and fuel standards take effect in the onroad and nonroad diesel engine sectors. About 3.7 $MMtCO_2e$ was estimated for 2002 BC emissions. Emissions are expected to decrease to 0.9 $MMtCO_2e$ by 2018. Appendix I contains a detailed breakdown of emissions contribution by source sector.

Appendix J provides background information on GHGs and climate-forcing aerosols.

Table 1. Utah Historical and Reference Case GHG Emissions, by Sector[a]

(Million Metric Tons CO_2e)	1990	2000	2005	2010	2020	Explanatory Notes for Projections
Electricity Production	**15.3**	**22.5**	**25.6**	**27.6**	**36.6**	
Coal	28.8	31.7	33.6	33.6	39.7	See electric sector assumptions
Natural Gas	0.05	0.6	0.4	2.3	3.1	in Appendix A
Oil	0.04	0.04	0.02	0.02	0.03	
Net Exported Electricity	-13.6	-9.9	-8.4	-8.4	-6.3	
Res/Comm/Non-Fossil Ind (RCI)	**14.1**	**15.7**	**12.2**	**13.7**	**16.3**	
Coal	5.1	5.1	1.4	1.5	1.6	Based on USDOE regional projections
Natural Gas	6.5	8.3	7.7	8.7	10.7	Based on USDOE regional projections
Oil	2.4	2.3	3.0	3.4	4.0	Based on USDOE regional projections
Wood (CH_4 and N_2O)	0.02	0.03	0.02	0.02	0.02	Based on USDOE regional projections
Transportation	**10.9**	**16.1**	**16.9**	**18.4**	**22.4**	
Motor Gasoline	6.5	9.1	9.4	9.8	12.0	VMT projections from UDOT
Diesel	2.1	3.5	4.3	5.2	7.1	VMT projections from UDOT
Natural Gas, LPG, other	0.1	0.3	0.4	0.5	0.7	Projected based on historical data
Jet Fuel and Aviation Gas	2.2	3.1	2.9	2.9	3.0	Aircraft operations projections from FAA
Fossil Fuel Industry	**2.5**	**3.1**	**4.1**	**4.4**	**4.6**	
Natural Gas Industry	0.8	1.8	1.9	2.1	2.4	Historical trends and USDOE regional
Oil Industry	0.2	0.1	0.1	0.1	0.1	projections
Coal Mining (Methane)	1.4	1.1	2.1	2.1	2.1	Held flat at 2004 levels
Industrial Processes	**2.2**	**2.8**	**3.7**	**4.3**	**5.8**	
Cement Manufacture	0.5	0.8	0.9	0.9	1.1	Utah manufacturing employment growth
Lime Manufacture	0.3	0.5	0.6	0.7	0.8	Utah manufacturing employment growth
Limestone and Dolomite Use	0.04	0.1	0.1	0.1	0.1	Utah manufacturing employment growth
Nitric Acid Production	0.2	0.1	0.1	0.1	0.1	Utah manufacturing employment growth
ODS Substitutes	0.002	0.6	1.1	1.6	2.7	EPA 2004 ODS cost study report
Semiconductor Manufacture	0.002	0.005	0.003	0.002	0.001	Based on national projections (USEPA)
Magnesium Production	1.0	0.7	0.9	0.9	1.1	Utah manufacturing employment growth
SF_6 from Electric Utilities	0.2	0.1	0.1	0.1	0.04	Based on national projections (USEPA)
Waste Management	**1.1**	**1.7**	**2.0**	**2.7**	**4.7**	
Solid Waste Management	0.9	1.4	1.7	2.3	4.2	Projected based on 1996-2005 trend
Wastewater Management	0.2	0.3	0.3	0.4	0.5	Projected based on population
Agriculture	**3.1**	**4.0**	**4.2**	**4.6**	**5.8**	
Manure Management	1.2	1.4	1.5	1.6	1.9	USDA livestock projections
Enteric Fermentation	0.3	0.6	0.7	0.9	1.5	USDA livestock projections
Agricultural Soils	1.6	1.8	1.7	1.8	1.9	Projected based on historical trend
Agricultural Residue Burning	0.001	0.001	0.001	0.001	0.001	No growth assumed
Total Gross Emissions	**49.3**	**65.9**	**68.8**	**75.7**	**96.1**	
increase relative to 1990		*34%*	*40%*	*54%*	*95%*	
Forestry and Land Use	**-12.3**	**-12.3**	**-12.3**	**-12.3**	**-12.3**	Historical and projected emissions held at 2004 level (excludes soil carbon flux)
Agricultural Soils	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	Historical and projected emissions held at 1997 level
Net Emissions (including sinks)	**37.0**	**53.6**	**56.5**	**63.4**	**83.8**	
increase relative to 1990		*45%*	*53%*	*72%*	*127%*	

[a] Totals may not equal exact sum of subtotals shown in this table due to independent rounding. NA = not available.

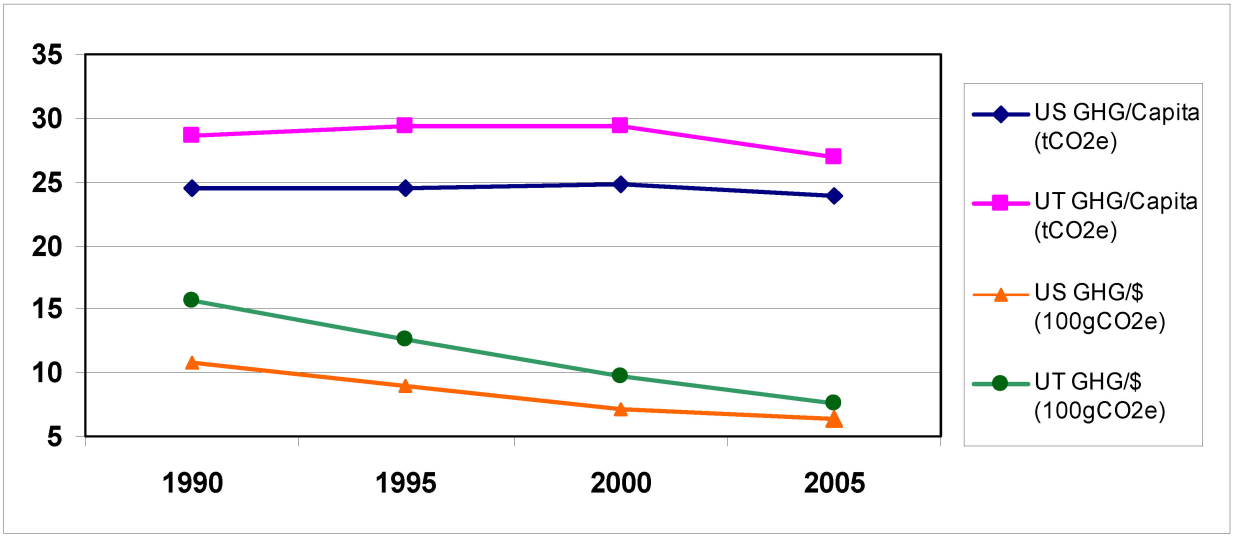
Historical Emissions

Overview

Our analyses suggest that in 2005, activities in Utah accounted for approximately 68.8 million metric tons (MMt) of *gross*[3] CO_2e emissions, an amount equal to 1% of total U.S. gross GHG emissions. Utah's gross GHG emissions are rising at a faster rate than those of the nation as a whole (gross emissions exclude carbon sinks, such as forests). Utah's gross GHG emissions increased by about 40% from 1990 to 2005, while national emissions rose by 16% during the same period.

On a per capita basis, Utahns emitted about 27 metric tons (Mt) of CO_2e in 2005, slightly higher than the national average of 25 $MtCO_2e/yr$. Figure 1 illustrates the State's emissions per capita and per unit of economic output. Unlike the nation as a whole, where per capita emissions have changed relatively little, per capita emissions have dropped slightly. The figure also shows that economic growth has exceeded emissions growth in Utah throughout the 1990-2005 timeframe. From 1990 to 2005, emissions per unit of gross product dropped by 40% nationally and by 52% in Utah.

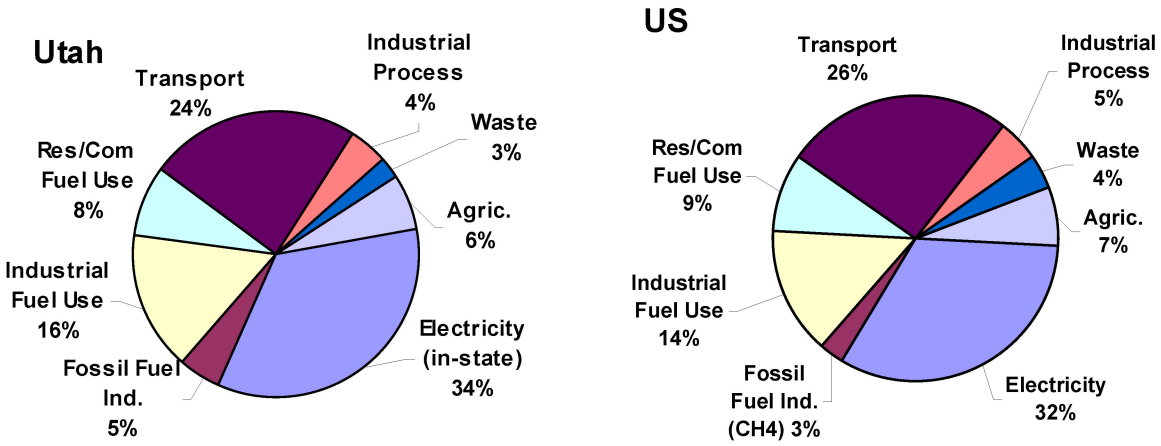
Figure 1. Utah and US Gross GHG Emissions, Per Capita and Per Unit Gross Product, 1990-2005



[3] Excluding GHG emissions removed due to forestry and other land uses and excluding GHG emissions associated with exported electricity.

Electricity use, transportation and residential/commercial/industrial (RCI) fossil fuel combustion are the State's principal GHG emissions sources. The combustion of fossil fuels for electricity generation used in-state and for transportation accounted for 61% of Utah's *gross* GHG emissions in 2005, as shown in Table 1. A comparison of Utah and U.S. emissions for 2000 is shown in Figure 2 below, which shows a 58% contribution from these two sectors. The remaining use of fossil fuels – natural gas, oil products, and coal – in the transportation and the residential, commercial, and industrial (RCI) sector, plus the emissions from fossil fuel production, constituted another 29% of total State emissions. The large drop in industrial coal combustion emissions shown in Table 1 between 2000 and 2005 is due to the shut down of the Geneva Steel plant in 2002 (see Appendix B).

Figure 2. Gross GHG Emissions by Sector, 2000, Utah and US



Agriculture (CH_4 and N_2O emissions from manure management, fertilizer use, crops, livestock, and agricultural burning) accounted for 6%, and landfills and wastewater management facilities produce CH_4 and N_2O emissions accounting for 3% of the State's emissions in 2000. Industrial process emissions comprised the remaining 4% of State GHG emissions in 2000, but these emissions are rising in part due to the increasing use of HFC as substitutes for ozone-depleting chlorofluorocarbons.[4] Other industrial process emissions result from CO_2 released during soda ash, limestone, and dolomite use.

Forestry and agricultural soils in Utah are estimated to result in an annual net sink of about 13 $MMtCO_2e$ in 2005. Details of these flux estimates are provided in Appendices F and H.

The 1990 historical emission estimates are comparable to estimates previously prepared by UDEQ.[5] In the UDEQ study, the total 1990 gross emissions estimate was about 64 $MMtCO_2e$

[4] Chlorofluorocarbons (CFCs) are also potent GHGs; they are not, however, included in GHG estimates because of concerns related to implementation of the Montreal Protocol. See final Appendix (Appendix I).
[5] *Utah Greenhouse Gas Inventory, 1990 and 1993*, UDEQ and the UT Department of Natural Resources, Office of Energy and Resource Planning, date unknown.

compared to the estimate provided in Table 1 of 63 $MMtCO_2e$. Note that the emissions for electricity exports (13.6 $MMtCO_2e$) need to be added to the gross emissions total to make this comparison.

Figure 3 shows the historical and forecasted emissions for all sectors and all pollutants in CO_2e. The two largest contributing sectors to emissions growth are electricity consumption and transportation emissions. This is shown graphically in Figure 4, which shows that the electricity consumption sector will add over 10 $MMtCO_2e$/yr to Utah's emissions by 2020, while the transportation sector will add almost 6 $MMtCO_2e$/yr. This figure also shows that these two sectors have been the strongest contributors to historic emissions growth since 1990.

A Closer Look at the Two Major Sources: Electricity and Transportation

As shown in Table 1, electricity use accounted for about 37% of Utah's gross GHG emissions in 2005 (25.6 $MMtCO_2e$), which was slightly higher than the national share of emissions from electricity production (32%).[6] In total (across the residential, commercial and industrial sectors), Utah has a lower per capita use of electricity than the U.S. as a whole (10,000 kWh per person per year compared to 12,000 kWh/person-yr nationally), which means that the carbon content of electricity consumed in the state is higher than the U.S. as a whole.

It is important to note that these preliminary electricity emissions estimates reflect the *GHG emissions associated with the electricity sources used to meet Utah demands,* corresponding to a *consumption-based* approach to emissions accounting (see Section 2). Another way to look at electricity emissions is to consider the *GHG emissions produced by electricity generation facilities in the State.* Utah power plants produce more electricity than is consumed in the State – in the year 2000, for example, Utah exported 28% of the electricity produced in the State. As a result, in 2000, emissions associated with electricity consumption (22.5 $MMtCO_2e$) were much lower than those associated with electricity production (32.4 $MMtCO_2e$).[7]

While CCS estimated emissions associated with both electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption-based emissions. The consumption-based approach can better reflect the emissions (and emissions reductions) associated with activities occurring in the State, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for policy-making. Under this approach, emissions associated with electricity exported to other States would need to be covered in those States' accounts in order to avoid double-counting or exclusions. Arizona, California, Oregon, New Mexico, and Washington are currently considering such an approach. Data to account for the electricity imported into Utah were not factored into the analysis conducted for this report.

[6] Unlike for Utah, for the U.S. as a whole, there is relatively little difference between the emissions from electricity use and emissions from electricity production, as the U.S. imports only about 1% of its electricity, and exports far less.

[7] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions described in Appendix A.

Like electricity emissions, GHG emissions from transportation fuel use have risen steadily since 1990 at an average rate of slightly over 3% annually. Gasoline-powered vehicles accounted for about 55% of transportation GHG emissions in 2005. Diesel vehicles accounted for another 25% of emissions and air travel for roughly 17%. Marine gasoline, locomotives, and other sources [natural gas and liquefied petroleum gas (LPG) vehicles and lubricants] accounted for the remaining 3% of transportation emissions. As the result of Utah's population and economic expansion and an increase in total vehicle miles traveled during the 1990s, onroad gasoline use grew by 45% between 1990 and 2005. Meanwhile, onroad diesel use more than doubled during this period, suggesting an even more rapid growth in freight movement within the State. Aviation fuel use grew by 32% from 1990-2005.

Reference Case Projections

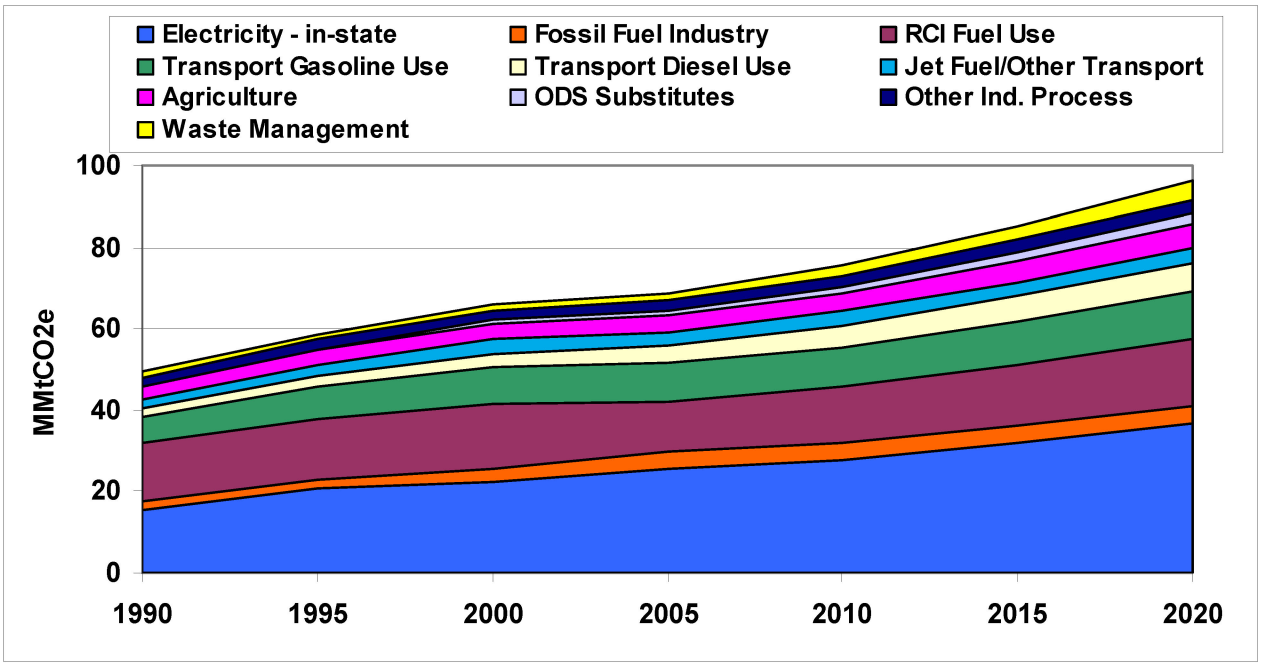
Relying on a variety of sources for projections of electricity and fuel use, as noted below and in the Appendices, we developed a simple reference case projection of GHG emissions through 2020. As illustrated in Figure 3 and shown numerically in Table 1, under the reference case projections, Utah gross GHG emissions continue to grow steadily, climbing to 98 $MMTCO_2e$ by 2020, 98% above 1990 levels. Electricity use is projected to be the largest contributor to future emissions growth, followed by the transportation sector and RCI fossil fuel use.

Key Uncertainties and Next Steps

Some data gaps exist in this inventory, and particularly in the reference case projections. Key tasks that should be performed in future updates include review and revision of key drivers, such as the electricity and transportation fuel use growth rates that will be major determinants of Utah's future GHG emissions (see Table 1). These growth rates are driven by uncertain economic, demographic, and land use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.

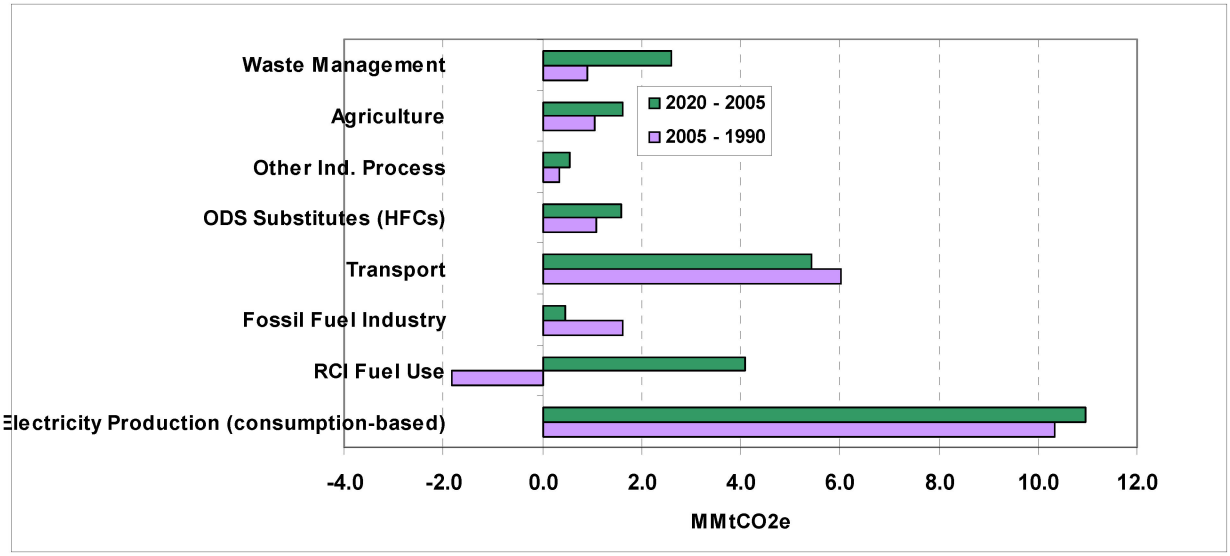
Perhaps the variable with the most important implications for GHG emissions is the type and number of power plants built in Utah between now and 2020. The assumptions on VMT and air travel growth also have large impacts on the GHG emission growth in the State. Finally, uncertainty remains regarding the estimates for historic GHG sinks from forestry, and projections for these emissions will greatly affect the net GHG emissions attributed to Utah.

Figure 3. Utah Gross GHG Emissions by Sector, 1990-2020: Historical and Projected



*RCI – direct fuel use in residential, commercial and industrial sectors (excluding the fossil fuel production industry)

Figure 4. Sector Contributions to Emissions Growth in Utah, 1990-2020: Historic and Reference Case Projections



*RCI – direct fuel use in residential, commercial and industrial sectors (excluding the fossil fuel production industry)

Table 3. Key Annual Growth Rates for Utah, Historical and Projected

Key Parameter	1990-2005	2005-2020	Sources
Population	2.6%	2.1%	The Utah Governor's Office of Planning and Budget
Employment Goods Services	 2.3% 3.2%	 2.4% 1.6%	Utah Department of Workforce Services, The Utah Governor's Office of Planning and Budget
Electricity Sales	3.3%	3.3%	EIA data for 1990-2005, Rocky Mountain power for projections
Vehicle Miles Traveled	3.8%	2.3%	Utah Department of Transportation

* Population and employment projections for Utah were used together with US DOE's Annual Energy Outlook 2006 projections of changes in fuel use on a per capita and per employee, as relevant for each sector. For instance, growth in Utah's residential natural gas use is calculated as the Utah population growth times the change in per capita natural gas use for the Mountain region.

Emissions of aerosols, particularly black carbon from fossil fuel combustion, could have significant impacts in terms of radiative forcing (that is, climate impacts). Methodologies for conversion of black carbon mass estimates and projections to global warming potential involve significant uncertainty at present, but CCS has developed and used a recommended approach for estimating black carbon emissions based on methods used in other States. Current estimates suggest a CO_2e contribution of about 7% overall from BC emissions, as compared to the CO_2e contributed from the gases (4.9 $MMtCO_2e$ from BC in 2002 compared to 66 $MMtCO_2e$ from the six GHGs). Emissions from two primary contributing sectors (onroad and nonroad diesel combustion) are expected to decline by 2020 due to new engine and fuel standards.

Approach

The principal goal of compiling the inventories and reference case projections presented in this document is to provide the State with a general understanding of Utah's historical, current, and projected (expected) GHG emissions. The following explains the general methodology and the general principles and guidelines followed during development of these GHG inventories for Utah.

General Methodology

CCS prepared this analysis in close consultation with Utah agencies, in particular, with the UDEQ staff. The overall goal of this effort is to provide simple and straightforward estimates, with an emphasis on robustness, consistency, and transparency. As a result, we rely on reference forecasts from best available state and regional sources where possible. Where reliable forecasts are lacking, we use straightforward spreadsheet analysis and linear extrapolations of historical trends rather than complex modeling.

In most cases, we follow the same approach to emissions accounting for historical inventories used by the U.S. EPA in its national GHG emissions inventory[8] and its guidelines for States.[9] These inventory guidelines were developed based on the guidelines from the Intergovernmental Panel on Climate Change, the international organization responsible for developing coordinated methods for national GHG inventories.[10] The inventory methods provide flexibility to account for local conditions. The key sources of activity and projection data are shown in Table 4. Table 4 also provides the descriptions of the data provided by each source and the uses of each data set in this analysis.

General Principles and Guidelines

A key part of this effort involves the establishment and use of a set of generally accepted accounting principles for evaluation of historical and projected GHG emissions, as follows:

- **Transparency:** We report data sources, methods, and key assumptions to allow open review and opportunities for additional revisions later based on input from others. In addition, we report key uncertainties where they exist.

[8] U.S. EPA, Feb 2005. *Draft Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2003.* http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2005.html.
[9] http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateInventoryGuidance.html.
[10] http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm.

Table 4. Key Sources for Utah Data, Inventory Methods, and Growth Rates

Source	Information provided	Use of Information in this Analysis
U.S. EPA State Greenhouse Gas Inventory Tool (SGIT)	US EPA SGIT is a collection of linked spreadsheets designed to help users develop State GHG inventories. US EPA SGIT contains default data for each State for most of the information required for an inventory. The SGIT methods are based on the methods provided in the Volume 8 document series published by the Emissions Inventory Improvement Program (http://www.epa.gov/ttn/chief/eiip/techreport/volume08/index.html)	Where not indicated otherwise, SGIT is used to calculate emissions from residential/commercial/industrial fuel combustion, industrial processes, transportation, agriculture and forestry, and waste. We use SGIT emission factors (CO_2, CH_4 and N_2O per BTU consumed) to calculate energy use emissions.
U.S. DOE Energy Information Administration (EIA) State Energy Data (SED)	EIA SED source provides energy use data in each State, annually to 2004 or in some cases 2005).	EIA SED is the source for most energy use data. We also use the more recent data for electricity and natural gas consumption (including natural gas for vehicle fuel) from the EIA website for years after 2001. Emission factors from US EPA SGIT are used to calculate energy-related emissions.
U.S. DOE Energy Information Administration Annual Energy Outlook 2006 (AEO2006)	EIA AEO2006 projects energy supply and demand for the U.S. from 2005 to 2030. Energy consumption is estimated on a regional basis. Utah is included in the Mountain Census region (AZ, CO, ID, MT, NM, NV, UT, and WY)	EIA AEO2006 is used to project changes in per capita (residential) and per employee (commercial/industrial) energy consumption
American Gas Association – Gas Facts	Natural gas transmission and distribution pipeline mileage.	Pipeline mileage from Gas Facts used with SGIT to estimate natural gas transmission and distribution emissions.
UDEQ	Data on industrial source activity.	Includes information on cement, lime production, and other sources.
U.S. EPA Landfill Methane Outreach Program (LMOP)	LMOP provides landfill waste-in-place data.	Waste-in-place data used to estimate annual disposal rate, which was used with SGIT to estimate emissions from solid waste, with additional data from UDEQ staff.
U.S. Forest Service	Data on forest carbon stocks for multiple years.	Data are used to calculate carbon dioxide flux over time (terrestrial CO_2 sequestration in forested areas)
USDS National Agricultural Statistics Service (NASS)	USDA NASS provides data on crops and livestock.	Crop production data used to estimate agricultural residue and agricultural soils emissions; livestock population data used to estimate manure and enteric fermentation emissions

- **Consistency:** To the extent possible, the inventory and projections will be designed to be externally consistent with current or likely future systems for state and national GHG emission reporting. We have used the EPA tools for state inventories and projections as a starting point. These initial estimates were then augmented and/or revised as needed to conform with state-based inventory and base-case projection needs. For consistency in making reference case projections[11], we define reference case actions for the purposes of projections as those *currently in place or reasonably expected over the time period of analysis*.

- **Comprehensive Coverage of Gases, Sectors, State Activities, and Time Periods.** This analysis aims to comprehensively cover GHG emissions associated with activities in Utah. It covers all six GHGs covered by U.S. and other national inventories: CO_2, CH_4, N_2O, SF_6, HFCs, and PFCs and black carbon. The inventory estimates are for the year 1990, with subsequent years included up to most recently available data (typically 2002 to 2005), with projections to 2010 and 2020.

- **Priority of Significant Emissions Sources:** In general, activities with relatively small emissions levels may not be reported with the same level of detail as other activities.

- **Priority of Existing State and Local Data Sources:** In gathering data and in cases where data sources conflicted, we placed highest priority on local and state data and analyses, followed by regional sources, with national data or simplified assumptions such as constant linear extrapolation of trends used as defaults where necessary.

- **Use of Consumption-Based Emissions Estimates:** To the extent possible, we estimated emissions that are caused by activities that occur in Utah. For example, we reported emissions associated with the electricity consumed in Utah. The rationale for this method of reporting is that it can more accurately reflect the impact of State-based policy strategies such as energy efficiency on overall GHG emissions, and it resolves double counting and exclusion problems with multi-emissions issues. This approach can differ from how inventories are compiled, for example, on an in-state production basis, in particular for electricity.

For electricity, we estimate, in addition to the emissions due to fuels combusted at electricity plants in the State, the emissions related to electricity *consumed* in Utah. This entails accounting for the electricity sources used by Utah utilities to meet consumer demands. If UDEQ decides to refine this analysis, they may also consider estimating other sectoral emissions on a consumption basis, such as accounting for emissions from combustion of transportation fuel used in Utah, but purchased out-of-state. In some cases this can require venturing into the relatively complex terrain of life-cycle analysis. In general, CCS recommends considering a consumption-based approach where it will significantly improve the estimation of the emissions impact of potential mitigation strategies. For example re-use, recycling, and source reduction can lead to emission reductions resulting from lower energy requirements for material production (such as paper,

[11] "Reference case" refers to a projection of the current or "base year" inventory to one or more future years under business-as-usual forecast conditions (for example, existing control programs and economic growth).

cardboard, and aluminum), even though production of those materials, and emissions associated with materials production, may not occur within the State.

Details on the methods and data sources used to construct the inventories and forecasts for each source sector are provided in the following appendices:

- Appendix A. Electricity Use and Supply.
- Appendix B. Residential, Commercial, and Industrial (RCI) Fossil Fuel Combustion (excluding fuel used by the fossil fuel production industry).
- Appendix C. Transportation Energy Use.
- Appendix D. Industrial Processes.
- Appendix E. Fossil Fuel Industries.
- Appendix F. Agriculture.
- Appendix G. Waste Management.
- Appendix H. Forestry.

Appendix I contains a discussion of the inventory and forecast for black carbon. Appendix J provides additional background information from the U.S. EPA on greenhouse gases and global warming potential values.

[To conserve paper, the appendices can be found online at:
http://www.deq.utah.gov/BRAC_Climate/docs/Final_Utah_GHG_I&F_Report_080907.pdf]

Governor's Blue Ribbon Advisory Council Members and Alternates

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SWG Members: Kathy Van Dame, Sarah Wright, Ron Daniels, Paul Dremann, and Tim Wagner.

Others:

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Roy Gunnell	Utah Department of Agriculture and Food
Sara Baldwin	Utah Sierra Club
Carl Hansen	College of Agriculture, Utah State University
Richard Beard	Utah State Cooperative Energy Resource Comm.
Andre Shoumatoff	Utah Biodiesel

Cross Cutting:
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SWG Members: Kathy Van Dame, Becky Wilson, Sarah Wright.

Others: Carol Revelt and Sara Baldwin.

Energy Supply:
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SWG Members: Ted Rampton, Mike Golas, Sara Wright, Ron Daniels, Kathy Van Dame, Paul Dremann, and Cheryl Murray.

Others:

Jeff Quick	Utah Geological Survey
John Baza	Utah Division of Oil, Gas, and Mining
Steven Aderholt	Sound Geothermal
Sara Baldwin	Utah Sierra Club
Kyle Davis	PacifiCorp
Cathryn Collis	SWCA
Renee Zollinger	Environmental Performance Group

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SWG Members: Cheryl Murray, Ron Daniels, Kathy Van Dame, and Mike Golas.

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Lisa Romney	Chevron Energy Solutions
Aaron Needham	DT Homes
Brittany Litz	TAC Energy Solutions
Richard Young	Environmental Performance
Phil Powlick	Utah State Energy Program
Betsy Wolf	Salt Lake Community Action Program
Jim Meyers	North American Insulation Manufacturers Ass'n.
Patti Case	etc. Group
Sara Baldwin	Utah Sierra Club

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Patrick Clark	Staker Parsons
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Dr. David Bowling	Asst. Professor, Department of Biology, University of Utah
Dr. Tim Garrett	Asst. Professor, Department of Meteorology, University of Utah
Dr. Rob Gilles	Director/State Climatologist, Utah Climate Center, Utah State University
Dr. John Horel	Professor, Department of Meteorology, University of Utah
Randy Julander	Snow Survey Supervisor, Utah Department of Natural Resource Conservation Srv.
Dr. David Long	Professor, Department of Electrical and Computer Engineering, Director, BYU Center for Remote Sensing
Dr. Thomas Reichler	Asst. Professor, Department of Meteorology, University of Utah

Acronym List and List of Sources

AF – Agriculture Forestry sector
APEP – Agricultural Pumping Efficiency Program (California)
ASHRAE – The American Society of Heating, Refrigerating and Air-Conditioning Engineers
BMP – Best Management Practices
BOC – Building Operator Certification
BRAC – Blue Ribbon Advisory Council
CC – Cross-Cutting
CCS – Carbon Capture and Sequestration
CCS – Center for Climate Strategies (See website: http://www.climatestrategies.us/)
CHP – Combined Heat and Power System
CIRES – Cooperative Institute for Research in Environmental Sciences at the University of Colorado, Boulder
CO_2e –CO_2 equivalents. The quantity of a given GHG multiplied by its global warming potential. This is the standard unit for comparing the degree of harm which can be caused by emissions of different GHGs.
CRP – Conservation Reserve Program (US Department of Agriculture)
DG – Distributive Generation
DOE – Department of Energy
DSM – Demand Side Management
EPS – Environmental Portfolio Standard
ES – Energy Supply sector
GHG – Greenhouse Gas
GWP – Global Warming Potential
IAC – Industrial Assessment Center at Arizona State University
IECC – International Energy Conservation Code
IPCC – Intergovernmental Panel on Climate Change (United Nations)
IPP – Intermountain Power Plant
KWh – Kilowatt Hours
LGE – Landfill Gas to Energy, a process by which gas is collected from Municipal Solid Waste landfills to generate energy.
LSE – Load Serving Entity
MMt – Million Metric Tons
MWh – Megawatt hours
MOU – Memorandum of Understanding
NEEA - Northwest Energy Efficiency Alliance
NEG - Net Excess Generation
PBF – Public Benefit Fund
PG&E – Pacific Gas and Electric
RCI – Residential/Commercial/Industrial sector
REC – Renewable Energy Certificates
R&D – Research and Development
RLF – Revolving Loan Fund
RMTA - Regional Market Transformation alliances

RPS – Renewable Portfolio Standard
SWEEP – Southwest Energy Efficiency Project
SWG – Stakeholder Work Group
UDOT – Utah Department of Transportation
USU – Utah State University
VMT – Vehicle Miles Traveled
WCI – Western Climate Initiative

Sources

State Climate Reports

- Arizona http://www.azclimatechange.gov/
- California http://www.climatechange.ca.gov/
- Colorado http://www.coloradoclimate.org/
- Florida: http://www.floridaclimatechange.com/
- Oregon http://www.sustainableoregon.net/climate/
- Montana http://www.mtclimatechange.us/
- New Mexico http://www.nmclimatechange.us/
- North Carolina http://www.ncclimatechange.us/
- Washington http://www.ecy.wa.gov/climatechange/cat_overview.htm

2000 Utah Office of Energy and Resource Planning Report
Utah Energy Efficiency Strategy
Final Utah Greenhouse Gas Inventory and Reference Case Projections, 1990-2020

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Dr. Hans G. Ehrbar

I have been a participant in the Renewable Energy Initiative Group since the beginning. In my view, the present draft version of the report underestimates both the urgency for and the potential of renewable energy.

(1) Urgency: The main reason for switching to renewable energy, which overshadows everything else, is global warming. Fossil energy was a one-time windfall which turned out too good to be true. Even if renewable energy is more expensive than fossil energy, we must switch to renewables if we want to leave a hospitable planet to our children and grandchildren. The question is not whether renewable energy is cheaper than fossil energy; the question is how we can use the available economic resources most productively to make this switch, and how we can remove any regulatory, legal, and organizational obstacles which are the leftovers from a different time period. This is a common goal transcending the economic interests of which the participants are the representatives.

(2) Potential: The report underestimates the capabilities of renewable energy. In the long run, all our energy needs must be met from renewable energy, because we cannot rely on an exhaustible stock forever. But this long run future is closer than the draft report makes it appear:

(a) Renewable energy is not scarce. Solar energy is by far the most abundant and could solve all our energy needs. It is presently not the cheapest, but it is clean and can be harvested in a distributed fashion. But wind and geothermal energy are also widely available at prices almost competitive with coal or nuclear energy.

(b) The intermittency of renewable energy is a challenge but not a show stopper. First of all, not all renewable energy is intermittent: geothermal energy is one of the most reliable steady sources of energy. Secondly, different renewable energies have different time profiles which complement each other. Third, along with the technology of renewable energy generation also the technologies of energy storage are developing, from pumped hydro to vehicle-to-grid storage to hydrogen. Fourth, technologies are in development to adjust demand to the time profile of the supply. Facit: intermittency will become a problem only gradually, as the percentage of intermittent renewable resources increases. But over the same time frame we can expect many of the technological solutions to gain traction. One of the things necessary will be the strengthening and modernization of the electric grid. But this is an infrastructural measure which will pay for itself in other ways as well.

(c) Renewable energy is not an unproven technology. Wind, geothermal, concentrating solar, and PV solar have been in operation for many years. Renewable energy has shorter lead times than large centralized coal or nuclear plants.

(d) Renewable energy is not too expensive. The report states correctly that fossil energy already today may be more expensive than renewable energy, if one adds all the externalities. But even if those externality costs are not added to the electricity bills, they do not go away and someone has to bear them. The question is: do you want to invest in more hospitals for asthmatic children, or in renewable energy technologies.

(e) Renewable energy can be produced by many small businesses and does not favor large monopolies. It involves the population which is concerned about the environment in a democratic way.

(f) Due to the concentration of our discussion on electricity we were not able to list an additional benefit of renewable energy: its distributed and small scale low temperature technology is especially suitable for co-generation of electricity and heat, which gives additional savings. There are also synergies between the technologies for renewable energy and the technologies for energy savings (both need the smart grid). The report should mention that a broader perspective will strengthen the case of renewable energy.

Hans G. Ehrbar
Associate Professor
Economics Department
University of Utah

Emery Energy



October 8th, 2007

RE: Comments on DRAFT REI Proposal

Dear REI Co-Chairs, Mr. Wessman and Mr. Wagner:

This letter is written to convey Emery's opinion and position on the definition of qualifying renewable energy resources and specifically on biomass resources. As per our participation in the REI committee meetings and as per our verbal recommendations during such meetings, we are expressing our position that **Municipal Solid Waste (MSW) should be included as a biomass feedstock that qualifies as renewable energy**. We recommend that the DRAFT REPORT be modified to reflect this change before being submitted to the Blue Ribbon Advisory Council.

If necessary, such language could read "the biomass fraction (i.e. plant or cellulosic material) of municipal solid waste"

It is illogical to include Landfill gas methane and to not include MSW. This approach only encourages ongoing landfilling and will result in incremental methane emissions from waste that off-gases over the life of the landfill before the new landfill cells become economical for energy recovery. Furthermore, if MSW is not included as a renewable resource, it will greatly limit the availability of economical sources of renewable and clean energy – reducing least cost alternatives for consumers.

To not include MSW as a renewable energy resource goes directly against the purpose of the Renewable Energy Initiative and broader goals of low carbon energy sources being championed by the Blue Ribbon Advisory Committee.

To not include MSW as an acceptable biomass feedstock is to ignore one of Utah's key renewable energy resources in a state that is otherwise limited or devoid of other renewable resources. Remember, most if not all, of the Blue Sky renewable energy comes from Wyoming based wind. The use of MSW within the state not only affords the opportunity for clean, baseload, dispatchable power (something wind and solar cannot provide), but can also create unique economic development opportunities (rural and

urban) within the State of Utah, that wind from Wyoming never will. One of the biggest constraints to a successful biomass energy portfolio is often the collection and delivery constraints of the biomass feedstock - and unlike other biomass resources (i.e. forest residue or agricultural residue), MSW has an existing collection infrastructure that contributes to its potential as a cost effective renewable energy resource.

Alternatively and if necessary, the REI Draft Report could include language similar to the California Energy Commission that reads *"MSW Facility must use a non combustion thermal process (i.e. gasification) to convert MSW to a clean burning fuel to generate electricity"*.

MSW can make a clean and lasting contribution to Utah's renewable energy needs if it is deservedly included in the current draft report. We appreciate the opportunity to contribute to an appropriate policy framework related to biomass feedstocks.

Sincerely,

Ben Phillips, President
159 Pierpont Avenue
Salt Lake City, Utah – 84101
Phone: 801-364-8283 / fax: 801-746-3256

Dr. Philip C. Emmi

Dear Mr. Campbell:

I offer a graduate course at the University of Utah this semester on Energy and the City. Students and I have been following the deliberations of the REI Focus Group and want now to submit the attached revisions to the REI Draft Report. We also submit the following statement for consideration as we are convinced that it presents initiatives that would be in the long-term interests of all parties concerned.

Whereas the REI Focus Group has advance a Renewable Portfolio Standard (RPS) for investor-owned utilities in Utah that is based on an Oregon case study, and

Whereas Utah is projected to grow at a rate that exceeds Oregon's projected growth by 30 percent, and

Whereas projected energy production in Utah is expected to grow at a rate that exceeds RPS growth in renewable generation capacity with corresponding increases greenhouse gas emissions, and

Whereas the proposed RPS does not currently encourage demand-side management, dispersed-site production or improved plant efficiencies,

We request that the REI Results report to be modified to include the following three propositions:

1) That up to 30% of each year's RPS target may be met with any or all of the following:
    a) Demonstrable results from demand-side management programs
    b) Verified improvements in utility plant efficiency
    c) On-site renewable energy installations in homes and small businesses

2) That the RPS targets be increased by 30 percent from 20% to 26% renewables by 2020

3) That, at a minimum, Renewable Portfolio Standards should change through time so as to guarantee a 26% reduction in greenhouse gas emissions by 2020 over current levels.

Sincerely,

Dr. Philip C. Emmi
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enXco Development Corporation

UTAH DEPARTMENT OF
ENVIRONMENTAL QUALITY
OCT 16 2007
DIVISION OF AIR QUALITY

October 17, 2007

Utah Renewable Energy Focus Group
Blue Ribbon Advisory Council on Climate Change

Re: Final Comments concerning REI Focus Group report

enXco Development Corporation has appreciated the opportunity to participate in the Utah Renewable Energy Focus Group process for the series of meetings held during the last several months. We believe the process has been very healthy, with numerous stakeholders represented, excellent presentations concerning material topics and vigorous discussion. The report is certainly meritorious and well worth the careful consideration of the BRAC, the Governor's office and the legislature.

enXco has been involved in the wind industry for twenty years and has its origins in operations and maintenance. Accordingly enXco has had a substantial involvement in the maturing of the renewable energy industry. enXco is the largest operator of third party-owned wind projects in this country, has developed a number of wind projects both for utilities and for its own account, and has broadened its horizons to include solar, biomass and other renewable technologies throughout the United States, as its parent companies pursue around the globe.

enXco is supportive of implementation of a renewable portfolio standard for Utah and strongly believes a well structured RPS can be a powerful policy tool to help achieve resource diversity, improve air quality and produce tremendous economic development benefits for the State. In general, enXco supported the "strawman" proposal structure as emulating in many respects the Oregon RPS structure, which is well reasoned, carefully crafted, with performance checks and safety valves, and has already begun to produce strong economic development prospects for Oregon. Utah would do well to achieve comparable results.

In addition to the RPS, it is imperative to emphasize the other two initiative efforts identified by the Focus Group. That is, Utah needs a strong package of incentives for development of renewable resources and implementation of sustained improvements to the transmission system within the state to facilitate addition of renewable resources to the electric system. Notwithstanding that many members of the Focus Group were not well informed about the numerous study efforts other states, Federal agencies such as NREL and third party organizations have undertaken regarding economic development benefits of a strong incentive program for renewable technologies, the compelling conclusion in both the relevant literature and the practical experience of a number of states is that as an economic development proposition renewable technologies have already proven to have a very strong benefit to cost ratio. Similar input-output modeling studies have already been performed for several Utah Counties by Utah State University

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for the wind industry, which support this general theme. enXco recommends that such study efforts be broadened to take in additional Counties and additional technologies, especially solar and geothermal, and that a strong incentive package be assembled as a high priority economic development initiative. It is clear that renewable technologies have very strong job creation, economic growth, rural benefits and water conservation characteristics.

Again, our appreciation for an excellent process and we look forward to further involvement in the economic development of Utah, for the benefit of the State and its people.

Sincerely,

Gregory L. Probst
Project Developer

Lakefront Gun, Fur and Reclamation Club

Focus Group

This letter is a joint letter of the President and Board of Directors of the Lakefront Gun, Fir and Reclamation Club; and Bruce Waddell (club shareholder), retired USFWS Environmental Contaminants Biologist for Utah.

Our comments are in regard to the mandate as we understand it to develop a Renewable Portfolio Standard which would require specific fractions of Utah's electricity from renewable sources such as wind, solar, etc. We expect that this would provide a mandate for future planning using approximately the period of this investigation as the basis to compare these percentages against. and, that credits for meeting this RPS would be based on future changes in the way that electricity is produced compared to this basis.

We assume that a full range of alternatives for producing electricity from renewable sources is being considered. Of the ones we are aware of and that currently have the greatest likelihood of success in the near term, solar seems the most likely to be productive without a large number of negative impacts to our environment. We would be much more in support of solar incentives and encouragements designed to help homeowners and personal property owners offset the cost of their electricity by contributing to the grid, or provide a means of obtaining electricity where no source is economically available.

Wind appears to be the next most likely to provide a renewable source of energy. Of concern to us is the thorough review required of the proposed sites to identify the impacts likely to resident and migrating birds. Areas such as the Great Salt Lake are likely to be poor sites due to tremendous use of the area by nesting and migrating birds. This is complicated in that migrations of some of these occur at night when the slow moving props might still be hazards. Other potential hazards might include migrating corridors, e.g. hawks, falcons and eagles migrating along mountain ranges. In spite of this it seems to be being used successfully in other states and needs to be evaluated further to determine if the seemingly large potential actually exists.

We are not in favor of significant new expansion of hydro power on our smaller streams because of concerns they have already impacted fisheries and would likely further impact fisheries and riparian habitats. Further development of reservoirs on larger rivers is unlikely because of endangered fish use.

Bruce has conducted a limited investigation of solar power as a way of reducing electric costs by connecting to the power grid. At this time even with the existing incentives, he has not convinced himself that he could come close to break even with the investment. We suspect that there are a lot of individual users or even Duck Clubs that might be

interested in solar electric power if enough technical and financial assistance were provided to offset the start-up costs.

Hope this assists you in prioritizing enhanced use of renewable resources.

Jason Kershaw, President. Lakefront Gun, Fur and Reclamation Club
Bruce Waddell, Shareholder, Retired USFWS

raser
TECHNOLOGIES

October 12, 2007

Governor's Blue Ribbon Commission on Climate Change
c/o Mr. James Campbell
Department of Environmental Quality
DEQ Building #2, Room 101
168 North 1950 West, Salt Lake City
jacampbell@utah.gov

Re: Support of a Renewable Portfolio Standard, as well as Critical Credits and Incentives Required to Advance the Development of Renewable Energy / Geothermal Power Generation

Raser Technologies (Raser) is pleased to submit our comments to be included in the Renewable Portfolio Utah Renewable Energy Initiative Focus Group Report, as well as to express our support of the implementation of a Renewable Portfolio Standard in Utah.

By way of introduction, Raser is a Provo-based, green-focused technology licensing and development company operating in two business segments. Raser's Power Systems segment is developing clean, renewable geothermal electric power plants. Raser's Transportation and Industrial technology segment focuses on using Raser's Symetron technology to improve the efficiency of electric motors and other applications.

Geothermal energy is one of the only renewable resources that can provide baseload power, meaning it is available 24 hours-a-day / 7 days-per-week. Utah currently has two operating geothermal power plants, including Blundell with a generating capacity of 27 MW and Cove Fort. Glitnir Bank, a world leader in financing geothermal power projects, MIT and the National Renewable Energy Laboratory each estimates that the potential for geothermal power generation in Utah is dramatic, including over 10,000MW in the case of the MIT study. In order to contribute in realizing this potential Raser has acquired geothermal lease rights on both public and private land throughout the state. Raser expects to have several small-scale (10 MW each) geothermal power plants operational within the next two years. Additional Utah projects are currently being identified.

In order for Utah to achieve its goals of a diversified energy portfolio, improved air quality, reduced CO_2 emissions, etc., the state should provide financial credits and other incentives to stimulate the development of renewable energy. Although many of the

incentives mentioned in the REI report will support renewable energy development in Utah, Raser views the following as the most critical:

Renewable Energy Sales and Use Tax Exemption

- Extend the exemption beyond the sunset date of June 30, 2009
- Extend the exemption to include renewable production facilities of all sizes.

Production Tax Credits

- Provide a state production tax credit for electricity generated from renewable resources, targeting geothermal, wind and solar.

Geothermal Resource Exploration Program

- Create and fund a cost-shared geothermal resource exploration program. Such a program would share exploratory drilling costs between the state and the geothermal power developer, with the state receiving a financial return from successful wells. The program will have the primary objective of developing collaborative efforts between the state and industry that support the exploration leading to the definition of new geothermal resources.

Raser Technologies looks forward to working with the Governor, state agencies, legislators, industry and citizenry in aggressively developing clean, renewable baseload geothermal power resources.

Respectfully,

Raser Technologies, Inc.
5152 Edgewood Drive
Suite 375
Provo, Utah 84604
Tel. (801) 765-1200
Fax (801) 374-3314

ROCKY MOUNTAIN POWER

To: Department of Environmental Quality

From: Carol Hunter and Kyle L. Davis

Date: October 16, 2007

Subject: Rocky Mountain Power's Comments on the Utah Renewable Energy Initiative

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As articulated by Governor Huntsman, the objective of the Utah Renewable Energy Initiative was to promote the development of *cost effective* renewable energy resources in an effort to: 1) enhance energy security, 2) reduce or avoid emissions of greenhouse gases, 3) improve air quality and 3) encourage economic development.

As you know, Rocky Mountain Power has already taken significant steps to add cost-effective renewables to its portfolio. Earlier this year, the company released its 2007 Integrated Resource Plan established a goal of acquiring 2,000 megawatts of cost effective renewable energy resources by the end of 2013. We also recently announced plans to build more than 1,200 miles of new 500-kilovolt transmission lines originating in Wyoming and connecting into Utah, Idaho, Oregon and the desert southwest. The two transmission lines are set for completion in year 2014. In addition to improving system reliability, these projects are also aimed at delivering wind and other renewable energy resources to more customers throughout PacifiCorp's six-state service area and the western region. The company's investments in new renewable energy resources and transmission, coupled with various tax incentives, will hasten the construction of new *cost effective* renewable energy resources within both Utah and the West.

Now that the Renewable Energy Initiative focus group has wrapped up its formal deliberations, we would like to reiterate the main points we believe we made, what we heard from various stakeholders, as well as offer a possible means for moving the endeavor forward.

The Need for a Renewable Portfolio Standard

1. A state mandate is not necessary to force PacifiCorp/Rocky Mountain Power to invest in cost-effective renewable energy; PacifiCorp is already a national leader in renewable energy.
2. To mitigate the risk of legislation drafted by others that is not cost effective and in the interests of our customers, the company believes it must take an active role in developing legislation and not rely upon its ability to avoid or modify someone else's legislation.

Critical Design Criteria

3. The company has prepared a legislative proposal that establishes a soft target of 20% of adjusted calendar year sales being met with renewable energy [The

4. The first year of the target would be 2025, with the target calculations based on adjusted retail electric sales for 2022. Using an historical period for the calculation of the kWh target avoids the need for the utility to estimate sales; the utility will still need to estimate renewable energy source production in 2025. The targets for years after 2025 will be calculated using the retail electric sales in the year that starts 36 months prior to the target year.
5. The proposal gives utilities partial credit for zero/low carbon dioxide emitting generation technologies other than renewable energy sources used to satisfy the target. Examples include demand side management, new carbon sequestered coal, new nuclear, and renewable generation (such as out-of-state hydro or pre-1995 QFs) that doesn't meet the definition of a renewable energy source. The partial credit is accomplished by a downward adjustment to the base year retail sales.
6. The following is an example of the calculation of the amount of qualifying electricity that would be required to satisfy the 20% target in 2025. Assume:
    - a utility's unadjusted retail sales in 2022 are 10,000,000 MWh;
        - 500,000 MWh of those sales are attributable to the utility's hydro generation located outside Utah;
        - 200,000 MWh of those sales are attributable to a PPA with a nuclear generator;
        - 300,000 MWh of those sales are attributable to a carbon sequestered coal unit;
        - 100,000 MWh are attributable to a renewable energy QF that went into service before 1995; and
        - the utility avoided 400,000 MWh of retail sales in 2022 as a result of its energy efficiency and demand-side management programs;
    - so, the utility's 2022 adjusted retail sales would equal 8,500,000 MWh;
    - and, in 2025, the utility would have a target of 20% of 8,500,000 MWh or 1,700,000 MWh of qualifying electricity.
7. We have been working with all Utah generators and utilities to craft a section of the legislation that would apply to those utilities. In recognition of the concerns of the smaller utilities, the legislation contains separate provisions for those entities. Because of revisions underdevelopment and the need for them to gain formal approval from their various boards, we do not include references to these legislative modifications at this time.
8. No interim targets prior to 2025 have been established. First, interim targets are unnecessary for Rocky Mountain Power which is already required by state law to add cost-effective renewable energy. Second, interim targets are contrary to the interests of our customers as they would require that we retire RECs that we could

otherwise sell to the benefit of our customers through the acquisition of renewables with a net lower cost.

9. For consistency, the proposal adopts the same definition of cost effectiveness as is used for integrated resource planning for Rocky Mountain Power.

10. Renewable energy sources are the same post 1994 resources as provided in the Oregon legislation except we have expanded the definition to include all geothermal and hydro-electric generation located in Utah, regardless of the date upon which the generation became operational. For example, this would capture Blundell. This is another provision sought by the small utilities.

11. The commission is charged with establishing and administering a process for issuing and tracking renewable energy certificates (RECs). The commission is authorized to work with regional administrators such as WREGIS. RECs are to be issued for any qualifying electricity generated since January 1, 1995. RECs have no expiration date and can be banked, which means they can be used or transferred in a year other than the year of the generation which gave rise to the REC. This will allow Utah utilities to sell RECs to utilities outside the state, with the resultant revenues credited to customers.

12. To assist solar development in Utah, solar facilities located in Utah receive credit for 2.4 kilowatt-hours of qualifying electricity for each kWh of generation. We understand the 2.4 credit amount is the same as Nevada is providing.

13. To address a concern about the lack of restriction upon the use of banked RECs, the legislation provides that the 20% target continues beyond 2025. This severely restricts the ability to satisfy the target with a high proportion of banked RECs. To address another concern of small utilities, a cap has been placed on the amount the target can increase from year to year.

14. The 2027 report to the Legislature by the commission may contain any recommendation for penalties or other action for failure to meet the 2025 target. The legislation requires that any recommendation for a penalty must provide that the penalty funds be used for demand side management programs for the customers of the utility paying the penalty.

15. Why not just adopt the Oregon bill?

    - While it is state of the art, the Oregon bill is a highly detailed and heavy handed approach.
    - Much of the verbiage in the Oregon bill addresses exemptions for public power and BPA – that isn't needed here.
    - The Oregon bill is focused more on a hydro based system; in Utah we have a coal based system.
    - The Oregon bill has as strong a tie to cost effectiveness as we could negotiate, but we prefer a much stronger provision.
    - In Oregon, we faced the certainty of a voter initiative if the Legislature did not pass a bill. This limited our negotiating leverage.

- The Oregon bill did not address zero/low carbon emissions technologies. This is the next generation of portfolio standards. Utah can become a leader in this area rather than merely copy Oregon or be the 26th state to adopt an RPS or in other words, RPS serial number 26.

Specific Highlights of Rocky Mountain Power's Proposed Legislation

The proposal:

- amends Title 54, Chapter 17, Section 201 to allow an affected electrical utility the option not to use the solicitation and approval process for new renewable energy sources of less than 300 megawatts;
- amends Title 54, Chapter 17, Section 303 to allow an affected electrical utility to recover the prudently incurred costs of developing a benchmark option;
- adds new Sections 601 through 607 to Title 54, Chapter 17, setting a target for electric corporations of 20% of adjusted retail sales to be supplied by qualifying electricity:
    - establishes 2025 as the first target year;
    - for the 2025 target, uses data from 2022 to enable electric corporations to know what the target is by mid-2023;
    - the targets for years after 2025 will be calculated using the retail electric sales in the year that starts 36 months prior to the target year;
    - retail sales are to be adjusted downward before calculating the 20% target to recognize the carbon reduction value of those technologies other than renewable energy sources that produce reduced or no carbon emissions;
    - provides that the target need only be satisfied if it is cost effective for customers;
    - defines the term "cost effective" consistently with the existing statutory criteria applied to integrated resource planning; also provides that the target need not be satisfied to the extent it would require an electric corporation (a) to substitute qualifying electricity for electricity from generation sources owned or contractually committed on the effective date of the law or from contractual commitments for power purchases on the effective date of the law; (b) to enter into any additional electric sales commitment or any other arrangement for the sale or disposition of electricity that was not already, or would not have been, entered into; or (c) to acquire qualifying electricity in excess of its adjusted retail electric sales.
    - applies the renewable energy source target to all electric corporations, ensuring that all Utah consumers receive the benefits of this legislation regardless of the ownership of the utility serving them;
    - allows electric corporations to meet the 20% target with owned renewable energy sources, power purchases of qualifying electricity, and renewable

energy certificates; provides additional options for electric corporations that are cooperative associations;

- defines renewable energy sources and, with the exception of geothermal and hydro-electric facilities located in this state, provides that to qualify the generation unit or upgrade had to become operational on or after January 1, 1995;
- defines qualifying electricity and requires that the electricity must have been produced on or after January 1, 1995 and not sold or otherwise used to satisfy a renewable energy program in another state;
- requires the commission to develop a process for certifying qualifying electricity; provides that certificates may be requested for any qualifying electricity; further provides that certificates do not have an expiration date and may be banked for usage or transfer after the year in which the generation occurred;
- requires electric corporations to file plans and progress reports with the commission by January 1 of each year 2010, 2015, 2020 and 2024; a final report must be filed by July 1, 2026;
- requires the commission to submit summaries of the progress reports to the Legislature on January 1 of the year following the plan and progress report filings.
- provides for the commission to submit a final report to the Legislature; the final report may contain any recommendation for legislative actions for any failure to meet the 2025 target;
- provides that the prudently incurred costs to own, operate and construct renewable energy sources and associated assets, including transmission, and other costs to acquire renewable energy, including power purchases of qualifying electricity, are to be recovered in rates at the same time customers receive the benefits of the renewable energy;
- provides that the prudently incurred costs of acquiring renewable energy certificates are recoverable in rates, but any net revenues from sales of renewable energy certificates must be credited to customers;
- provides that the prudently incurred costs of investigating and developing renewable energy sources (including siting, permitting, licensing and pre-construction costs) may be deferred and recovered in rates even if the renewable energy source does not become operational;

- adds new Sections 701 through 704 to Title 54, Chapter 17 which establish a regulatory framework for carbon sequestration and geologic storage of carbon in Utah.

Salt Lake City Mayor's Office

Policy Recommendation: A Renewable Portfolio Standard for the State of Utah

In the United States more than 85% of our electricity is generated by burning fossil fuels. In Utah that number jumps to an astonishing 97%. The process of producing electricity from fossil fuels—coal, oil, and natural gas—is negatively impacting human health and our environment. Many in Utah do not associate electricity use with air pollution and global warming. However, continued reliance on electricity from fossil fuels will result in persistent acid rain, smog, regional haze, and dangerous greenhouse gas pollution.

To move beyond electricity produced from fossil fuels at the speed necessary to significantly combat climate change and improve public health, Utah should act now by mandating renewable portfolio standard (RPS). Renewable portfolio standards have been extremely effective in significantly reducing greenhouse gas emissions and criteria air pollutants. Many states have also discovered that an RPS is of great benefit in meeting critical fuel diversity, energy security, and long-term economic goals, as well as stabilizing the price for energy production.

Twenty three states have already implemented an RPS and many more are exploring the opportunities that exist in adopting an aggressive standard. Utah is currently behind the curve in the Rocky Mountain region. New Mexico, Arizona, and Nevada have all adopted RPSs and Colorado is now seeking to expand its standard to at least 20% by the year 2020.

The adoption of an RPS can produce tremendous economic opportunities

- In 1993, Nevada's geothermal power plants paid $800,000 in county taxes and $1.7 million in property taxes. In addition, the U.S. Bureau of Land Management collects nearly $20 million each year in rent and royalties from geothermal plants producing power on federal lands in Nevada. Half of these revenues are returned to the state.**(1)**
- The renewables industry is growing. The global photovoltaic (PV) industry earned $1.3 billion worldwide in 1997, with the U.S. PV industry collecting $380 million. **(2)**

The global wind industry sold approximately $3.8 billion in equipment in 2001. In the United States, investors poured $1 billion into wind energy projects in 2001.(3)

- The 240 MW of wind capacity installed in Iowa in 1998 and 1999 produced $2 million per year in tax payments to counties and school districts and $640,000 per year in direct lease payments to landowners.(4)
- The 143 wind turbines in the 107-MW Lake Benton I project in Minnesota, installed in early 1998, brought $250 million in investment.
- Lake Benton's director of economic development notes that each 100 MW of wind development generates about $1 million annually in property tax revenue.(4)
- Expanding Colorado's renewable energy standard to 20% by 2020 would create a net increase in total wages paid to energy workers in the state by a net cumulative total of $570 million. (5)
- Expanding Colorado's renewable energy standard would increase Colorado's share of gross domestic product (GDP) by a net of $1.9 billion through 2020. (5)
- According to the National Renewable Energy Laboratory, wind energy provides ten times more local tax revenue than a coal-fired power plant in Colorado on an energy-equivalent basis.

Creation of Jobs

- Wind and PV offer 40% more jobs per dollar than coal.(3)
- Nevada's RPS (20% by 2020) is projected to create 8,092 installation, operation, and maintenance jobs over 10 years. If the entire manufacturing process is added to the installation and O&M employment, the total rises to 27,229 jobs over ten years.(6)
- Even with conservative assumptions for in-state manufacturing for wind farm components, wind power could provide Vermont with 70% more one-year jobs and more than three times as many permanent jobs as natural gas provides over a 20-year time frame. Wind power could also provide property tax payments to local governments distributed across a wider area of the state, conserve water that natural gas plants would otherwise consume, and pay significant royalties to farmers, ranchers, and other rural landowners.(7)
- In 1996, the U.S. geothermal energy industry provided about 12,300 direct domestic jobs, and an additional 27,700 indirect domestic jobs.(1)
- One megawatt (MW) of PV relies upon 69,650 hours of labor. This translates into approximately 36 person-years.(3)
- A 37.5-MW wind farm would create over 356,250 hours of work, or 180 person-years. Two thousand megawatts of wind power, as is expected in Texas shortly, will create 19 million hours of work, or 9,694 person-years.(3)

States must set renewable portfolio standards to substantially decrease dangerous greenhouse gas emissions.

- With current state RPS laws, it is projected that by 2017, carbon dioxide emissions (the gas most responsible for global warming) will be reduced by nearly 75 million metric tons—the equivalent of removing 11.1 million cars and planting trees in an area larger than West Virginia.(8)

Today less than 2% of Utah's electricity is generated from clean renewable sources. Adoption of an aggressive standard will allow Utah to continue to lead the western region in innovation, economic development and encourage a much needed market in renewable energy for the state. For these reasons the Salt Lake City Mayor's office implores the Governors Blue Ribbon Advisory Council on Climate Change to formally recommend the adoption of an RPS to phase in at no less than 20% by 2020, with the flexibility to ramp up that percentage as new and more efficient renewable energy technologies become available.

Sources:

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(6) "What's Energy?" Alliance to Save Energy. 29 September 2004 <http://www.ase.org/uploaded_files/powersmart/whtsenrgy.html>.
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Salt Lake County Mayor's Office

To: Renewable Energy Initiative (REI) Focus Group
c/o James Campbell
Jacampbell@utah.gov

From: Salt Lake County Mayor Corroon

Re: Net Metering Issues for REI Focus Group

Dear Focus Group Members:

Salt Lake County is interested in diversifying the energy portfolio of the Salt Lake Valley, both internally for our government infrastructure and externally for our constituents. Given the committees focus on "actions that could encourage the transmission and distribution system to be strengthened to support renewable resources," I am submitting this letter for your consideration to encourage amendments to Utah's Interconnection and Net Metering policies and procedures. In 2006, Salt Lake County installed its first solar photovoltaic (PV) system as a part of the Salt Palace Expansion project. Since that time, we continue to look for new opportunities to further promote environmentally and socially responsible energy resources.

In light of the upcoming REI report, I write to discuss two Salt Lake County renewable energy projects and the barriers currently impeding their successful implementation. First, Salt Lake County is interested in partnering with local financial institutions to install $12 million worth of solar PV systems on our County facilities. Our initial discussions have been promising. Local governments across the United States have successfully installed these types of systems using similar business plans.

The second project we are considering is a major Concentrating Solar Power (CSP) installation as part of the "Solar Salt Lake Project", a partnership with Rocky Mountain Power, Utah Clean Energy, Kennecott Land, the State of Utah and Salt Lake City.

Although we are in the early stages for both of these projects, we have identified some significant barriers, in the context of net metering and interconnection, to the development of small-scale and large-scale distributed renewable energy. Please accept the following issues for consideration:

1) The current project size cap for net metered systems is 25 kW, which is relatively small compared to an average commercial load in Utah. If a commercial facility installs a solar PV (or other renewable energy) system larger than 25 kW, the process becomes significantly more challenging, time-consuming, and financially cumbersome. Our neighboring state, New Mexico, currently allows 80 Megawatts net metering.

2) Our efforts to obtain information on net metering and interconnection have been onerous and somewhat confusing, due to seemingly obscure program administration policies and procedures. The information on these matters is not readily available, transparent, or straightforward to the general public.
3) The current net metering rule payment structure is not favorable for commercial rate schedules, as the net metering rule only compensates for the kWh charge, not other charges, such as the "demand charge." This does not accurately reflect the peak demand value of Utah's solar resource and creates a significant disincentive for large-scale commercial projects. We would recommend that net metering compensate for the demand charge in addition to the normal kWh charge.

I appreciate that Rocky Mountain Power and Questar have already taken strides to allow for distributed renewable energy; however, we are eager to explore ways to eliminate unnecessary barriers to adoption and encourage increased development of renewable energy resources. We look forward to working with you on this process.

Regards,

Peter M. Corroon
Mayor, Salt Lake County

Gary M. Sandquist

Date: 16 October 2007
To: REI Focus Group
From: Gary M. Sandquist, Professor Emeritus, University of Utah.

The reasons cited by Governor Huntsman for pursuing more renewable energy are:

- Enhancement of Energy Security through Resource Diversity
- Reduction or Avoidance of Greenhouse Gas Emissions
- Improvement of Air Quality
- Encouragement of Economic Development

The REI Focus Group focused upon renewables with very small energy impact and supply in the US. Wind, solar, and geothermal account for less than 2% of total US electric supply. Given the mandate from the Governor for resource diversity, reduction of greenhouse gases, improvement of air quality and economic development an obvious response is the development of nuclear generated electricity in Utah. Of all non-greenhouse gas sources of US electricity, nuclear accounts for over 75% of this proven generation sector.

Nuclear energy has both the potential and demonstrated record to:

- Diversify Utah's electric generation resource portfolio.
- Manage potential increases in and volatility of energy prices. (Similar costs of coal and much cheaper than wind and solar).
- Help improve energy independence and security (Utah mines uranium).
- Have no carbon emissions and not subject to future carbon regulation.
- Improve air quality.
- Provide new economic development opportunities.

The BRAC, REI and especially the Governor and Legislature should acknowledge and seriously consider the development and implementation of nuclear generated electricity as an important and necessary component of Utah electrical power. Rocky Mountain Power includes nuclear as an important component of its generation future. US utilities have plans for siting and operation of dozens of new nuclear power plants. We must at least be open and rational regarding the development of nuclear power in Utah.

Andy Schoenberg

Renewable Energy Initiative – Experience and Recommendations from residential customer with a grid-tied solar system

Background

Our home has a 1400-watt, grid-tied solar photo-voltaic (PV) system, including a battery bank, which has been operational since the summer of 2006. This system also has provision for connecting several solar powered commuter vehicles whose batteries can be charged from the home PV system as well as providing some PV power to the home when the vehicles are fully charged. (See Appendix) The experience gained in installing, getting permits and tax credits, dealing with Rocky Mountain Power and operating this system should be of value in considering initiatives which would promote renewable energy, and PV systems in particular.

The system cost was $7861 not counting labor since I installed the system myself. **Federal and State tax credits reduced this cost by $2000 and $1903 respectively**. It should be noted that the State does not give credit for battery backup systems, which accounts for a slightly lower state tax credit. With these tax credits, the net equipment and supply costs for our solar system amounted to $3958**. This month Rocky Mountain Power (RMP) announced its incentive program of $2000 per kW of solar generated AC power. This would have reduced our hardware cost to $1958.**

We do not have exact figures about how much energy our system generates. Review of our monthly statements from RMP, indicates that we have reduced our usage of energy by 6 kW hr per day or 180 kW hr per month. Our home solar system supplies approximately half of our power needs during the spring and fall when the furnace motor and the air conditioner are not running**. Assuming a value of $0.10 per kW-hr for clean PV power (we pay that rate for the blue sky program) the annual savings is $216 or 11% of the net "capital" cost of $1958.** Thus a PV system installed this year would give a reasonable return on investment even if we discounted many other good reasons to install a PV system.

Some of these other good reasons to go solar are enumerated here. (1) If home solar systems become popular, the increased resale value of the home may recapture most of the investment. (2) **Home electric solar systems enhance independence and security**. This was illustrated last year when power in our neighborhood was interrupted for 2 days due to a severe windstorm. We were able to run our refrigerator, stove and several lights from our solar system and the energy stored in our battery bank. (3) There is great satisfaction in knowing that we are reducing the pollution and global warming associated with fossil fuel generated electricity. The esteem and satisfaction factor should not be discounted, given that people are willing to spend $10,000 to $50,000 to remodel their kitchens, bathrooms and bedrooms. (4) Since the energy from the sun is essentially free, the cost of an installed solar system will not escalate in contrast to the inevitable increased cost of electricity based on coal and gas fired power plants. (5) Our increased awareness and understanding of electric power and energy cost leads to many other efforts to reduce energy usage. (6) **Owning your own power generating system makes**

each of us a stockholder in the electric "power grid" and less dependent on "remote" owners to supply our essential needs for energy.

Given these great incentives and advantages to home solar electric systems why don't we have a massive demand for PV systems in Utah?

Obstacles and Needs for Wider Use of Grid-tied home PV systems.

1. **Lack of PV Vendors and Installers**

Learning about solar power systems was a multi-year process for me as a home owner. The Internet, and "Home Power" magazine were the main sources. There are no real "stores" for grid-tied solar PV systems in Salt Lake City. The Solar Power Company (see Yellow Pages) is a one-man operation specializing in remote cabin solar installations. Although very helpful and knowledgeable, the owner is not licensed to install grid-tied solar systems and is often out of town installing cabin systems. The other vendors listed under "Solar Power" in the phone book typically are not there to answer your questions, and require that you leave a message.

I ordered the components of my system and installed them myself. I had a very difficult time finding a licensed electrical contractor willing or able to inspect my installation. Most major contractors turned me down saying they had no experience and did not know the NFPA codes for solar PV systems. The few that had experience were too busy to even come out to give me an estimate for changes that may be needed. Finally one of them suggested that I get the county inspector to come out and tell me what did not meet code or needed fixing. He came in a few days and to my surprise, approved the system without corrections. I had probably over designed my system with lots of circuit breakers at various junctions.

I believe that the lack of vendors, installers and people with knowledge of solar PV systems is the great barrier to more solar PV power in Utah.

2. **Cost issues**

Our own experience of costs given the rebates and recent incentives contradicts the public's perception that PV systems are too expensive. The federal, state and RMP incentives, rebates and or tax credits will likely reduce the cost of a residential system by more than 50%. Pending legislation in Congress will likely lift the cap of $2000 tax credit, further increasing the advantage of renewable energy generation. The history of dramatic cost reductions in silicon based solar panels indicates that the current price of $4 to $5 per watt for solar panels will likely decrease by half in the next 5 to 10 years. I am submitting 9 copies of a book, "Exponential Solar", (See www.exponentialsolar.com) which presents the evidence of how solar PV will transform the electric power generation system. It also includes the estimates of electric power needed for the future fleet of plug-in hybrid and EV vehicles.

3. **Regulations, Codes and Permit Issues and Approvals**

Getting a permit to install the system from the Salt Lake County involved providing a detailed electrical diagram of the system as well as a drawing of the house and placement of the solar panels on the property. A potentially serious obstacle for approval was the placement of the solar panel array at ground level, which in our case needed to be fairly close to the southern property line. There is some question whether a tilt-frame with

solar panels meets the definition of accessory building or structure and which set back regulations apply. The set back can be 1, 3, 10, 20 or 25 feet depending on interpretations of the regulation. After some debate with the regulators, who were helpful and reasonable, we managed to get approval for the placement of the solar panels. The permit for the electrical modification to our house was $70.

One of our early solar arrays was placed on our garage roof. The current regulation of a maximum height of a non-attached garage of 16 feet is difficult to meet if the gable runs north to south and the array needs to face south at 45 degrees from horizontal. The code needs to be modified for roof-mounted solar systems, which may not be flush with the shingles. **Both the setback and the maximum height issue of solar panels needs to be clarified and harmonized statewide.**

After approval of the county inspector, we were able to apply for the State and Federal tax credit. This involved filling out considerable paperwork and providing receipts of the purchased items for the solar power system. This took a week or two of time and some clarification of cost items. **It may be noted that the cost of battery backup for the grid-tied system was not included in the State's tax credit. That provision of the law should be modified**, since the battery backup system supplies needed electricity when the grid is disabled due to natural disasters or other shutdowns of the grid.

4. **Net Metering and reimbursement Issues**

Rocky Mountain Power (RMP) required us to sign a contract for net metering which was mailed to us without much hassle. After signing the contract, the new LCD remote-sense net-metering power meter was installed by RMP without cost. This meter has two alternating readings with the first showing the kW-hrs supplied by RMP, the second the kW-hrs our solar system supplied to RMP. After a year the first meter failed. RMP installed a new meter within a few days and it has been functioning well since then.
We discovered that the current regulations allow **RMP to pay us only $0.043 per kW-hr if during any month we generate more energy than we use.** In most states the lower rate applies only if the net energy supplied to the power company during the whole year is greater than that supplied to the customer. **This net-metering regulation in Utah should be changed accordingly**. Furthermore, since PV power is clean power, is generated during highest load periods, and avoids the power losses associated with multiple transformers and long transmission lines, the power supplied by **PV solar systems should be reimbursed at a premium rate of up to $0.15 per kW-hr.**

5. **Maintenance issues**

Our system has functioned reasonably well both in summer and winter. In the winter, snow removal after a storm is required to restore power generation**. For this reason we recommend that PV panels be installed where they can be easily cleaned.** Ground level installations are preferable. The capability of tilting the panels to horizontal in the summer and to a steep 50 degrees to the south in winter has helped with the efficiency and also the snow removal. The four panels that are installed on top of the garage are less efficient in the winter since mechanical snow removal is hazardous, and melting of the snow by the sun is slow especially during prolonged freezing temperatures.
Our battery backup system requires periodic maintenance by adding distilled water to the batteries as needed.

Conclusions

1. **Residential Solar PV systems are very cost effective with the current and proposed rebates and tax credits. The cost is likely to decrease by more than 50% in the next 5 to 10 years. Generation of clean PV energy should be reimbursed at a premium rate of $0.10 to $0.15 per kW-hr.**
2. **A great need as well as opportunity exist in the state to expand vendors and installers of grid-tied solar systems. Several "stores" with displays of solar power systems are needed in the Salt Lake Valley.**
3. **Regulations should be clarified and harmonized statewide to simplify public and vendor education and promote adoption of residential PV installations.**

Submitted by: Andy Schoenberg, 801 274 7423, wfaut@comcast.net

Richard Simon

My work takes me across the USA and the world. We are seeing a "revolution" in green power across the planet. There are many causes of this: some a desire for cleaner energy, some to avoid dependence on foreign sources, and some strictly because they are cost-effective strategies to lead us through the 21st century.

Think of a blank map of the USA 30 years ago. Tiny little splotches of blue color could be dabbed on in the few places at that time where "renewable" energy was cost-effective--mostly remote communications towers where solar was cheaper than bringing in power lines.

During the past 10-15 years, these patches of blue have grown and continue to grow. In several states (e.g., Texas, Colorado) wind has proven more economic than conventional power--especially with the vacillating prices of natural gas.

Thus the "renewable" map is filling in across the United States. This is even with "subsidies" no greater than afforded the other energy technologies. Clearly as fossil fuels become more expensive and the political situation of the world seems to get more polarized, this map will continue to fill in.

So even on cost basis alone, 21st century thinking points us towards renewable energy technologies. And it is happening all around Utah: the Nevada, Oregon, California, Arizona, Colorado and Washington RPS's, widespread wind development ongoing in New Mexico, Colorado, Wyoming, and the coastal states.

Utah has decent wind resources (although obviously not as strong as Wyoming) and excellent solar resources. We are already poised for wind energy development even within the current difficult infrastructure and price challenges of the state.

Even if not the most economic now, it behooves Utah to consider the next 20 years. Renewable energy will become cheaper and in more demand. If given any kind of reasonable incentive, we will see development in Utah too. Consider renewable energy as part of a risk-management portfolio--how many more trapped coal miners, or the imposition of a carbon tax, will it take before conventional power becomes too expensive.

I personally cannot advise whether there should be an RPS, pure economic incentives, a mandate, or some combination. But something should definitely be put forth. It is also important that some (1/2 to 2/3) of the new guidelines are for native production in Utah--otherwise, we will see it pumped in from Wyoming.

Renewable energy helps greatly with property tax, with rural economic development, and many other bottom line attributes.

Finally, many wind turbine manufacturers are looking for places to set up factories. Utah is centrally located in the west, has a world-class airport, two major interstate highways, an educated and solid work force, and likes economic development. Just as there is currently a plan to bring in a solar manufacturer, a major wind company could happily set up shop in our state.

A renewable initiative will surely bring more dollars into Utah than whatever is "spent" via PTC, RPS, etc. Therefore, I strongly encourage support for a solid initiative.

Thank you,

Richard Simon, Director
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Salt Lake City, UT 84111

JON M. HUNTSMAN, JR.
Governor
GARY R. HERBERT
Lieutenant Governor

State of Utah
Department of Commerce
Committee of Consumer Services

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Director, Committee of Consumer Services

COMMITTEE MEMBERS
Dee Jay Hammon, Chair
Franz Amussen
Kelly Casaday
Robert McMullin
Andrew Riggle

October 16, 2007

Dear REI Co-Chairs, Mr. Wessman and Mr. Wagner:

The Committee of Consumer Services (Committee) is pleased to have participated in the Renewable Energy Initiative (REI) and offers the following comments to be included in the REI report. The Committee commends the co-chairs and the staff of the Division of Air Quality for their significant efforts in pulling together many divergent views and stakeholders in producing this report. However, the Committee has some concerns with the report itself as well as the process used in developing the report. Our comments here will focus on three areas of primary concern:

- Insufficient analysis of other states' policies, cost effectiveness, and claims regarding economic development
- Lack of consumer focus
- Weak ties to existing regulatory processes for electric resource procurement

The lack of technical analysis associated with the REI efforts is of greatest concern to the Committee. Although the Committee understood the group's original intentions to include a survey of all existing renewable policies and statutes, the efforts quickly settled into using the Oregon model as a strawman policy. The Committee explicitly objects to this practice. There was no particular analytical basis for using Oregon. In fact, many other states have attributes of their population and electric resource mix that would make them more relevant for comparison. Better still would be a comprehensive survey from which the group could pick and choose best elements. The result of a more analytical process would have been likely to yield more appropriate recommendations for policymakers to consider. As it stands, this document simply provides an overview of the various stakeholder positions on elements of a single plan.

Cost effectiveness was also examined on a cursory basis only. A true analysis of any initiative would have provided details for policy makers to consider. For example, analysis of cost effectiveness would consider what types of resources are viable to meet renewable targets under consideration, how soon they could come online, how the system could be operated in a manner to accommodate such resources (and at what costs), and what the cost differential would be of pursuing renewable targets as compared to the

status quo. None of these issues were considered. This leaves the discussion open to emotional pleas and unsubstantiated claims of theoretical costs and benefits without providing a basis for policymakers to measure whether the policy is in the public interest. However, Appendix 3 addresses some high level conclusions about cost effectiveness and issues for consideration. The Committee urges policymakers to consider those issues more carefully as they determine how to proceed on the REI.

The Committee's final concern with the lack of analysis relates to claims of economic development. Because this concept was never adequately defined in our discussions, the Committee believes that participants had a wide ranging understanding of what economic development referred to. Again, additional analysis could help to bring this issue into focus. Specifically, does economic development relate to the development of new technologies within this state? Does it refer to benefits that could accrue to the actual developers of specific renewable resources? Does it consider the overall impact to the economy that these resources could have if they significantly change existing energy prices in the state? The Committee would like to see this issue better defined and studied and recommends that policymakers use caution in ensuring a common understanding of what economic development may or may not entail.

The next area of primary concern to the Committee was the apparent lack of focus on the consumer in the development of policy alternatives. It is too easy to refer to "utility money" in considering who pays the costs associated with electric resource choices. The Committee would like to keep the discussion focused on who will truly pay these costs: the consumer. Utilities receive recovery of all prudently incurred costs. When policymakers mandate utility action, and the utility complies, such actions are typically found to be prudent. Thus, policymakers must remember that these costs are borne by consumers. The Committee is hopeful that policymakers will explicitly consider these issues in determining what future policies with respect to resource alternatives are in the public interest. We must assure that the benefits to the consumer outweigh the costs.

The final area of concern to the Committee is the weak ties of the process to existing relevant regulatory processes, specifically those related to resource procurement. These existing processes include the integrated resource plan, the statutes requiring specific RFP processes for new resources, and the determination of prudency of utility incurred costs. The regulatory system provides a forum for rigorous analysis to be presented and evaluated. Equally important, by following these processes we could utilize existing consumer protections that have been developed and refined with considerable time and effort. Again, the Committee asks policymakers to review Appendix 3 to the report which addresses some specific recommendations relating to these processes and ways in which the process could be strengthened and improved.

Beyond this report, however, the Committee urges all stakeholders with strong views regarding future resource choices to educate themselves on the regulatory processes and intervene and participate. The process is only as robust as its participants. The Committee continues to believe that our future resource choices are some of the most important issues facing all of us in the energy industry. We believe that the way to

ensure a favorable outcome is to give the issues a thorough examination and analysis and look forward to continuing this work and dialog in all appropriate forums.

Sincerely,

Michele Beck
Director, Committee of Consumer Services

State of Utah
Department of Commerce
Division of Public Utilities

FRANCINE GIANI
Executive Director

THAD LEVAR
Deputy Director

CONSTANCE B. WHITE
Director, Division of Public Utilities

JON HUNTSMAN Jr.
Governor
GARY HERBERT
Lieutenant Governor

MEMORANDUM

To: Renewable Energy Initiative
Ernie Wessmen, Chair
Tim Wagner, Chair
James Campbell, Utah Division of Air Quality
Glade Sowards, Utah Division of Air Quality

From: Utah Division of Public Utilities
Constance White, Director
Energy Section
Artie Powell, Manager
Jamie Dalton, Utility Analyst II
Brenda Salter, Utility Analyst II

Date: September 18, 2007

Ref: Comments from the Utah Division of Public Utilities (Division) regarding a Renewable Portfolio Standard (RPS) "strawman" proposal prepared for Utah Renewable Energy Initiative working group

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Attached are comments from the Utah Division of Public Utilities (Division) regarding a Renewable Portfolio Standard (RPS) "strawman" proposal prepared for Utah Renewable Energy Initiative (REI) focus group. The Division sincerely appreciates the hard work and support from the REI Chairs in effectively facilitating this process and for providing for an open forum to discuss ideas and concerns. We also extend our appreciation to James Campbell and Glade Sowards, REI staff, for their hard work and assistance, particularly in light of the group's tight time frames. We especially appreciate the opportunity to offer comments on the strawman proposal.

It is our desire to offer constructive suggestions to this proposal. The Division believes that an RPS is one tool that may be used to promote the development of renewable resources and achieve the over-riding objective of reducing green house gases and improving air quality. It is our hope that these comments will help the group develop policies that will lead to the best possible solutions and outcomes for Utah's citizens.

Attachment:

RENEWABLE PORTFOLIO STANDARDS

DIVISION OF PUBLIC UTILITIES, COMMENTS

The following are comments from the Utah Division of Public Utilities (Division) regarding a Renewable Portfolio Standard (RPS) "strawman" proposal prepared for Utah Renewable Energy Initiative working group.

September 18, 2007

INTRODUCTION

On August 22, 2007 a strawman proposal on renewable portfolio standards prepared by James Campbell and Glade Sowards was presented to the Utah Renewable Energy Initiative (REI) workgroup. Parties were asked to review the proposal and make comments. During meetings of the REI held on August 29 and September 5, the Division participated in the proposal discussions and made several comments and observations. At the end of the meeting on September 5, participants were invited to submit any additional comments or concerns in writing to the REI chairs, Tim Wagner and Ernie Wessman, and the support staff from the Department of Environmental Quality (DEQ), Mr. Campbell and Mr. Sowards. The Division respectfully submits the following in response to that request.

The Division supports the promotion and development of cost-effective[1] renewable resources for purposes of generating electric energy or power. The REI's charge is to study and recommend ways to promote the development of renewable resources within the State and region, presumably with the ultimate objective of reducing green-house gases and improving air quality. The Division offers the following comments in an attempt to help the REI group or others formulate recommendations to achieving an effective RPS.

The Division appreciates the work and support from the DEQ and especially its staff, in putting together an RPS proposal for discussion. The Division believes that an RPS is one tool that may be used to promote the development of renewable resources and achieve the over-riding objective of reducing green house gases and improving air quality.

As was explained in the REI meetings, the strawman proposal is, by design, closely modeled on Oregon's RPS legislation. In discussing the strawman proposal, it became apparent that many of the components of Oregon's RPS were designed in response to unique circumstances in the northwest and consistent with Oregon statute, and therefore, may not be applicable for a Utah RPS. For example, whereas Utah is

[1] While cost-effectiveness and cost efficiency (least cost) are related, there are important distinctions. Cost-efficiency amounts to allocating resources strictly based on defined costs. In addition to defined costs, cost-effectiveness includes risks and uncertainties such as price volatility, load growth, and carbon legislation. Defined costs can include both internal and external costs associated with electric generation and transmission. For example, in PacifiCorp's IRP external costs for SO_2, NO_x, and H_g (mercury) are included in the variable costs for each resource considered, and a cost adder for CO_2 (carbon dioxide) is used to represent the possibility of mandated green house gas reduction. PacifiCorp's IRP process and modeling are intended to balance costs and risks to achieve an optimal combination of supply (generation), demand (energy efficiency and DSM), and transmission resources.

highly dependent on fossil fuel to generate electricity, the northwest is highly dependent on large hydroelectric facilities. It appears that in part the intent of some elements of Oregon's RPS are designed to diversify away from large hydro facilities. The Division's comments will highlight this and other elements that it believes may not be applicable in designing a Utah RPS.

Other comments are consistent with the Division's statutory charge as outlined in UCA, §54. Briefly, this charge includes the promotion of the public interest, which includes the balancing of ratepayer, State, and utility interests. The Division believes that the promotion of cost-effective renewables can be consistent with this charge.

STRAWMAN PROPOSAL: GENERAL OBSERVATIONS

The REI working group has been given a charge to develop public policy actions to increase the development of cost effective renewable electrical resources. In addition, the group was tasked with developing strategies to increase energy diversity in Utah, and improve the State's energy security.

The REI objectives generally appear to be in line with many of the goals that policy experts typically associate with an RPS policy. According to a report issued by the Pew Center on Global Climate Change, possible program goals include:

- Reduction of negative environmental impacts, e.g., reduced greenhouse gas emissions, or improved air quality;
- Promotion of economic development opportunities with the development and operation of renewable energy infrastructure;
- Enhancement of existing renewable energy facilities and expansion and diversification of a state's energy resources;
- Provision of a reliable base of energy resources to hedge against fluctuating energy prices;

- Promotion of growth in renewable energy technology to achieve lower costs and greater acceptance by the public.[2]

To achieve these goals, some policy experts argue that a properly structured RPS will contain, at a minimum, the following three basic design elements:

- To the extent possible, goals are met through market-based mechanisms;
- The state's quantity of renewable energy resources will be maintained and increased over an extended period of time; and
- Enforceable penalties will be exercised to ensure that goals will be met.[3]

Other potentially important design elements include:

- Development of targets or goals that are flexible and can adapt to changing conditions;
- Accounting for future uncertainty and accurately estimating program benefits and costs; and
- Identifying an accurate baseline from which outcomes can be measured.

These RPS design elements should be fully considered as specific program components are developed. The Division also believes that a successful RPS will contain clear definitions of the three main policy goals: "diversity," "security," and "cost-effectiveness."

With respect to the third measure noted above, cost-effectiveness, the Division points to a longstanding process under which that very issue is examined in the context of PacifiCorp's acquisition of generation resources, in an open, public, broadly vetted process. The Division provided the REI "Subgroup on Least Costs" a description of the Public Services Commission's rules governing the Integrated Resource Plan (IRP)

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[2] Rader, Nancy and Hempling, Scott, 2001. "The Renewables Portfolio Standard: A Practical Guide."

[3] Rabe, Barry, 2006. "Race to the Top: The Expanding role of U.S. State Renewable Portfolio Standards, " pp. 6-7. Report Prepared for the Pew Center on Global Climate Change.

process for PacifiCorp.[4] These rules indicate that, "The process should result in the selection of the optimal set of resources given the expected combination of costs, risks, and uncertainty."[5] Specifically, the Commission's IRP rules defines least cost as achieving the lowest possible total utility and ratepayer costs considering (or balancing) the combination of costs, risks and uncertainty. Under current IRP practice, costs and uncertainty include internal costs of each resource, a limited range of external costs associated with some resources, and the potential for future carbon dioxide regulation. Among other factors, risks include gas price volatility. A working definition of cost-effectiveness, consistent with the IRP definition, may enhance an RPS design.

STRAWMAN PROPOSAL: SPECIFIC COMMENTS

The Division provides specific comments on each of the strawman components. As the strawman proposal was presented to elicit comments and recommendations, it is our intention to provide constructive suggestions that are relevant to the circumstances found in Utah, informed by our experience with the IRP and other regulatory processes.

The Division has reviewed a number of documents, research papers, and other information on the topic of Renewable Portfolio Standards. In making our comments, our intention is to base many of our suggestions on this research and provide the REI chairs with some relevant "pros and cons" that other states have experienced so far. The Division believes this information may be helpful in developing a potential RPS recommendation. Consequently, our comments are quite lengthy.

The discussion below is formatted to highlight general points about each issue area, taken from the draft REI report and shown in italics, and then provide detailed comments and suggestions on each point.

PROPOSAL COMPONENT

[4] The IRP is mandated by the Utah Public Service Commission (PSC), and is the product of a planning process that culminates in recommendations about future actions that PacifiCorp should take to provide reliable, least-cost service while reasonably managing risks (prices, service reliability, etc.) to customers.
[5] Utah Public Service Commission, Report and Order, Docket No. 90-2035-01, p. 18.

a) Target:

Investor Owned Utility (IOUs): *20% by 2020*
Municipalities: *5-10% by 2020*
Rural Electric Co-ops: *5-10% by 2020*

Targets for Municipalities and Co-ops that currently have a surplus in energy will not be applicable unless new resources are acquired.

Annexing of IOU service territory by Municipalities or Co-ops without consent, will trigger full (IOU) RPS targets.

DIVISION COMMENTS:

- Targets, because of the interdependency of several components of the proposal, would be best specified only after other details of an RPS are determined.
- The more aggressive the targets, the greater the need for supporting complimentary elements such as "renewable energy zones" and tax or other incentives.
- Targets should be flexible to enable adaptation to changing conditions.

Target Specification

The Division believes that additional data and information would produce a more informed decision about the goals or targets. For example, a more in-depth evaluation of the mix of renewable resources that is feasible and available within the state and region should be conducted before a final determination of targets is set. Likewise, any discussion of targets would be more meaningful, and setting targets likely would be more successful, if other questions and suggestions, outlined below, regarding resource selection, eligibility, implementation of RECs, REC trading, and other relevant program components, were more fully addressed first.

Until targets are more clearly defined, it is virtually impossible to determine the cost impacts on customer classes, identify benefits from policy implementation, or determine how the policy mitigates risks relating to health, energy availability, price stability, etc. This information is crucial and better articulating it before the proposal is considered in the larger public arena likely would make for more informed debate and better policy choices.

As noted above, the REI proposal calls for selection of cost-effective renewable resources that provide for diversification and energy security. The Division believes that the best process would be to first define and articulate explicit goals and objectives for energy diversity and energy security, which in turn would inform the direction needed to achieve the selected targets. There is also a need to determine how the cost-effectiveness criterion will factor into the quantity of resources needed to achieve diversity and security. For example, a renewable resource may be selected to help diversify the portfolio, but it may not be the most cost-effective renewable energy source. What type of program criteria would be provided to justify selection of the more expensive resource? Consideration should be given to whether the PSC has the authority under current law to set rates that are not "least cost," as presently defined in the regulatory arena. For example, the IRP guidelines state that if two resource portfolios have a comparable valuation of expected cost and risk, the portfolio that results in the lowest net present value of the associated revenue requirement will be favored.

Regarding the goal of diversity, policy experts recommend that an RPS aimed at diversifying the base of renewable energy resources should broadly define the list of eligible resources. The only caveat to this is in the case where a state is already being served by a predominant source of existing renewable power. If one of the RPS strategies is to rely on market solutions to bring new resources to bear, policy experts recommend that least-cost alternatives should be a primary factor in determining resource eligibility. With a market-based RPS, least-cost resources will likely be favored. Consequently, policy makers should consider the extent to which the market should be allowed to determine eligible technologies and resources. Some argue that a separate eligibility category may be considered for technologies and resources that may not be cost-effective now, but have promising characteristics that may make them more viable in the future.[6] However, policies that promote a less economically viable renewable technology on the basis of portfolio diversity carry the short-term risks of reduced generation or customer uptake from other, more efficient, renewable resources. Again, questions such as these cannot be resolved until objectives for energy diversity are explicitly spelled out.

[6] Rader and Hempling, p. 16.

With respect to the REI's goal to achieve energy security, it is assumed that the objectives would be the achievement of price stability and reliability of service. Again, once a more robust discussion about overall program goals and related issues is completed, specific targets for this issue could also be defined explicitly.

Finally, with respect to setting RPS targets, fairness and program consistency appear to be essential elements to a successful RPS. Accordingly, some experts argue that obligations should be placed equally on all retail electricity sellers, power producers and developers. According to Hamrin, et al., "All those who benefit from the increases in renewable supply should share in the costs and customers cannot avoid those costs by changing suppliers, as well as costs of helping establish a more predictable and stable market for development of new generation."[7] The Division recommends that any RPS proposal be designed to be consistent with this recommendation. It should be noted that under current law, entities such as municipal power producers, electrical co-ops, and merchant power suppliers may not be bound by RPS mandates, or may not fall under the jurisdiction of the PSC. Thus, attention needs to be paid to how parties will participate, and how compliance will be measured. Again, depending on how rules are defined, the DEQ may be the best agency for overall governance of an RPS, with the Division providing support with respect to the regulation of entities that currently fall under its purview.

Complementary Elements: Program Incentives

If RPS targets are aggressive and market-based, likely there will be a greater need for incentives such as "renewable energy zones," tax credits, or other incentives. The Division believes that the discussion on incentives held in the September 5 REI meeting was useful. (The Division previously made contributions in this area with its analysis on potential barriers to participation in Utah's Net Metering program.[8] More in-depth

[7] Hamrin, Jan, Leiberman, Dan, and Wingate, Meredith, 2006. "Regulators Handbook on Renewable Energy Programs and Tariffs," pp. 34-36.

[8] Refer to the Division's February 2007 Report: "Utah's Net Metering Program, Best Practices, Program Barriers, and Recommendations"

evaluation of the impacts of specific incentive programs should likewise be pursued. Again, clarifying definitions relating to targets will be useful in designing specific incentive strategies. The Division recommends that this evaluation also include renewable energy zone proposals which were raised by the REI.

Targets or goals should be flexible

The Division believes that rigid standards carry greater economic risk where the future is uncertain. A policy that cannot be adapted to changing conditions can lead to significant unintended consequences. A report prepared by the AEI-Brookings Institute on California's emission standards is instructive. Regarding the consequences of inflexible emission reduction standards, the researchers noted: "In the presence of cost uncertainty, rigid adherence to particular standards or emission targets increases the risk that policies will cause undesirable economic consequences. An inflexible cap on NO_x emissions established under California's RECLAIM program led to a dramatic increase in program costs in 2000…"[9] The AEI-Brookings report claims that a more flexible cap would have helped mitigate rapidly escalating energy costs that were occurring during that period of time.

The REI effort should carefully consider methods to mitigate future cost uncertainty before implementing specific standards. The failure of policymakers to adequately account for cost uncertainty can lead to significant over- or under- estimation of program costs. With respect to developing an RPS, it is important that the potential areas of uncertainty – future fuel prices, technological advances, economic growth – be considered. Both an RPS and any strategies to mitigate uncertainty should be capable of adapting quickly to changing conditions. To the extent possible, program objectives should be consistent with market-based strategies, as such solutions may provide more flexibility to achieve renewable energy goals across various sectors, particularly in times of escalating costs.

[9] Stavins, Robert, Jaffe, Judson, and Schatzki, Todd, 2007. "Too Good to Be True? An Examination of Three Economic Assessments of California Climate Change Policy," p. 33.

PROPOSAL COMPONENT

b) *Definitions of "Renewable"*

biomass energy; hydroelectric energy (needs to be qualified); geothermal energy; solar energy; wind energy.

- biomass energy" means any of the following that is used as the primary source of energy to produce fuel or electricity:
(i) material from a plant or tree; or
(ii) other organic matter that is available on a renewable basis, including:
(A) slash and brush from forests and woodlands;
(B) animal waste;
(C) methane produced:
(I) at landfills; or
(II) as a byproduct of the treatment of wastewater residuals;
(D) aquatic plants; and
(E) agricultural products.
(b) "Biomass energy" does not include:
(i) black liquor;
(ii) treated woods; or
(iii) biomass from municipal solid waste other than methane produced:
(A) at landfills; or
(B) as a byproduct of the treatment of wastewater residuals.

- Other resources as determined by the state wide governing body (PSC, DEQ?).

DIVISION COMMENTS:

- With renewable power currently accounting for a small proportion of Utah's domestic electric power production, a broad-based definition of renewable power may be warranted.
- Broadly-defined resource eligibility criteria are also needed to ensure that program targets can be met in a cost-effective manner.

Broadly define renewable resources

The definition of renewable resources, as listed in the strawman proposal, appears to be consistent with current state code.[10] Other states' RPS policies include low-impact hydroelectric power. There is some question if Utah's hydroelectric energy resources should be included. From one perspective, these resources, particularly investor-owned, municipal or cooperative hydroelectric power, appear to be small, carry low environmental impacts, and account for an insignificant share of the state's generation resource mix (see comments on "Existing Facilities" below). On the other hand, out-of-state hydroelectric resources supplied to the Utah may not have these same qualitative characteristics. As Utah is included in the service area of a six state regional investor-owned utility (IOU), restrictions on the interstate trade of hydroelectric power may be problematic. (More on this issue appears below). Finally, as mentioned earlier, careful consideration should be given to determining which state agency should have oversight and approval authority in determining those renewable resources that may comply with RPS requirements.

Broadly define eligibility criteria

In defining what resources should be "eligible", there are a number of concerns. An effective policy would be broad-based, and would rely on a combination of in-state renewable resources, Renewable Energy Credits (RECs), and other resources to most efficiently achieve program targets. The Division recommends that the policymakers be wary of adopting restrictive policies that attempt to limit eligibility to resources generated within the state, limit eligibility to resources that sell to in-state customers, or restrict eligibility to producers that provide in-state benefits.

The reason to be cautious about over-restrictive policies or definitions is that such measures may not be feasible or legal. First, it is difficult – perhaps impossible -to track the physical flow of generated electricity, or confine economic or technological benefits to a political boundary. Given such problems, researchers note that it is difficult to predict whether restrictions based on in-state benefits will actually benefit the enacting state.[11]

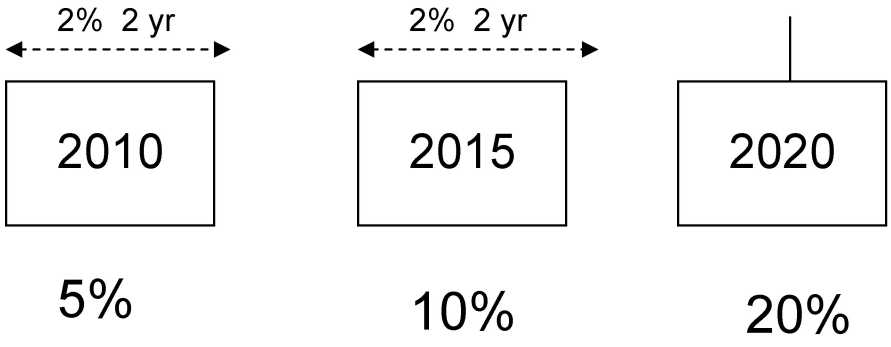
[10] See UCA, §59-12-102 (11, 74, and 75).
[11] Rader and Hempling, p. 33.

Second, limiting the benefits of renewable generation to a specific state may inhibit resource diversity and reliability, stifle competition among renewable producers, inhibit other market-based options such as REC trading, and impede price stability. Finally, there may be significant potential legal problems associated with policies that attempt to limit benefits to a defined area. Rader and Hempling note that "Location requirements raise questions of constitutionality under the Commerce Clause of the U.S. Constitution."[12] Likewise, in-state consumption requirements may be fraught with similar risks (in addition to the practical difficulty of tracking electron flow from generator to consumer).

PROPOSAL COMPONENT

c) Compliance

Beginning in calendar year 2010 IOU's have the following milestones:



There would be a 2% 2 yr window for 2010 and 2015 milestones to prevent artificial markets; however 2020 is a hard deadline.

DIVISION COMMENTS:

- Compliance policies should be predictable, provide stability for investors, and encourage self-sustaining markets.
- Compliance criteria should be flexible to meet unexpected future events.
- Consider linking targets to an entity's output occurring in a previous year.

As noted previously, flexibility should be a key factor in measuring compliance. Given the inherent difficulties in accurately predicting costs of achieving the goals set in

[12] Rader and Hempling, p. 35.

RPS policies, some experts in this field recommend that RPS requirement should be ramped up predictably using a fixed schedule.[13] The REI proposal appears to be generally consistent with this approach. Many RPS experts argue that gradual increases in RPS purchase obligations will encourage continued investment in renewable resource generation facilities and will lead to greater renewable market stability. Allowing adequate time for final obligations can encourage the use of long-term contracts which reduces the risks of financing and developing renewable generation capacity.[14] RPS experts claim that this will provide for steady increases in market growth with accompanying enhancements in renewable technology, industry development, reductions in costs, and avoidance of "boom and bust" cycles in renewable development.[15]

The "Regulator's Handbook on Renewable Energy Programs and Tariffs" recommends that an RPS be designed with flexible criteria to meet unexpected future events such as potential supply constraints or changes in market demand. Such unforeseen events can make overly proscriptive RPS obligations unrealistic.[16] For example, goals or targets may need to be adjusted as there are unforeseen additions of renewable resources or if inconsistent federal RPS policies are mandated. Further increases toward the ultimate goal would be contingent on the program's ability to meet annual or periodic targets within reasonable program cost estimates.

In keeping with this approach, the REI may want to consider an incremental policy that provides for a "pilot period" before final hard targets or percentages are codified. The program would be implemented and then reviewed after a given period of time to assess performance in meeting objectives, impacts of cost, and so forth. Here, a targeted "trial" approach may be prudent to better determine program strengths and weaknesses.

The REI may also want to consider linking required targets to a participating entity's power production in a previous period. For example, a participant's renewable production

[13] Rader and Hempling, p. 11.
[14] Hamrin, et al., p.36.
[15] Ibid.
[16] Hamrin, et al., p. 34.

target for 2020 would not be required to be met until 2021 or 2022. This effective lead-time will allow a participant enough time to plan and competitively procure or develop the required resources. This would allow each participant more flexibility to react to market conditions and minimize costs as they secure the required amount of resources.

PROPOSAL COMPONENT

d) Renewable Energy Certificates

Compliance of the RPS requires proof of the qualifying electricity. This proof is in the form of a Renewable Energy Certificate (REC). Electric utilities can use both bundled and unbundled RECs within the Western Electricity Coordinating Council (WECC).

The Electricity associated with a bundled REC must also be delivered to the utility. However, the associated renewable electricity can be "swapped out" for non-qualifying electricity (e.g., from natural gas or coal) as it makes its way to the final destination. This allowed for non-qualifying electricity to "shape" or "firm" wind power and other intermittent power resources.

For IOU's, no more than 20 percent of their compliance in a given year may be met through the use of unbundled RECs. For the Municipalities and Co-ops, no more than 50 percent of their compliance in a given year may be met through the use of unbundled RECs.

DIVISION COMMENTS:

- A broad-based use of RECs in an RPS policy may be essential to achieve flexibility and lower costs
- An RPS should include both bundled and unbundled RECs
- More analysis is needed before setting caps on the use of RECs.

The Division agrees with experts who argue that a broad-based use of RECs in an RPS policy may be essential to maintain flexibility and lower compliance costs.[17] Indeed, as Utah's domestic base of renewable electric resources (including hydroelectric resources) currently comprise less than 2 percent (see comments on "Existing Resources"

[17] Chen, Wiser, and Bolinger, "Weighing the Costs and Benefits of State Renewables Portfolio Standards: A Comparative Analysis of State-Level Policy Impact Projections," p.1.

below) of all electricity generated within the state, RECs will be a necessary short-term component of an RPS policy.

Experts argue that the use of RECs or tradable credits improves overall efficiency as retailers are free to purchase renewable resources competitively. They also note that a broad-based REC policy will help promote competition among renewable energy projects and will provide more flexibility in meeting program objectives.[18]

On the negative side, reliance on RECs to support an RPS policy may lead to unexpected cost impacts. In Massachusetts for example, a lack of long-term contracts for new renewable development, along with siting and permitting difficulties, has led to an increased demand for RECs to meet RPS compliance standards. As a consequence, rates are higher than originally anticipated.[19]

The Division believes that including tradable energy credits as eligible resources will facilitate portfolio diversification, particularly since Utah's in-state renewable resources are in short supply. Again, the Division would recommend that the approach be broad-based, and that it allow both bundled and unbundled RECs. A restrictive REC policy likely will mean that fewer renewable resources will be available. This will make it more difficult to achieve program goals and to minimize program costs.[20]

The strawman proposal recommends a cap on the use of RECs to meet compliance standards. However, the Division recommends that further analysis on the pros and cons of implementing a REC cap is needed before such a policy is included. In general, a restrictive REC policy could result in fewer eligible renewable resources, thus endangering program goals and increasing costs.

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[18] Rader and Hempling, p. 3.

[19] Rabe, pp. 14-15.

[20] Note that some experts argue that out of state RECs should be bundled with energy to better capture price stability benefits in renewables (see Hamrin, et al, p. 35).

PROPOSAL COMPONENT

e) ***Issuance of Certificates***
A statewide governing body will issue RECs and the tracking will be done by WREGIS.

DIVISION COMMENTS: (NONE AT THIS TIME)

PROPOSAL COMPONENT

f) ***Existing Facilities***
An existing facility is defined as those that became operational before January 1, 1995.

DIVISION COMMENTS

- Given Utah's proportionately small output of renewable electric resources, exclusion of existing facilities may make it more difficult to achieve program goals.

The Division is concerned that a "vintage date" that excludes existing facilities will only make it more difficult and costly to achieve program goals. The most recent information provided by the State Energy Program shows that Utah's net generation of electrical power by (potential) renewable resources is a small fraction of all net power generated in the state (see Table 1 below).

Table 1: Electric Power Sector Net Generation by Energy Source, 2004 - 2006 (MWh)[21]

	Fossil Fuel			Renewable*				
Year	Coal	Natural Gas	Petroleum	Hydro**	Geothermal	MSW/Land-fill Gas	Total	Renewable/Percent of Total
2004	36,617,854	909,850	32,567	449,848	194,876	6,982	38,211,977	1.7%
2005	36,026,201	964,998	40,245	784,463	n/a	n/a	37,815,907	2.1%
2006	37,017,364	3,214,427	33,871	n/a	n/a	n/a	40,265,662	n/a

*Includes Hydro

**Includes Power from Federal Resources (Flaming Gorge, Deer Creek; 245,323 MWh in '04; 404,984 MWh in '05)

Even with hydropower included in the renewable resource mix, current in-state renewable production accounts for less than 2 percent of all electric power produced in-state.

Policy experts point out several reasons to support arguments that RPS policies should exclude existing renewable facilities. According to Rader and Hempling, it may "make economic sense to exclude existing resources if [they don't] require support to operate profitably over the long term."[22] Others argue that where one renewable resource already dominates a state's renewable energy portfolio, other resources may need to be included to promote diversity goals.

However, in Utah's case, such reasoning may not be helpful. Excluding an older existing facility, for example the Blundell geothermal plant, would result in a significant loss to the base of renewable power produced within the state. Similarly, as all existing renewable electricity resources that might be included in an RPS are insignificant in proportion to the total net generation of electric power produced within Utah, the Division believes that a careful analysis of existing facilities should be conducted before any exclusionary policies are finalized.

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[21]Utah Geological Survey, State Energy Program, "Utah Energy and Mineral Statistics, Chapter 5: Electricity." http://geology.utah.gov/sep/energydata/electricitydata.htm

[22] Rader and Hempling, p. 19.

PROPOSAL COMPONENT

g) Renewable Energy Certificate Trading
Electric utilities can use both bundled and unbundled RECs within the Western Electricity Coordinating Council (WECC). RECs may only be used once and only by the owner of the REC.

DIVISION COMMENTS

- Issues regarding REC ownership and transfers should be addressed.
- There may be undesirable impacts if other REC-based programs are not integrated into the RPS.

The Division agrees with the need for a broad-based REC trading policy where electric utilities can use both bundled and unbundled certificates. However, the Division advocates a thorough discussion to clarify important issues such as: who owns the credit, how credits are transferred or retired, and how to handle competing demand for credits when RECs are used for other non-RPS policies or programs.

There are various REC trading strategies that should be evaluated. For example, some experts advocate a REC "re-bundling" strategy. Here, RECs may originally be bundled with energy under a given transaction. However, the REC purchaser may not exercise the REC, and may rather hold it as a "banked" credit. Ultimately, this purchaser may re-bundle the REC and sell it with a given quantity of produced energy. Of course, there may be concerns about what type of energy the REC is bundled with, but such strategies probably warrant examination.

The Division believes that there will be market distortions if current voluntary REC-based programs such as Blue Sky power are not integrated into an RPS policy. Failure to include such programs into an RPS may have unintended consequences on the ratemaking process, or may have significant impacts on participation within the voluntary programs.

As noted above, given the current lack of in-state renewable electrical resources, a narrowly defined REC trading policy with strict geographical limitations may make it more difficult to achieve program objectives and keep cost impacts at a minimum.

PROPOSAL COMPONENT

h) Recovery of Costs
All prudently incurred costs associated with complying with the RPS are recoverable.

DIVISION COMMENTS

Consistent with current policy, the Division believes that a utility should be able to recover costs in the reasonable and prudent provision of electrical service. Nevertheless, this does not imply that cost recovery under an RPS will be without controversy. For example, there are concerns that volumetric-based allocation of program costs may unduly burden industrial and large commercial customers. Allocation of program costs may be a significant issue within the ratemaking process. A better understanding of potential program costs and impacts would be useful before making recommendations.

PROPOSAL COMPONENT

i) Cost Caps
Utilities are not required to comply with the RPS to the extent that the sum of the incremental costs of compliance with the RPS, the costs of the unbundled RECs, and the alternative compliance payments made exceed four percent of a utility's annual revenue requirement in a compliance year. RPS compliance costs are not included in the annual revenue requirement to prevent a compounding effect.

DIVISION COMMENTS

- Cost caps should be included in the RPS proposal, but before adopting specific measures, any proposals should undergo sufficient analysis and discussion.

The Division agrees with the need to design a cap on costs. One way to do this might be to make graduated increases in a goal contingent upon the program's ability to stay within specified cost parameters.

The Division believes that more discussion and analysis needs to be conducted in order to more fully understand how to design a cap, rather than simply arbitrarily adopting designs from other states' RPS. For example, policy experts Rader and Hempling recommend target ranges that include establishing a maximum acceptable cost of the required renewables, indexing the average above-market wholesale renewable power cost to an acceptable wholesale generic power price indicator, or establishing an acceptable ratio between above-market renewables costs and average consumer bills.[23]

As mentioned above, there are unresolved questions about rate recovery and RPS-induced cost allocation among customers who consume large quantities of electricity. The Division acknowledges the implied concerns on such consumers and recommends that further study or comment be provided to determine if these consumers may incur excessive cost burdens under the current class allocation design.

Again, the Division believes that maintaining flexibility in implementing cost caps will lead to a better RPS for Utah. One possible approach would be to reduce the size of the goal if costs exceed an established level.

PROPOSAL COMPONENT

j) Alternative Compliance Payments
In lieu of procuring renewable energy resources, utilities can pay an Alternative Compliance Payment (ACP), to be placed in a fund that can only be used for acquiring renewable energy resources in the future, or for energy efficiency and conservation programs. Rates for each utility will be established on a per megawatt-hour (MWh) basis by the Utah Public Service Commission (PSC). This mechanism sets an effective cap on the cost of complying with the RPS.

DIVISION COMMENTS:

While the Division acknowledges that ACPs appear to be a reasonable mechanism to facilitate achievement of program goals, there is some concern that an ACP may lead to an artificial upper bound on renewable development or RECs. Further analysis is needed to assess the pros and cons of such policies, if implemented.

[23] Rader and Hempling, p. 8.

PROPOSAL COMPONENT

k) Green Power Programs for All Utilities

Every utility in Utah must offer their customers the option of voluntarily purchasing renewable energy. These purchases will not count toward an RPS.

DIVISION COMMENTS:

- It is possible that excluding voluntary green power programs will lead to increases in REC prices, lower green power program participation, and will impact the cost recovery process.

As indicated above, the Division is concerned that the exclusion of green power programs such as Rocky Mountain Power's Blue Sky program from a potential RPS requirement may have unintended consequences. The Division believes that voluntary REC-based programs such as Blue Sky power will be forced to compete with the RPS in the purchase of RECs or other renewable resources. As a result, prices for the Blue Sky program may be higher than they otherwise would have been and may affect customer participation. Moreover, as Blue Sky rates are tariff-based, the utility may be held accountable for ensuring the most cost-effective purchase of RECs when cost recovery determinations are made during the ratemaking process.

PROPOSAL COMPONENT

l) Misc

By Oct 1, 2008, the state must establish an automatic adjustment clause method that allows timely recovery of costs prudently incurred by an electric company to construct or otherwise acquire facilities that generate electricity from renewable energy sources and for associated electricity transmission.

Utilities and Independent Generators must submit annual compliance reports to the PSC or governing state-wide body.

DIVISION COMMENTS:

The Division believes that as this issue would primarily affect investor-owned utilities, it would best be determined in a general rate case setting under the auspices of

the PSC. It is recommended that if an RPS is proposed, the draft language should state that issues such as these should be determined in a ratemaking arena.

Additional Division Comments and Recommendations

Penalties

While the topic of penalties may actually fit in the compliance or the alternative compliance sections (sections c and j), the Division nevertheless offers the following information regarding the topic here. Policy experts argue that a RPS policy should clearly articulate enforcement policies and associated penalties. If there is no clear signal that failure to comply will result in enforcement actions, RPS targets will likely be ignored.[24]

It is recommended that penalties should constitute an environment in which compliance results in the least-cost outcome for obligated entities.[25] A variety of penalties can be adopted using either a capacity or energy-based scheme. Many RPS policies designate the state's Public Utilities Commission as the impartial regulatory body to enforce the policy.

Measurement Criteria: Energy vs. Capacity

The REI briefly discussed the issue that RPS policies typically measure the required renewable energy obligation in one of two ways. The first method measures the energy produced, as measured in megawatt hours. A second method looks at the capacity or potential renewable power output that can be produced, as measured in megawatts.

Most policies use the energy-based standard, due to the relative ease of its application to either generators or retailers. This standard typically is set as a percentage of retail sales or is applied as a percentage of total electricity generated. One advantage of this approach is that environmental benefits occur as the renewable energy generated replaces nonrenewable energy production. The down-side of an energy-based standard is

[24] Hamrin et al., p.36.
[25] Ibid.

that it requires continuous tracking and verification of generation to prove compliance. Experts note that generation information systems and RECs can provide a means for regulators to monitor energy production by source, date, or through transactions or tax incentive information.

A capacity-based standard is usually a more simple approach, as it is merely a measure of the required increase in renewable generation capacity over a specified compliance period. Actual implementation of the measure is a bit more difficult, as the actual amount of renewable capacity obligation for each individual participant must be calculated from the entity's market share using the previous year's sales. Of greater concern with a capacity-based standard is the fact that it is "static" and there may be little incentive for a participating entity to optimize investments in facility operation or maintenance, to plan for potential times of curtailed output, or to even operate the facility.[26]

[26] Hamrin, et al., pp. 33-34.

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Utah Renewable Energy Initiative

Comment One of SunEdison, LLC
September 11, 2007

Introduction

SunEdison, LLC appreciates the opportunity to present its thoughts about the Renewable Portfolio Standard Strawman, and apologize for being unable to participate in previous meetings. SunEdison is North America's largest solar energy services provider, providing solar-generated energy to a diverse client base of commercial, municipal and utility customers. We have offices in California, Colorado, Hawaii, New Jersey and Maryland. We finance, install, own, operate and maintain photovoltaic (PV) power plants at customers' facilities. Our customers pay only for solar electricity, not solar equipment. Our investors include Goldman Sachs, Missionpoint Capital Partners, and the Allco Finance Group. We have national accounts with companies that include Kohls, Walgreens, Staples, Whole Foods and Walmart, and are building centralized PV powerplants for utilities including an 8.2 MW solar facility that has already created 78 new jobs in Colorado. Moreover, this plant will be built from groundbreaking to in-service in 8 months.

Given the renewable resource base in Utah, a Renewable Portfolio Standard (RPS) that is consistent with other standards in the West can provide economic development, energy security, and environmental benefits. In addition, renewable energy provides a hedge against future fossil fuel price increases. Utah has some of the best solar resources in the country, and these resources should be captured in the most cost-effective way possible.

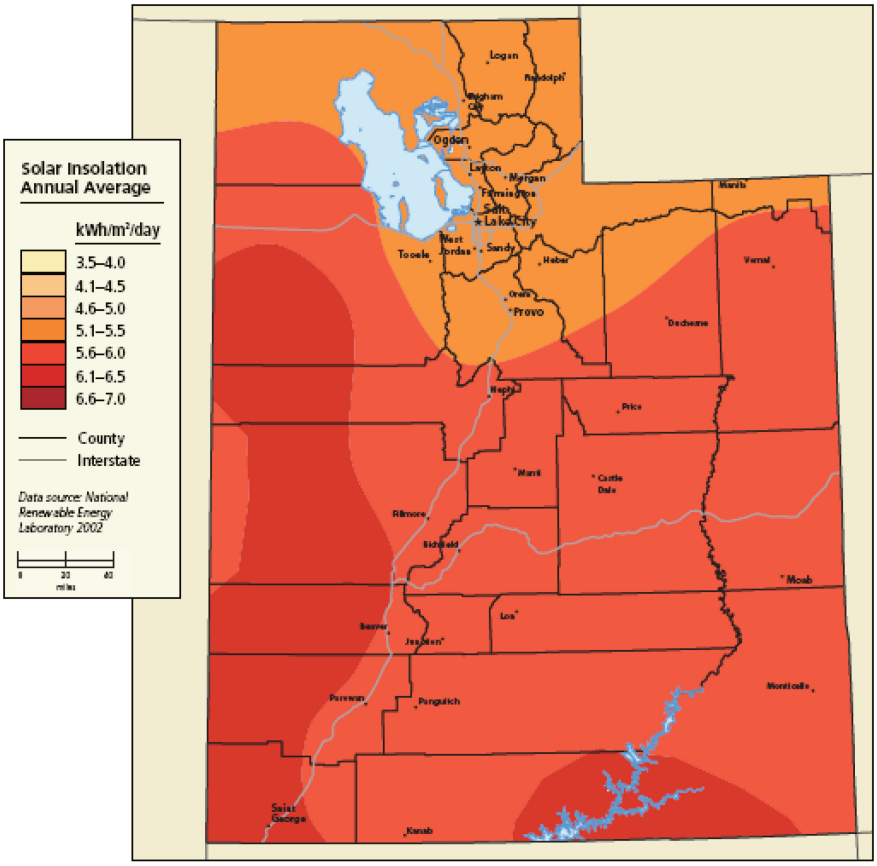
We urge the group to consider a solar requirement within the Utah RPS that grows to 2% of retail sales by 2020. To allay concerns of retail rate impact, a limit of 4% net retail rate impact is reasonable. Finally, the RPS needs the kind of enforcement incentives that arise from an alternative compliance payment, or ACP.

SunEdison strongly supports development and implementation of a RPS in Utah and believes that it can incorporate best practices of similar standards in surrounding states, placing Utah among the states leading the nation towards a sustainable energy future.

Utah's Solar Resources

The state of Utah holds extraordinary solar resources, particularly in the southern half of the state. Based on information from the National Renewable Energy Laboratory (NREL), the potential energy production from solar resources is approximately 69 million MWh per year. The land mass required to meet that goal represents 0.5% of total land mass available, including all residential, commercial and industrial rooftops.

Solar Energy Map of Utah



Residential solar installations currently cost $7 to $8 per watt, however increased experience will help bring down the cost to install as has been the case in Germany. Commercial installations are lower cost due to economies of scale. Customers of utilities are willing to invest their own capital in generating facilities that serve a portion of their own consumption for a variety of reasons – be it economic, environmental, or otherwise – thereby providing the general body of rate-payers effective access to low-cost capital from dispersed and diverse sources, factors which reduce overall risk and contribute to lower cost of capital overall and more optimal capital allocation. Furthermore, the cost of photovoltaics (PV) is declining. First Solar recently announced panel prices below $2 per Watt – roughly half of the current price of Si-based products.

Utah's summer peak demand is growing at over 6% year. Solar electric resources can be utilized to address this growth, and mitigate future cost impacts.

Renewable Portfolio Standards

Given that the southwest United States, and Utah in particular, is home to world class solar resources, energy policy development must address the solar resource. Each of the states adjacent to Utah that currently has a RPS in place has incorporated some type of requirement for solar resources.

State	**CO**	**NM**	**AZ**	**NV**
Solar/DG Requirement in 2020	0.8%	4.6%	3%	1%

There are four key policy areas required to capture solar electric resources. Interconnection and net metering policies are two baseline practices that serve to level the playing field, that is, to remove barriers. It's critical to adopt best practices policies in these areas, and the Commission has begun a process to address these policies. Third, utility rates can also either promote or inhibit distributed solar resources. Smart rates can drive clean and efficient use of energy while making sure utilities are paid in full; bad ones can encourage sloppy use of energy. The final policy area is standards and incentives. All energy resources have incentives built into them – some have been around for a long time and some are relatively recent. Good incentive design can ramp the solar market up as spending is contained. At the moment, solar electricity cannot compete effectively with fossil fuel generation, which is heavily subsidized with tax credits, depletion and depreciation allowances, liability shields and other measures.

With the support of temporary incentives that enhance the economics and accelerate demand however, solar has the potential to compete against traditional resources today. This has been proven in several markets to in turn reduce costs over time through volume component manufacturing and the education of a local labor force in more efficient installation practices.

Different states have chosen different paths to stimulating their individual markets depending on local needs and interests. Some have chosen to rely exclusively on a renewable portfolio standard (RPS) to drive incentives for solar adoption. Others have chosen to provide direct incentives either through their state tax codes or through programs at regulated utilities. Still others have combined the two in creative ways that maximize the effectiveness of the effort while minimizing costs. The overall package of programs, practices and policies must work together to achieve certain fundamental principles:

Build Enough Scale to Drive Investment. Moving a solar industry into a state requires major investments in jobs, facilities, and inventory – investments that drive down cost. To make a successful program, incentives should support these investments – with at least 10 years of committed funding. All customer types should be able to participate in the solar market – from homes to commercial, industrial and government facilities.

Small residential systems build participation and public support, while large systems drive large deployment numbers and low costs. A robust industry can only develop if there is a full range of system types supported – from small residential retrofits, new construction, and commercial rooftops, to large ground-mounted systems, and building-integrated photovoltaics (BIPV).

Phase Out Incentives Over Time. Solar costs have been declining, and all projections are for continuation of that trend (note the First Solar prices) – even as conventional energy prices go up. Incentives that phase out over time create strong competitive incentives for the industry while limiting the total price tag. As a side note here, we point out that extra credit multipliers for solar resources have not worked to encourage solar in any jurisdiction of which we are aware. Indeed, the New Mexico Public Regulation Commission just eliminated a 3 for 1 solar multiplier in favor of a diversity standard that requires a minimum of 20% of the RPS be derived from solar resources, and 1.5% to 3% from distributed renewable resources.

Encourage High-Performing Systems. Incentives should drive the industry to build the best systems it can at the lowest cost. Incentive programs should require quality installations and reward performance. This includes use of performance-based incentives (PBI) and other performance-based standards where feasible.

Utilize Market Discipline. A competitive, open and transparent market is required to develop the solar market for the good of all consumers. There should be a level playing field for all companies to promote price competition. Competitive procurement, especially for large systems, will result in most favorable pricing. Additionally, long-term, low-cost financing, which is available for conventional electricity projects, must be available for solar generating equipment.

Program Administration. Incentive programs should be simple, transparent, easy to understand and administer. Some states utilize a third party administrator, while others allow the utilities to administer the incentive programs. All stakeholders should have access to a program's data and status on a regular basis. The program must have adequate oversight and standards to protect public investment.

A single state agency should have responsibility for implementation of the RPS including the solar portion. Negotiation and coordination with organizations that have a stake in the deployment of PV systems and who actively support solar PV is critical. This includes solar advocacy groups, environmentalists, builders, utilities, companies, and all other interested organizations. For example, Public Service Company of Colorado (PSCo – the largest utility in the state) leverages its resources by partnering with the solar developers in the state. The developers (residential and commercial) find the customers, the utility provides the rebates, and once a month a meeting is held among the developers

and the utility to review issues and challenges and ultimately to improve the program. As a result of this structure, the Company is well ahead of its solar targets.

Similarly, other aspects (such as program design, funding, reporting, etc) of the RPS can improve over time as state agencies, utilities and stakeholders gain experience. All parties should be prepared to build on success and replicate winning models.

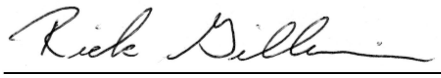
Recommendations

SunEdison again thanks the Utah Department of Environmental Quality for the opportunity to comment on the Renewable Energy Initiative. We look forward to doing business in the great state of Utah.

In sum, we make the following recommendations:

- Include a required solar component in the proposed RPS;
- Grow the solar component as a percentage of the overall RPS to reach 2% of retail sales by 2020 (e.g. 10% of a 20% RPS), roughly mid-pack in the region;
- Use performance-based incentives and competitive procurement to incorporate market discipline into solar resource acquisition;
- Incorporate a 4% retail rate impact limit; and
- Incorporate an alternative compliance payment as an enforcement measure.

Respectfully submitted this 11th day of September, 2007.



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Utah Renewable Energy Initiative

Comment Two of SunEdison, LLC
September 18, 2007

Introduction

On September 11, SunEdison, LLC provided comments to the Utah Department of Environmental Quality (DEQ). On September 12, we had the opportunity to participate in the Renewable Energy Initiative (REI) meeting held at the Utah Department of Natural Resources providing us with a better picture of the ongoing REI process. As a result, we submit these additional thoughts for your review.

In our initial comments, we focused on the solar resource in Utah and how that resource could best be captured in a Renewable Portfolio Standard (RPS). In addition, we reviewed the four pillars of good solar policy including net metering, interconnection, rates, and incentives. In sum, we made the following RPS recommendations:

- Include a required solar component in the proposed RPS;
- Grow the solar component as a percentage of the overall RPS to reach 2% of retail sales by 2020 (e.g. 10% of a 20% RPS), roughly mid-pack in the region;
- Use performance-based incentives and competitive procurement to incorporate market discipline into solar resource acquisition;
- Incorporate a 4% retail rate impact limit; and
- Incorporate an alternative compliance payment as an enforcement measure.

In these comments we review other policies with potential to promote solar resources within Utah. To be clear however, all of SunEdison's projects have been installed in states with formal RPS policies. In addition, much of our work (and our offices outside of California) can be found in states with solar requirements *within* the RPS. States in which we have developed significant business that do not have a solar carve-out, generally have very strong financial incentives.

While financial incentives alone can drive a market, one must design such programs very carefully so as not to overheat the market which can lead to large amounts of solar, but at excessive prices. We believe in using market forces as much as possible to acquire *best cost* solar electric resources.

Following, we review packages of policies enacted in nearby states and show that there is a high level of inter-relatedness among policies adopted. We suggest that piecemeal adoption of individual policies without consideration of the larger picture may result in unintended outcomes. We then review the solar marketplace in the U.S. in comparison with other countries, and show that developing positive policies towards solar electric resources today will pay economic dividends in the future.

Policy Packages

Our initial comments and a significant portion of the discussion in the Renewable Energy Initiative meetings have been geared towards the RPS Strawman. We believe it's important to understand that the RPS is the most important policy directive, but does not always address the full spectrum of issues, barriers, and incentives often found in multiple pieces of legislation. In other words, while it may be helpful to look to other states as the basis for a piece of legislation, it is important to review related legislative initiatives in that state. In that way, the inter-relatedness of policies becomes evident and informative for policy development in Utah. For comparison purposes, we present the efforts of three Western states in the 2007 legislative session.

Oregon:

- SB 838 created a RPS for large electric utilities of 25% by 2025, with interim steps of 5% by 2011, 15% by 2015, and 20% by 2020. Solar PV is an eligible resource but gets no special treatment in this bill.
- HB 2211 authorized a transferable Business Energy Tax Credit (BETC) up to 50% of the costs of a qualifying project, but not to exceed $20 million. This bill is geared towards medium to large scale solar development.
- HB 2620 requires state or local governments to devote a minimum of 1.5% of the construction cost of a new building, or renovation of an existing building, to solar energy technologies if the building receives state funding.
- HB 3488 expands the property tax exemption for residential users of solar energy to businesses, including systems that can be used for net metering. This bill also allows the PUC to revise tariffs and rules to encourage IOUs to invest in renewable energy resources beyond what is provided by IOUs through the current public purpose charge.

In addition to these statutes, the Energy Trust of Oregon administers a three percent "public purposes charge" collected from utility customers. It is charged by the Oregon Public Utility Commission with investing in cost-effective energy conservation, helping to pay the above-market costs of renewable energy resources, and encouraging energy market transformation in Oregon. It provides grants to homes and businesses for customer-sited PV systems.

Colorado:

- HB 1281 doubled the RPS in Colorado to 20% by 2020, and included cooperatives and municipal utilities (10% by 2020). The RPS includes a solar carve-out of 4%.
- HB 1279 provided an exemption from state sales tax for all renewable generation equipment.
- HB 1169 required cooperatives to adopt the interconnection rule incorporated into the RPS implementation rules of the PUC. These interconnection rules are considered "best practices."
- SB 1150 established the Colorado Clean Energy Development Authority to leverage bond proceeds and provide government backed loan guarantees through a public authority.
- HB 1228 directed the PUC to develop incentives for the promotion of distributed generation (primarily solar) throughout the state, and report back to the legislature before the 2008 session begins.

- SB 91 established a task force to identify renewable resource generation development areas within Colorado that have "potential to support industry development among renewable energy developers for development of renewable resource generation projects." These areas will be mapped to a GIS system with appropriate overlays including local utility policies that promote or inhibit solar resource development.

- SB 100 establishes energy resource zones to promote investment in transmission and allow for cost recovery by utilities for building transmission to rural resource zones.
- SB 246 establishes the clean energy fund to provide a steady funding source to the Governor's Energy Office for the purposes of advancing energy efficiency and renewable energy throughout the state.
- SB 145 allows counties and municipalities to offer property or sales tax rebates or credits to residential and commercial property owners who install renewable energy systems on their property.

New Mexico:

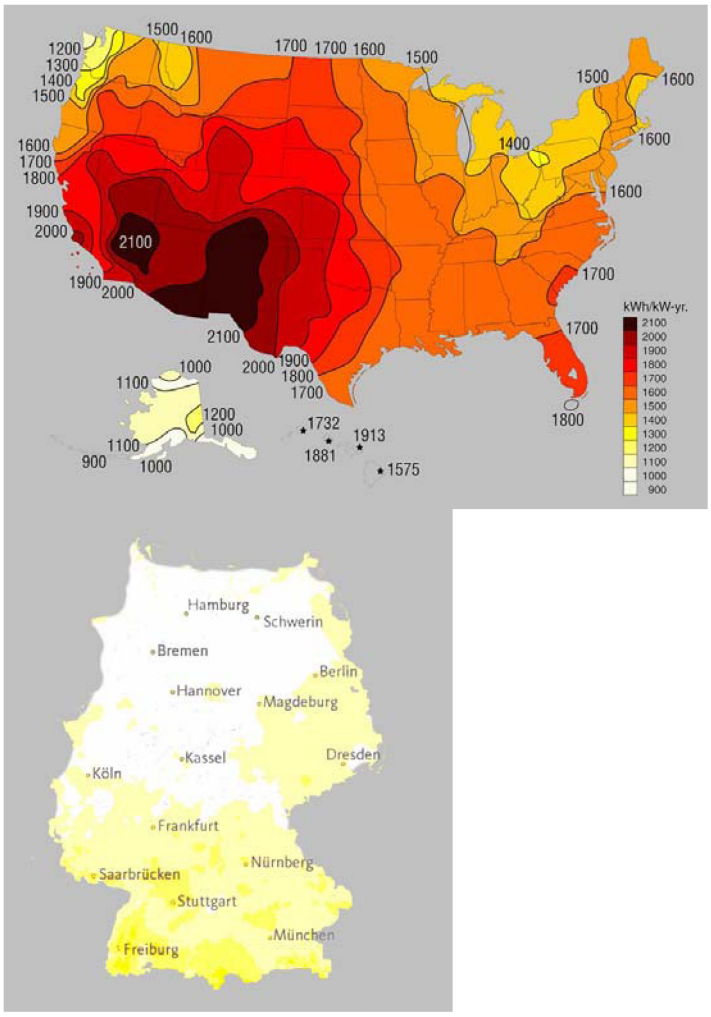
- SB 418 doubled the Renewable Portfolio Standard to 20% by 2020 for IOUs and 10% by 2020 for cooperatives. This program supports distributed (rooftop) systems as well as utility-scale, and requires a diversity of resources.[27]
- HB 996 creates a gross receipts tax deduction for receipts from the sale and installation of solar energy systems.
- HB 188 creates the Renewable Energy Transmission Authority (RETA) a quasi-governmental agency, to facilitate the transmission and use of renewable energy, and requires that a minimum of 30 percent of the power transmitted over the new transmission lines comes from renewable sources.
- HB 996 creates a gross receipts tax deduction for receipts from the sale and installation of solar energy systems.
- SB 463 amends the existing renewable energy production credit with a new more expansive credit allowed for electricity produced by solar energy sources. The solar credit is phased in from $.015 cents per kWh in year one to $.040 in year six and then back down to $0.020 over the next four years. The solar credit is allowed for the first 200,000 MWh and for only ten years of qualified electricity generation. The Act also lowers the size of electric generating plant to 1 megawatt (MW) from the current 10 MW.

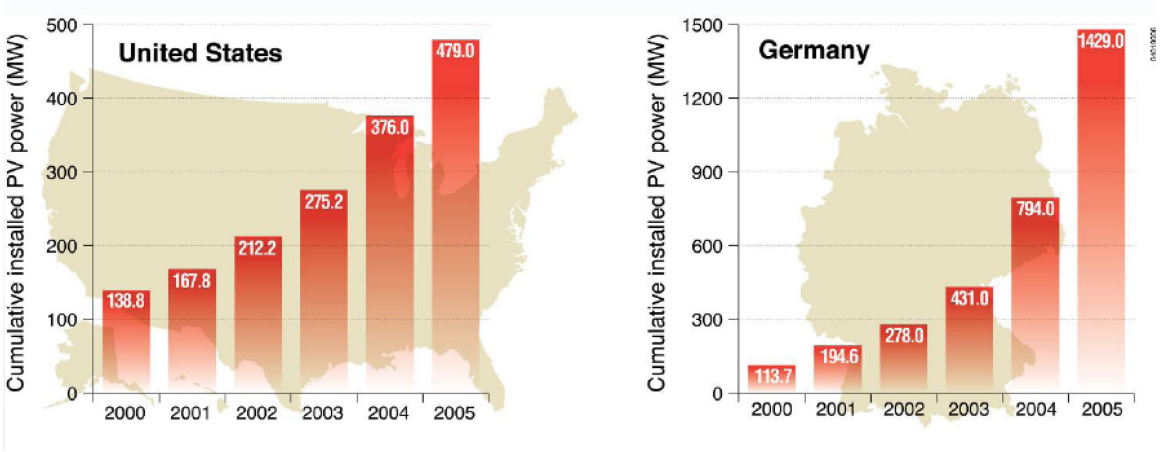
Again, the point of these reviews is to show that RPS policies do not operate in a vacuum. In order to promote solar electric resources, an explicit solar component in the RPS is the most direct and effective mechanism. States with excellent solar resources (like Utah) in our region that utilize this policy directive include Arizona, Colorado, Nevada, and New Mexico. Even these states use additional incentives to encourage citizens to utilize solar resources. Other states, notably Oregon, do not include an explicit solar component, but rather use other financial incentives to allow solar to compete in the clean energy marketplace. Oregon's key incentive is the BETC, along with grant programs and effective net metering and interconnection policies..

[27] The New Mexico PRC has implemented a diversity rule to implement the statutory diversity requirement. It requires a minimum of 20$ wind, 20% solar, 10% other, and 1.5% distributed generation by 2011.

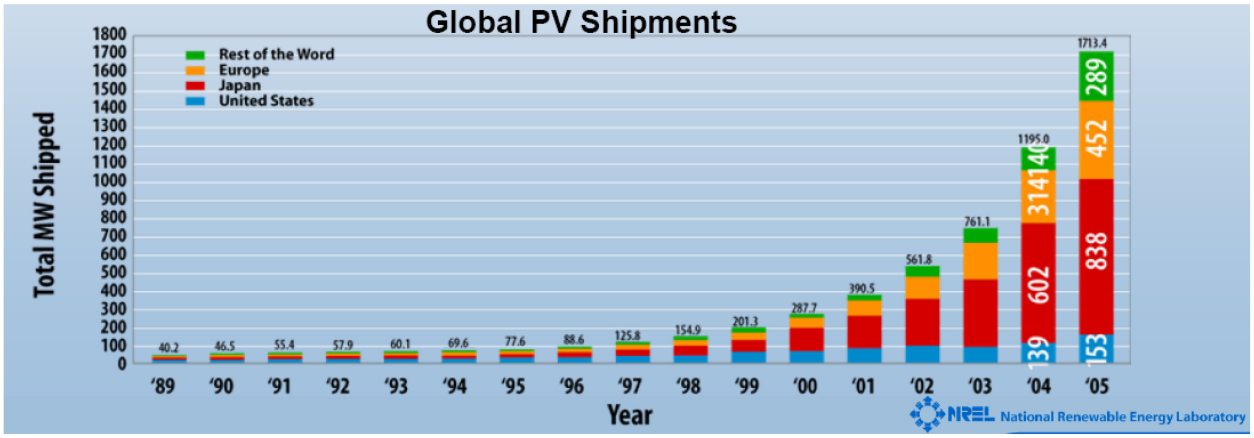
Why Solar and Why Now?

The use of solar energy and PV in particular has been growing rapidly. However, the U.S. has been lagging other countries despite its vastly better solar resource. For example, Germany has been installing more than half of all the PV manufactured over the past few years, with Spain and Greece now beginning to follow its lead. The resources of the respective countries are depicted below.



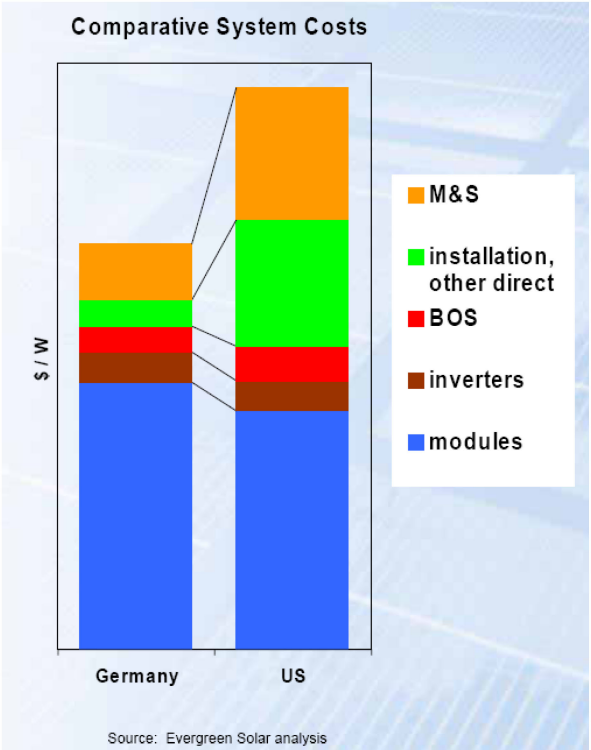


These realities have resulted in worldwide growth in the manufacturing of PV equipment, much of which has left the U.S. behind. Historically, the U.S. has been a technology leader, but without policies that promote the use of these resources domestically, the incentive is for corporations to locate their manufacturing and assembly facilities overseas. The following chart shows the results graphically.



Finally, despite higher hardware costs, German system costs are lower than comparable systems in the U.S. Nearly half of the total cost of installed PV is "local" including marketing, sales, installation, support, permitting, and financing. The take-home message is that global markets reduce hardware costs but local markets lower *local* costs.

In order for U.S. markets to improve efficiency of operations and installation, we must be able to build long-term businesses around stable and consistent policies and incentives at both the state and Federal level. Solar requirements within RPS policies, tax

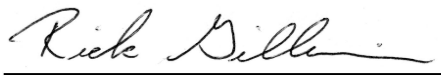


credits, and other incentives are all important ways to send these signals to the market.

Over time, such incentives should phase-out so that the industry has a known and consistent time frame within which it much reach long term viability. For Utah to capture the economic development benefits of the solar PV market, including manufacturing, assembly, and installation and support-related jobs, it must send appropriate signals to the marketplace. As a result, it will be able to capitalize on this great natural resource with which it has been blessed.

As noted in our earlier comments – all energy resources have incentives and policy supports built into them. Some have been around for a long time and are institutionalized. More recent examples are less so. Good incentive design can ramp the solar market up in Utah as spending is contained. Once again, SunEdison thanks the Utah Department of Environmental Quality for the opportunity to provide its thoughts and ideas in the Renewable Energy Initiative process. We look forward to constructive participation in future meetings to help Utah achieve its solar energy goals.

Respectfully submitted this 18th day of September, 2007.



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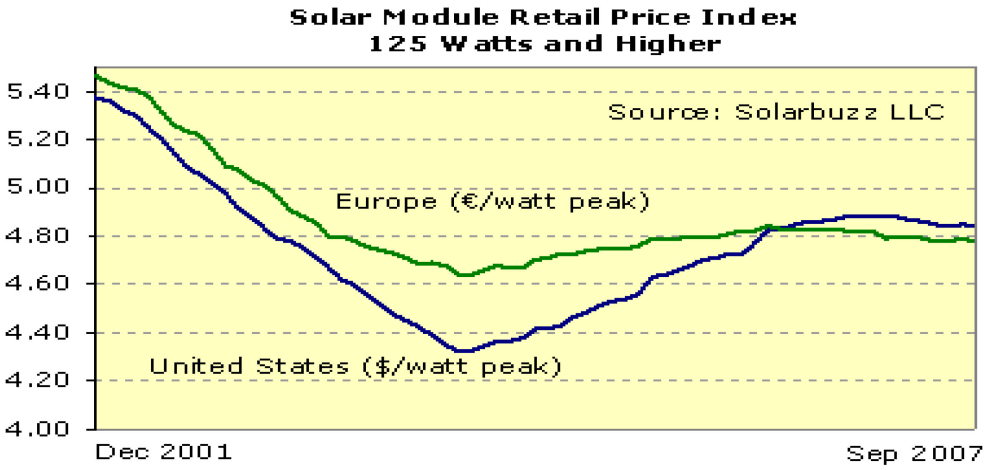
Utah Renewable Energy Initiative

Comment Three of SunEdison, LLC
September 21, 2007

1. **Two previous sets of comments from SunEdison incorporated by reference**

2. **Comments on "Ernie's Report Draft" in body of this draft document**

3. **Comments on PV cost slides from 9/20 presentation: SLIDE 14**



COMMENT: First Solar has announced PV module prices at $2/W or better, and are already in commercial production.

SLIDE 15:

- **UT SEP (price / kWh for 20 yr payback)**
  - **Small PV, no financing, fed credits = 23.5 cents**
  - **Small PV, 7% interest, fed credits = 43.7 cents**
  - **Large PV, no financing, fed credits = 18.0 cents**
  - **Large PV, 7% interest, fed credits = 35.0 cents**

COMMENT: In the real world, SunEdison signed a contract in 2006 to deliver energy from an 8.2 MW PV facility to Xcel Energy for 22.4¢/kWh, complete with financing, but no state tax credit or other state based incentives.



Utah Renewable Energy Initiative

Comment Four of SunEdison, LLC

October 16, 2007

SunEdison, LLC has thus far provided three sets of comment to the Utah Department of Environmental Quality (DEQ) in this process. These brief comments will summarize our key point and clarify a couple of issues.

Governor Huntsman's first reason for pursuing more renewable energy in Utah is to enhance energy security through resource diversity. The proposed RPS strawman may result in more wind resources in Utah (or Wind RECs from other states like Wyoming), but not a rich and diverse array of renewable resources. Further, the RPS should push energy suppliers to move beyond the level of renewable resources that would have occurred through a business as usual approach. It is our view that under the current proposal, there will not be any significant development of Utah's vast solar resources.

All states that border Utah have established a requirement for solar resources or distributed generation, or both. Recognizing that it may be difficult to set appropriate diversification requirements in the legislative process, we suggest the legislature require diversification in the RPS and allow the energy experts at the Public Service Commission to get the numbers right through a rulemaking process. The following language was incorporated into New Mexico's recent legislation which doubled its RPS:

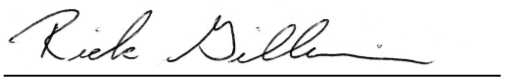
> *The renewable portfolio shall be diversified as to the type of renewable energy resource, taking into consideration the overall reliability, availability, dispatch flexibility and cost of the various renewable energy resources made available by suppliers and generators*

Clarifications in REI report:

- Page 17: SunEdison is listed as supporting RPS percentages in excess of 20% by 2020. This is in error as we support 20% by 2020 at this time.
- Page 44: There are several errors and omissions in paragraph 1
    - Colorado's major utility offers a $4.50/W rebate. Rebates are not limited to $6,000, but eligibility is limited to 10kW. Everything over 10kW is based on a pay for performance model.
    - Oregon: in addition to the RPS, the most significant policy development is a 50% tax credit (10% per year for five years) that will support robust solar market development.

Once again, SunEdison thanks the Utah Department of Environmental Quality for the opportunity to provide its thoughts and ideas in the Renewable Energy Initiative process and look forward to helping Utah achieve its clean energy goals.

Respectfully submitted this 16th day of October, 2007.



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COMMENTS ON THE RENEWABLE ENERGY INITIATIVE

FOCUS GROUP

On Behalf of the Utah Association of Energy Users

Renewable Energy Initiative

October 12, 2007

The Utah Association of Energy Users (UAE) appreciates this opportunity to comment on the Renewable Energy Initiative (REI) report to the Blue Ribbon Advisory Council (BRAC) on Climate Change. UAE supports Governor Huntsman's overall goals of increasing the development of cost effective renewables, enhancing energy security, reducing greenhouse gas emissions, improving air quality and encouraging economic development.

UAE presents the following comments:

There is No Need for Mandatory Renewable Standards

UAE strongly supports Governor Huntsman's goals for the State of Utah. However, for a number of reasons, UAE does not believe that a mandatory RPS is needed or appropriate to the achievement of these goals. A voluntary RPS, particularly if coupled with tax and other incentives, is the preferable means of achieving these goals.

Mandatory standards are not needed to spur the development of cost-effective renewable energy. PacifiCorp's 2007 Integrated Resource Plan (IRP) commits to the pursuit of up to 1,400 megawatts of new cost-effective renewable resources by 2010 and 2,000 MW by 2013. These targets have already spurred development of renewable resources in Utah and the region. PacifiCorp's 2007 IRP illustrates a serious commitment to the acquisition of significant renewable resources. An RPS that imposes mandatory requirements for additional renewable energy resources would have costly and unintended consequences for Utah.

Under existing case law, statutes and regulations, PacifiCorp is required to develop the most cost-effective set of generation resources, after taking into consideration reliability and other relevant standards. UAE strongly supports these requirements and vigorously resists any effort to force the utility to pursue non-economic resources at ratepayer expense. If the State of Utah elects for policy reasons to require its utilities to pursue non-economic resources, it should do so through tax and other incentives so that the extra costs of such resources are not borne disproportionately or unfairly by PacifiCorp ratepayers.

Because PacifiCorp is committed to develop all cost-effective renewable resources and in light of numerous BRAC recommendations for things the State can do to reduce greenhouse gas emissions, UAE believes that the governor's goals can best be achieved without a mandatory RPS.

Numerous RPS Issues Remain Unresolved

Many unresolved and unstudied issues require further evaluation before any mandatory RFP standard should be considered. Uneconomic renewable energy resources are both expensive and risky. In an effort to make uneconomic renewable resources more cost competitive, some groups argue for consideration of "external costs." However, such "external costs" are subjective and difficult to quantify. There are simply no consistent or reliable tools available for meaningful quantification of external costs. Tools often proposed for such purposes have not been adequately vetted or verified in the utility

planning arena. Because of difficulties in reliably identifying and quantifying externalities and the limited tools available for such purposes, external costs should not be added to actual costs for the purpose of artificially inflating costs. Rather, to the extent the State of Utah elects to pursue non cost-effective energy resources in light of externalities or policy considerations, the extra costs should be acknowledged and dealt with openly rather than collected through hidden taxes embedded in utility rates.
Some renewable resources, including wind and solar, are intermittent resources. These resources, when added to the system at certain levels, can impact grid reliability. Grid reliability is extremely important and cannot be compromised. UAE recommends that adequate intermittent resource integration studies should be completed before the level of such resources reaches a point that reliability could be impacted. Such studies, which have been undertaken in various regions of the country, should be completed in the Intermountain region before a significant amount of additional intermittent resources can safely be added to the system.

To the extent any extra costs for uneconomic renewable resources are to be imposed on Utah ratepayers, an economic/rate impact study should first be completed to identify the magnitude of such rate impacts and the resulting economic consequences for the State. The real price tag for mandatory renewable energy standards in Utah should be known before a mandatory standard is adopted. This should be done through detailed economic/rate impact studies. As large industrial and commercial energy users, UAE members spend a significant portion of their total operating expenses on electricity. An arbitrary RPS could drive up electric rates substantially – greatly impacting Utah industry. Utah ratepayers must understand all projected impacts of an RPS.

Critical Design Features for an RPS

If a mandatory RPS is implemented in Utah, several critical design features should be included. First and foremost, the design of any RPS should permit maximum flexibility to respond to changing conditions. The PSC should be given ongoing oversight of any RPS and should be allowed to delay and/or modify standards based on changing conditions. This will allow the PSC to moderate rate impacts on Utah customers and protect Utah's economy. The relatively low cost of electricity in Utah allows its commercial and industrial customers to remain competitive. The loss of that competitive advantage would have serious economic ramifications.

UAE does not support the RPS targets suggested in the REI report to BRAC. The selection of renewable energy targets should be done only *after* all other critical design aspects are finalized (including adoption of a proper definition for renewable energy resources) and a comprehensive rate impact/economic impact study has been completed. Adoption of arbitrary targets without a thorough evaluation or understanding of potential impacts constitutes poor public policy and puts Utah residents and industry at risk.
To the extent added costs for mandatory renewable resources are buried in utility rates, a reasonable cost-cap is critical in order to mitigate rate impacts. It is vital that a reasonable cost-cap be set to ensure the RPS does not harm the State's economy. A reasonable per-meter cap, similar to the one implemented in Arizona's Environmental Portfolio Standard, is also critical. In Arizona, the cap sets monthly surcharge limits for

the Environmental Portfolio Standard. Per-meter caps, tied to the overall cost-cap, would provide critical protections for Utah ratepayers.

Alternative Compliance Payments (ACPs) should be permitted in connection with any mandatory RPS. ACPs give the customer another level of certainty about potential impacts on electricity rates and help protect customers from price gauging in renewable energy markets. ACPs should be set and monitored by the PSC.

The definition of renewable resources in the REI report is a reasonable starting point. However, the definition should be expanded to include other technologies that reduce CO_2 emissions, including combined heat and power applications, demand-side management and energy efficiency measures. UAE supports a broad range of "renewable energy" alternatives for any mandatory RPS. All hydroelectric resources should be recognized as renewable resources. The more restrictions that are placed on the definition of renewable energy the more expensive the RPS will become for customers. Furthermore, eligible renewable facilities should not be restricted to those built after Jan. 1, 1995. This is an arbitrary restriction with no relevance to Utah and would result in higher costs to customers. Under this definition, for example, the Blundell Geothermal Plant would not be considered eligible for the RPS. All existing renewable resources should be considered in determining compliance with a mandatory RPS.

In order for PacifiCorp to acquire unbundled RECs or make ACPs, current "least cost resource" guidelines may need to be changed. Any such changes should be done with extreme caution, taking into account how the changes will affect acquisition of non-renewable generation sources.

The REI report recommends an automatic adjustment clause to allow for the timely recovery of the costs of renewable generation. UAE supports the Committee of Consumer Services' recommendation that an automatic adjustment clause should be an option rather than a requirement. This issue should be addressed in the regulatory arena through a rulemaking process to permit all interested parties to fully evaluate the proposal and potential implications.

Another key factor for any mandatory renewable energy requirement is availability of adequate transmission to ensure delivery. UAE supports consideration of a transmission or infrastructure authority in Utah with proper goals and objectives. Such an authority should help alleviate delays experienced in building transmission infrastructure. Utah is both an importer and an exporter of electricity and any such authority should be given specific and reasonable powers and goals.

Conclusion

UAE is grateful for the opportunity to participate in and comment on the REI process. UAE supports the goals of increasing cost effective renewable energy resources, enhancing energy security, reducing greenhouse gas emissions, improving air quality and encouraging economic development. UAE believes that these goals can best be achieved,

without the risk of serious consequences to Utah's economy, through the voluntary approach being pursed by PacifiCorp, coupled with tax and other incentives. To the extent a mandatory RPS is nevertheless implemented in Utah, additional studies must first be performed and critical design elements must be included in order to identify and mitigate potential economic consequences to Utah residents and businesses.

Utah Associated Municipal Power Systems

UAMPS Position Regarding Renewable Portfolio Standard

September 20, 2007

We are grateful for the opportunity to participate in open discussions related to climate change issues. UAMPS and its members recognize the importance and need to be a part of a process which will recommend possible actions and solutions to climate change problems. It is our desire to make available and encourage member participation in the utilization of renewable resources as a possible remedy to climate change. Study and analysis of all practical renewable resources is current being undertaken by UAMPS. In addition, many members are independently evaluating renewable resource options on their own to ensure that no renewable opportunity is overlooked.

However, in reviewing all renewable energy options, it is evident the acquisition of these resources will drastically increase our member's power costs. As we consider moving toward adoption of a renewable portfolio standard by municipalities, the following must be considered:

1. Because of their non-profit nature Municipalities would face difficulty in passing increased costs of renewables to their consumers.
    1. Regulators of municipal electric systems are elected or appointed officials who themselves are system electric consumers charged with keeping electric rates as low as possible.
    2. Because of the non-profit nature of municipal systems, municipalities cannot take advantage of incentives such as tax credits, accelerated depreciation and other cost crediting designed to encourage renewable development. Therefore, the full cost of renewable acquisition would immediately be born by municipal power consumers.
2. Most UAMPS members already have a portfolio that would contain in excess of 20% renewable resources, when older hydroelectric resources are included. UAMPS members strongly feel that older renewable resources should be counted toward achievement of any renewables target, because those older resources provide the same environmental benefit as new renewable resources built after some arbitrary date such as 1994.
3. UAMPS would like to make the following recommendations pertaining to an RPS for municipal electric systems:
    1. No regulation or review by the Public Service Commission.
    2. Reasonable RPS benchmarks and timetables could be recommended as targets for municipalities as long as they are voluntary. Due diligence tests of the targets may be considered as municipalities attempt to meet RPS goals. An economic impact "off ramp" might be substituted for voluntary compliance provision, but the voluntary provision is preferred over the economic off-ramp.

3. All hydroelectric generation must be included in the determination of renewable resource, including pre 1994 and large projects.

Utah Municipal Power Agency
Position on Renewable Portfolio Standard
September 16, 2007

UMPA appreciates the open discussion and dialog regarding climate change issues. UMPA has always recognized the importance of and welcomed the benefits of an open process that will make meaningful recommendations for possible solutions and actions to address important issues. Renewable resources constitute a large share of our generation portfolio and we continue to analyze and study all practical renewable options. Near-term and long-term economic impact of resource acquisition decisions for our consumer-owners is an inescapable reality of utility ownership and operation. A renewable portfolio standard will have economic impacts. Consideration must be given to:

1. UMPA is resource surplus to current load requirements. Our resource portfolio has been carefully acquired in past years to serve the near and long term growth of our member cities. UMPA has resources to meet our needs for several years. In addition, some future resources under development are at critical stages in their development to provide for future base-load needs. Any renewable portfolio standard would need to recognize prior prudent planning on our part for resources currently being developed.
2. Municipal utilities are self-regulated by elected and/or appointed officials who are part of the customer base. Part of their charge is to keep electric costs to consumers as low as possible. This governance structure needs to recognized and preserved.
3. Cost recovery structures for municipal systems are based on well proven and accepted methods based on cash flow requirements and recognizing their consumer-owner nature. Certain practices unique to for-profit entities (accelerated depreciation, tax credits and other cost crediting methods) are not applicable, nor available, to municipal systems. Cost impacts of a renewable portfolio standard will be immediately felt by our consumers.
4. UMPA's renewable portfolio constitutes over 20% of member loads in FY 2007.

UMPA makes the following recommendations pertaining to any Renewable Portfolio Standard for municipal power systems:

1. No regulation or review by state agencies.
2. Voluntary participation by municipals to reasonable RPS timetables and benchmarks which would include an analysis of economic impacts of RPS.
3. Recognition of resource surplus status of some municipal entities. Don't recommend a policy that would require and acquisition of a renewable resource if no resource is needed.
4. Recognition of all hydroelectric generation must be included in the determination of renewable resources.

Utah Clean Energy

UTAH CLEAN ENERGY

October 16, 2007

To: James Campbell, Department of Environmental Quality
Ernie Wessman, Co-Chair Renewable Energy Initiative Focus Group
Tim Wagner, Co-Chair Renewable Energy Initiative Focus Group

From: Sarah Wright, Utah Clean Energy

RE: Comments on Renewable Energy Initiative Focus Group Report

Utah Clean Energy respectfully submits these comments on the Renewable Energy Initiative Focus Group Report. Utah Clean Energy appreciated having the opportunity to be a part of this group and provide input on the Governor's Renewable Energy Initiative. Please direct any questions to Sarah Wright at (801) 363-4046 or sarah@utahcleanenergy.org.

Renewable Portfolio Standard

Utah Clean Energy is supportive of a Renewable Portfolio Standard (RPS) policy in concert with state incentives for renewable energy. An RPS is an effective mechanism to advance renewable energy technologies, promote economic development across the state, attract new clean energy industries to the state, improve environmental quality, reduce carbon risk, and diversify Utah's energy portfolio. As noted in the report, 25 states and the District of Columbia have adopted Renewable Portfolio Standards, including two states that adopted an RPS during the REI Focus Group process.

Utah has substantial, yet untapped, renewable energy resource potential that could provide inexhaustible, clean energy and new economic opportunities to the State. Surrounding states that have adopted RPS policies are capitalizing on these clean energy resources. We strongly support a well-designed and visionary RPS, which will create positive market forces resulting in a robust renewable energy market with competitive prices in Utah.

Utah Clean Energy supports the majority of the report and positions outlined in the RPS Strawman. We would like to suggest the following recommendations to the report:

1) We would like to see the overall goal of the RPS to be set to 25% by 2025, with the same interim targets as the Oregon RPS.
2) We support a solar requirement within the Utah RPS that grows to 2% of retail sales by 2020, consistent with other state's efforts. Utah has an excellent solar

resource that should be utilized to help meet Utah's burgeoning summer peak demand.

3) It is our position that large-scale hydroelectric should not be included in the RPS. The majority of state RPS policies do not include large-scale hydro, including the recently passed Oregon RPS and Washington RPS, where hydroelectricity is abundant. Since Oregon and Washington do not include large-scale hydroelectric in their RPS, it is conceivable that Utah's utilities could use large-scale hydroelectricity generation to satisfy the Utah RPS, thereby negating the intent of the RPS to diversify the existing portfolio and drive new renewable energy development.
4) We object to expanding the definition of renewables to include "low-carbon" resources. However, we would be supportive of a separate Energy Efficiency component in the policy.
5) We support the proposed cost-cap of four percent of a utility's annual revenue requirement in a compliance year. However, other mechanisms to reduce the risk of compliance with the RPS may be effective. One example is the California Market Price Referent (MPR), wherein the cost of a long-term renewable energy contract is tied to the market price (cents/kwh) of a combined cycle gas turbine facility, which is determined annually.[28] The MPR helps ensure cost recovery and simplifies the PSC approval process, while still tying the approach to a market referent.

Other Renewable Energy Incentives and Complimentary Policies

In addition to an RPS, Utah Clean Energy supports state incentives to drive in-state renewable energy development and the associated economic development benefits. We would like to recommend the following for consideration:

- Improve the net metering/interconnection policies in the state to encourage the development of distributed renewable energy resources;
- Increase the production tax credit incentive for Utah-based renewable energy resources;
- Provide added incentives for locally-owned community-scale (i.e. up to 30 MW) renewable projects.
- Develop incentives for concentrating solar power;
- Remove the current tax credit cap for distributed renewable energy projects;
- Create a fund designed to cover a portion of the cost of geothermal drilling, whereby successful geothermal projects would repay the fund the amount they borrowed for drilling and replenish the fund for future use.

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28 http://www.cpuc.ca.gov/static/energy/electric/renewableenergy/qandas/marketpricereferent.htm

Transmission

Regarding the matter of transmission, it is our position that state transmission policies and regulations should be designed to facilitate the development of renewable energy technologies, allowing Utah to fully utilize and reap the benefits of the state's renewable energy resources.

Least-Cost/Least-Risk Planning

Regarding the matter of least-cost/least-risk and cost-effectiveness, numerous REI group discussions illuminated the challenge of accurately evaluating all energy resources on a level playing field given current utility planning models and the working definitions of 'cost' and 'risk.' This is especially apparent with respect to externalities, such as public health impacts, air quality, water use, and climate change (along with the associated environmental and societal impacts). Specifically, the Integrated Resource Plan process does not adequately address these externalities, thereby limiting the ability to evaluate the total cost of any given resource portfolio.

Under the current Utah Statute and IRP guidelines, regulators and utilities are charged with considering "other factors" when evaluating the least-cost/least-risk portfolio. However, given the broad nature of the statute, we recommend that the Governor provide a clear directive to the Public Service Commission, Division of Public Utilities, and Committee of Consumer Services on how externalities should be evaluated in the regulatory arena. We agree with the recommendations of the Least-Cost Subgroup that more accurate least cost/least risk planning would provide a forum for analyzing the benefits and costs of all resource decisions, including those that would be attributable to an RPS.

Thank you for the opportunity to provide comments and be involved in this important group effort.

Respectfully,

Sarah Wright
Executive Director

Utah Farm Bureau Federation

Renewable Energy Mandates or Market Incentives?

As Americans, we are eager to diversify our energy portfolio by integrating wind, sun, geothermal and bio-mass into our energy mix recognizing the environmental benefits. The Renewable Energy Initiative (REI) Focus Group, at the request of the BRAC, has spent numerous hours discussing and listening to presentations related to renewables. As with the climate change options presented by BRAC, there has been no economic analysis of the costs and benefits of a REI and economic impact to rate payers and Utah's businesses.

The philosophical debate currently centers on the role of government. Should there be a policy mandate to achieve a 10%, 20% or more level of renewable energy or should the government provide adequate time, a positive business environment and incentives? According to Richard Walji, president of Pacific Corp (Rocky Mountain Power parent company) population growth in Utah will require an additional 3,500 megawatts of electricity by 2016. Renewable technology is decades away from handling more than a small part of our energy needs and ultimately, being cost effective.

Renewables currently make up a very modest part of the U.S. electric generation portfolio. Renewables, excluding hydro, provide slightly less than three percent of the nation's energy needs. Of that, wind makes up around 90 percent of the electricity attributed to state renewable mandates. Would a Utah renewable mandate therefore be a wind mandate benefiting a specific industry sector?

Utah, the United States Congress and numerous other states are currently debating the wisdom of joining 23 others states and the District of Columbia in mandating a percentage of our electricity from renewable resources. As we approach this debate something the Emperor Marcus Aurelius (AD 121-180) said has merit. "The object of life is not to be on the side of the majority, but to escape finding oneself in the ranks of the insane," he observed.

Virtually every state to date that has implemented a renewable portfolio mandate has had relatively high retail electricity rates and a high potential for developing renewable energy. According to the Energy Information Administration, states with renewable portfolio standards in 2005 paid an average of 42 percent higher electric rates.

Utah's Renewable Energy Initiative (REI) Focus Group is currently locked in a philosophical debate. Do we join 23 other states in mandating ten percent, twenty percent or even higher renewable portfolios or do we ask state government and policymakers to provide a favorable business climate and incentives to foster a market response?

Our natural resources allow Utahns to enjoy some of the nation's lowest power rates. Any of the renewable options currently under consideration will be at a higher cost to rate payers. Our state is enjoying an economic surge. Business is attracted by a set of tangible and intangible assets. Quality of life and aesthetics in Utah are complemented by the seventh lowest power rates in the nation, powered by Utah's abundant coal and natural gas.

Technology for capturing renewable energy, for the most part, is currently very expensive. While we recognize the need to broaden our energy portfolio, it must be cost effective. With the abundance of coal and other carbon based energy sources in Utah, incentives promoting clean coal technology seem to make sense.

Some argue that coal is a limited resource that is becoming more dangerous and difficult to harvest. Utah has an abundant supply of low sulfur, clean burning coal in the Kiaparowits Plateau which was placed off limits by the stroke of President Bill Clinton's pen without input from Utahns or Congress. Rather than mining 2,000 feet below the surface, Utah coal could be harvested more safely 500-600 feet underground.

As Utah scientists and economists have looked at potential for renewable energy development, a number of issues surface.

Solar is Utah's highest potential renewable opportunity, based on National Renewable Energy Laboratory (NREL) estimates, ranking us in the top five or six states. The technology exists to convert sun to energy, but it is extremely expensive. Utah has good potential for geothermal but drilling a well to harvest thermal energy can cost over $1 million with no guarantee of success. Today, technology for capturing energy from wind is the most proven and cost effective, with a number of specific sites in Utah holding promise. NREL ranks Utah near the bottom in biomass opportunities.

Wind and solar energy capture are intermittent. A state renewable energy mandate will not only impact costs, it could jeopardize the economic viability of our current providers as well. Renewables can only contribute to the overall energy supply but do little to help power providers meet peak demand. Not many of us are willing to have electricity when the sun shines or the wind blows. A recent integration study for Utah estimating incorporating a10-percent intermittent power supply increases the cost of the renewable power over its production cost by 4.5 to 5-cents per kilowatt hour.

Utah's geography and government land ownership (65% federal) provides a unique set of problems. The most cost effective harvest of solar energy is on flat landscapes requiring five-acres per of photovoltaic cells per megawatt. Utah's wind harvest opportunities are spread across the state, most far from transmission lines, and must compete with Wyoming Wind who arguably has some of the nation's most productive wind farms.

Integrating renewable power requires transmission lines that cost at least $250,000 or more per mile depending on geography. Constraints include distance, terrain, national

parks, recreational areas, wilderness areas, National Forest Service and Bureau of Land Management land use plans, endangered species habitat and road access to build and maintain power lines.

Then of course there is the not-in-my-backyard (NIMBY) issue. This sentiment makes it hard to site renewable energy facilities. Some of the landowners in Wyoming who contracted to install wind turbines are having second thoughts when they see their historic wide-open views impacted. Probably the most notorious NIMBY comes from the Commonwealth of Massachusetts. A 420 megawatt wind farm proposal in Cape Code Bay has been awaiting approval for six years. Will politics ultimately determine the value and outcome of a REI? It's interesting to note, United States Senate champion of environmental causes Massachusetts Senior Senator Ted Kennedy makes his home near the Bay.

As the debate continues on what Utah's role in reducing global greenhouse gases will be, it is important to consider the higher energy costs associated with a renewable portfolio mandate. How much will our citizens and economy have to pay?

Utah Farm Bureau Federation

Utah Moms for Clean Air

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November 2, 2007

via email
James Campbell
Renewable Energy Initiative Focus Group
jcampbell@utah.gov
Dear Mr. Campbell:

With this letter, Utah Moms for Clean Air would like to respectfully submit our comments on the Renewable Portfolio Standard (RPS) strawman presented to the Renewable Energy Initiative Focus Group. Utah Moms for Clean Air is a non-profit, grassroots group of mothers and allies who share a concern about the health impacts of Utah's dirty air. Utah Moms for Clean Air strongly supports a state RPS policy as a means to facilitate a transition towards more effective use of clean, sustainable renewable energy and to reduce the impact on our airshed caused by highly polluting coal-fired power plants. We believe that an RPS policy combined with greater state incentives for efficiency and conservation will support our position calling for a moratorium on new coal-fired power plants. We also look forward to the other benefits an RPS policy would provide, namely the advancement of renewable energy technologies, the attraction of new clean energy industries to the state, and the much-needed diversification of Utah's energy portfolio.

The utility market in Utah is highly regulated and "free-market" choices are not truly available for renewable technologies. An RPS has been shown in other states to be an effective strategy to drive the development of renewable energy sources and provide more customer choice, thus pushing the market in a direction beneficial to public health, energy security, and diversified risk.

Utah has abundant potential for developing renewable natural resources that can be applied to providing our state's energy needs. We concur with the conclusions of the Union of Concerned Scientists who find that a national 20% RPS policy would generate

$26 billion of energy savings by 2025.[29] Even a very conservative study authored by the Energy Information Administration (EIA) 5 years ago, before the increase in oil prices, found that an RPS policy of 10% would have a negligible impact on electricity costs to the consumer (the consumer would actually see a slight savings).[30] In short, there is no reason *not* to implement an RPS policy in Utah.

We appreciate that the RPS strawman written by the Focus Group suggests moderate targets for our standard. We support as strenuous of targets as our energy market can achieve and recommend thorough economic analysis and reporting by the Focus Group, or some entity assigned by the task force.

Following are our comments on the specifics of the strawman proposal. We are continuing to review RPS policies in other states and look forward to working with the Focus Group further in the future.

- We are mindful of the hardships posed to municipal and rural electric co-ops by RPS, but we would encourage that the higher end of the proposed spectrum (10%) be adopted rather than 5%. We recommend that municipal facilities have standards for co-generation, as they are located in close proximity to their customers and co-generation increases efficiency and reduces pollution. We recommend that rural electric co-ops have standards for distributed power generation as transmission inefficiencies increase pollution and security risk. Standards for co-generation and distributed power generation should be created for municipalities and co-ops that would work in concert with RPS policies. We also hope that the Focus Group would consider including incentives for decentralized, community-based projects as is being done in Colorado.

- We are concerned with some of the definitions of "renewable" in the current strawman.

    - First, the definition of biomass is too broad and too vague. We note that incineration of biomass can contribute to pollution (for example, if agricultural products are laced with pesticides), and that biomass cannot be considered as clean as wind and solar. Biomass energy generation standards need to be written with air quality concerns in mind. Burning of animal wastes can have negative impacts on surrounding communities. Furthermore, large-scale use of biomass resources has the potential to generate incentives for undesirable land use and land management practices. We question the value of including biomass in the RPS standard and whether, especially as defined, it could constitute a source of "green power."

    - Second, the hydroelectric power needs to be limited in this definition to include only small-scale hydro, and to be sure that it refers only to existing, and not any new, dams. Furthermore, we would submit that any hydroelectricity that is being considered pursuant to the RPS must be compliant with the recommendations of the World Commission on Dams.

[29] "Renewing Where We Live," Union of Concerned Scientists, August 2003.

[30] "Impacts of a 10-Percent Renewable Portfolio Standard," Energy Information Administration, February 2002.

- The language about “other resources as determined by the state-wide governing body” is problematic because it is too broad and has no qualifying language requiring public comment or input.

- The language in the comments about “low-carbon” in the context of renewables is problematic also, particularly if this language would be used to allow nuclear to count towards the RPS.

- Demand side management (DSM), plant efficiency, and end-use efficiency are very important topics and deserving of their own standards, but they are separate topics and should not be included in a Renewable Portfolio Standard. They are not renewable sources of energy in and of themselves.

  The synergy of an RPS together with efficiency measures can be especially economically successful. However, by combining efficiency and renewable energy under one standard we risk undermining the renewable energy standard intent. On balance, renewable energy technologies have larger up front investment commitment than DSM, but renewable energy also generally provides longer term returns and has a longer installment life cycle.

  We believe that efficiency standards are important and should be implemented and that there should be a strategy for promoting energy efficiency and demand management. However they should be addressed separately. If it is felt that it is simpler to implement efficiency and renewable energy standards in one standard, the standard must include a minimum renewable energy percentage.

  Because both renewable energy and DSM are typically purchased with up-front capital but their benefits are achieved over time, a DSM investment that last 5 years, isn't the same as a renewable energy investment that lasts 30 years.

- Green Power programs are a useful intermediary solution for advancing the renewable energy market, but are no substitute for an RPS. The National Renewable Energy Laboratory (NREL) has shown that voluntary green power purchase programs only have a modest impact on overall renewable energy availability and cost and a strong RPS is needed to see the benefits we hope to see from renewables.

- The REC structure should encourage distributed power generation. Transmission of power from large generation facilities is a large source of inefficiency and pollution in Utah. By encouraging distributed generation through the RPS policy, we can reduce the polluting impact of power generation even further.

- We would like to see additional consideration of creating stronger incentives for solar development, considering its strong potential in Utah, including concentrating solar power.

Thank you for your time and consideration of our concerns. We appreciate the opportunity to participate. We look forward to working with the Renewable Energy Initiative Focus Group closely in the future to help shape Utah’s energy future as we move away from polluting sources of energy and toward cleaner air for all of us.

Sincerely yours,

Travis Anna Harvey and Dana Clark

Co-founders, Utah Moms for Clean Air

Utah Rural Electric Association

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A Touchstone Energy℠ Cooperative

Dixie Escalante REA Flowell Electric Garkane Energy Moon Lake Electric
Wells Rural Electric
Bridger Valley Electric Empire Electric Mt. Wheeler Power Raft River Electric
Deseret Power Uintah Basin Telephone

October 16, 2007

RE: Renewable Energy Initiative Working Group

As the Renewable Energy Initiative Working Group (REI) concludes its assigned task, we extend our appreciation to Ernie Wessman, Tim Wagner, James Campbell, Glade Sowards and others who have staffed the group and/or provided information and resource materials. We also extend our appreciation to the many individuals and organizations who have given countless hours in preparation and attendance at the group meetings.

While the process generated significant discussion regarding renewable energy, we conclude that there is no quick fix to address the Governor's charge to the group of encouraging the development of renewable resources to: 1) reduce green house gases, 2) create energy diversity and 3) provide energy security. One thing appears certain, reducing carbon dioxide emissions will come at a cost, and perhaps a very significant cost, to Utah citizens.

The Utah Geological Survey and State Energy Program's presentation to the REI on the technical and economic resource potential for renewables in Utah provided a glimpse into what the cost implications could be for ratepayers, particularly in a "compliance market" mandated by a renewable portfolio standard. Given the time constraints placed on the process the group was not able to adequately study the consumer costs associated with the creation of an artificial market under a renewable portfolio standard.

We believe the renewable energy initiative group process highlighted the need for policy makers to proceed cautiously with any type of renewable portfolio lawmaking. Sufficient consideration must be given to the unique renewable resource characteristics of

Utah, the attributes of the various utility companies serving the state, and the impact to taxpayers/ratepayers.

Despite the appeal of renewable energy and the work of the REI group, best estimates indicate renewables will still contribute only a small piece to the overall energy resource pie needed to power Utah and the United States. According to the October 10, 2007 issue of the *Salt Lake Tribune,* Governor Huntsman's Blue Ribbon Advisory Council on Climate Change has reported "*Utah is responsible for more greenhouse gas emissions per capita than the rest of the nation and is warming faster than anywhere else on the planet*."

If this statement by the Tribune is correct, reducing emissions cannot be addressed with only conservation and renewables. New technology and approaches may be the best strategy and preferred investment for an affordable long-term solution to the stated goals of reducing green house gases, energy diversity and energy security. As public opinion continues its shift toward building nuclear plants that leave no carbon footprint, taxpayer dollars may best be directed to those types of electricity production activities that maintain electric reliability while not decreasing our standard of living and weakening our economic structure.

Moving beyond the scope of the work accomplished by the REI group, attention must now be given by policy makers to how the cost of any renewable policies will integrate with other policy considerations in a CO2 constrained world. As numerous proposals are developed and advanced, including cap and trade programs, taxes on CO2, gasoline taxes, elimination of mortgage interest deductions on certain home sizes, renewable portfolio standards, etc., we must ensure that the costs borne by Utah citizens to meet Governor Huntsman's stated objectives provide the greatest return on their investment to help ensure there is a reliable, and hopefully affordable, source of electricity.

Sincerely,

MIKE PETERSON

Utah Rural Electic Association

Wasatch Wind

Wasatch Wind, Inc

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September 17, 2007

Dear James Campbell:

Wasatch Wind welcomes the opportunity to submit our comments on the Utah Renewable Portfolio Standard (RPS) to the Renewable Energy Initiative Focus Group. Wasatch Wind supports both a state initiated RPS policy and other state incentives for renewable energy. Renewable Portfolio Standards have been adopted by many states to promote renewable energy technologies, to diversify their energy portfolio, to reduce risks associated with future environmental legislation and other mandates and to promote economic development within their states. We recommend that Utah adopt a RPS this coming legislative session.

Wasatch Wind supports the RPS Strawman developed from the Oregon RPS model and request that the additional changes listed below be adopted by the Blue Ribbon Advisory Committee.

1) Wasatch Wind recommends that the overall goal of the RPS be increased to 25% by 2025, with the same interim targets as the Oregon RPS.

2) Wasatch Wind recommends that all existing large-scale hydroelectric facilities be excluded from the RPS and severe restrictions to new hydroelectric facilities be instituted before considered as part of the RPS. Hydroelectric facilities have their own unique detrimental impacts on the environment and should be excluded in all cases unless credible evidence is provided that the resource has little or no impact on the environment. This restriction is particularly important for Utah and other arid regions where water resources are scarce. Oregon and Washington have excluded large-scale hydroelectric from their RPS. The inclusion of these resources in a Utah RPS could have unintended consequences. For instance, Rocky Mountain Power (RMP) could use their large-scale hydroelectricity generation in the Northwest to satisfy the Utah RPS and negate the intent of the RPS to diversify the existing portfolio and drive new renewable energy development.

3) Wasatch Wind recommends that nuclear power not be included as a low carbon renewable resource. Nuclear power is not a renewable resource, and has its own set of issues that should be addressed separately.

4) Wasatch Wind supports a separate solar requirement within the Utah RPS that grows to1% or 2% of retail sales by 2020. This will promote the development of Utah's excellent solar resource that can be leveraged to help meet Utah's exploding peak demand as well as diversify Utah's renewable portfolio.

5) Wasatch Wind supports the development of a separate Energy Efficiency component in the policy.

6) Wasatch Wind recommends that Renewable Energy Credits (RECs) purchased by Blue Sky participants be excluded from the RPS requirements. The inclusion of Blue Sky RECS in the RPS will undermine the incentives of current participants and could ultimately destroy this currently successful voluntary program.

7) Wasatch Wind supports the proposed cost-cap of four percent of a utility's annual revenue requirement in a compliance year. Another mechanism worth investigating is the California Market Price Referent where the rate of a new renewable energy project in cents/kWh is related to the increase in price over a combined cycle gas turbine facility.

8) Wasatch Wind believes that the RPS legislation should be designed to establish a competitive market for renewable resources in Utah. A level playing field that treats independent power producers, regulated utilities and municipal service providers equally will produce the best results and provide the lowest costs to Utah ratepayers. The major portion of the Utah electric market is controlled by PacifiCorp, dba, Rocky Mountain Power which in turn is regulated by the Utah Public Service Commission. The Commission's mandate is to promote the public interest by establishing fair and reasonable prices and terms and conditions of service. Rocky Mountain Power currently operates under Senate Bill 26 which states that all resource acquisitions over 100 MWs must be subject to a competitive bid via a RFP. The legislative intent of the bill was to provide a level playing field for all potential generators and thus the Company would be forced to acquire the least expensive resources. Yet PacifiCorp is currently in the process of acquiring two 99 MW wind facilities in Wyoming thus avoiding direct competition with independent producers. Review of the RFP size limit should be reevaluated.

9) Additional attention should be provided to smaller independent renewable energy projects to ensure fair and equal cost treatment by the regulatory system and to lower potential barriers to entry that have been inadvertently erected by regulatory policy. Resources that fail to meet the RFP 100 MW minimum requirement are left with few options, one being to sell power at the avoided cost rates. For example, Wasatch Wind is in the process of developing over 2500 MW of wind

energy in Utah, however due to geographic constraints, more than 50% of these projects are in the 20 to 80 MW size. These small to mid size projects are ineligible to participate in the RFP process so the prevalent option is to sell power as a Qualifying Facility as determined by FERC at a rate determined by the Utah Public Service Commission. This rate is commonly referred to as avoided costs rates. The current method for determining avoided costs rates is the last executed contract from a renewable resource RFP issued by Rocky Mountain Power "RMP". However because RMP is presently developing wind projects below the RFP minimum size limit, future RFP's may be delayed or even negated. The excessive delay creates uncertainty for an independent developer that the last RFP may not reflect present true costs of wind projects. Stated another way, the current pricing method relies on the last executed wind contract from an RFP. These rates reflect projects that procured turbines about two years prior. Turbine prices have been increasing over the last four or five years and further price increases are expected. The current lag time to procure a wind turbine is approximately 18 to 24 months. With prices set based on historical costs, a current developer cannot get avoided cost prices that reflect adequate cost recover based on the present project costs. However the regulated utility can build its own resources below 100 MWs absent a competitive bid and can be assured cost recovery of its investment and is granted the opportunity to earn a fair return on the investment. This places the independent producer at a severe disadvantage.

10) Attention should be addressed to establishing fair and equivalent transmission access policies for projects below the 100 MW cutoffs. When a utility builds/buys projects or purchases power inside the RFP based competitive process their obligation is to evaluate trade offs regarding transmission access and generation allocation decisions. For example, the highest value wind projects may be those in areas where transmission is constrained. Since the utility is obligated to provide "least" cost power, they must determine from the RFP applicants if backing down coal plants or other generators to allow wind generated transmission access provides the lowest cost power. Unfortunately, the utility is under no obligation to back down power when a QF project requests transmission access. As one example, a QF wind IPP has little opportunity to access transmission in Wyoming for delivery to Utah yet RMP is able to deliver power from two 99 MW wind projects recently announced that avoid the competitive RFP process and are also able to deliver the power to Utah by backing down coal. We strongly argue that this situation is capricious, not in best rate payer interests, and should be corrected.

11) There are additional issues with the current method of determining avoided cost rates that places smaller projects at a disadvantage. The minimum size requirement for the renewable bid is approximately 70,000 MWHs. Thus a small facility of approximately less than 25 MWs is excluded from the RFP process. This should be corrected to eliminate this artificial barrier.

12) The REI should address the issue of establishing a mechanism to create incentives for renewable resource projects to be located in the state of Utah. This could be done with other incentives such as taxes credits or other mechanisms or it could be done directly with the RPS requirements. There could be a set aside for Utah projects such that some percentage of the RPS must come from Utah. This set aside is justified given the economic benefits in terms of employment and tax base that the state would inure.

13) Wasatch Wind recommends that the RPS recommend that the Public Service Commission review the procedures for disseminating information about transmission access and capacity availability of the regulated utility's transmission facilities. Availability of transmission from potential renewable resource sites to potential loads should be made accessible to the public so that independent renewable resource developers can evaluate potential sites within the state. Limiting transmission information only to network providers will discourage competitive entry of small renewable resource developers and will restrict the development of renewable resources within the state. Currently the only way to glean transmission availability is to submit either a Small or Large Generation Interconnection Request with at least a $10k deposit and then have a scoping meeting with RMP to learn the capacity of the line. For small wind developers, hiring a consultant to assist with the technical requirements of the request, submitting the $10k (some of which will be returned if the Interconnect Agreement doesn't get signed) to get a sense if there is ample transmission capacity is cumbersome and inefficient. Unfortunately, at this point it is the only option. In defense of RMP, they have stated that they would have a public meeting to discuss transmission availability, but they have admitted it is significant work and they are extremely busy and to be frank, they have little incentive to do this is a timely manner. Public reviews and complete dissemination of the network constraints should be required on a regulated update basis. In addition removal of the "network" customer requirement is suggested such that all IPP's can request reviews in private of transmission availability and impacts.

In addition to an RPS, Wasatch Wind supports additional state incentives to encourage in-state renewable energy development and associated economic development benefits. We will provide further comments at a later time, but initially we would like to recommend the following for consideration:

- Increase and extend the production tax credit incentive for Utah-based wind and consider larger incentives for community-scale wind projects up to 20 MW and community-owned wind projects of any size.
- Remove the current tax credit cap for distributed renewable energy projects
- Create a fund similar to geothermal to cover a portion of the cost of wind prospecting and costs assessed by the utility for transmission availability

studies whereby successful wind projects would repay the fund and replenish the fund for future use.

- Provide an incentive to Utah based manufacturers of renewable energy devices used in Utah renewable energy projects.
- Develop a self sufficient loan fund for projects less than 20 MW.
- Establish fair and reasonable costs for the standardized interconnection studies of the FERC mandated "Small Generation Interconnection Procedures" for projects no larger than 20 MW.

Thank you for consideration of these comments. Questions should be directed to Tracy Livingston at tlivingston@wasatchwind.com

Western Resource Advocates

WRA Comments to the Utah REI

Western Resource Advocates (WRA) wishes to thank the various parties that supported and maintained the working group process that allow us to comment on the Utah Renewable Portfolio Standard (RPS). WRA was involved in the development of RPS programs in Arizona, Nevada, New Mexico, and Colorado, working with regional stakeholders to develop RPS programs unique to each state's resources and economy.

We believe the RPS is a critical component to achieving the important goals established at the beginning of this process: (1) to increase fuel and power supply diversity, and (2) to reduce the output of CO2 and the related climate change impacts. Through the IRP process, PacifiCorp (via its regional utility – Rocky Mountain Power) is already developing or planning to develop a fairly significant portfolio of wind resources. We strongly support their efforts, but also note that there is significant opportunity to do more.

Generally, WRA supports the RPS structure as outlined in the Straw Man proposal utilized by the working group. Accordingly, we chose to only comment on certain items of concern.

a) Target

WRA supports the 20% by 2020 target for the IOUs. Given the long lead times associated with energy resource planning, we would also advocate a 25% target for 2025. Given the state's new commitment via the Western Climate Initiative, we believe the state and its utilities will need to invest on a sustained and aggressive renewable energy path to meet stated WCI-based objectives. Further, Utah joined other western states via the Western Governor's Association's Clean and Diverse Energy Advisory Committee (CDEAC) in a goal to develop 30,000 MW of new renewable energy supplies by 2015. Utah should consider these additional and aggressive goals when developing the RPS targets.

Importantly, the target should not be adopted as a goal, but rather a statutory requirement. A statutory requirement will actually protect the utility from unnecessary prudence considerations and more clearly define the risks in a RPS program. Also, the established targets should be based on retail sales, not nameplate capacity as fuel diversity and carbon mitigation is directly associated with energy production rather than capacity.

Regarding the municipalities and rural electric co-ops, we advocate for a goal of no less than 10% by 2020, but preferably at least 15% by 2020. All citizens share in the responsibility to combat global warming and the deleterious effects associated with this extraordinary problem. From more frequent and larger forest fires to longer cooling seasons and higher cooling bills to reduced snowpack and water availability, the impacts of climate change currently are, and will continue to be, felt by *all* citizens of Utah. Accordingly, we all need to invest in renewable energy to reduce our impact on the climate – and enjoy the benefits of fuel diversity and commodity price stability associated with renewable energy investments – regardless of whether our electricity is served by an investor-owned utility or a rural electric co-op. Although municipalities and rural co-ops frequently lack the staff and resources to develop new renewable energy facilities, existing organizational structures these entities belong to – and a liquid, well utilized Renewable Energy Credit (REC) market – will alleviate the need for the unilateral purchase of costly engineering and development skills.

In addition to the overall RPS target, WRA strongly encourages the development of a separate solar target, or carve-out. Solar energy, while currently expensive, holds extraordinary promise. Utah is blessed with extraordinary solar resources. A primary goal in developing the RPS is fuel diversity. Given the current advantages wind resources hold over other renewable energy sources, wind resources will likely dominate the investments developed to meet the RPS targets. Accordingly, fuel diversity will only be modestly improved. Creation of a separate solar carve-out will further the fuel diversity goals, and will also push the solar market. That is, the increased demand for solar technologies and development and installation capability will have valuable impacts in reducing the cost and increasing the associated knowledge base over the long-term.

b) Alternative Compliance Payment

The market for renewable energy credits (RECs) is currently in its infancy. Its evolution requires liquidity, *i.e.*, many buyers and sellers engaging in competitive arms-length transactions. WRA recognizes the concern of some members of the working group that the REC market may undergo periods of price volatility, leading to the purchase of high-priced RECs to meet the RPS requirement. Importantly, volatility is a critical facet of commodity markets – it sends a powerful signal that greater supply is required. All commodity markets whether it be for wheat, gold, oil, or pork bellies, go through periods of volatility and, while painful to certain market players, price volatility has a critical role in those markets, sending powerful financial signals through that economic sector.

The alternative compliance payment mechanism, while well-intentioned, will be counter-productive, and lead to reduced liquidity in the REC market. The short-term advantage of the alternative compliance payment (*i.e.*, reduced chance of volatility-based price increase) will be overshadowed by the long-term disadvantage of reduced investment in renewable energy facilities. Many states use the WREGIS system to track

and trade RECs. Utah's use of the WREGIS system will increase the liquidity of that market and allow Utah utilities to meet the RPS requirements at lower cost.

Importantly, the Straw Man proposal already incorporates mechanisms to minimize the possibility of obligatory purchasing during episodes of volatility. Under the compliance section of the Straw Man proposal, the 2% 2 year window mechanism essentially eliminates the need for PacifiCorp to procure RECs during episodes of extreme volatility. Other states have implemented a banking mechanism whereby utilities are allowed to save RECs from a renewable energy investment and utilize these banked RECs as needed to meet the subsequent RPS requirements via a five-year window period. In fact, these mechanisms can be combined to provide the utility significant flexibility to meet the RPS targets.

WRA would encourage the working group to reject the alternative compliance payment mechanism, or at a minimum, advocate strong barriers to their use during only extraordinary circumstances (*e.g.*, if RECs exceed 3x the prior 12 month average). Otherwise, the REC market will lose liquidity and value as critical trading mechanism as we proceed down the path of creating renewable energy markets.

c) Cost Effectiveness Analysis

The manner in which renewable energy facilities are assessed for cost-effectiveness is very important. Throughout the country, with incentives from utilities, homeowners and businesses are making significant investments to distributed photovoltaic installations. While these investments have a very long payback, they are often a source of pride (and marketing) in reduced global impact and self-sufficiency. For example, customers of Public Service of Colorado (Xcel) are currently paying at least 40% of total costs to install PV systems, the remainder being picked up by Xcel as a direct subsidy or the transfer of RECs. Accordingly, the cost to the utility can be far less than the total cost.

Also, because solar facilities are producing coincident with peak requirements, they have very high capacity values. This needs to be properly considered when assessing the cost-effectiveness of solar investments.

d) Utility Green Power Programs

WRA supports the concept of mandatory Green Power programs. All utilities, including municipalities and rural co-ops, should make available to its customers 100% Green Power options so that customers can elect to purchase renewable energy above and beyond the RPS simply and directly. Utility Green Power programs offer citizens a direct mechanism to limit their impact on the environment and support renewable energy technology.

Patricia Willis, Teresa Griffiths, Vella Evans, Rachael Sloan, Jazmynn Pok[1], Christineo Oravec, Yael Calhoun, Don Wilkerson, Richard Spotts, Amy Defresse, Mark Danenhauer

REI Focus Group
Blue Ribbon Advisory Council on Climate Change
climatechange@utah.gov

Dear Members of the REI Focus Group,

As a resident of Utah who is concerned about the future of our citizens and wildlife, I applaud your work to develop renewable energy solutions for implementation in Utah. Non-renewable energy sources are no longer an option given climate change and our poor air quality here in Utah.

I understand that one proven way to facilitate more renewable energy development is with a Renewable Portfolio Standard (RPS). I am writing today to urge you to carefully consider how much hydropower will be included in your proposed RPS. While hydropower may be clean as far as the air is concerned, its development requires the construction of dams which pose a serious threat to native fisheries and associated ecosystems. By including unrestricted hydropower in your RPS, you would be encouraging energy providers across Utah to either build more hydro-electric dams, or rely too heavily on existing hydropower. The state of Utah needs a diverse energy portfolio in order to boost our economy and prepare for the future. We do not need more ecologically costly dams.

I encourage you to either eliminate hydropower from the RPS, or restrict its use like other states have done. I understand that Oregon has passed an RPS that will include hydropower only if it was built after 1995. I support a similar restriction that will promote a diverse portfolio, hearten Utah's economy, and eliminate the construction of more damaging dams for hydropower.

Please look hard at the future of our rivers! The public values this resource and trusts you to consider the threat posed by hydropower.

Sincerely,

Patricia Willis[2]

---

[1]This comment was identical for those listed above, however an additional paragraph was included as the third paragraph for the comment submitted by this individual; it stated "The state of Utah prides itself on natural beauty and diversity. Endless activities are available for the residents and visitors to the state. I fear that allowing much use of the waters for power would limit this, and am positive that it would make it less enjoyable. Extra dams and development would be devastating to the natural beauty we are lucky to host here in Utah. Please don't do that to us."

[2]This comment was submitted individually by those listed above.

UTAH RENEWABLE ENERGY INITIATIVE FOCUS GROUP

FINAL REPORT
OCTOBER 15, 2007

FOR SUBMISSION TO THE GOVERNOR'S BLUE RIBBON ADVISORY COUNCIL ON CLIMATE CHANGE

OCTOBER 19, 2007

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EXECUTIVE SUMMARY

The Renewable Energy Initiative (REI) Focus Group was organized in late June 2007, as a technical group for the Governor's Blue Ribbon Advisory Council on Climate Change. The purpose of the Initiative is to develop detailed public policy actions that can be taken by state government and other leaders to increase the development of cost effective renewable energy resources within the electric sector.

The reasons cited by Governor Huntsman for pursuing more renewable energy are:

- Enhancement of Energy Security through Resource Diversity
- Reduction or Avoidance of Greenhouse Gas Emissions
- Improvement of Air Quality
- Encouragement of Economic Development

The REI Focus Group consisted of representatives from a wide range of stakeholders, including state environmental, energy, and regulatory agencies; public and investor-owned utilities; environmental and health advocacy organizations; renewable energy developers; financial and legal firms; academic institutions; and other interested parties. The first meeting convened on July 9, 2007, and the group met nearly every week thereafter for two to four hour periods, with the goal of submitting its report to the BRAC on October 19, 2007.

Because the REI Focus Group was given a very tight timeframe with which to complete its charged task, it was recognized that the scope of discussions and subsequent study and proposals would have to be maintained at a relatively high level in terms of detail. The group also realized that any effort to advance renewable energy development in the state would likely involve many varied public policy actions that, in some cases but clearly not all, could be difficult and political in nature.

At the start, the REI Focus Group completed simple exercises to identify economic, regulatory, and technology forces that would encourage or discourage renewable energy development. As a result, a list of benefits, barriers, and policy options were developed. Renewable energy resources have the potential to:

- Diversify Utah's electric generation resource portfolio, which is currently fueled predominantly by coal and natural gas
- Help manage the risk of potential increases in and volatility of energy prices.
- Help improve energy independence and security
- Have low or reduced carbon emissions, and are not subject to future carbon regulation, thereby reducing the risk to Utah's consumers
- Improve air quality
- Provide new economic development opportunities

Some of the concerns surrounding and/or potential barriers to renewable energy development included:

- Higher costs in some cases (by using traditional utility cost analysis) due to economies of scale, upfront capital costs, varied capacity factors, development risks, and technological or market constraints
- A lack of transmission in areas where certain renewables have a high potential, therefore acting as a hindrance to project development
- Some renewables are intermittent generators, meaning they cannot be dispatched when the power is needed by the local utility
- The overall electric system must be developed to integrate, to the extent cost effective and feasible, intermittent resources to ensure that the utility can meet customer demands when the renewable resources are not available and that system frequency, voltage, and grid reliability standards are met.

This was followed by several presentations in order to provide information to the group on the pertinent issues related to policy options. Out of this exercise, two subgroups were formed, one to explore what resources could be defined as renewables and another to help define cost effectiveness with regards to resource supply.

Finally, an expanded list of state-level issues, programs, and policies were developed. From the expanded list, three initiative areas were selected for more detailed discussions. They included:

- A Renewable Portfolio Standard (RPS)
- Incentives to foster renewable energy project development
- Enhancement of the transmission and distribution system

Renewable Portfolio Standard – An RPS is a requirement that utilities must supply a fixed percentage of electricity sold to the utility's customers from an eligible renewable energy source. Currently, 25 states and the District of Columbia have adopted RPSs. While there was not an agreement regarding the need for an RPS, nor an agreement regarding the nature of the RPS, the parties agreed to: 1) examine the recently passed Oregon RPS as a way to quickly educate the group members on the details of what an RPS entails, and 2) use a "strawman," as an initial framework only, as a way to expedite and facilitate group discussion on a possible Utah RPS.

Some participants felt that an RPS should be adopted as soon as possible, others felt additional studies must be conducted, and still others felt an RPS was unnecessary. There was consensus that Renewable Energy Certificates (RECs) could be used to measure compliance, but the identification of a governing body to certify such RECs remained unsettled. In addition, the trading of RECs, both bundled and unbundled, by participating utilities would be allowed. However, the use of unbundled RECs will increase costs if used for compliance. Changes to the regulatory framework would be needed before unbundled RECs can be used as a compliance mechanism. There was consensus that recovery of prudently incurred costs and the implementation of cost caps would be necessary. And finally, the use of Alternative Compliance Payments could be an acceptable form of meeting RPS requirements, with the caveat that certain changes may be needed to the regulatory framework.

There was disagreement in several key areas, with the acknowledgement that additional work may be needed to address these issues. Areas of disagreement included whether RPS targets should be mandatory versus voluntary. There was also disagreement on the specified targets for an RPS, with some believing that they needed to be more aggressive while others supported less aggressive targets. Some of Utah's smaller energy providers expressed concern over meeting RPS targets without specific plans to increase generation resources in coming years.

There was consensus that, at a minimum, qualifying renewable resources for an RPS should include wind, solar, geothermal, biomass, and hydroelectric. However, there was disagreement over what types of hydroelectric and biomass would be considered as qualifying resources. Some argued that additional types of low-carbon emitting resources should be considered as renewables, but the group did not reach agreement on any additions.

Incentives for renewable resource development – Most states, including Utah, have already implemented various tax credits and incentives to assist in renewable resource development. The Focus Group agreed that current incentive programs should be expanded and that new incentives should be created. The group also agreed that incentives should be implemented for a continuous period of time that will be consistent with the planning horizon and implementation schedule of any proposed RPS targets.

Enhancement of the transmission and distribution system – Inadequate transmission infrastructure, and siting delays and complications, are significant barriers to new centralized generation from renewable resources in Utah. To help familiarize the group with such issues, a presentation was given by a representative from the Wyoming State Infrastructure Authority. An infrastructure authority may be a helpful vehicle to encourage the development of transmission infrastructure in Utah. The REI Focus Group recommended that the state fund transmission studies, possibly through the use of a state infrastructure authority.

There was wide consensus that improvements in the state's transmission infrastructure could be partially aided by the establishment of renewable energy development zones (REDZs), a concept that had previously received support from the BRAC. The example of California was cited, where efforts are already underway to explore REDZs in conjunction with improved transmission infrastructure to provide additional renewable electricity to customers by 2020.

The investor owned utilities are allowed to do general transmission studies at the regional level. However, under Federal Energy Regulatory Commission transmission rules and regulations, renewable developers are responsible for the cost of interconnecting and integrating resources. This includes the cost of all studies. The group felt that a funding source needs to be identified for renewable energy projects and zones and for interconnection studies.

The group discussed the benefits of smart grid technology, especially with regard to supporting small-scale, distributed generation. The group was unable to reach consensus on the timing and cost. In addition, net metering is an important enabler of the development of small-scale, distributed renewables.

Based on the deliberations of the past three-and-a-half months, the REI Focus Group recommends that the State:

- Evaluate REDZs and how best to implement them
- Conduct rate and economic impact studies of implementing an RPS
- Perform a cost-benefit study on externalities associated with all electrical energy sources
- Assess state utility regulations to determine if changes are needed to help facilitate more renewable resources
- Study the potential capacity and benefits from distributed generation
- Evaluate the benefits of improvements to the transmission and distribution system
- Research integration of renewable energy into the electrical system

Lastly, the co-chairs would like to express their sincere gratitude to all members of the REI Focus Group for their diligence and hard work in this fruitful effort. We extend our particular thanks to UDAQ staff for their incredible professionalism and extraordinary commitment in assisting this process. Finally, we want to thank Governor Jon Huntsman Jr. and his energy advisor Dianne Nielson for this tremendous opportunity.

REI FOCUS GROUP DESCRIPTION

The Renewable Energy Initiative (REI) Focus Group Purpose

The Renewable Energy Initiative (REI) Focus Group was organized in late June 2007, as a technical group for the Governor's Blue Ribbon Advisory Council on Climate Change. The purpose of the Initiative is to develop detailed public policy actions that can be taken by state government and other leaders to increase the development of cost effective renewable energy resources within the electric sector.

The reasons cited by Governor Huntsman for pursuing more renewable energy are:

- Enhancement of Energy Security through Resource Diversity
- Reduction or Avoidance of Greenhouse Gas Emissions
- Improvement of Air Quality
- Encouragement of Economic Development

REI Focus Group Membership

The group consisted of representatives from a wide range of stakeholder groups, including state environmental, energy, and regulatory agencies; public and investor owned utilities; environmental organizations; renewable energy developers; financial and legal firms; academic organizations; and other interested parties. Meetings were open to the public, so attendance varied from meeting to meeting. See Appendix 1 for a list of participants, based on signed attendance lists from the various REI group meetings.

REI Focus Group Work Schedule and Study Scope

The group first met on July 9, 2007, and was tasked to submit its report to the Governor's Blue Ribbon Advisory Committee on Climate Change (BRAC) before October 19, 2007. Due to the time constraints, the group met nearly every week for 2-4 hours during the period of July 9 – October 12, 2007.

REI Focus Group Work Plan

The REI Focus Group utilized the following work plan:

- The group completed some exercises to identify high level economic, regulatory, and technology forces that either encourage or discourage renewable energy project development within the state of Utah. From this work, the group identified costs and benefits of renewable energy resources, barriers to renewable energy development, and an initial list of policy options to consider.
- Presentations and subsequent discussions were scheduled over the next four weeks to educate the group on the renewable energy marketplace, different generation

technologies, various policy options, and related utility regulatory and cost recovery issues. See Appendix 2 for a list of the topics covered in this phase.

- Two subgroups were created to develop a state definition of renewable energy and a definition of cost effectiveness. Summaries of the subgroup discussions are provided in Appendix 3.
- The group then developed an expanded list of state-level issues, programs and policies affecting renewable energy development.
- From the expanded list, three initiative areas were selected for more detailed discussions. They included:
  - Renewable portfolio standards
  - Incentives to foster renewable energy project development
  - Enhancement of the transmission and distribution system

REI FOCUS GROUP RESULTS

The following paragraphs summarize the results of the REI Focus Group discussions.

Benefits to Renewable Electrical Energy Development

The following reasons were identified for developing more renewable electrical energy resources to supply Utah's electrical energy needs. Renewable energy resources have the potential to:

- Diversify Utah's electric generation resource portfolio, which is currently fueled predominantly by coal and natural gas.
- Help manage the risk of potential increases in and volatility of energy prices.
- Help improve energy independence and security.
- Have low or reduced carbon emissions, and are not subject to future carbon regulation, thereby reducing the risk to Utah's consumers.
- Improve air quality.
- Provide new economic development opportunities.

Barriers to Renewable Energy Development

The REI Focus Group identified the following barriers to the development of renewable electrical energy resources:

- Renewables are often perceived as too expensive or risky:
  - When using traditional electric utility regulatory cost analysis methods, most types of renewables are more expensive or have a higher development risk compared to other types of generation technologies. The group agreed this is due largely to lower economies of scale, higher capital costs, lower generating capacity factors, increased development risk (i.e., in particular for geothermal field exploration), and technological/market maturity of some technologies.
  - Traditional electric utility cost analysis models may not adequately take into consideration external costs (or externalities). Some argued that renewables actually would be more competitive compared to traditional generation resources if all of the external costs are considered. Examples include a project's cumulative impact on air quality, public health, water scarcity, greenhouse gas emissions, and land use impacts. Others argued that if externalities were to be addressed, the impact on the economy resulting from higher energy prices would also need to be considered.
  - However, there was no consensus on which externalities should be considered in setting utility rates. Such externalities are often difficult to quantify or value financially, and consistent methods to include or consider these costs in utility rates have either not been developed or have seen limited use during utility planning and resource procurement.

- There was consensus that, in the near future, there will likely be additional costs associated with the generation of electricity from fossil fuel resources. This additional cost may be in the form of a carbon tax or new compliance costs associated with a carbon dioxide cap and trade program, thus making renewables more cost competitive with traditional fossil fuel resources.

- Some renewables are more economical than others to develop. Some geographic regions that hold high potential for renewable resource development often are located many miles from major load centers, and frequently are not located near existing transmission lines that could carry the renewable power to markets. New transmission lines and associated electrical infrastructure are often difficult to justify for a single project. Such new investments are costly to build and usually take many years to design, obtain rights of way and permits, and construct.
- Some renewables are intermittent generators, meaning they cannot be dispatched when the power is needed by the local utility. Rather the power is available on an intermittent basis. The overall electric system must be developed to integrate, to the extent cost effective and feasible, intermittent resources to ensure that the utility can meet customer demands when the renewable resources are not available and that system frequency, voltage, and grid reliability standards are met. Enabling technologies, such as energy storage, may need to be developed to further mitigate operational challenges created by large amounts of intermittent renewable resources.

Additional Policies and Factors that Can Affect Renewable Resource Development

The REI Focus Group identified the following economic and regulatory conditions, policies or programs that influence how much renewable electrical energy resources will be developed:

- Whether a (public or investor owned electric) utility can achieve full and timely recovery of renewable energy resource and related infrastructure costs without creating unacceptable price increases to its customers.
- Whether new resources are necessary and if so when, so the utility is not obligated to add renewable generation when it does not need the output to serve its customers.
- Whether conservation, load shaping, demand side management, or other measures are economically and operationally more cost-effective than adding new renewable generation resources.
- Whether policy mandates create supply restrictions or distorted prices that reduce the availability of cost effective renewable generation, or do policy mandates create positive market forces that result in a robust renewable energy market with competitive prices.
- Whether the state should specify the quantities of various types of generation that a utility should have in its portfolio, such as renewable energy and low/zero

carbon emissions energy. This is often accomplished by implementing portfolio standards (i.e., such as a renewable or a clean energy portfolio standard).

- Whether a package of streamlined site study and selection processes, permitting, tax and other economic incentives exist that will facilitate the development of renewable energy projects in a specific location in an efficient and timely manner. This might be accomplished through the creation of renewable energy economic development zones, similar in concept to economic development zones that have been created to encourage commercial and industrial development in many Utah locations.
- Whether prices and net metering policies allow the energy output from renewable projects (including distributed generation) to be sold to the host utility at a price that is both attractive to the owner and still cost-effective to the utility ratepayer.
- The existence of green power purchasing and marketing programs, giving customers the choice of purchasing electricity from renewable sources or of paying into a fund that the utility will use to develop renewable generation resources.
- The removal of transmission and other infrastructure barriers that discourage the development of renewable energy resources
- The degree to which the transmission and distribution system is modernized and strengthened to support large or distributed renewable energy resources. Technical considerations include transmission capacity, system control and stability issues, and ease of interconnection between suppliers and the transmission system.
- Government approved or provided incentive programs. Tax credits can spur development, as can utility rebate or buy-down programs. State grants, such as those provided for economic development projects, can also boost development.

DESIGN AND NEED FOR A UTAH RENEWABLE PORTFOLIO STANDARD

A Renewable Portfolio Standard (RPS) is a requirement that utilities must supply a fixed percentage of electricity sold to the utility's customers from eligible renewable energy sources. Currently 25 states and the District of Columbia have adopted Renewable Portfolio Standards.

There was no consensus as to whether an RPS is needed in Utah. However, the REI Focus Group decided it was necessary to study potential design features of an RPS before considering whether Utah should adopt an RPS. In order to use limited meeting time efficiently, the Focus Group asked Kyle Davis of PacifiCorp to present a case study of the Oregon RPS legislation and the process that was used in Oregon to develop their RPS. [1] Mr. Davis also provided a set of 17 questions to address when considering an RPS, which were initially presented during testimony offered by Brent E. Gale, Sr. Vice President, Regulation and Legislation, MidAmerican Energy Holdings Company to the Utah Legislature's Public Utilities and Technology (PUT) Interim Committee on June 20, 2007. A list of the 17 questions can be found in Appendix 4. This approach helped the REI Focus Group to identify key design issues for possible inclusion in a Utah RPS, while also taking into consideration the important differences between Utah and Oregon's needs.

UDAQ staff presented an overview of a presentation by Dr. Ryan Wiser, Lawrence Berkley National Laboratory, entitled, "Renewables Portfolio Standards-An Introduction to State Experience-and Possible Cost Impacts."[2] Dr. Wiser's key findings were:

- Expected cost of state RPS policies is typically modest; benefits are not insignificant
- A state-specific cost-benefit study can be helpful in educating stakeholders
- (Estimated) RPS costs in most states have, in general, been relatively low
- Cost caps and RPS design can be tailored to avoid some adverse cost impacts
- But… it is true that an RPS *may* increase retail electricity rates

In general, the REI Focus Group concluded that if a Utah RPS is implemented, it must be carefully designed, with the right balance of features, in order to be of value and not create unintended consequences. While the REI Focus Group was able to identify some features that probably should be included, it was not possible to complete the balancing of the various features in the few weeks available to the group. In comparison, the

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[1]The Oregon RPS case study can be found at:
http://www.deq.utah.gov/Issues/REIFG/docs/Oregon_RPS_Summary_080807.pdf.
[2] Dr. Wiser's presentation in can be found at:
http://www.deq.utah.gov/Issues/Climate_Change/docs/Renewables_Portfolio_Standards-An_Introduction_to_State_Experience-and_Possible_Cost_Impacts_050807.pdf

development and balancing effort in Oregon took over a year of intense work by many stakeholders and policy makers. Even after the year of work, some decisions were decided by the Governor or during the political process in the legislature.

Scope: Renewable Portfolio vs. Low Carbon Portfolio

Background: Staff from Rocky Mountain Power/PacifiCorp asked whether the goal of the group should be to establish a clean energy or low carbon portfolio standard, or if the goal was focused exclusively on a renewables portfolio standard.

Discussion: The group was told that no additional guidance had been provided by the Governor other than it should result in a policy that significantly contributes to the commercialization of renewable energy resources within the state of Utah. Rocky Mountain Power/PacifiCorp then suggested a portfolio standard based upon carbon might be more appropriate, especially since existing RPS states have now turned their focus to CO2 reductions and that Utah recently joined the Western Climate Initiative. Also, the utility argued, renewables would be highly incentivized and could even be mandated, within an appropriately designed low carbon portfolio standard. Several participants commented that the focus of this group was renewable energy.

Outcome: *In the end, the REI Focus Group decided, given the brief amount of time remaining before having to deliver a recommendation to the BRAC by mid-October, it was easier to focus the discussions on design criteria for a traditional RPS.*

Mandatory vs. Voluntary Targets

Background: There was considerable debate about whether an RPS is even necessary.

Discussion: There was robust discussion on the role of Mandatory vs Voluntary targets in which consensus could not be found.

Outcome:

All of the utilities (and public utility member governments), UAE, and the CCS believe that voluntary targets are sufficient to meet the REI objectives and are the preferred course of action. However, renewable energy advocates, renewable energy developers, academics, Salt Lake City, Salt Lake County and some citizen groups believe mandatory targets are required to meet the REI goals and are a necessary means to address externalities.

Utah "Strawman" RPS and Design Features

During the REI's RPS discussion, Utah Division of Air Quality staff prepared a Utah "strawman" document that listed the various RPS design features based loosely on the Oregon RPS,[3] which the REI Focus Group used to guide its discussion.

The following section includes the RPS strawman design features that were considered by the REI Focus Group (gray boxes) and group comments and conclusions concerning those features. **The strawman design features listed in the following sections are included for discussion purposes only**. The REI Focus Group concluded that any specific final parameters must be set after careful analysis and through the interaction of many stakeholders during the shaping of actual legislation. It is expected that Utah policy makers will establish a process to develop final RPS legislation, if Utah policy makers decide that an RPS is necessary. Once again, it should be noted that there was not a consensus regarding the need or the appropriateness of an RPS.

The following abbreviations are used for stakeholders throughout this section: ASP – Applied Science Professionals LLC, CCS-Committee of Consumer Services, DPU-Division of Public Utilities, RMP-Rocky Mountain Power, SC-Sierra Club, SE – Shoshone Energy, SLC-Salt Lake City, SLCo – Salt Lake County, UAE-Utah Association of Energy Users, UAMPS- Utah Associated Municipal Power Systems, UCE-Utah Clean Energy, UMPA-Utah Municipal Power Agency , UREA-Utah Rural Electric Association, WCAC – Wasatch Clean Air Coalition, WRA-Western Resource Advocates, WW-Wasatch Wind, WWW – West Wind Wires.

A) Preliminary Target

Background: A Renewable Portfolio Standard (RPS) is a requirement that utilities must supply a fixed percentage of electricity sold to the utility's customers from eligible renewable energy sources. An RPS is typically expressed in terms of a percentage target of renewable energy to be reached by a certain point in time.

[3] The Oregon RPS may be found at: http://www.leg.state.or.us/07reg/measpdf/sb0800.dir/sb0838.en.pdf.

STRAWMAN (*for discussion purposes only*)::

Investor Owned Utility (IOUs):	20% by 2020
Municipalities:	5-10% by 2020
Rural Electric Co-ops:	5-10% by 2020

Targets for Municipalities and Co-ops that currently have a surplus in energy will not be applicable unless new resources are acquired.

Annexing of IOU service territory by Municipalities or Co-ops without consent, will trigger full (IOU) RPS targets.

Discussion:[4]

- A Utah RPS that includes public power entities may present governance concerns, especially related to any enforcement or oversight provisions.
- Rocky Mountain Power expressed concern that there should be equitable treatment of all electricity customers, and that a renewable energy target be applied to all electric corporations and municipal electric utilities, ensuring that all Utah consumers receive the benefits and costs of the standard regardless of the ownership of the utility serving them.
- Some participants believed the RPS should include not just an energy requirement, but also a requirement to address utilities' available capacity needs, so that the mechanism fosters renewable and other technologies that can overcome limitations associated with intermittent renewable resources.
- Some representatives objected to mandatory strawman targets and indicated that they could not commit until they had seen the remaining terms and conditions.
- Some participants stated that the strawman targets were either too high or not ambitious enough.
- Some participants felt that target values must be set very carefully, with detailed analysis and system modeling of the Utah specific situation on a utility-by-utility basis. In particular, some participants expressed concern about the cost effectiveness of varying levels of renewable resources and the technical potential of reaching the strawman targets.
- Rocky Mountain Power indicated that the company was currently required to identify and pursue the acquisition of the least cost/risk balanced portfolio of resources and to the degree that renewable energy resources were the least cost/risk balanced they would be acquired. If renewable energy resources acquired to satisfy a target do not represent least cost/risk balanced acquisition, the acquisition would either increase the cost or risk to the company's customers.
- Rocky Mountain Power observed that it is in the process of adding considerable new renewable generation resources (1400 MW by 2010 and 2000 MW by 2013),

[4] Please note: in instances where parties are explicitly named, there may be additional participants who supported the position in question.

and has committed to add wind and geothermal resources as part of the commitments that Mid American Energy Holdings Company made as part of its acquisition of PacifiCorp.

- Some public power entities do not expect to add generating resources for at least several years, and are small enough that it may be impossible for them to add renewables without also adding expensive gas-fired peaking generation that would operate when the renewables were not available.
- Some public power entities objected to the provision that annexation of IOU service territories without consent would trigger IOU RPS targets, stating that provision is counter to current process and practice for annexation and would lead to additional and unnecessary complexity.
- Some participants felt that renewable targets should be selected in a manner that is consistent with Utah's eventual CO_2 reduction targets under the Western Climate Initiative.
- Some felt that targets and interim milestones should be established and approved at the final resource planning point for a given year, and consideration should be given to use of three or five year rolling averages for establishing actual compliance.
- Others felt that targets and interim milestones could create market distortions which would result in an increased cost for renewable energy resources, thereby increasing the costs to customers and/or reducing the amount of available cost effective renewable resources.
- Some participants recommended that the selection of the renewables targets be established after the definition of qualifying renewables and other components of the RPS are finalized.
- Rocky Mountain Power suggested the alternative of a clean energy or low-carbon portfolio standard, noting that existing RPS states have now turned their focus to CO2 reductions.
- All felt a standard should allow electric corporations and municipal electric utilities to meet the target with owned renewable energy sources, power purchases of qualifying renewable electricity, and renewable energy certificates
- The utilities indicated that if resource carve-outs[5] were required, the ability to acquire cost-effective renewable resources could be impacted.

[5] A "carve-out" refers to setting specific targets for certain types of resources (e.g. 2% target for solar electricity).

Outcome: *Please see summary table below:*

Opinion	Supporters
More Aggressive (i.e. greater than 20% by 2020)	UCE, SC, SLC,WW, WRA, Interwest, Utah Moms, , enXco, WCAC, SE, WWW, SLCo
Less Aggressive (i.e. lower target or voluntary approach)	RMP, UAMPS, UMPA, UREA, UAE
Resource type based on % carve-outs	UCE, SC, SLC,WW, WRA, Interwest, Utah Moms, SunEdison, , enXco, WCAC, SE, SLCo
Resource type based on cost-effectiveness	RMP, UAE, UREA, UAMPS, UMPA, CCS
Target should be set after some studies and other design features	DPU, UAE, RMP, UAMPS, UMPA, UREA
Standard based on carbon advoidance/reduction (renewables, energy efficiency, DSM, etc)	RMP, ASP, UREA, UAMPS, UMPA, UAE

B) Definitions of Renewable Energy Resource

Background: Which resources qualify as renewable is a matter of some debate. For example, renewable energy is defined differently and for different purposes in separate sections of Utah State Code. For the purpose of an RPS, the issue of qualifying renewables must be addressed.

STRAWMAN (*for discussion purposes only*):

As a minimum, renewable energy resources should be defined in accordance with existing Utah statute, to include biomass energy; certain qualifying hydroelectric energy, geothermal energy, solar energy, and wind energy. In addition, any RPS legislation should allow for other resources to be defined as renewables by a state wide governing body such as the Public Service Commission, State Energy Program, or Department of Environmental Quality.

Biomass energy means any of the following that is used as the primary source of energy to produce fuel or electricity:

- material from a plant or tree; or
- other organic matter that is available on a renewable basis, including:
  - slash and brush from forests and woodlands;
  - animal waste

- methane produced at landfills or as a byproduct of the treatment of wastewater residuals;
- aquatic plants; and
- agricultural products.

Biomass energy does not include
- black liquor
- treated woods; or

biomass from municipal solid waste other than methane produced at landfills or as a byproduct of the treatment of wastewater residuals.

Discussion:

- Some participants argued that the design of the portfolio standard or the list of qualifying renewable resources should recognize other low-carbon emitting, and otherwise environmentally low-impact resources such as demand side management, improved plant efficiency, combined heat and power, and other actions that avoid emissions of CO2 into the atmosphere. These types of resources could be just as effective in helping Utah achieve its CO_2 emission reduction and other targets as the resources that presently qualify as renewables. Some states have sought to tap this potential resource by setting a percentage target for energy efficiency, demand-side management or other measures as part of their RPS legislation or rule making.
- Some participants felt that only certain hydroelectric power projects should qualify.[6]
- Public power entities objected to qualifications or limits on the inclusion of hydroelectric power.
- Emery Energy felt that Municipal Solid Waste (MSW) should be included as a biomass feedstock that qualifies as renewable energy. They suggested that it may be appropriate to include the following qualifying language: "MSW Facility must use a non-combustion thermal process (i.e. gasification) to convert MSW to a clean burning fuel to generate electricity."
- Some participants felt that MSW should not be included due to concerns that it will diminish efforts to reduce waste streams and promote recycling. Some also expressed concerns regarding emissions/waste that may result from the use of MSW to generate electricity. Further, some noted that a portion of the energy content of MSW is not from renewable feed stocks.
- Some participants believed that biomass projects which use plant or tree material should be limited to true waste material (i.e. no deforestation for fuel), with net zero or negative CO2 emissions.

[6]Some states limit the types or vintage of hydroelectric power that qualify towards meeting their RPS targets. For example, a state may limit qualifying hydroelectric power plants to those built after a certain year or to small or run-of-river plants.

Outcome: *Please see summary table below:*

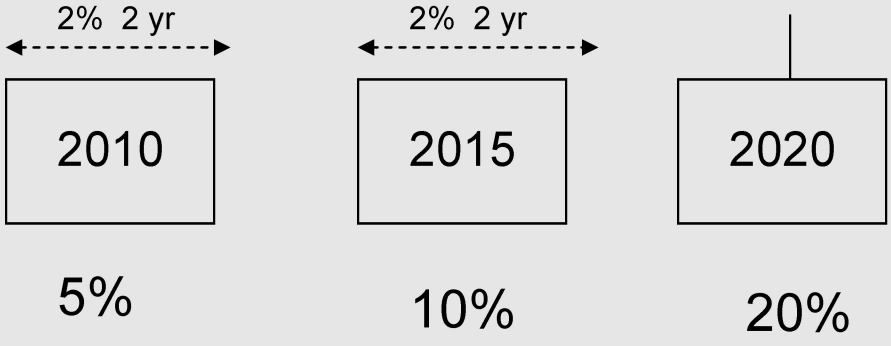
Opinion	Supporters
Current Statute w/Qualified Hydro	UCE, SC, SLC,WW, WRA, Interwest, Utah Moms, Sun Edison, DPU, WCAC, WWW, SLCo
Current Statute w/All Hydro	UAMPS, UMPA, UREA, UAE

C) Compliance

Background: In some instances, an RPS may include interim milestones or goals along the way towards meeting an ultimate target. Such milestones can be fixed or can include provisions that allow more compliance flexibility.

STRAWMAN (*for discussion purposes only*):

Beginning in calendar year 2010, investor-owned utilities would be required to reach the following milestones:



There would be a 2%, 2 year compliance window for 2010 and 2015 milestones to prevent artificial markets (i.e. a utility would be considered in compliance if they were within two percentage points of the milestone target within +/- two years of the milestone year). However 2020 would be a hard target.

Municipalities and Co-ops do not have intermediate milestones.

Compliance will be met and verified on the basis of Renewable Energy Certificates.

Discussion:

- Several participants indicated that it is very important to have flexibility in meeting the compliance targets, due to uncontrollable events such as weather, equipment availability, natural disasters, market conditions, or utility system loads.
- Some participants felt that targets and interim milestones should be established and approved during the final resource planning process for a given year, and that consideration should be given to use of three or five year rolling averages to verify actual compliance.
- Others felt that targets and interim milestones could create market distortions which would result in an increased cost for renewables. Also, they pointed out that interim targets could require retirement of renewable energy certificates that could otherwise be sold to benefit customers.
- Some participants felt that it is arbitrary to establish interim milestones without study of when renewable resources might feasibly be brought online; however, other participants felt that such a study will not accurately reflect renewable resource potential since project developers may be waiting for an RPS before announcing their projects.
- Some participants felt it was reasonable to require electric corporations and municipal electric utilities to file interim compliance plans and a final compliance report; electric corporations would file with the Public Service Commission and municipal electric utilities file with the Department of Environmental Quality (DEQ) or with their respective city council, with all filings available for public review.
- Some participants noted that costs caps (section I below) could be used to protect against the cost of compliance in the face of unanticipated events.
- Some participants felt a target need not be satisfied to the extent it would require acquisition of electricity in excess of a utility's load requirements or substitution of qualifying electricity for electricity from generation sources owned and contractually committed

Outcome: *Please see summary table below:*

Opinion	Supporters
Interim Hard Targets	UCE, SC, SLC,WW, WRA, Interwest, SunEdison, SE, enXco, WCAC, WWW, SLCo
Flexibility in Targets	RMP, UAE, CCS, UREA, UAMPS, UMPA

D) Renewable Energy Certificates

Background: Renewable Energy Certificates (RECs) serve much the same functions as commodity futures contracts that are bought and sold between parties without the underlying actual quantities of the commodity being physically moved between buyer and seller until the final delivery. Bundled RECs are RECs that are always bought or sold along with the energy itself that has been produced by a renewable generation resource, from the point of creation to the point of final consumption. Unbundled RECs are RECs that have been administratively separated from and bought and sold independently of the actual energy.

STRAWMAN (*for discussion purposes only*):

In order to demonstrate compliance with the RPS requirements, an electric utility must provide proof of having obtained or produced the qualifying electricity (or its environmental attributes) and having delivered it to its customers. This proof is accomplished through the creation of a market tracking mechanism that follows the creation, market transactions, and eventual retirement of renewable energy units using RECs. Electric utilities are allowed to use both bundled and unbundled RECs within the Western Electricity Coordinating Council (WECC).

If a utility purchases a bundled REC, the electrical energy associated with that bundled REC must also be delivered to the utility. But in the case of an unbundled REC, the actual electric energy from a renewable resource can be "swapped out" for non-qualifying electricity (e.g., from natural gas or coal) as it makes its way to the final destination, with the utility's total purchased and retired RECs demonstrating that the right amount of renewable energy was produced to meet the utility's RPS requirement. By allowing for the use of unbundled RECs, utilities can gain the flexibility of using non-qualifying electricity to "shape" or "firm" wind power and other intermittent power resources, as long as the total number of RECs that are purchased and retired by the utility equal the renewable energy percentage of total electrical energy sales specified by the RPS.

For IOU's, the Oregon RPS requires that no more than 20 percent of their compliance in a given year may be met through the use of unbundled RECs. For the Municipalities and Co-ops, no more than 50 percent of their compliance in a given year may be met through the use of unbundled RECs.

Discussion:

- Some felt the State should develop a renewable energy certificate program;
- Some felt that certificates should not have an expiration date and be banked for usage or transfer after the year in which they were created.

- Some indicated that to optimize the amount of cost effective renewable energy, the utilities should be allowed to purchase and sell renewable energy credits with the benefits used to offset the cost of the renewable resources.
- UREA felt it would be best not to impose a geographic limitation on where the RECs can be purchased.

Outcome: *Renewable Energy Certificates (RECs) should be used to measure compliance (consensus).*

E) Issuance of Certificates

Background: There is a need for an entity to issue and track RECs if a Utah RPS is established. One potential candidate for such tracking is the Western Renewable Energy Generation Information System (WREGIS). WREGIS is an independent, renewable energy tracking system for the region covered by the WECC. WREGIS tracks renewable energy generation from units that register in the system using verifiable data and creates renewable energy certificates (RECs) for this generation.

STRAWMAN (*for discussion purposes only*):

A statewide governing body will issue RECs and the tracking will be done by WREGIS.

Discussion:

- Some participants asked if a statewide governing body should oversee the certification of RECs using standards and tracking provided by WREGIS; it was noted that a statewide governing body likely cannot issues RECs, but could determine whether a project meets the portfolio standard's eligibility requirements.

Outcome: *There was general consensus that a State governing body should oversee certification of RECs.*

F) Existing Facilities

Background: Some states have limited facilities that qualify towards meeting an RPS to those that were built after a certain year. This is typically done in an effort to encourage the development of new renewable resources as opposed to relying on existing facilities. In some instances, existing facilities have been limited to exclude some types of facilities from qualifying.

STRAWMAN (*for discussion purposes only*):

An existing facility is defined as those that became operational before January 1, 1995.

Discussion:

- Several participants noted that this is an arbitrary deadline and that impacts on Utah-specific generation resources need to be considered before the issue of existing facilities/facility vintage can be adequately addressed.

Outcome: *Project eligibility needs to be determined and needs to address resource type, vintage (i.e. commercial operation date), and geographic location criteria (consensus).*

G) Renewable Energy Certificate Trading

Background: If a Utah RPS is established, there is a need to determine what types of RECs can be used, what geographic boundaries may apply, and how those RECs can be used in meeting the requirements on an RPS.

STRAWMAN (*for discussion purposes only*):

Electric utilities can use both bundled and unbundled RECs within the WECC. RECs may only be used once and only by the owner of the REC.

Discussion:

- It is important to establish a system that will ensure against double-counting.
- There may be opportunities to sell RECs if there are no interim hard targets; revenues from such sales are credited to customers, helping to reduce the cost of renewable energy resources.
- Some participants noted that targets could only apply to Utah retail kilowatt-hours sales.
- Some suggested that incentives could be created for in-state renewable energy development if utilities were allowed to use unlimited amounts of unbundled RECs procured from in-state projects, with some restrictions placed on amounts of out-of-state unbundled RECs (i.e., the Oregon RPS).
- Some participants opposed geographic restrictions on resource procurement. The narrower the geographic restrictions placed on renewable resource eligibility criteria, the fewer options that will be available to satisfy the target; this can lead to more expensive projects, more costs to the consumer and/or fewer cost effective resources developed.

- Some participants indicated that if required to meet a mandate through the use of unbundled RECs, the costs to the investor owned utility consumers would increase without the offsetting benefits associated with the delivery of energy.
- Currently the use of unbundled RECs to satisfy a mandate would not satisfy the investor owned utilities cost effectiveness test.

Outcome: *Before unbundled RECs can become a compliance mechanism, changes may need to be made to the existing regulatory framework (consensus)*

H) Recovery of Costs

Background: The group discussed the recovery of prudently incurred costs.

> **STRAWMAN (*for discussion purposes only*):**
>
> All prudently incurred costs associated with complying with the RPS are recoverable.

Discussion:

- Some noted that it is important to ensure that the rate-setting process results in all elements of cost being captured and recovered and that costs and utility cost recovery are matched.
- Rocky Mountain Power noted that its wind energy additions occur in multiple increments of approximately 100 megawatts each during the course of a year. These additions are capital intensive (currently over $2 million per megawatt) but the energy cost after construction is nearly zero, providing a significant benefit to customers. Rocky Mountain Power stated that it was essential that customers see benefits and costs at the same time (i.e., that rates match costs and benefits). Rocky Mountain Power prefers an adjustment mechanism rather than a general rate case to achieve such matching, recognizing the multiple number of renewable energy additions in a year. Several participants noted that energy cost after construction is not necessarily nearly zero for all renewable energy resources.
- Utility representatives emphasized prudently incurred costs to own, operate and construct renewable energy sources and associated assets should include transmission and other costs to acquire renewable energy (i.e., power purchases of qualifying electricity would be recovered in rates at the same time customers receive the benefits of the renewable energy);
- Utility representatives emphasized prudently incurred costs of acquiring renewable energy certificates should be recoverable in rates with any net revenues from sales of renewable energy certificates credited to customers;
- Some participants felt that prudently incurred costs of investigating and developing renewable energy sources (including siting, permitting, licensing and pre-construction costs) should be recovered by utilities.

- Some participants noted that the tax credits that can make renewable resources more attractive in the marketplace cannot be used by electrical co-ops or municipal power entities; however, it was also noted that a right to sell or transfer the credits to other entities might mitigate this issue as well as encourage in-state project investment from out of state investors.
- Some noted that statutes and regulatory processes already exist to give cost recovery for prudently incurred costs, and that an RPS does not need to provide any new assurances, only refer to existing ones.
- It was noted that in the rural electric cooperative and municipal models, all costs are born by members/ratepayers.

Outcome: *Prudently incurred costs should be recoverable (consensus).*

I) Cost Caps

Background: Cost caps can provide a backstop to help ensure that the costs of complying with an RPS do not become excessive.

STRAWMAN (*for discussion purposes only*):

Utilities are not required to comply with the RPS to the extent that the sum of the incremental costs of compliance with the RPS, the costs of the unbundled RECs, and the alternative compliance payments made exceed four percent of a utility's annual revenue requirement in a compliance year. RPS compliance costs are not included in the annual revenue requirement to prevent a compounding effect.

Discussion:

- Rocky Mountain Power representatives emphasized that cost-effectiveness as defined in the law for integrated resource planning should be the economic criteria for meeting any target. They argue that penalty provisions are not needed and are unwise since weather, equipment problems, supplier shortages, availability of tax incentives and natural disasters will alter the economics of a renewable energy project.
- Utility representatives explained that a cost cap should not be necessary as long as satisfaction of any renewable energy target was conditioned upon it being cost effective. In fact, if a cost cap were imposed, it should allow the utility to exceed the cost cap if the utility could demonstrate that it was cost effective.
- CCS recommended that other states' models be considered regarding cost caps.
- UAE noted that four percent is an arbitrary amount taken from Oregon's RPS and that a cost cap more appropriate for Utah should be evaluated. In addition, they noted that four percent of the annual revenue requirement is a significant amount of money, approximately $52M annually.

Outcome: A mechanism to protect against unreasonable price increases is needed *(consensus)*.

J) Alternative Compliance Payments

Background: An Alternative Compliance Payment (ACP) is a payment that a utility can make into a fund in lieu of the utility actually purchasing renewable energy resources through acquisition of assets or through power purchase contracts. ACPs would typically be made if market conditions resulted in unacceptably high prices, or if renewable resources were not available at a given time to satisfy the requirements of an RPS.

STRAWMAN (*for discussion purposes only*):

In lieu of procuring renewable energy resources, utilities can pay an Alternative Compliance Payment (ACP) to be placed in a fund that can only be used for acquiring renewable energy resources in the future, or for energy efficiency and conservation programs. Rates for each utility will be established on a per megawatt-hour (MWh) basis by the Utah Public Service Commission (PSC). This mechanism sets an effective cap on the cost of complying with the RPS.

A state agency would calculate the ACP value in dollars per megawatt-hour, not the utility. The ACP mechanism helps to ensure that price gouging does not occur during negotiations between developers or sellers and buyers. In the event that renewable project prices rise above the ACP value, the utility would be allowed to defer investments until the market corrected itself.

Discussion:

- Rocky Mountain Power noted alternative compliance payments would not be necessary if renewables are added based upon cost-effectiveness
- CCS noted that any compliance payments are being paid by consumers and that any program must be designed such that consumers making the payments receive the benefits from those payments.
- Some noted that alternative compliance might also be achieved through reduction in consumption through demand-side management measures and energy efficiency.
- UAE felt that it is important that the PSC be able to closely oversee and monitor the ACP fund.
- UAE also noted if the statutes are changed to allow for ACPs and unbundled RECs, such changes need to be made with great care and in a manner that enables all parties to understand how statutory changes will affect acquisition of other, non-renewable, resources.

Outcome: *Before Alternative Compliance Payments (ACP) can become a compliance mechanism, changes may need to be made to regulatory framework (consensus)*

K) Green Power Programs for All Utilities

Background: Various green power programs exist in which customers are encouraged to purchase power from "green" sources or to voluntarily donate to funds that will be used to develop renewable energy resources and other green power alternatives. An example is the Rocky Mountain Power Blue Sky Program.

STRAWMAN (*for discussion purposes only*):

Every utility in Utah must offer their customers the option of voluntarily purchasing renewable energy. These purchases will not count toward an RPS.

Green power programs allow customers to purchase renewable energy above and beyond the RPS compliance level.

Discussion:

- Some felt that green power programs might be better addressed through rule-making.
- Public power entities felt that renewable resources from green power programs should be counted towards any targets or goals.
- Some felt that renewable resources from green power programs should not be counted towards targets in that it would create a disincentive for participating in such programs.

Outcome: *The group did not reach consensus on how to handle green power programs.*

L) Miscellaneous

Background: The REI Focus Group discussed several miscellaneous RPS design aspects.

STRAWMAN (*for discussion purposes only*):

By Oct 1, 2008, the state must establish an automatic adjustment clause method that allows timely recovery of costs prudently incurred by an electric company to construct or otherwise acquire facilities that generate electricity from renewable energy sources and for associated electricity transmission.

The RPS shall allow utilities to recover in the rates of all but the largest customers the costs of conservation measures.

Utilities and Independent Generators must submit annual compliance reports to the PSC or governing state-wide body.

Discussion:

- While the miscellaneous issues listed in this section could possibly be addressed in the regulatory arena rather than in legislation, some participants expressed a

preference for the issues to at least be addressed at some level within legislation, thus providing specific guidance to regulators.

- Several parties argued the term "cost effective" should be defined consistently with the existing statutory criteria applied to integrated resource planning.
- It was noted that research needs to be done on how plants such as Bonanza and Intermountain Power Project should be addressed in an RPS. Significant amounts of power produced by those plants are delivered to customers outside Utah.
- CCS noted that it would be better to allow an automatic adjustment clause than to require it.
- Some participants felt that conservation measure cost recovery should apply to all customers.
- Shoshone Energy felt that RMP resource procurement procedures and policies need further refinement in order to level the project development playing field and create true competition.
- Shoshone Energy felt that avoided cost calculations should be updated annually.
- Shoshone Energy felt that avoided costs should include IGCC as a resource alternative.
- Shoshone Energy felt that RMP should conduct annual renewable energy RFPs in order to meet RPS targets.

Outcome: Because of the miscellaneous nature of the items in this section, no definite outcome was determined.

Additional Issues to be Addressed

If there is to be a Utah RPS, the REI Focus Group identified the following issues that need to be addressed (please note level of support in parentheses following each item):

- The cost-effective (least-cost/risk-balanced) standard (RMP, DPU, CCS, UREA, UAE)
- Before Alternative Compliance Payments (ACP) and unbundled RECs can become a compliance mechanism, changes may need to be made to regulatory framework (consensus)
- System reliability[7] (consensus on the issue, but no consensus on the amount of intermittent resources that trigger reliability issues)
- The legal structure and governance of the utilities and the impact on RPS design (consensus)
- Encouragement of renewable resources while minimizing adverse market distortions (consensus)
- Analyze and address the economic/rate impacts (positive and negative) of instituting an RPS (consensus on this issue, but no consensus on whether this needs to occur before or after legislation is passed).

[7] Intermittent, non-dispatchable resources can create system reliability issues; a study needs to be conducted to determine the amount of intermittent resources that can reasonably be added prior to causing reliability issues.

- Project eligibility needs to be determined and needs to address resource type, vintage (i.e. commercial operation date), and geographic location criteria (consensus).

CREDITS AND INCENTIVES

The REI Focus Group discussed various tax credits and incentives during their September 5, 2007 meeting. The REI Focus Group reviewed a number of tax credits and incentives that have been enacted at the Federal level, or used in one or more Western states. See Appendix 5 for a summary of the credits and incentives that the group reviewed. As the discussion progressed, it became apparent that a wide variety of different incentives or tax credits can be implemented that would encourage the development of renewable energy resources.

The Focus Group also agreed that incentives or credits should be implemented for a continuous period of time that will be consistent with the planning horizon and implementation schedule of the renewable resources that must be built to comply with any RPS targets

Potential Credits and Incentives

- Increased production tax credits for in-state renewable energy generators
- Expansion of production tax credits or investment tax credit to cover concentrating solar.
- Increasing investment tax credit amounts/caps (current state caps are 25% up to $2,000 for residential and 10% up to $50,000 for commercial systems).
- Make current tax credits transferable so that non-profit agencies and governmental agencies can sell the credits for value to offset project costs
- Provide direct assistance to non-profits or local government agencies that cannot take advantage of tax credits
- Provide tax credits to companies for the development costs of large projects (esp. geothermal and wind)
- Provide “bonus” REC’s to utilities for in-state renewable energy and for locally-owned, community-scale (~30MW) renewable projects (e.g. for every kilowatt hour of energy generated from solar resources, the state would issue 2.4 (Nevada standard) kilowatt hours of renewable energy credits)
- Provide added incentives for locally-owned, community-scale renewable projects.

TRANSMISSION AND DISTRIBUTION SYSTEM ACTIONS

In order to help the REI Focus Group to understand transmission and distribution system issues, Mr. Jim Tarpey of Holland and Hart gave a presentation on the Wyoming State Infrastructure Authority (WIA). See Appendix 6 for a summary of Mr. Tarpey's presentation.

Following Mr. Tarpey's presentation, the REI group discussed the following possible actions to help spur the development of transmission to serve renewable energy resources.

Establish a Utah infrastructure authority

When asked about how Utah might consider setting up an infrastructure authority, Mr. Tarpey suggested broad authority, a high level board appointed by the Governor, with a clear mission about whether the state is planning to be an import or an export state, the role of renewable energy resources, and whether the authority should be a state instrumentality with the associated separation from state government (which gives leverage and avoids the authority being seen as just another state agency).

Create Renewable Energy Development Zones.

Inadequate transmission infrastructure and siting delays and complications are two significant barriers to all new renewable energy development in Utah. Both of these hurdles maybe alleviated with the establishment of renewable energy development zones (REDZs) in Utah. The State could provide funding to establish streamlined, coordinated and expedited siting and transmission policies in REDZs. Traditional economic development tools could be used to promote REDZs. The Focus Group also noted that there are other transmission policy options to advance renewables, such as New Mexico's RETA approach and the laws passed in Texas (SB 20) in 2005 and Colorado (SB 100) in 2007 to spur in-state renewable development by requiring: 1) the designation of renewable resource zones, coupled with transmission development plans to access the energy in those zones, and 2) the build out of transmission to bring the electricity out from the renewable resource areas.

Allow Cost Recovery for Transmission Development & Scoping Costs

The investor owned utilities are allowed to do general transmission studies at the regional level. However, under Federal Energy Regulatory transmission rules and regulations, renewable developers are responsible for the cost of interconnecting and integrating resources. This includes the cost of all studies. This situation makes it very difficult for any party to fund the necessary transmission studies, thereby delaying the development of

renewable energy resources. The group noted that in order to expedite these studies while complying with Federal Energy Regulatory Commission rules, the state could provide the funding, perhaps through an infrastructure authority.

California Renewable Energy Transmission Initiative

Rocky Mountain Power/PacifiCorp briefly mentioned developments occurring in California. The California Energy Commission (CEC), the California Public Utilities Commission (CPUC), California Independent System Operator (CaISO) and load-serving entities began in 2007 an initiative called the California Renewable Energy Transmission Initiative (CRETI). The CRETI will build upon the work of the Tehachapi Collaborative Study Group, and identify and assess renewable resource zones in the state and develop coordinated, cost-effective resource development plans that could provide sufficient renewable electricity to California consumers by 2020 to meet AB 32 targets. The work of the CRETI will take place over two years in three phases.

1) Statewide identification and assessment of competitive renewable energy zones.
2) Identification of priority REDZs and creation of conceptual transmission plans for these zones.
3) Development of Plans of Service (POS) for highest priority REDZs. These POS will provide detailed plans for transmission and infrastructure upgrades necessary to develop these zones but will not select specific transmission routes.

Create Incentives for a Smart Electrical Grid

In responding to questions about how to provide incentives for large scale and widespread distributed renewable generation, Rocky Mountain Power/PacifiCorp replied that smart grid technology may be necessary. The group then discussed various considerations related to the smart grid, including:

- The widespread deployment of low or no carbon distributed renewable generation resources, plug-in hybrid electric vehicles and end-use efficiency devices will require a “smart”, interactive grid and communication infrastructure.
- Today’s grid was designed to only transmit energy from source to the demand site and stands to benefit from the previous internet and computer boom and the current efforts in material sciences.
- A modernized grid would also improve operational security and allow increasing amounts of distributed renewable resources generated near load, which would reduce overall system losses and thus result in additional carbon savings.
- If plug-in hybrid electric vehicles become common place and solar distributed generation applications continue to increase, the energy grid must become more of a two-way operation where energy can be both delivered and received.
- Two-way flow of energy and data would also allow customers to respond to price signals to reduce usage at peak times, when the lowest efficiency fossil-fired units are operating.

- A range of technology exists today that can improve the grid such that reliability and efficiency is improved, and cleaner, distributed renewable energy resources are better integrated, including new smart meters, remote sensors, energy-management systems, better transmission lines, and advanced storage technologies that serve to optimize electricity generation, dissemination, and usage.
- Currently smart grid technology is not cost effective for the utilities to pursue. The utilities should be encouraged to review the potential on an ongoing basis.

Create Incentives for Energy Storage

Rocky Mountain Power/PacifiCorp had expressed a desire to discuss energy storage as an enabling technology for intermittent renewables, but there was insufficient time to do so. What follows below are the comments provided by Rocky Mountain Power/PacifiCorp to the REI co-chairs and DEQ staff.

The electricity sector has identified storage as having the distinct capability of enabling higher penetrations of variable output renewable energy in Utah's energy portfolio. Other types of renewables – geothermal, biomass – are base load resources and do not require storage. Some concentrating solar power projects will be built with heat storage to generate off-peak. The ability of electricity grids to absorb wind power has limits, which will be reached before the full potential of these sources is exhausted unless resources are added to firm, balance, and integrate intermittent renewables. Pumped water, compressed air, or battery storage can firm wind resources and therefore create energy that can be scheduled to match customer load base. In addition, storage provides emergency power supply and backup and remote area power supply. Coupled with advanced power electronics, storage systems can reduce harmonic distortions, and eliminate voltage sags and surges.

Storage technologies are particularly attractive for wind power, in effect overcoming the intermittent and frequently off-peak nature of wind power by storing the power, subsequently becoming a dispatchable power source that can be moved from the off-peak to the peak. Storage can firm wind capacity, and therefore avoid penalties for energy falling below the forecast, and utilize power above forecast. Wind energy then can increase its capacity credit, reduce grid connection rating, increase overall load penetration, and create profit maximization/price arbitrage. System operators and proponents of high wind energy penetrations recognize that energy storage systems can help mitigate the variability of intermittent resources, both for operating and capacity reserve needs. Storage can be on-site or centralized at utility facilities. Utility-scale central storage is much cheaper than on-site storage, but it requires more transmission to take the intermittent resource to the storage site or to load.

Examples of energy storage and the status of their development are as follows:

- Flywheel storage – Good for smoothing short-term fluctuations.

- Pumped hydro – the most widespread energy storage system in use on power networks; large scale capacity, quick deployment, and can be particularly effective for wind resources with diurnal generation profiles.
- Compressed air energy storage (CAES) – used for reducing the parasitic load at a conventional power plant but not used to generate electricity directly.
- Batteries – older technologies are commercially viable; newer technologies are being tested:
  - Sodium-sulfur batteries (NaS) battery technology are being demonstrated at over 30 sites in Japan totaling more than 20 MW with stored energy suitable for 8 hours daily peak shaving. The current life of the batteries is about 15 years. The largest NaS installation is a 6MW, 8h unit for Tokyo Electric Power Company. Combined power quality and peak shaving applications in the U.S. market are under evaluation. American Electric Power (AEP) has been using a 1.2 megawatt NaS battery in Charlestown, West Virginia the past year and plans to install one twice the size elsewhere in the state next year. The costs are somewhat prohibitive, at $2,500 per kilowatt, though costs are expected to come down within the next 10 years due to mass production.
  - Flow batteries are a special class of battery where electrolyte is stored outside the main power cell of the battery, and circulated through it by pumps, like a reversible fuel cell. Flow batteries can have relatively large capacities and are gaining popularity in grid energy storage applications.
- Thermal storage – thermal energy storage technologies store heat, usually from active solar collectors, both utility-scale and distributed technologies, in an insulated repository for later use in space heating, domestic or process hot water, or to generate electricity.
- While these technologies are currently not cost effective for the utility to pursue, consideration should be given to the role of the above technology in integrating resources over time.

NEXT STEPS

Based on the deliberations of the past three-and-a-half months, the REI Focus Group recommends that the State:

- Evaluate REDZs and how best to implement them
- Conduct rate and economic impact studies of implementing an RPS
- Perform a cost-benefit study on externalities associated with all electrical energy sources
- Assess state utility regulations to determine if changes are needed to help facilitate more renewable resources
- Study the potential capacity and benefits from distributed generation
- Evaluate the benefits of improvements to the transmission and distribution system
- Research integration of renewable energy into electrical system

APPENDIX 1: REI FOCUS GROUP PARTICIPANT LIST

The following individuals attended one or more of the REI Focus Group meetings. Meetings were open to the public, so attendance varied from meeting to meeting, and some individuals who were present might not have signed the attendance lists.

CoChair: Tim Wagner, Sierra Club
CoChair: Ernie Wessman, utilities consultant and Air Quality Board

Abdinasir Abdulle, Utah Division of Public Utilities
Steven Aderholt, Sound Geothermal
Rick Allis, Utah Geological Survey
Renette Anderson, DEQ Public Affairs
Mike Avant, Garkane Energy
Joe Andrade, Utah Science Center
Lane Ashton, Raser Technologies
Sara Baldwin, Utah Clean Energy
Des Barker, DBA, Inc.
Michele Beck, Utah Committee of Consumer Services
Vicki Bennett, Salt Lake City Environmental Program Manager.
Jason Berry, State Energy Program
Ted Boyer, Public Service Commission
Alyson Brennan, VP Political Advocacy UWABC
Gary Bryner, Brigham Young University
Jim Byrne, West Wind Wires
James Campbell, Utah Division of Air Quality
Patrick Clark, Staker Parsons
Richard Clayton, Raser Technologies
Caitlin Collins, Utah Association of Energy Users
Cathryn Collis, SWCA Environmental Consultants
David Curtiss, EGI University of Utah
Jamie Dalton, Utah Division of Public Utilities
Ron Daniels, State Energy Policy Coordinator
Kyle L. Davis, PacifiCorp/Rocky Mountain Power
Jennifer de Tapia, Student
Hans Ehrbar
Stephen Foerster, Student
Naomi Franklin, League of Women Voters
Jordan Gates, Salt Lake City
Rick Gilliam, Sun Edison
Steve Graham, Utah Community Reinvestment Corporation
Cheryl Heying, Utah Division of Air Quality
Keith Hill, Deseret Power

Jim Holtkamp, Holland and Hart
Marion Horna, MJH Power Consulting
Carol Hunter, Rocky Mountain Power/PacifiCorp
Andy Huttgren, Environmental Performance Group
Susan Innis, Western Resource Advocates
Tom Jepperson, Questar
Kelly Knutsen, Utah Clean Energy
Chris Lilley, Kennecott Utah Copper
Nykole Littleboy, Division of Air Quality
Sam Liu, Utah Division of Public Utilities
Tracy Livingston, Wasatch Wind
Alexander Lofft, Principal & Broker Corporate Real Estate Group, LLC
Tim Loftis, Morgan Stanley
Douglas Maxfield, Roan Power
Al McKee, Bureau of Land Management
Geoff McNaughton, Division of Forestry , Fire and State Lands
Michael Mendelsohn, Western Resource Advocates
Steven Michel, Western Resource Advocates
Cheryl Murray, Committee of Consumer Services
Dianne Nielson, Governor Huntsman's Energy Policy Advisor
John Njord, Utah Department of Transportation
Ann Ober, Salt Lake County
Dave Olive, Shoshone Energy
Russ Olsen, Kennecott Utah Copper
Randy Parker, Utah Farm Bureau
Leon Pexton, Utah Municipal Power Agency
Mike Peterson, Utah Rural Electric Association
Ben Phillips, Emery Energy
Artie Powell, Utah Division of Public Utilities
Phil Powlick, State Energy Program
Greg Probst, enXco
Pepper Provenzano
Ted Rampton, Utah Associated Municipal Power Systems
Kirt Rhoades, Geo Engineers
Lisa Romney, Chevron Energy
Brenda Salter, Utah Division Public Utilities
Gary Sandquist, Applied Science Professionals LLC
Andy Schoenberg, Utah Population and Environment Coalition
Richard Simon, V-Bar
Glade Sowards, Division of Air Quality
Rick Sprott, Department of Environmental Quality Executive Director
Brad Stevens, Utah Solar/Green Power
Jim Tarpey, Holland and Hart, LLP
Roger Tew, Utah Associated Municipal Power Systems
Mark Thomas, M. D. Thomas Consulting
Todd Thorner, Foresight Wind

Kent Udell, University of Utah Mechanical Engineering
Kathy VanDame, Wasatch Clean Air Coalition
Christy White, RAAM Power
Becky Wilson, Utah Public Service Commission
Carol Withrow
Betsy Wolf, Salt Lake Community Action Program
Sarah Wright, Utah Clean Energy
Joni Zenger, Utah Division of Public Utilities
Marelynn Zipser, League of Women Voters
Renee Zollinger, Environmental Performance Group

APPENDIX 2: LIST OF PRESENTATION AND DISCUSSION TOPICS

In order to develop a shared understanding of renewable resources and the issues affecting their development, the REI group met several times in July and early August to hear presentations and discuss aspects of the following topics:

- The options identified by the Climate Change Stakeholder Working Group's Energy Supply Sector subgroup
- Utah's renewable energy landscape, presented by Philip Powlick of the State Energy program
- An overview of Renewable Portfolio standards, including an introduction to state experience and possible cost impacts, prepared for the CCSWG by Ryan Wiser of the Lawrence Berkeley National Labs
- Comparisons of Congressional global warming bills, prepared by Amy Royden-Bloom, National Association of Clean Air Agencies
- A discussion of the nature of an electrical "smart grid,": presented by James Campbell of UDAQ staff
- Review of renewable initiatives in various western states, presented by James Campbell
- Presentation on utility avoided costs, presented by Becky Wilson of the Utah PSC staff
- Presentation on barriers to solar energy development, presented by Sarah Wright of Utah Clean Energy
- Presentation of geothermal project development hurdles, by Richard Goff of PacifiCorp
- A case study of the Oregon Renewable Portfolio Standard and other supporting legislation, presented by Kyle Davis of PacifiCorp
- Discussion of questions to address when considering a renewable portfolio standard, presented by Kyle Davis of PacifiCorp
- Wyoming State Infrastructure Authority (WIA) presentation by Mr. Jim Tarpey of Holland and Hart. See Appendix 6 for a summary of Mr. Tarpey's presentation.
- Presentation on barriers to wind energy development, presented by Tracey Livingston of Wasatch Wind, Inc.

In addition, on September 20, the State Energy Program presented the results of an evaluation requested for the REI to determine the technical and economic potential for renewable resources in Utah.

All of the above presentation handouts and other written materials will be available on the REI Focus Group web site at http://www.deq.utah.gov/Issues/REIFG/index.htm, or available by contacting the Director of the Utah Division of Air Quality.

APPENDIX 3 – SUBGROUP DISCUSSION SUMMARIES

Renewables Definition Subgroup

The Renewables Definition Subgroup reviewed definitions of renewable energy from current State Code. After some discussion, the subgroup recommended using the definition associated with the sales and use tax exemption for renewable electric generation equipment found in Section 59-12-102. Excerpts from 59-12-102 are listed below:

59-12-102:

(11) (a) Except as provided in Subsection (11)(b), "biomass energy" means any of the following that is used as the primary source of energy to produce fuel or electricity:
(i) material from a plant or tree; or
(ii) other organic matter that is available on a renewable basis, including:
(A) slash and brush from forests and woodlands;
(B) animal waste;
(C) methane produced:
(I) at landfills; or
(II) as a byproduct of the treatment of wastewater residuals;
(D) aquatic plants; and
(E) agricultural products.
(b) "Biomass energy" does not include:
(i) black liquor;
(ii) treated woods; or
(iii) biomass from municipal solid waste other than methane produced:
(A) at landfills; or
(B) as a byproduct of the treatment of wastewater residuals.

(75) "Renewable energy" means:
(a) biomass energy;
(b) hydroelectric energy;
(c) geothermal energy;
(d) solar energy; or
(e) wind energy.

(76) (a) "Renewable energy production facility" means a facility that:
(i) uses renewable energy to produce electricity; and
(ii) has a production capacity of 20 kilowatts or greater.
(b) A facility is a renewable energy production facility regardless of whether the facility is:
(i) connected to an electric grid; or

(ii) located on the premises of an electricity consumer.

Cost Effectiveness Subgroup

A subgroup was formed to discuss the meaning of "cost effective" as it should be applied to the development of renewable energy resources. Utilities generally must show, either to the Utah Public Service Commission in the case of investor owned utilities, or to various government entities or boards in the case of public power agencies, that investments are prudent and have been made in the best interest of the utility's customers. Further, investor-owned utilities are required to file integrated resource plans every two years with the Commission. In these filings, the utility considers costs and operating attributes associated with various resource alternatives, as well as the performance of resource alternatives under different risk analysis scenarios. Using this process, the utility proposes its future expansion plan for new resources by demonstrating which resource alternatives result in the lowest cost and risk for its future revenue requirements.

Dr. Artie Powell of the Utah Division of Utilities presented some information on Least Cost/Least Risk as it applies to PacifiCorp's IRP planning process on August 15, 2007.[8]

In addition to Dr. Powell's presentation, the group discussed the limitations and concerns of the current working definition of cost-effectiveness. The group also identified possible means to accurately and adequately assess the risks and costs associated with externalities. The following summarizes the group discussion:

- Long term planning should not be focused solely on lowest costs. When long term planning is done correctly, the process results in a least cost/least risk plan that examines (and sometimes quantifies) a variety of risk factors and externalities.
- Current statutes and PSC guidelines create an environment for such analysis. However, many participants believe that in practice the analysis of risk and externalities is insufficient.
- Done correctly, least cost/least risk planning would provide a forum for analyzing the benefits and costs of all resource decisions, including those that would be attributable to an RPS.
- Under the current Utah Statute and IRP guidelines, regulators and utilities are charged with considering "other factors" when determining the least-cost/least-risk, and therefore statutes do not have to be changed to affect change in the IRP process.[9]
- Externalities such as public health impacts, air quality, water use, and the stability of the climate along with the associated environmental and societal impacts, may not adequately be incorporated in the utility resource planning model, which

[8] Dr. Powell's presentation can be found at:
http://www.deq.utah.gov/Issues/REIFG/docs/Least_Cost_REI_Presentation_082107.pdf
[9] "Standards and Guidelines for Integrated Resource Planning for PacifiCorp, Utah Jurisdiction" may be found in Appendix 7.

limits the ability to accurately evaluate the total cost of any given resource portfolio.

- If the Utah Legislature or Governor were to provide the Commission, Division, and Committee of Consumer Services with a more clear directive on what "other factors" they should be evaluating in their respective regulatory roles, that might help clarify to what extent and how externalities should be handled in the regulatory arena.
- To implement the above change, the PSC would need to take specific action and make specific findings on IRP filings. This may require legislative changes.

APPENDIX 4 – 17 QUESTIONS TO ADDRESS WHEN CONSIDERING AN RPS

Utah Renewable Energy Initiative August 2, 2007
Kyle L. Davis, PacifiCorp / Rocky Mountain Power
(503-813-6601) or kyle.l.davis@pacificorp.com
Excerpts from testimony offered by Brent E. Gale, Sr. Vice President, Regulation and Legislation, MidAmerican Energy Holdings Company to the Utah Legislature's Public Utilities and Technology (PUT) Interim Committee on June 20, 2007

Questions to address when considering a Renewable Portfolio Standard (RPS):
1. What is the purpose that the state wants to accomplish?

2. Is a mandate necessary or is it sufficient to set targets and remove statutory and regulatory impediments?

3. If a mandate is imposed, will it be reconciled with state standards regarding cost effectiveness?

4. How will consumers' interests be protected?

5. How should benefits and costs be passed on to customers and through what mechanism?

6. Will RPS targets be based on nameplate capacity or retail sales?

7. What ultimate percentage of renewable energy should be achieved by what date, and what, if any, interim benchmark goals should be established?

8. Should the details be developed in legislation or delegated to a regulatory agency?

9. Which resources qualify as "renewable energy" and what limitations, if any, will be placed on the use of these resources for compliance?

10. Through what means can an electric utility comply with an RPS; e.g., ownership of renewable generation, purchase of renewable energy, purchase of renewable energy credits (RECs), alternative compliance payments (ACPs), penalties in lieu of compliance?

11. What restrictions would be placed on an electric provider's ability to use RECs to comply with an RPS?

12. With regard to facility vintage, which generating facilities count toward compliance with the RPS?

13. With regard to geographic eligibility, will limitations be established for use of qualifying generation and RECs for compliance?

14. Would the same RPS requirements apply equally to all retail electric providers, or would requirements vary based on a provider's market share?

15. Under what circumstances will a utility be granted an exemption from compliance with RPS requirements?

16. Should there be penalties for an electric provider's failure to comply with RPS?

17. What considerations should be given to the establishment of a State RPS to provide for maximum compatibility with a prospective Federal RPS?

Specific RPS Design Elements that Will Affect Compliance Costs:
– Percentage targets and timeframes
– Resource eligibility
– Geographic eligibility and delivery requirements
– Set asides for solar or other resource types
– Flexible compliance mechanisms (RECs, banking, borrowing, settlement periods)
– Encouragement for long-term contracting

Resource/Project "Cost Effectiveness" Cost Cap Mechanisms in Use in Other RPS States:
– **Codification of Risk-Adjusted, Least-Cost Standard**
  • Oregon
– **Bundled Contract Price Caps**
  • New Mexico, Hawaii, Montana
– **Alternative Compliance Payments** *(freely available)*
  • Massachusetts, New Jersey, Rhode Island
– **Alternative Compliance Payments** *(available/recoverable in rates if least cost measure and/or insufficient available renewable energy)*
  • Delaware, District of Columbia, Maryland, Oregon

Overall RPS Program Compliance Cost Cap Mechanisms in Use in Other RPS States
– **Retail Rate/Revenue Cost Cap**
  • Colorado, New Mexico, Oregon, Washington
– **Financial Penalty** *(for competitive suppliers, will act as cost cap)*
  • Connecticut, Texas, Oregon, Pennsylvania
– **Customer-Class Bill Impact**
  • New Mexico, Maryland, Delaware, Maine
– **Renewable Energy Fund Limitation**
  • Arizona, California, New York
– **Force Majeure Clauses**
  • Pennsylvania, Minnesota, Nevada, Maine, Oregon, etc.

APPENDIX 5 – TAX CREDITS AND INCENTIVES

The REI Focus Group reviewed the following tax credits and incentives that have been enacted at the Federal level, or used in one or more Western states:

Current Incentives for Renewable Electricity

Federal Incentives

1. Renewable Energy Production Tax Credit: 1.9 cent/kWh tax credit for electricity generated by wind, solar, closed-loop biomass, and geothermal resources. Cannot be used with the Solar and Geothermal Business Tax Credit and sunsets December 31, 2008.

2. Solar and Geothermal Business Tax Credit: 10% for geothermal and 30% for solar for commercial or industrial facilities using solar or geothermal technologies.

3. Farm Bill Grant, Section 9006: For energy efficiency and renewable energy projects by agricultural producers and small businesses in rural areas – not historically utilized in Utah – only one previous award. applicant cost share may be a deterrent, capped at $500,000.

4. Residential Solar and Fuel Cell Tax Credit: 30% up to $2,000 for solar electric. Sunsets December 31, 2007.

5. Modified Accelerated Cost-Recovery System (MACRS): Businesses can recover investments in certain property through depreciation deductions.

6. Clean Renewable Energy Bonds (CREBs) [2007 awards have been made, but congress has not yet passed funding beyond this FY]: financing mechanism for public sector renewable energy projects 0% interest rate, the borrower pays back only the principal of the bond, and the bondholder receives federal tax credits in lieu of the traditional bond interest.

State Incentives - Utah

1. Renewable Energy Systems Tax Credit: State tax credit for residential (25% up to $2,000) and commercial (10% up to $50,000 or PTC for wind, biomass and geothermal over 600kW of 0.35 cents/kWh during first 4 years for systems from 2007 forward) renewable energy systems. PTC cannot be used in conjunction with the investment credit.

2. Renewable Energy Sales and Use Tax Exemption: State sales tax exemptions for the purchase or lease of equipment used to generate electricity by a renewable energy production facility with generation capacity of 20kW or greater. Sunsets June 30, 2009.

3. Net Metering Program: requires all electric utilities and cooperatives (municipal utilities are excluded) to allow customers to connect renewable energy systems to the grid for their own use and to supply excess electricity to the electric grid. The utility will "net"

the customer's electricity use and production over the monthly billing period, in essence, paying the customer retail price for the electricity they produce. If net metering results in excess customer-generated electricity over the billing period, the utility will credit the customer for the electricity at the avoided cost rate – i.e., the cost the utility would otherwise incur to generate power if it did not purchase electricity from another source. System size capped at 25 kW.

4. Solar Easements: Rights to sunlight access attached to property rights

Other Incentives for Renewable Electricity (from neighboring and other states)
Listed on www.dsireusa.org

1.*Solar Rebate/Buydown Programs (examples of participating states: WY- 50% up to $3,000, CO – many - Rebates for grid-tied PV systems are offered at $2.00 per watt, up to $6,000, AZ – many, OR – buydown – Res:$2.00/W-DC to $2.25/W-DC- $10,000 cap, Com: $1.50/W-DC to $1/W DC- $57,000-$70,000 cap, FL - Res - $20,000/ Com- $100,000, very common idea often funded by a Public Benefit Fund: see #12)

**This is something that PacifiCorp is currently testing out, beginning this year, in a small pilot project of 107 kW/year at $2/watt.*

2. Tax credit/deduction increases (examples of participating states: ID – deduction - 40% up to $5,000/year, $20,000 total, OR – credit -Very aggressive business energy tax credit –35% up to $10,000,000 over 5 years, 50% for RE generating facilities, $9,000 for single family homes – Residential credit caps at $6,000)

3. Green Tag Purchase

Example: The Northwest Solar Cooperative (NWSC) offers to purchase the rights to the environmental attributes or "Green Tags" derived from grid-connected solar PV- or wind-generated electricity at a rate of $0.05/kWh through December 31, 2009 (examples of participating states: ID, OR, NV- portfolio energy credit trading program)

4. Low or Zero Interest Loans (examples of participating states: ID - Res: $15,000, Com: $100,000, 4% interest, 5 years, generating projects not eligible, 0% interest for heat pump, OR - Small scale RE loans - Typically $20,000 - $20 million)

5. Grants (example of participating states: OR - RE grants: large scale, generating projects preferred, ID - RE grants: large scale, generating projects preferred)
Solar for Schools (examples of participating states: OR, ID)

6. Bond program (examples of participating states: ID, NM - Projects financed with the bonds will be paid back to the bonding authority using the savings on energy bills, state government and school district buildings)

7. Property Tax Exemptions (examples of participating states: CO, AZ)

8. PV leasing Program for PV water pumps (example of participating state: TX)

9. Building Permit Fee Credit (Exemption) for Solar (example of participating state: AZ – up to $1,000)

10. Mandatory Utility Green Power Option - All electric utilities are required to offer green power options to their customers (examples of participating states: CO, NM, MT, WA).

11. Permitting Standards

12. Public Benefit Funds/Trusts

13. Renewable Energy Zones –developed to instigate siting and construction of transmission to facilitate electric output from renewable energy technologies (example – TX – Competitive Renewable Energy Zones (CREZs).

APPENDIX 6 – WYOMING INFRASTRUCTURE AUTHORITY

The following is a summary of Jim Tarpey's presentation[10] to the REI Focus Group on the Wyoming Infrastructure Authority:

The WIA is set up as a state instrumentality; in a way that the state is not pledging full faith and credit on bonds issued by the authority a necessary condition to address Wyoming constitutional issues. Even with that limitation, the WIA scope is very broad, with essentially cradle to grave authority to build and strengthen the transmission system, inside or outside the state. WIA can partner with the private sector, and has bonding capability up to $1 billion on projects it doesn't own, and unlimited for projects owned by WIA.

The WIA has found that its most effective role is that of facilitator to help get the right players to the table, to serve as a catalyst/coordinator, advocate, or project sponsor. Much of its budget is used to fund feasibility studies that will help participants decide whether to build a transmission line. The WIA works with project partners to complete the studies. If the parties decide to proceed, the intent is to recover the Authority's costs so that the money can be re-used. Major partners would take the major lead going forward. Major projects facilitated by WCI include the Wyoming-Colorado Intertie Project, the Trans West Express, the Frontier Project, and the IGCC Pilot Project.

Some of the challenges that the WIA faces include the need to engage many different stakeholders with very different agendas; engineering challenges including technology, terminal locations, suitable corridors, and the impact on the rest of the grid; environmental and permitting issues; financing; the breadth and depth that should be included in the feasibility studies; equity financing during the development stage; and risk allocation and certainty of the revenue stream during the construction stage.

Public policy challenges include the use of a regional approach to transmission planning and development rather than individual states doing their transmission planning independent of other states or regional needs, the coordination of state and federal regulatory commissions, and coordinating for site approval processes.

Also, there are challenges concerning the application of open meetings laws and the Public Records Act, and the impact those requirements have on the willingness of participants to share confidential, proprietary or market-sensitive information.

The WIA is not required to comply with the Wyoming State procurement policy processes.

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[10] A copy of Mr. Tarpey's presentation may be found at: http://www.deq.utah.gov/Issues/REIFG/docs/Infrastructure_Authority.pdf

APPENDIX 7 – IRP Standards and Guidelines

Attachment A: Docket No. 90-2035-01

Standards and Guidelines for Integrated Resource Planning
for PacifiCorp, Utah Jurisdiction

Procedural Issues:

1. The Commission has the legal authority to promulgate Standards and Guidelines for integrated resource planning.

2. Information Exchange is the most reasonable method for developing and implementing integrated resource planning in Utah.

3. Prudence Reviews of new resource acquisitions will occur during ratemaking proceedings.

4. PacifiCorp's integrated resource planning process will be open to the public at all stages. The Commission, its staff, the Division, the Committee, appropriate Utah state agencies, and other interested parties can participate. The Commission will pursue a more active-directive role if deemed necessary, after formal review of the planning process.

5. Consideration of environmental externalities and attendant costs must be included in the integrated resource planning analysis.

6. The integrated resource plan must evaluate supply-side and demand-side resources on a consistent and comparable basis.

7. Avoided Cost should be determined in a manner consistent with the Company's Integrated Resource Plan.

8. The planning standards and guidelines must meet the needs of the Utah service area, but since coordination with other jurisdictions is important, must not ignore the rules governing the planning process already in place in other jurisdictions.

9. The Company's Strategic Business Plan must be directly related to its Integrated Resource Plan.

Standards and Guideline:

1. Definition:

Integrated resource planning is a utility planning process which evaluates all known resources on a consistent and comparable basis, in order to meet current and future customer electric energy services needs at the lowest total cost to the utility and its customers, and in a manner consistent with the long-run public interest. The process should result in the selection of the optimal set of resources given the expected combination of costs, risk and uncertainty.

2. The Company will submit its Integrated Resource Plan biennially.

3. IRP will be developed in consultation with the Commission, its staff, the Division of Public Utilities, the Committee of Consumer Services, appropriate Utah state agencies and interested parties. PacifiCorp will provide ample opportunity for public input and information exchange during the development of its Plan. 4. PacifiCorp's future integrated resource plans will include:

a. A range of estimates or forecasts of load growth, including both capacity (kW) and energy (kWh) requirements.

i. The forecasts will be made by jurisdiction and by general class and will differentiate energy and capacity requirements. The Company will include in its forecasts all on-system loads and those off-system loads which they have a contractual obligation to fulfill. Non-firm off-system sales are uncertain and should not be explicitly incorporated into the load forecast that the utility then plans to meet. However, the Plan must have some analysis of the off-system sales market to assess the impacts such markets will have on risks associated with different acquisition strategies.

ii. Analyses of how various economic and demographic factors, including the prices of electricity and alternative energy sources, will affect the consumption of electric energy services, and how changes in the number, type and efficiency of end-uses will affect future loads.

b. An evaluation of all present and future resources, including future market opportunities (both demand-side and supply-side), on a consistent and comparable basis.

i. An assessment of all technically feasible and cost-effective improvements in the efficient use of electricity, including load management and conservation.

ii. An assessment of all technically feasible generating technologies including: renewable resources, cogeneration, power purchases from other sources, and the construction of thermal resources.

iii. The resource assessments should include: life expectancy of the resources, the recognition of whether the resource is replacing/adding capacity or

energy, dispatchability, lead-time requirements, flexibility, efficiency of the resource and opportunities for customer participation.

c. An analysis of the role of competitive bidding for demand-side and supply-side resource acquisitions.

d. A 20-year planning horizon.

e. An action plan outlining the specific resource decisions intended to implement the integrated resource plan in a manner consistent with the Company's strategic business plan. The action plan will span a four-year horizon and will describe specific actions to be taken in the first two years and outline actions anticipated in the last two years. The action plan will include a status report of the specific actions contained in the previous action plan.

f. A plan of different resource acquisition paths for different economic circumstances with a decision mechanism to select among and modify these paths as the future unfolds.

g. An evaluation of the cost-effectiveness of the resource options from the perspectives of the utility and the different classes of ratepayers. In addition, a description of how social concerns might affect cost effectiveness estimates of resource options.

h. An evaluation of the financial, competitive, reliability, and operational risks associated with various resource options and how the action plan addresses these risks in the context of both the Business Plan and the 20-year Integrated Resource Plan. The Company will identify who should bear such risk, the ratepayer or the stockholder.

i. Considerations permitting flexibility in the planning process so that the Company can take advantage of opportunities and can prevent the premature foreclosure of options.

j. An analysis of tradeoffs; for example, between such conditions of service as reliability and dispatchability and the acquisition of lowest cost resources.

k. A range, rather than attempts at precise quantification, of estimated external costs which may be intangible, in order to show how explicit consideration of them might affect selection of resource options. The Company will attempt to quantify the magnitude of the externalities, for example, in terms of the amount of emissions released and dollar estimates of the costs of such externalities.

l. A narrative describing how current rate design is consistent with the Company's integrated resource planning goals and how changes in rate design might facilitate integrated resource planning objectives.

5. PacifiCorp will submit its IRP for public comment, review and acknowledgement.

6. The public, state agencies and other interested parties will have the opportunity to make formal comment to the Commission on the adequacy of the Plan. The Commission will review the Plan for adherence to the principles stated herein, and will judge the merit and applicability of the public comment. If the Plan needs further work the Commission will return it to the Company with comments and suggestions for change. This process should lead more quickly to the Commission's acknowledgement of an acceptable Integrated Resource Plan. The Company will give an oral presentation of its report to the Commission and all

interested public parties. Formal hearings on the acknowledgement of the Integrated Resource Plan might be appropriate but are not required. 7. Acknowledgement of an acceptable Plan will not guarantee favorable ratemaking treatment of future resource acquisitions.

8. The Integrated Resource Plan will be used in rate cases to evaluate the performance of the utility and to review avoided cost calculations.