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Residential, Commercial, Institutional and Industrial Technical Work Group
Summary List of Recommended High Priority Mitigation Options

Note: Text *with italics* and yellow highlights indicates provisional text added by CCS based on TWG input following the May 3, 2007, RCII TWG call, including text suggested by TWG members but not yet reviewed by the full TWG. Also appearing in yellow highlights are analysis results (or changes in results) and related materials not yet reviewed by the TWG. Policy design elements where further TWG input is needed also, in some cases, appear in *italics*. Changes made or issues raised during the May 11, 2007 CCAC meeting appear in green highlights. Please note that options marked as "Completed" in the table below were accepted by the CCAC during its 5/11/07 meeting for inclusion in the CCAC Final Report, but text on and analyses of these options can still receive modifications for clarification, elaboration, or to reflect new information or improved assumptions.

Please note that details of the analyses of these options can be found in Annex 2 to these Summary Options Descriptions (found at the end of this document).

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
RCII-1	Demand Side Management Programs, Efficiency Funds and Requirements (and Financial Incentives)	0.04	1.15	6.6	-$141	-$21	Completed
RCII-2	Market Transformation and Technology Development Programs	0.03	0.30	1.9	-$43	-$23	Completed
RCII-3	State Level Appliance Efficiency Standards and State Support for Improved Federal Standards	0.05	0.20	1.5	-$55	-$36	Completed
RCII-4	Building Energy Codes	0.03	0.25	1.6	-$15	-$10	Completed

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Status of Option
		2010	2020	Total 2007-2020			
RCII-5	"Beyond Code" Building Design Incentives and Mandatory Programs	0.07	0.52	3.4	-$17	-$5	Completed
RCII-6	Consumer Education Programs	*Not Quantified*					Completed
RCII-7	Support for Implementation of Clean Combined Heat and Power	*Quantified in Coordination with ES*					Completed
RCII-8	Support for Renewable Energy Applications	*Quantified in Coordination with ES*					Completed
RCII-9	Carbon Tax	*Not Quantified*					Pending
RCII-10	Industrial Energy Audits and Recommended Measure Implementation	0.07	0.56	3.6	-$93	-$26	Completed
RCII-11	Low Income and Rental Housing Energy Efficiency Programs	0.05	0.75	4.7	-$41	-$9	Pending
RCII-12	State Lead by Example	0.03	0.27	1.7	-$10	-$6	Completed
RCII-13	Metering Technologies w/Opportunity for Load Management and Choice	0.01	0.03	0.2	-$3	-$12	Completed

RCII-1. Demand Side Management Programs, Efficiency Funds and Requirements *(And Financial Incentives)*

Policy Description

This policy option involves increasing the efficiency of electricity and natural gas use in Montana through Demand Side Management (DSM) programs, funds, and/or requirements. This option focuses on what are typically termed DSM activities – programs, usually delivered by utilities or government-designated agencies, designed to reduce energy consumption and/or change the timing of energy use. Examples of DSM programs include technical assistance for and implementation of energy efficiency and renewable energy measures, electrical (and in some cases fuel) demand response, alternative rate schedules, and research activities. Note that the activities described for this option may also support implementation of other options recommended by the Climate Change Action Committee (CCAC), such as RCII-11 and RCII-12.

Policy Design

This policy design is focused on increasing energy efficiency programs through the State utilities, and is linked with the energy efficiency element of Energy Supply TWG option (ES-1), "Environmental Portfolio Standard (EPS)." ES-1 would require that each utility capture 100% of its cost-effective energy efficiency over a period of 15 years.

Implementation of energy efficiency/energy conservation programs could include the following elements:

- *Creation of an independent, non-profit, state-wide provider of energy efficiency services to support, in particular, the provision of energy-efficiency/conservation programs in the service territories of smaller utilities, including cooperatives. Consideration should also be given to allowing utilities, such as NorthWestern Energy, that already implement demand side management programs funded by their customers through energy supply charges, to opt out of the program. A statewide energy efficiency provider tasked with undertaking demand side management programs for participating utilities – proportionate to the amount invested by the customers of those utilities – would realize significant efficiencies and would ensure that all Montanans and all Montana utilities benefit from the acquisition of what is typically the lowest cost resource.*
- *Establish a revolving loan program, similar to that included in Montana Senate Bill 445, to focus on energy-efficiency/conservation investments.*
- New or expanded state tax credits may provide an additional means of increasing investments in energy efficiency, particularly for appliances and equipment (ground-source heat pumps are an example in some applications) that require a significant initial outlay on the part of consumers.

Goals/Timing: The goals for this option follow the goals from the ES-1 option:

Each investor-owned and public utility should:

- Meet 20% of its load using renewable energy resources by 2020, increasing to 25% by 2025.
- Implement a plan to achieve 100% of cost-effective energy conservation by 2025.
  - By 2010, identify its achievable cost-effective energy conservation for the subsequent 10 years.
  - Update its energy-efficiency assessment and plan regularly, possibly every two years.
  - "Energy conservation" refers to both electricity and natural gas.

Parties Involved: Investor-owned utilities, electric cooperatives, Montana PSC, state government.

Implementation Mechanisms

The goals noted above would be implemented through an Environmental Portfolio Standard, to be adopted on the basis of legislation, regulation or other agreement.

Effective implementation of expanded DSM programs may require a larger pool of qualified and reliable contractors to implement energy efficiency measures. Owners of homes and commercial buildings must also be educated to understand the benefits of energy conservation/improved energy-efficiency/DSM. Consumer and specialist education are therefore important as supporting mechanisms to enable implementation of this policy.

It is expected that additional energy efficiency programs might focus on:

- Providing expanded residential and commercial energy audit programs, and offer incentives and assistance for building owners to follow up on audit recommendations.
- Promoting ground-sources heat pumps *(where applicable)* and other relevant technologies for heating and cooling of buildings, including homes, churches, schools, and commercial buildings, as applicable *and cost-effective*.
- Conserving space-conditioning energy by promoting weatherization (insulation, high-efficiency window systems, and other measures) of homes and other buildings.
- Promoting and expand water heater demand-control programs to reduce peak period electrical energy use, and promote the use of higher-efficiency water heaters.
- Promoting the use of compact fluorescent lamps (CFLs) and other high-efficiency lighting and lighting control systems, including applications in the commercial sector.
- Promoting the use of ENERGY STAR® appliances.
- *Promoting fuel switching when doing so cost-effectively reduces overall (electricity generation plus direct fuel use) GHG emissions.*
- Expand existing effective energy efficiency activities.

Note that this listing of options is not meant to preclude any existing or future DSM options that might be applicable to Montana—it is intended only as a list of promising examples for use of expanded USB funds or funds otherwise earmarked for energy efficiency investments. In many cases, examples of such programs already exist, but could be expanded in scope and effectiveness with additional resources.

Related Policies/Programs in Place

As part of its 1997 restructuring legislation, Montana established its Universal System Benefits Program (USBP). Beginning January 1, 1999, all electric utilities began annually contributing 2.4% of their 1995 revenues to the USBP. *As of 2006, the total funds estimated to be collected by from electricity consumers by NorthWestern Energy were approximately $9.4 million. The funds support energy efficiency, renewable-energy resources, low-income energy assistance, renewable-energy research and development, and large customer rebates. The guidelines for expenditures of Universal System Benefits (USB) funds (both gas and electric) for 2006 are established in an interim order of the Montana Public Service Commission (PSC) dated November, 2005, and are presented in the table below*[1].

Table 3. 2006 electric and natural gas USB allocations.

Program category	Electric USB expense target	%	Gas USB expense target	%
Conservation	$1,239,352	14%	$327,000	11%
Market transformation	$112,036	1%	NA	
Renewables	$651,094	8%	NA	
R&D	$89,261	1%	NA	
Low-Income	$3,505,277	40%	$2,547,372	89%
Bill discounts	$1,853,584		$1,945,800	
Energy Share	$575,000		0	
Free weatherization	$962,843		$585,000	
Large Customer	$3,126,527	36%	NA	
Total Expenses	$8,723,547	100%	$2,874,372	100%
Projected USB revenue	$9,367,246		$2,278,585	
Surplus/(deficiency)	$643,699		$(595,787)	

NorthWestern Energy programs have led to the installation of photovoltaics (PV) on residences, schools, fire stations, and commercial facilities throughout the state. Electric cooperatives and Montana-Dakota Utilities Co. also contribute to the USBP.

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1 *Montana Public Service Commission, Order No. 6679a in Dockets numbered D2004.7.99, D2004.12.292, and D2005.6.016. Table shown is from page 27 of the referenced order. Order is available as http://www.psc.state.mt.us/eDocs/eDocuments/pdfFiles/D2004-12-192_6679a.pd f.*

A USB program applying to natural gas also exists (as authorized under MCA 69-3-1408). The natural gas USB program has recently been amended by the Montana Legislature (see http://data.opi.mt.gov/bills/2007/billpdf/HB0427.pdf), but what the impact of the amendment on existing USB-funded activities is not yet certain.

Montana's USBP is effective until December 31, 2009, when it is scheduled to "sunset". *Note that the USB program has been scheduled to sunset on several previous occasions[2], but has been renewed each time. It is possible that the program will again be renewed in 2009, or replaced with a comparable or more effective program.* Utilities may spend all or a portion of the funds on internal programs, or they may opt to contract or fund these programs externally. Large industrial customers with average monthly demand loads exceeding 1,000 kilowatts also fall under the law and may choose to "self-direct" the funds that would normally go to the USBP to internal energy programs.[3]

At present, some utilities, including NorthWestern, have shifted some of what were previously USB funds spent on energy efficiency into their rate base, and are thus supporting energy-efficiency programs in the same manner that electricity supply resources are supported.

A $500 conservation tax credit, and a revolving loan program for conservation done in association with renewable energy projects, was established under MCA 75-25-101.

Types(s) of GHG Reductions

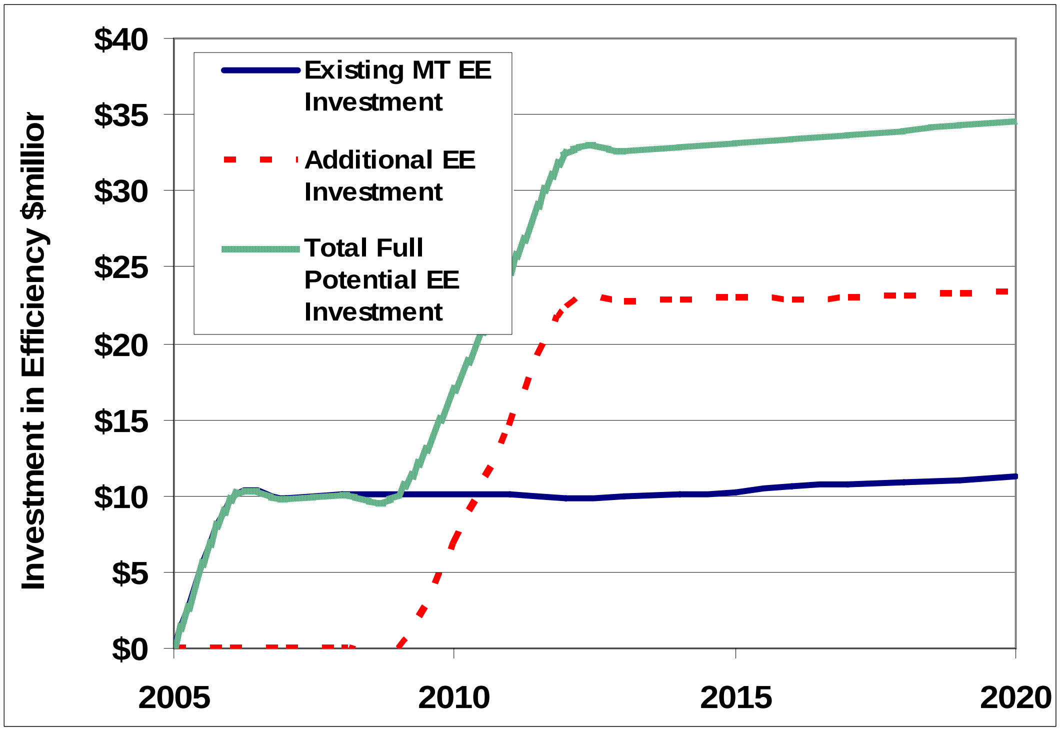
Principally, the reduction in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

[2] *The history of USB legislation includes the following: 1997 — SB 390 established USB for the period 1/1/99 to 7/1/03; 2003 — SB 77 extended USB from 7/1/03 to 12/31/05; and 2005 — SB 365 extended USB from 12/31/05 to 12/31/09.*

[3] Database of State Incentives for Renewables and Efficiency, available at http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MT01R&state=MT&CurrentPageID=1&RE=1&EE=1 .

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-1	Demand Side Management Programs, Efficiency Funds and Requirements	Current/expected Energy Efficiency Investment	0.29	0.78	6.5	N/A	N/A
	Electricity Savings	(as above)	0.24	0.63	5.3	N/A	N/A
	Natural Gas Savings	(as above)	0.05	0.15	1.2	N/A	N/A
RCII-1	Demand Side Management Programs, Efficiency Funds and Requirements	New/Expanded Energy Efficiency Investments	0.04	1.15	6.6	-$141	-$21
	Electricity Savings	(as above)	0.03	0.92	5.4	-$79	-$15
	Natural Gas Savings	(as above)	0.01	0.23	1.2	-$61	-$49



CCS facilitators will review information from NW Power and Conservation Council on cost-effective energy conservation as an additional/alternative input to revise the analysis done to date to estimate electricity savings.

Data Sources: The analysis relies on the following key sources:

- The Energy Efficiency (EE) Task Force Report to the Clean and Diversified Energy Advisory Committee (CDEAC) of the Western Governors' Association (WGA), referred to here as the "WGA CDEAC EE report".[4] This report provides estimates of cost-effective efficiency potential, and the average cost per MWh saved ($25/MWh).
- Various other efficiency assessments by the Southwest Energy Efficiency Project (SWEEP), the Northwest Power Planning Council, and the California Energy Commission. Together, these sources suggest an average savings from utility energy efficiency programs of approximately 6 kWh per annual program dollar invested.
- Electricity avoided costs are provisionally based on the levelized value of long-term standard Qualifying Facilities Tariff from the Montana Public Services Commission. ($49 per MWh).[5]

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[4] WGA, 2005. *The Potential for More Efficient Electricity Use in the Western United States, December 19, 2005.* http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency.htm

[5] Estimate derived from contract data underlying the "the long-term, standard QF [Qualifying Facilities] tariff", "Option 1" ($49.90 per MWh, nominal cost average of quarterly contract costs from 2007 through 2014) as set by the Montana Public Services Commission, in an order covering DOCKET NO. D2003.7.86, ORDER NO. 6501f 2, DOCKET NO. D2004.6.96, ORDER NO. 6501f, and DOCKET NO. D2005.6.103, ORDER NO. 6501f, dated

- Average cost of gas DSM programs reported in Tegen, S. and Geller, H., 2006, Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org.
- *Natural gas avoided costs based on costs of gas supply to Montana, with future gas costs estimated based on projections from the USDOE's Annual Energy Outlook 2006***.**

Quantification Methods: As Montana-specific electricity or gas efficiency potential studies are not presently in-hand, estimates of efficiency savings and costs are based on regional studies and analyses/experience in other states. These studies were used to derive an estimate of efficiency savings per dollar spent on programs, which in turn, are used to translate spending levels into energy savings and program savings targets. The achievable efficiency potential was estimated based on the analysis of best practices and of other efficiency potential studies in the Western US (see WGA CDEAC EE, 2005). The WGA analysis suggests a range from 0.8 to 1.0 percent savings per year is achievable, and we used the high end of that range here (1.0%) given the relatively low historical level of efficiency investment in Montana—at least until recent years (suggesting higher potential savings). The assumption of 1.0 percent annual energy savings results in an estimated annual energy efficiency investment level (for DSM only) on the order of 2.5% of revenues (for electric utilities). These estimates are based on programs and policies that aim for cost-effectiveness for all measures.

Key Assumptions:

- Avoided costs of electricity ($49/MWh)
- Avoided cost of gas ($6.5/MMBtu, levelized).
- Average cost of electricity efficiency measures ($25/MWh saved). *Note, however, (for example) that NorthWestern Energy's most recent default supply plan estimated an average levelized acquisition cost of energy efficiency of $20/MWH over a 20 year period, and the equivalent of about 870 GWh/yr of cost-effective DSM potential [Reference to "aMW" removed at the request of the CCAC]*, *based on an avoided cost of $45 per MWH*.
- Average cost of gas efficiency measures ($2.1/MMBtu saved.)
- Full, achievable cost-effective efficiency improvements (1.0% reduction in sales per year.)
- Savings target includes savings from existing programs.
- Savings from existing programs estimated based on the current (2005/2006) investments in efficiency by NorthWestern Energy (electric and gas) relative to total revenue from utility sales.

December 19, 2006. The $49.90 cost indicated is shown in paragraph 184 of the PSC document. Cost shown here extends the stream of nominal costs in the original NWE/PPL document by including values for 2015 to 2020 that increment the 2014 average value at the rate of inflation, levelizes the resulting 2007 to 2020 stream, and adjusts the levelized value to 2005 dollars.

- Avoided electricity emissions (Assumes that reductions in electricity generation requirements through 2010 will come from the average emissions rate of then-existing fossil-fueled sources; by 2020 the predominant effect is assumed to be a reduction in reference case new coal and gas builds during the 2010-2020 period.)

Key Uncertainties

- Montana-specific costs of DSM programs at savings levels modeled.
- Levels of spending/savings from Existing DSM programs in Montana (some utilities).
- Impact of electricity energy efficiency programs on peak demand as well as energy requirements.

Additional Benefits and Costs

Benefits

- Reducing use of electricity and natural gas through this option also reduces emissions of local and regional air pollutants, such as sulfur and nitrogen oxides, which in turn reduce the human health and other impacts of those emissions.
- Reducing peak demand and improving the utilization of the electricity system.
- Reducing the risk of power shortages.
- Supporting local businesses and stimulating economic development.
- Transmission/distribution system costs reduction.

Costs

None Cited.

Feasibility Issues

- Costs and performance vary substantially between measures that might be considered for DSM programs. Some measures may present low capital costs and higher operating costs (or vice versa), and there is uncertainty about the costs and savings for other measures.
- Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-2. Market Transformation and Technology Development Programs

Policy Description

Market transformation is a relatively new term for energy efficiency programs that focus on voluntary efforts implemented by non-utility organizations to encourage greater uptake by consumers (residential, commercial, and industrial, as well as the professionals that service energy-using equipment) of cost-effective energy efficiency practices. Market transformation also seeks to ensure sufficient supplies of technologies and practitioners to meet the subsequent increased demand for energy efficiency. As such, a market transformation program is designed to create a situation where the bulk of the private market automatically adopts or incorporates technologies or techniques that result in improved energy efficiency. The goal of a market transformation and technology development program is to put energy efficiency technologies and practices into a position where they will be demanded by the public, chosen by builders and manufacturers, and provided by retailers and contractors. Methods of transformation can be different for each technology or technique, but often revolve around public and private review of quality and effectiveness, including partnerships between government agencies, retailers, manufacturers, and non-governmental agencies. Market transformation programs can be statewide or regional.

Policy Design

Market transformation is an important goal for Montana, and an important mechanism to cost-effectively bring energy-efficient products and services to consumers. It is recognized, however, that Montana constitutes a limited market, by itself, for energy-efficient products. As a result, Montana should focus its efforts on joining, supporting, or increasing its participation in regional market transformation alliances (the Northwest Energy Efficiency Alliance and the Midwest Energy Efficiency Alliance are examples) that develop and implement technologies for reduction of energy use and GHG emissions. This could include, as applicable, working to extend market transformation efforts currently focused on specific parts of the state to consumers statewide, as well as expanding the number and types of different energy-efficient products included in market transformation efforts in Montana.

Market transformation and technology development efforts should stress addressing technologies of particular significance to Montana. One example is the testing and monitoring of residential and commercial high-efficiency structures to determine their performance under Montana conditions and to identify barriers to implementation of energy-efficient building practices.

The State should consider the establishment of an independent entity or an entity within state government to assess cost-effective efficiency potential (per the EPS in RCII-1), and should work with other states in the region to assess efficiency potential. In developing a new or extended market transformation effort for Montana, the lessons learned from previous efforts should be carefully incorporated, and the costs to state government and to consumers of an extended market transformation program should be carefully evaluated.

Goals: By 2009, put in place mechanisms to allow broader coverage of market transformation programs in Montana both to additional geographic areas and with regard to technologies covered. *Is consideration of a specific energy savings target desirable?*[6]

Timing: as above.

Parties Involved: Under development.

Other: Under development.

Implementation Mechanisms

Important implementation mechanisms for this Option include (*partial list at present)*:

- Consumer education.
- Electricity and gas pricing (to encourage purchase of higher-efficiency appliances and equipment or control systems.)
- *As applicable and appropriate, rebate offers for high-efficiency appliances and equipment (high-efficiency front-loading clothes washers may be an example here.)*
- Tax incentives to encourage purchase of higher-efficiency appliances and equipment.
- *An expanded revolving loan program to fund energy-efficiency/conservation program investments.*

Related Policies/Programs in Place

The Northwest Energy Efficiency Alliance (NEEA, www.nwalliance.org) is a non-profit corporation supported by electric utilities, public benefits administrators, state governments, public interest groups and energy efficiency industry representatives. These entities work together to make affordable, energy-efficient products and services available in the marketplace.[7]

NEEA participation is limited, in principle, to utilities west of the continental divide (in Bonneville Power Administration's (BPA) service area). NorthWestern Energy, Bonneville Power Administration, and electric cooperatives in the BPA service are all partners in NEEA and provide some funding. The electric co-operatives outside the BPA service area and Montana Dakota Utility are not partners.

The Midwest Energy Efficiency Alliance (www.mwalliance.org) uses a similar model of partners and goals but does not currently cover Montana, only extending as far west as Illinois. However, utilities in the eastern portion of Montana might find stronger connections with programs in this area.

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[6] The Northwest Power Planning Council (NPPC) may have information on Market Transformation, possibly by utility area, within its most recent Power Plan.

[7] See http://www.nwalliance.org/aboutus/index_aboutus.aspx .

Types(s) of GHG Reductions

As with RCII-1, this option would principally yield reductions in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.)

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-2	Market Transformation and Technology Development Programs		0.03	0.30	1.9	-$43	-$23

Data Sources: Market transformation program costs and performance based on programs and experience of the Northwest Energy Efficiency Alliance.

Quantification Methods: Apply program results, expressed in percent savings, from the Northwest to Montana.

Key Assumptions:

- Market transformation programs can reduce electricity demand by 0.2% annually.
- Implementation of specific measures and programs must be timed correctly for maximum impact on market adoption of new technologies.
- Avoided cost for electricity as noted in RCII-1.

Key Uncertainties

Degree to which savings from regional efforts will continue to accrue as they have in the recent past; degree to which MT consumers not in the NEEA area will be able to use or replicate successful NEEA programs.

Additional Benefits and Costs

Benefits

- The non-energy and non-emission benefits are almost always going to be the economic drivers behind the success of these programs. Focusing only on emission reductions or only on payback through energy efficiency of the user will eliminate many technologies when they could otherwise provide substantial economic benefits. An example is an improvement to an industrial production line that may have negligible overall energy consumption reduction at the plant, but that decreases the energy consumption per unit produced (energy intensity) while speeding up production and retaining jobs in the state.

- Co-benefits could include transmission/distribution system costs reduction.
- Programs could help to lower capital and installation costs.

Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-3. State Level Appliance Efficiency Standards and State Support for Improved Federal Standards

Policy Description

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or where higher-than-federal standard efficiency requirements are appropriate.[8] Regional co-ordination for state appliance standards can be used to avoid concerns that retailers or manufacturers may (1) resist supplying equipment to one state that has advanced standards or (2) focus sales of lower efficiency models on a state with less stringent efficiency standards.

Policy Design

In recognition of the fact that Montana represents, on its own, a relatively limited market for appliances and equipment, this policy is designed to encourage the State to work with other states and with regional entities[9], as applicable, to:

- Review federal appliance standards, and work with federal agencies and others toward raising federal appliance and equipment energy efficiency standards where applicable.
- Implement, in concert with other states, higher-than-federal energy efficiency standards for appliances where technological advances allow. Analyses of possible energy efficiency standards that can be enacted at the State-level are available at www.standardsasap.org[10]. Draft legislative language can be found at http://www.apolloalliance.org/strategy_center/model_legislation/eelegis.cfm.

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[8] In recent years, Arizona, Oregon, and Washington, among other states, adopted state standards for several appliances; this led to the inclusion of standards for these appliances in the 2005 federal Energy bill.

[9] It was suggested that the TWG review any activities that the Northwest Energy Efficiency Alliance have underway with regard to improving energy efficiency standards. The CCAC also noted the desirability of working with adjacent states, including Idaho and Wyoming, to adopt uniform standards, and possibly adopting standards across a wider region of the West, possibly including states covered in the Western Systems Coordinating Council.

[10] Appliances and equipment noted by the American Council for an Energy-Efficiency Economy and the Appliance Standards Awareness Project (in their report Leading the Way: Continued Opportunities for New State Appliance and Efficiency Standards, dated March, 2006, and available as http://www.standardsasap.org./a062.pdf) as being candidates for new or more stringent state-level standards included "bottle-type water dispensers, commercial boilers, commercial hot food holding cabinets, compact audio products, DVD players and recorders, liquid-immersed distribution transformers, medium-voltage dry-type distribution transformers, metal halide lamp fixtures, pool heaters, portable electric spas (hot tubs), residential furnaces and boilers, residential pool pumps, single-voltage external AC to DC power supplies, state-regulated incandescent reflector lamps, and walk-in [commercial] refrigerators and freezers". Other devices sometimes mentioned as candidates for state-level standards (or for federal standards) include ceiling fans and ceiling fan light kits, and commercial clothes washers.

- Develop and implement standards for residential-sector appliances not currently covered by federal standards.
- Develop and implement standards for commercial-sector appliances and equipment not currently covered by federal standards.

It is anticipated that the process of setting higher energy-efficiency standards in Montana, in concert with other states, will encourage higher federal standards and higher-volume manufacturing of higher-efficiency appliances and equipment, resulting in wider distribution and likely lower prices for these devices.

Goals: Review of standards and report to Governor by 2008, with adoption of changes in standards by 2009 (activities designed to be timed to coordinate with consideration of energy matters by the Montana State Legislature).

Timing: as above.

Parties Involved:

- Electric and gas utilities.
- State government agencies, including the Department of Environmental Quality and the Department of Commerce.
- Appliance manufacturers and appliance/equipment industry representatives.

Other: Under development.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this option include:

- Appliance standards promulgated by legislation or developed administratively.
- Assistance programs to help low-income consumers with purchase of appliances meeting more stringent standards, so as to reduce the higher-first-cost burden of higher-efficiency appliances on those consumers.
- Elevated energy standards for appliances and equipment purchased by public agencies.
- Work with manufacturers and consider impacts on manufacturers when setting new standards.

Related Policies/Programs in Place

Under development.

Types(s) of GHG Reductions

GHG impacts are similar in nature to those noted for RCII-1 and RCII-2 above.

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-3	State Level Appliance Efficiency Standards and State Support for Improved Federal Standards	Electricity plus Natural Gas	0.05	0.20	1.5	-$55	-$36
		Electricity Savings	0.05	0.17	1.3	N/A	N/A
		Natural Gas Savings	0.00	0.03	0.2	N/A	N/A

Data Sources: Fractional savings and costs drawn from the Appliance Standards Awareness Project ASAP and American Council for an Energy-Efficient Economy ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards."[11]

Quantification Methods: Results for Montana from report above adapted by adjusting for different analysis period, discount rate, and energy prices.

Key Assumptions: Costs and savings from efficiency improvement via standards will be similar in Montana to those indicated in the ASAP/ACEEE report cited above.

Key Uncertainties

The effectiveness and cost-effectiveness of the higher-than-federal standards adopted by Montana will depend in part on the standards implemented by other states, including other states in the region.

Additional Benefits and Costs

Benefits

Reduction in water use for some appliance upgrades.

Costs

None Cited.

[11] *See, for example, the following from the Appliance Standards Awareness Project (ASAP) web site: http://www.standardsasap.org/stateops.htm and http://www.standardsasap.org/a062_mt.pdf.*

Feasibility Issues

Feasibility enhanced by ongoing efforts in nearby states.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-4. Building Energy Codes

Policy Description

Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. Given the long lifetime of most buildings, amending state and/or local building codes to include minimum energy efficiency requirements and periodically updating energy efficiency codes could provide long-term GHG savings. Implementation of building energy codes, particularly when much of the building occurs outside of urban centers, can require additional resources.

Policy Design

The proposed policy to improve energy-efficiency-related elements of building codes in Montana, so as to reduce the amount of fossil energy input needed to operate buildings in the state, includes the following elements:

- Undertake a comprehensive review of existing building codes in Montana to determine where increased energy efficiency can be achieved.
- Increase standards such that the minimum performance of new and substantially-renovated buildings, both commercial and residential, is at least 15% higher by 2010 than that required by today's building codes (International Energy Conservation Codes [IECC] 2003, though IECC 2006 codes are under consideration, see below), and 30% higher by 2020.
- Encourage and work toward achieving the goal of "carbon-neutral"[12] status for new buildings. Reductions in greenhouse gas emissions related to building energy use can be achieved through a combination of increased energy efficiency, switching to low- and no-carbon fuels (including solar energy) for previously fossil-fueled end-uses, purchases of "green power" from off-site providers, and/or installing on-site power generation fueled by renewable energy sources.
- Encourage the use of recycled and local building materials.
- Express energy efficiency standards on a per-unit floorspace basis for commercial buildings, and on a per-dwelling-unit basis for residential buildings.
- Periodically and regularly (no less frequently than every 3 years) review building codes, including energy efficiency requirements of building codes, to assure that they stay up-to-

[12] "Carbon-neutral" status for a building means that any energy needs of a building, net of building design to reduce energy use and of on-site renewable energy use, should be supplied by renewable energy sources (such as "green power").

date.[13] Include a review of standards related to air infiltration, building "tightness", and related ventilation requirements.

- Offer, and require as appropriate, education to equip building code officials, builders, designers, and others to effectively implement building energy code improvements. This might include, for example, developing a corps of licensed independent contractors who could serve to inspect buildings for compliance with the new energy codes, especially in rural areas that currently may have minimal code inspection.
- Explore new mechanisms, such as working with financial institutions, and the use of spot checks, to improve code implementation in rural areas.

Goals: See above.

Timing: See above.

Parties Involved:

- Building Codes Council (which includes representatives from the League of Cities and Towns as well as builders, engineers, local government officials, and representatives of state agencies).
- Citizens/consumer advocates (including expanding Council membership to include citizen representation).
- Department of Labor and Industry.
- Department of Environmental Quality.
- Electric utilities.

Other: Under development.

Implementation Mechanisms

- Education is expected to be a significant component of improving building codes. It may be necessary to increase the training of code officials, builders, and others, as well as providing consumer education on building energy use. Continuing education programs for builders and others may be helpful in improving compliance with new codes.
- Institute a statewide building permit program to ensure consistency with regard to code application and enforcement among buildings built both in urban and rural areas.
- Consider providing additional code enforcement to improve understanding of/compliance with more rigorous energy-efficiency codes.
- *Consider using utility resources to help implement building energy codes – for example, having utilities review building designs and monitor energy performance. Utilities might play a role in enforcement through the application of interconnection rules, tariffs, and connection charges that encourage the construction of buildings that use energy*

[13] It is expected the role of state agencies in the code review process will largely be to set it in motion.

efficiently and at an appropriate level. Further information will be provided to the TWG on examples of utility programs.

Related Policies/Programs in Place

Montana has previously adopted the 2003 version of the IECC (International Energy Conservation Code). The Montana Building Codes Council will consider adoption and amendments to the 2006 IECC during code hearings in the summer of 2007.

Recent legislative interest in State energy-efficiency building codes is indicated by the 2003 Montana Senate Joint Resolution (No. 13), which called for a "an interim study to investigate options for improving energy efficiency building codes laws and other energy efficiency and conservation practices."[14]

Types(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, black carbon emissions from avoided fuel consumption.

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-4	Building Energy Codes	Electricity plus Natural Gas	0.03	0.25	1.6	-$15	-$10

Data Sources: WGA CDEAC EE report and detailed results prepared for that report by the Building Code Assistance Project (BCAP); US DOE Building Energy Survey and related documents. State-level building activity/building stock statistics (if available). Building Code Assistance Project (BCAP) analyses by state (including Montana) to derive base savings.

Quantification Methods: Apply general BCAP method to estimate code savings, but apply 15 and 30% target savings figures.

Key Assumptions: Average costs of building code improvements, ratio of gas improvements to electricity improvements.

Key Uncertainties

Relative cost of code improvements more aggressive than those reflected in WGA analysis.

[14] See http://data.opi.mt.gov/bills/2003/billhtml/SJ0013.htm.

Additional Benefits and Costs

Benefits

- Potential to also yield water savings, comfort/indoor air quality improvements, with related improvements in health and productivity.
- Saving consumers and businesses money on their energy bills. More stringent energy codes for buildings will benefit low-income tenants by reducing their monthly energy bills.
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes.
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements, and reduced water use in power plants.
- Supporting local businesses and stimulating economic development

Costs

None Cited.

Feasibility Issues

Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-5. "Beyond Code" Building Design Incentives and Mandatory Programs

Policy Description

This policy provides incentives and targets to induce the owners and developers of new and existing buildings to improve the efficiency with which energy and other resources are used in those buildings, along with provisions for raising targets periodically and resources to help achieve the desired building performance. Many "Green Building" programs have been developed that define standards for efficient energy and resource use and that encourage demand for these green buildings through recognition, incentives, and government mandates.[15] This policy includes elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy- and resource-efficient design and construction.

Policy Design

A combination of financial and regulatory incentives would be used to provide incentives for owners and developers of new and existing buildings to improve their structures, or to build new structures, that exceed energy-efficiency (and net greenhouse-gas emissions) provisions of building codes in force.

Goals:

- Reduce per-unit-floor-area consumption of grid electricity and natural gas by 20% by 2020 in existing buildings, and by 50% in new buildings by 2020. Up to 10% of the targeted reduction for new homes can come from use of off-site electricity generation from renewable energy[16]. These requirements should be phased in over time, and will have the following targets:
- Improve 25% of existing residential units in Montana by the year 2020.
- Improve 25% of existing commercial floorspace in Montana by the year 2020.
- Provide incentives such that 25% of new or substantially remodeled residential units in Montana exceed building energy and greenhouse gas emissions codes in force by the amounts above by the year 2020.
- Provide incentives such that 25% of new or substantially remodeled commercial floorspace in Montana exceeds building energy and greenhouse gas emissions codes in force by the amounts above the year 2020.

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[15] Existing programs include EPA's ENERGY STAR Homes and Leadership in Energy and Environmental Design (LEED).

[16] Note that this limit on the use of renewable off-site electricity generation is assumed to count only the renewable fraction of electricity purchased that is beyond that included in any statewide renewable portfolio standard.

Timing: See above.

Parties Involved:

- State and local government permitting agencies.
- Utilities.
- Financial services industries.
- Building industries.

Other: Under development.

Implementation Mechanisms

Implementation mechanisms, as noted above, could include a combination of financial assistance, special regulatory or administrative consideration for buildings projects that achieve "beyond code" performance, and other types of incentives. Specific examples of such mechanisms are as follows:

- Offering programs to adjust "impact fees" or "connection fees" – such as reduced fees for sewer and water hook-ups for homes that use less hot and cold water – for new and upgraded existing buildings that meet specific higher-than-code energy efficiency standards. Municipalities could be compensated for fees reduction out of a revolving loan fund or by some other mechanism. Develop systems and programs that recognize reduced impacts, and adjust fees accordingly. Such fees adjustments could be made by utilities, municipalities, or other entities, as applicable.
- Offer regulatory advantages, such as "fast-track" (expedited review) processing of applications, for buildings certified as having "beyond code" energy efficiency and environmental performance.
- Develop systems and programs that reward "beyond code" energy efficiency/emissions reduction improvements, including "green mortgages", or adding "points" in project review processes for building features that meet or exceed environmental targets.
- Consider property tax adjustments that waive all or a portion of additional taxes on investments to improve building performance to "beyond code" levels.
- Increase existing tax incentives for building energy efficiency improvements.[17]

Related Policies/Programs in Place

Existing Montana Residential Energy Tax Credits for selected energy efficiency improvements.

Under development.

Types(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.

[17] [Footnote on Senate Bill 210 deleted].

- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, black carbon emissions from avoided fuel consumption.

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$) 2010	2020	Cumulative Reductions (2007 - 2020)	NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
RCII-5	"Beyond Code" Building Design Incentives and Mandatory Programs	Electricity plus Natural Gas	0.07	0.52	3.4	-$17	-$5
		Electricity Savings	0.06	0.43	2.8	-$9	-$3
		Natural Gas Savings	0.01	0.09	0.54	-$8	-$15

Data Sources: Costs of energy efficiency improvements based on studies of costs of building improvements and code changes.

Quantification Methods: Estimates fractional savings in energy intensities needed to meet targets in new commercial and residential buildings. Allocates intensity savings among energy efficiency, renewable energy sources, off-site "green power".

Key Assumptions: Fractions of electric and gas intensity improvement accounted for by efficiency improvements, solar thermal, solar PV, increased biomass use, purchases of renewable-generated power from off-site; fractional savings targets over (new) code levels; growth in housing stock and commercial sector floorspace (linked to projections of Montana population growth); incremental cost of "green power".

Key Uncertainties

- Total commercial building space in Montana (regional estimates can be adapted to provide estimates if needed).
- Fractions of new and existing commercial buildings, and residential units, participating in program.

Additional Benefits and Costs

Benefits

Potential to also yield water savings, comfort/air quality improvements.

Costs

None Cited.

Feasibility Issues

Interaction with appliance standards and energy efficiency programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-6. Consumer Education Programs

Policy Description

The ultimate effectiveness of emissions reduction activities in many cases depends on providing information and education to consumers, as well as to future consumers (primary and secondary school students), regarding the energy and GHG emissions implications of consumer choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions. Public education and outreach efforts should integrate with and build upon existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all of the mitigation actions proposed by the CCAC, as well as those that may evolve in the future.

In addition, in order to effectively implement many of the other options in the residential, commercial, institutional, and industrial sectors, as well as in other sectors, specific and targeted education, outreach, and licensing requirements will be required for professionals in, for example, a variety of building-related and other trades in order to ensure that those professionals have the expertise to support aggressive GHG mitigation options in Montana.

Policy Design

Elements of the design for this policy will:

- Offer consumer education related to energy efficiency and the environmental consequences of energy and other choices.[18] Dovetail with public broadcasting media.
- Direct the Office of Public Instruction and others to develop and implement curricula for primary and (particularly) secondary schools that educate students so that they can evaluate the implications of consumption choices.
- Implement and enhance professional education and certification programs for teachers and for those involved in providing products and services related to energy use and greenhouse gas emissions, so as to build the statewide pool of individuals trained to support RCII and other policy options. This training for professionals (including architects, engineers, builders, code inspectors, lighting and HVAC[19] equipment installers, *electricians, plumbers*, and others) who advise the public on energy choices is seen as a crucial component to the success of other RCII initiatives.

[18] Note that there is overlap between this RCII option and some of the elements of an option (CC-4) being elaborated by the Cross-Cutting TWG.
[19] Heating, Ventilation, and Air Conditioning.

- Provide education programs with a strong focus on energy savings in existing buildings that include follow-up surveys on the actions that have been implemented by participants.
- Educate businesses and retailers about the GHG emissions associated with products and supply chains. Explore regional efforts to rate the GHG emissions of products.
- Discourage use of excessive lights, such as yard lights and unneeded street lights. Some possible guidelines are as follows:
    - Allow only cutoff or semi-cutoff luminaries.[20]
    - Allow only fluorescent lighting or High Intensity Discharge (HID) bulbs in yard lights (no incandescent bulbs).
    - Limit lighting levels on pedestrian walkways to 1.0 fc (foot-candles) on the horizontal and vertical planes.
    - Limit lighting levels in parking areas to an average of 1.5 fc on the ground plane, with a uniformity ratio of 6:1 and a minimum of 0.25 fc.
    - Limit lighting levels on community roadways to 1.0 fc on the ground, with a 3:1 uniformity ratio.
    - Limit lighting levels for main roads to 1.5 fc.
    - Limit lighting levels for building Entries to 3.0 fc.
    - Encourage the use of motion detection switches and other types of control mechanisms to minimize the use of lights when they are not needed.

  Quantitative analysis of the impacts of these lighting guidelines is not expected to be undertaken.

Goals: As noted above.

Timing: Synchronize education initiatives with development and implementation of other RCII options so that those who will make decisions related to energy efficiency and GHG emissions reduction, and those who will implement improvements, will have the background to do so effectively.

Parties Involved:

- Utilities.
- Government agencies (local, state, and federal).
- Private entities.

[20] To reduce glare, cutoff luminaires (light fixtures) allow very little or no light above the horizontal (a maximum of 2.5 percent of the fixture's light output at an angle of 90 degrees from the fixture, and 5 percent at an angle of 80 degrees from the fixture), and semi-cutoff luminaires produce limited light above the horizontal (a maximum of 5 percent of the fixture's light output at an angle of 90 degrees from the fixture, and 20 percent at an angle of 80 degrees from the fixture). See, for example, http://www.lrc.rpi.edu/programs/NLPIP/lightinganswers/lightpollution/cutoffShielded.asp#.

- Primary and secondary schools.
- Building trade organizations.
- Extension services
- Colleges and Universities (including involving both in development of curriculum for education programs)

Other: Under development.

Implementation Mechanisms

Potential implementation mechanisms for this option include:

- Financial support for energy-efficiency training sessions.
- Wide advertisement of education and training sessions and regular and consistent offering of such services.
- Offering incentives or vouchers (for example, for energy-efficient products or other goods or services) for consumers who undertake consumer education and/or change their consumption patterns so as to reduce GHG emissions (this could be applied in a manner analogous, for example, to safe driver discounts for car insurance).

Related Policies/Programs in Place

- **Dark Sky Ordinance**- in Bozeman, the dark sky ordinance limits light pollution by regulating outdoor lighting.

Types(s) of GHG Reductions

These education and information programs are crucial in enabling and supporting GHG emissions reductions in a number of RCII areas and in other sectors, but their direct GHG reduction impacts are very difficult to assess.

Estimated GHG Reductions and Costs (or Cost Savings)

As this option supports many other RCII (and some ES) options, and is difficult to attribute specific GHG-savings, the emissions reductions associated with this option will not be quantified.

Data Sources: Under development.

Quantification Methods: Under development.

Key Assumptions: Under development.

Key Uncertainties

None Cited.

Additional Benefits and Costs

None Cited.

Feasibility Issues

Potential contribution of consumer education programs to reducing GHG emissions is difficult to estimate.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-7. Support for Implementation of Clean Combined Heat and Power

Policy Description

Distributed generation with clean combined heat and power (CHP) systems reduces fossil fuel use and GHG emissions both through the improved efficiency of the CHP systems, relative to separate heat and power technologies, and by avoiding transmission and distribution losses associated with central power stations that are located far away from where the electricity is used. Implementation of these systems by residential, commercial, institutional and industrial energy consumers should be encouraged through a combination of regulatory changes and incentive programs.

Policy Design

The Energy Supply TWG is developing a similar option (as a part of ES-4, "Incentives and Barrier Removal (Including Interconnection Rules and Net Metering Arrangements) for Combined Heat and Power (CHP) and Clean Distributed Generation (DG)"). Information from that group is being shared with the RCII TWG. A review of existing studies on CHP potential in Montana is to be undertaken with help from TWG members. Please see description of ES-4 for additional details.

Goals: See ES-4 Description

Timing: See ES-4 Description

Parties Involved: See ES-4 Description

Other: See ES-4 Description

Implementation Mechanisms

See ES-4 Description

Related Policies/Programs in Place

See ES-4 Description

Types(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control.

Estimated GHG Reductions and Costs (or Cost Savings)

See ES-4 Description

Data Sources: See ES-4 Description. *Includes* estimates of potential from Western Governors' Association Clean and Diversified Energy Initiative Combined Heat and Power White Paper (January 2006).

Quantification Methods: *See ES-4 Description Approach is modeling of the incremental implementation of a target fraction of Montana's CHP potential achieved through adoption of CHP systems fueled with gas, coal, or biomass.*

Key Assumptions: *See ES-4 Description. Includes combined heat and power generation capacity (as a fraction of MT potential, by sector) achieved via this option, and types of fuels used in CHP.*

Key Uncertainties

- Ultimate CHP potential in Montana.
- Heating fuels actually displaced by CHP.

Additional Benefits and Costs

Benefits

- Programs could help to lower capital and installation costs of CHP.
- Develop local expertise with CHP systems.
- Develop market for locally-derived biomass fuels.
- Utility system co-benefits.
- Cost savings and decreased impacts of transmission and distribution (by deferring/displacing need for additions).

Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Completed (as a part of ES-4).

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-8. Support for Renewable Energy Applications

Policy Description

Distributed electricity generation sited at residences and commercial and industrial facilities, and powered by renewable energy sources (typically solar but also wind and hydro), displaces fossil-fueled generation and avoids electricity transmission and distribution losses, thus reducing GHG emissions. This policy can also encourage consumers to switch from using fossil fuels to using renewable fuels in applications such as water, process, and space heating, as well as to supply new energy services using fuels that produce low or no GHG emissions. Increasing the use of renewable energy applications in homes, businesses, and institutions in Montana can be achieved through a combination of regulatory changes and incentives.

Policy Design

[Note that related options are being considered by the Energy Supply TWG (see ES-4) and the AFW TWG (Biomass Fuels)]

The design of this policy may include the following elements:

- Utility incentives for consumers to develop distributed generation, including net-metering policies.
- Removal of barriers to the implementation of distributed generation, including revising interconnection rules as appropriate.
- Tax or other incentives, or favorable tax treatment, for investments in distributed generation.

This policy encompasses solar (thermal and photovoltaic) systems and biomass fuels for use in homes and business, as well as geothermal (ground source) heat pumps.

Goals: *Goals for this option are incorporated in those developed as a part of the Energy Supply TWG's ES-4, "Incentives and Barrier Removal (Including Interconnection Rules and Net Metering Arrangements) for Combined Heat and Power (CHP) and Clean Distributed Generation (DG)"),* Current penetration of solar photovoltaic systems in the NorthWestern Energy service territory in Montana suggest that about 0.1% or less of Montana homes currently use these systems. The penetration of solar thermal water heating systems is also quite limited. The ES and RCII TWGs are seeking other studies of distributed energy potential to help set program targets.

Timing: See ES-4 Description.

Parties Involved: See ES-4 Description.

Other: See ES-4 Description.

Implementation Mechanisms

See ES-4 Description.

Related Policies/Programs in Place

National "Million Solar Roofs" program, adopted in 1997, suggests a target of 1,000 home systems (of 3 kW) for Montana by 2010. NorthWestern Energy and other Montana utilities offer "net metering" programs for some distributed generation.

Types(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, black carbon emissions from avoided fuel consumption.

Estimated GHG Reductions and Costs (or Cost Savings)

Please see results and related material provided in the description for ES-4.

Data Sources: As above.

Quantification Methods: As above.

Key Assumptions: As above

Key Uncertainties

None Cited.

Additional Benefits and Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Completed (as a part of ES-4)

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-9. Carbon Tax

(This option is being considered jointly with ES TWG.)

Policy Description

A CO_2 tax would be a tax on each ton of CO_2 emitted from an emissions source covered by the tax. A CO_2 tax could be imposed upstream based on carbon content of fuels (e.g. fossil fuel suppliers) or at the point of combustion and emission (e.g. typically large point sources such as power plants or refineries). Taxed entities would pass some or all of the cost on to consumers, change production to lower emissions, or a combination of the two. As the suppliers respond to the tax, consumers would see the implicit cost of CO_2 emissions in products and services, and would adjust their behavior to purchase substitute goods and services that result in lower CO_2 emissions. CO_2 tax revenue could go completely to state revenue and be used in a variety of ways such as income tax reduction or policies and programs to assist with CO_2 reductions. CO_2 tax revenue can also be directed to helping the competitiveness of industries or assisting communities most affected by the tax.

Policy Design

The RCII TWG will coordinate with the Energy Supply TWG in considering and developing this option. The ES TWG has expressed the sense that a regional/national approach would be far preferable to Montana-alone tax (which should likely not be considered).

Goals: Under development.

Timing: Under development.

Parties Involved: Under development.

Other: Under development.

Implementation Mechanisms

Carbon tax revenues should be used, in part, to offset the impact of carbon taxes on low-income customers. This could be accomplished, for example (and as applicable) by using carbon tax proceeds to fund weatherization projects that will reduce energy costs for low-income households.

Related Policies/Programs in Place

- See Annex 1: "Summary Table of Carbon Tax Programs", for information on selected carbon tax initiatives to date in Europe, Japan, and North America

Types(s) of GHG Reductions

Under development.

Estimated GHG Reductions and Costs (or Cost Savings)

Under Development (with ES TWG), but will likely be largely a qualitative analysis focusing on review of existing studies germane to the Montana situation, and on the impacts in Montana of *the implementation of a national or regional carbon tax. The focus of analysis will thus be on regional programs and design elements rather than on specific quantification of this option.*

Data Sources: Under development.

Quantification Methods: Under development.

Key Assumptions: Under development.

Key Uncertainties

None Cited.

Additional Benefits and Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Pending.

Level of Group Support

TBD

Barriers to Consensus

TBD

RCII-10. Industrial Energy Audits and Recommended Measure Implementation

Policy Description

This policy option includes providing industrial-sector energy technical assistance (energy audits) to identify and recommend options for reducing fossil energy and electricity use, and for reducing non-energy emissions of GHGs. For example, an agency could be set up, or housed at an existing post-secondary institution, that hires experts who will visit industrial sites to assess current practices and equipment and provide recommendation for reducing GHG emissions. A combination of incentives, expertise, and information to implement recommended options are included in the policy to encourage the operators of industrial-sector facilities to follow up on audit recommendations.

Policy Design

The cost-effective potential for industrial electricity savings in Montana has been estimated at 40 to 84 MW. To address this potential, a program of energy audits for the industrial sector is recommended, coupled with a program of low- or no-interest loans designed to encourage industrial customers to take up energy efficiency measures that reduce both electricity and natural gas consumption.

Goals: The estimated cost-effective potential for industrial-sector electricity savings noted above (40 to 84 MW) is approximately 6 to 12 percent of Montana's industrial-sector electricity use in 2005. Savings of 10 percent of industrial electricity and natural gas use is taken as an overall target for RCII-10 programs to achieve by 2020. The goal of this option is to address 8 percent of this (10 percent reduction in industrial electricity and gas use) target annually, starting in 2009 with a phase-in year, and continuing thereafter.

[The CCAC suggests that the TWG include text that clarifies the distinction between industrial and commercial customers in the context of this option.]

Timing: As noted above.

Parties involved:

- Industrial consumers of electricity and natural gas.
- State government agencies.
- Electric utilities.
- Industrial audit providers (engineers and technicians, including specialists in equipment for particular industries.)
- Suppliers of industrial energy efficiency measures.

Other: None cited.

Implementation Mechanisms

- Low- or no-interest loans for efficiency improvements.
- Monitoring and evaluation arrangements to confirm effectiveness of installed measures.
- Provide incentives and information to encourage industries to adopt USEPA Energy Star standards and measures.
- Tax credits for industrial energy-efficiency improvements, possibly as an extension to tax credits currently proposed in Montana for the energy industry.
- Encourage collaboration between utilities and large industries that may have waste heat that could be tapped for power generation (this may also be an implementation option for RCII-7 and ES-4).
- *Offer opportunities for industrial facilities to self-identify measures for GHG reduction, and to apply for incentives to implement identified measures.*

Related Policies/Programs in Place

Under Development

Types(s) of GHG Reductions

GHG impacts are likely similar in nature to those noted for RCII-1 and other options above, except that to the extent that audit recommendations included emissions reduction efforts that targeted non-energy emissions, GHG impacts will vary on a case-by-case basis.

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-10	Industrial Energy Audits and Recommended Measure Implementation		0.07	0.56	3.6	-$93	-$26

Data Sources: Estimate of cost-effective industrial-sector energy efficiency potential in Montana from John Campbell of Northwestern Energy.

Quantification Methods: The savings target above, the rate at which it is addressed by the option, and the average (2005) consumption of electricity and gas per industrial consumer are used to derive a target number of audits per year, which in turn is used to estimate electricity and natural gas savings, by year, from the option. The costs of saved energy from the measures applied under this option are calculated based on the assumptions as to the average simple payback and lifetime of energy efficiency options noted below. Net costs of energy savings for electricity and natural gas are calculated as the difference between the cost of saved energy for the measures installed and the avoided costs for electricity and natural gas in Montana.

Key Assumptions:

- Cost-effective industrial electricity savings are as noted above, and are available with an average simple payback of 2.5 to 3 years, based on industrial power costs.
- Available savings through industrial-sector natural gas measures are similar to those for electricity measures, and provide similar simple paybacks.
- The average lifetime of industrial-sector energy efficiency improvements is taken to be 12 years.

Key Uncertainties

Actual savings available from industrial sector measures, and average costs of those measures.

Additional Benefits and Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Completed

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-11. Low Income and Rental Housing Energy Efficiency Programs

Policy Description

Energy efficiency programs are a key component of other RCII options, and energy efficiency programs typically yield significant economic benefits (as well as greenhouse gas emissions reductions) to consumers that participate. Low-income consumers, however, are frequently unable to participate in energy efficiency programs due to a lack of funds to pay for improvements or, in the case of renters, an inability to either make changes to their residences or fully benefit from any cost savings. In recognition of this barrier, this policy urges the implementation of programs specifically targeted to the needs of low-income residents for services such as home weatherization—*or replacement, for example, of manufactured homes for which weatherization is inappropriate*, updating or repairing inefficient appliances, and funding for renewable energy systems. These programs could be designed so as to offer low-income residents energy efficiency services with a minimum of up-front costs, and should be marketed through an aggressive campaign of outreach to low-income households and communities. Programs designed to work with both landlords and tenants could also be considered, *and are particularly important, for example, in University towns where weatherization of rental homes is difficult due to a transient population, low tenant incomes, and a limited supply of housing.*

Policy Design

Goals:

- Starting in 2009, Increase energy efficiency by 30% in 50% of eligible low-income residential units in Montana by the year 2015.
- Increase energy efficiency by 50% in 75% of eligible low-income residential units in Montana by the year 2020.
- Eligible homes are those whose household income is below 150 percent of the federal poverty level.
- Extend program to rental housing in general [Note: The CCAC recommends extending this program to rental housing in general, whether or not it is occupied by low-income residents. It is not clear how this extension would affect the goals above (which the CCAC found acceptable)].

Timing: As above.

Parties involved:

- Government housing and other state and federal government agencies.
- Weatherization service providers.
- Owners of rental property.

- Tribal representatives/authorities.
- *Community Action Agencies/Human Resource Development Councils.*
- The Montana Conservation Corps and the Governor's "Warm hearts/warm homes" initiative[21].
- *Non-governmental organizations such as AARP Montana, which can assist with education and outreach;* Habitat for Humanity.

Other: None cited.

Implementation Mechanisms

- Residential energy audits and measure installation.
- Weatherization grants.
- Low-interest loan programs for homeowners and/or rental property owners/managers.
- *Training programs for weatherization providers, possibly in collaboration/cooperation with the parties noted above.*
- *State support for financing or purchase of efficient manufactured housing to replace manufactured housing that cannot be practically weatherized.*

The CCAC encouraged the TWG to consider additional implementation mechanisms aimed at rental dwellings, including:

- Income tax credits for rental property owners who weatherize rental properties to meet energy efficiency standards set by the program.
- Time of sale/rental disclosure of utility bills for a dwelling.
- Tenants' rights laws relating to energy efficiency, possibly including tenants' rights to request an energy audit of their rental.
- Command-and-control requirements similar to those applied to rental of private homes to vacationers—including, for example, a program for licensing or certification of the energy-efficiency of rental properties[22].

Related Policies/Programs in Place

Last year 3% of eligible Montana households used federal tax credits for energy conservation. A Montana DEQ program currently provides weatherization and related health and safety improvement services to about 1700 qualifying low-income households annually, with average savings equal to about 22 percent of household energy use.

Types(s) of GHG Reductions

[21] See, for example, http://deq.mt.gov/Energy/warmhomes/.

[22] *The CCAC recognizes that the overall energy consumption of a rental home is a function of both the energy efficiency of the home itself and of the way that the tenants use energy. Both parameters should be taken into account when judging whether a structure meets efficiency standards.*

GHG impacts are likely to be similar in nature to those noted for RCII-1 and other options related to building energy efficiency improvements.

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO$_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-11	Low Income and Rental Housing Energy Efficiency Programs		0.05	0.75	4.7	-$41	-$9

Data Sources: Average costs and savings achieved by low-income weatherization programs currently operating in Montana obtained from representatives of the MT Department of Environmental Quality form the basis for extrapolation of per-household costs to reach the performance goals listed above.

The CCAC urged the TWG to consult with experts in State agencies that address low-income and rental home energy consumption issues. Discussions with DEQ experts involved in the existing Montana low-income household energy efficiency program have informed the revised estimates presented above.

Quantification Methods: Starting with an estimate of eligible low-income and rental households, estimate rate of penetration of program over time (with eligible households reduced by the number of households participating in the existing DEQ program), and apply target savings rates and costs to estimate savings in electricity and heating fuel use, option total cost, and option cost net of avoided electricity and fuel costs.

Key Assumptions:

- Savings of 30 percent of energy use in low-income households are available at an average cost of $2900 per housing unit for energy efficiency-related options[23].
- Savings of 50 percent of energy use in low-income households are available at an average cost of $5400 per housing unit for energy efficiency-related options.
- The average consumption of electricity, gas, and other heating fuels in low-income households is similar to the average consumption in all households in Montana[24].

[23] The existing DEQ low-income assistance program also implements health- and safety-related measures that do not necessarily provide energy-efficiency (or GHG-reduction) benefits. The average per-household costs shown are net of the estimated costs of these primarily health- and safety-related

- The 2005 estimated fraction of persons with incomes below 150 percent of the federal definition of poverty, 23.7 percent, holds throughout the analysis period[25]. The same fraction of occupied housing units is assumed to be occupied by households with incomes below 150 percent of the poverty level. Based on US Bureau of the Census statistics, this equates to about 20.3% of ALL MT homes (occupied or not).
- An additional 14.6 percent of MT housing units are rental units occupied by households with incomes above 150 percent of the federal definition of poverty, and are thus eligible for the program.
- Low-income weatherization programs in MT currently operating reach 1700 households per year, and continue to do so.

Key Uncertainties

None Cited.

Additional Benefits and Costs

None Cited.

Feasibility Issues

None Cited.

Status of Group Approval

Pending.

Level of Group Support

TBD

Barriers to Consensus

TBD

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[24] This assumption should be reviewed, but takes into account that though low-income homes may be smaller than average MT homes, they use more energy per unit floor space than average homes due to poor insulation and other problems. It may also be that low-income customers may depend on electric heating to a higher degree, on average, than other customers.

[25] 2005 fraction of MT residents of all ages living at incomes below 150 percent of the poverty threshold, from http://pubdb3.census.gov/macro/032006/pov/new46_135150_01.htm. Data used to derive the fraction of rental units occupied by residents with incomes above the 150-percent-of-poverty level are from the US Bureau of the Census 2005 American Community Survey, table S2503: Financial Characteristics, accessed through http://factfinder.census.gov/, and from year 2000 US Bureau of the Census data on the income level of households in rental units in MT.

RCII-12. State Lead by Example

Policy Description

The Montana state government can provide leadership in moving the state toward a stock of buildings with much higher energy efficiency, and toward improving efficiency in the operations of state buildings. The proposed policy provides energy efficiency targets that are much higher than code standards for new state-funded and other government buildings. The proposed policy also includes elements to encourage the improvement and review of efficiency goals over time and to encourage flexibility in contracting arrangements to encourage integrated energy-efficient design and construction. Targets are also provided for the upgrading of energy efficiency in existing state government facilities.

Policy Design

Key elements of this policy include:

- New state government buildings should be LEED-certified at the "silver" level[26], and meet or exceed the energy efficiency and renewable energy goals below.
- State government purchasers should purchase Energy Star-certified appliances and equipment where available, including through bulk purchase programs when applicable, and should also purchase appliances and equipment with higher-than-standard energy efficiency for device types where Energy Star ratings do not apply.
- County and local governments should be encouraged to adopt the same or similar policies covering their buildings and purchases.

The Cross-Cutting TWG suggested having the option include a requirement for carbon-neutral bonding. Climate neutral bonding means that there is no net increase in GHG emissions within the bond issuing agency's geographical jurisdiction after the project becomes operational. A climate neutral performance standard will require architects and engineers to design buildings that minimize the amount of energy they use in the first place. High performance buildings meeting a climate neutral requirement and built to meet or exceed the State's existing sustainable building guidelines will save taxpayers money over the long term as a result of their lower operating costs.

Funding should be provided to analyze and benchmark the energy performance of all existing State government buildings.

[26] "LEED" is Leadership in Energy and Environmental Design. See www.usgbc.org. Note also that an analysis by KEMA of DSM options for buildings in Montana is currently underway.

Goals:

- Reduce per-unit-floor-area consumption of grid electricity and natural gas by 20% by 2020 in existing buildings and by 40% in new buildings by 2020. These requirements should be phased in over time.
- Require 25% of energy use to be generated from renewable sources by 2025 in new and existing buildings. These goals may be met through any combination of on-site generation and "green power" purchases. *Green power purchases must be in excess of the amount of renewable energy supplied as a "standard product" by the utility in order to count toward the goal (that is, must be in excess of the renewable energy included in grid power as a part of any renewable portfolio standard).*
- *Implement bulk-purchase program that affects 10 percent of government energy demand by 2020, reducing that demand by 20 percent [placeholder goals to be reviewed by TWG].*

Timing: See above. Begin implementing program by 2010, with full implementation as above.

Parties Involved: State agencies such as DEQ, building owners, developers, municipal governments, financial institutions (for climate-neutral bonding), building inspectors, architects, engineers, and air monitoring professionals.

Other: The following design elements and goals have been suggested by the Cross Cutting TWG:

- Climate neutral bonding will require that any building projects financed with the issuance of state, county, or local/municipal bonds result in no net increase in GHG emissions.
- If a new construction project is projected to result in an emissions increase, there must be GHG emissions offsets within the state or particular jurisdiction. Offsets could include on-site renewable energy development, renewable energy purchases, energy efficiency (in existing state buildings), carbon sequestration (tree planting), and switching to cleaner or renewable fuels. So, any GHGs emitted after the bond-financed project becomes operational will have to be offset.
- The new buildings could also offset their emissions by purchasing renewable electricity from their local utility. Paying a premium for what's known as "green pricing" electricity will usually be a more expensive offset option than energy efficiency.
- Buildings under this program should be designed in the most economically and energy-efficient manner.
- A community or state could install their own renewable energy project as a way to offset their GHG emissions.
- Monitor building emissions over time.

Implementation Mechanisms

A key implementation mechanism for this option will be to first provide a thorough assessment of the status and energy consumption of all existing state buildings, including establishing a database of buildings and building attributes including floor area, insulation level, energy-using equipment, and history of energy consumption. This assessment would serve as the basis for evaluation of efficiency improvement opportunities in State buildings. Building benchmarking or targets on the commissioning and operation of state buildings, using an ESCO function/entity to implement improvements in state buildings, and capping energy state building energy use per square foot are additional implementation mechanisms. Motion sensors are a specific technology for reducing lighting energy use in government buildings that may have broad application in Montana.

Related Policies/Programs in Place

The Montana State Buildings Energy Conservation Bond

Program provides some funding for energy conservation in state buildings.[27] Some monitoring of building energy use has been carried out under the program. *The State Buildings Energy Conservation Bond program is designed to finance energy improvement projects on state-owned buildings. The Montana Department of Environmental Quality administers the program, which uses bond proceeds to fund the projects and energy savings to repay the bonds. The state of Montana encourages agencies to participate in the program to achieve available energy savings.*

Types(s) of GHG Reductions

As with RCI-1 and other energy-efficiency/building improvement options, this option would principally yield reductions in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$) 2010	2020	Cumulative Reductions (2007 - 2020)	NPV (2007–2020) $ Millions	Cost-Effective-ness $/tCO$_2$
RCII-12	State Lead by Example	Total for Policy	0.03	0.31	2.0	-$11	-$6
		Building Improvement	0.03	0.30	2.0	-$10	-$5
		Bulk Purchasing	0.00	0.01	0.1	-$1	-$22

[27] See, for example, State Bonding Program Update, available at http://leg.mt.gov/content/publications/fiscal/interim/financecmty_dec2001/state_bonding_program.pdf. *As of May, 2007, the Montana State Bonding Energy Conservation Program was not funded during the regular legislative session, but may be considered in the upcoming special legislative session.*

Data Sources: Costs of energy efficiency improvements based on studies of costs of building improvements and code changes.

Quantification Methods: Estimates fractional savings in energy intensities needed, after code improvements, in new and existing government buildings. Allocates intensity savings among energy efficiency, renewable energy sources. *Note that bulk purchase programs are not yet included in the analysis of this option.*

Key Assumptions: Fractions of electric and gas intensity improvement accounted for by efficiency improvements, solar thermal, solar PV, green power purchase beyond RPS requirements, and/or increased biomass use; fractional savings targets over new code levels. Fractional savings and fraction of electricity demand addressed by bulk purchase program.

Key Uncertainties

- Total government building space in Montana (regional estimates currently used).
- Fraction of government agencies occupying leased space in Montana
- Rate of building renovations versus new construction in the government sector.

Additional Benefits and Costs

Benefits

Co-benefits could include transmission/distribution system costs reduction.

Costs

None Cited.

Feasibility Issues

- Costs for this option are uncertain, depending on the measures included.
- Potential interaction with appliance standards and utility programs.

Status of Group Approval

Completed

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

RCII-13. Metering Technologies with Opportunity for Load Management and Choice

Policy Description

Providing energy consumers with price and other information via metering that allow consumers to more clearly identify the outcomes of their choices is a potentially useful tool in improving energy efficiency, reducing greenhouse gas emissions, and saving consumers money in Montana. This policy encourages the implementation of electricity metering technologies and tariff systems, including real-time energy pricing and rates that reflect the cost and greenhouse gas implications of the resources that must be used to provide power. This provides consumers incentives to manage their energy consumption so as to both reduce costs and GHG emissions.

Policy Design

Building on experience in Europe[28] and elsewhere,[29] Montana utilities would implement a system of metering of electricity demand and consumption that: (a) allows a consumer to purchase electricity from specific types of generating resources (b) allows the distribution utility and electricity generators to provide information on the cost and source of the electricity that the consumer is using at any given time. This system allows for interaction on a time-sensitive basis between the consumer, the utility, and the generating source. Through utility reports, the state can review the choices made by the consumers, and target state incentives and rules/tax structures so as to move electricity consumption/production toward choices that produce lower GHG emissions.

This option could accommodate different types of electricity tariff structures, including time of use rates (which typically have impacts on the overall cost of generation, but modest if any impacts on GHG emissions) and increasing-cost block rate structures (in which tier rate structures charge more per unit used as consumers use more electricity per month), which can encourage electricity conservation. The metering system can also be used by the customer to place restrictions on the timing and amount of energy use, including restricting overall demand.

Goals: Develop and implement a pilot program of installation of smart meters at residential and some non-residential customers' sites starting in 2009, with a target implementation of 45,000 residential meters by 2011. The pilot program thus would thus result in the installation of smart meters in less than 10 percent of homes in Montana. Following the pilot program, implement a program resulting in the installation of smart meters for *an additional 30% [Note—this value included by CCS as a starting point for analysis of a full smart metering program, and needs to be reviewed/revised by TWG] of residences by 2020.*

Timing: As above.

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[28] For example, see the ENEL Contatore Elettronico program offered in Italy.

[29] References to be provided.

Parties Involved: Utilities, electricity generators, electricity consumers, state regulatory agencies.

Other: Under development.

Implementation Mechanisms

- Set up a stakeholder technical committee to consider the option, and report back with technical recommendations, which could include a recommendation to move forward with pilot programs in applicable consumer classes.
- Design pilot program (stakeholder/utility representatives/consumers).
- Implement and evaluate pilot program.
- Publish results of pilot program with recommendations.
- If the pilot program is successful, proceed with statewide implementation of meters.

Related Policies/Programs in Place

NorthWestern Energy was considering running a time-of-use pilot program in Missoula, but has reportedly recently decided not to do so.

Types(s) of GHG Reductions

As with RCI-1 and other energy-efficiency and conservation options, this option would principally yield reductions in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Reductions and Costs (or Cost Savings)

#	Policy	Scenario/Element	Reductions ($MMTCO_2e$)			NPV (2007–2020) $ Millions	Cost-Effective-ness $/$tCO_2$
			2010	2020	Cumulative Reductions (2007 - 2020)		
RCII-13	Metering Technologies with Opportunity for Load Management and Choice	Policy Total	0.02	0.12	0.9	-$10	-$12
		Pilot Program	0.02	0.03	0.4	-$5	-$13
		Full Program	0.00	0.09	0.5	-$6	-$11

Data Sources: Experience with Smart Meters in other jurisdictions[30].

Quantification Methods: Based on goals above, phase in smart meter use in Montana, apply meter cost and savings estimates below, and estimate GHG benefits and electricity avoided costs.

Key Assumptions:

- Average incremental installed cost per meter--$200.
- Average electricity use reduction per meter—8 percent.

Key Uncertainties

None Cited.

Additional Benefits and Costs

Benefits

Under development.

Costs

To the extent that low-income households may be covered by new metering and rate policies, low-income residents may be adversely affected, as they often live in substandard rental housing that uses a significant amount of energy, but they lack both the ability and incentive to upgrade appliances, heating equipment, or the building envelope.

Feasibility Issues

None Cited.

Status of Group Approval

Completed

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

[30] For example, experiences describe in Smart Meters: Commercial, Policy and Regulatory Drivers, by Gill Owen and Judith Ward, which reports on experience with smart meters in the UK, and reports one to several percent net savings in electricity consumption from implementation of smart meters, as well as peak reduction impacts. Dated March 2006, Published by Sustainability First, and available as http://www.sustainabilityfirst.org.uk/docs/smart%20meters%20pdf%20version.pdf .

ANNEX 1 TO POLICY OPTIONS DESCRIPTIONS: Survey of Carbon Tax Programs

Jurisdiction	Status: Start Date	Tax Rate - Applicability	Where tax applied	Use of Revenue
Finland[1]	1990 Revised 1997 Revised 2002	1990 $1.54 per ton 1993 $3.00 per ton 1997-8 Electricity: $0.007 per kWh Heating: $22.53 per ton CO2 Natural gas: $11.26 per ton CO2	1990 Fuels 1997 Electricity consumption not fuels Reduced for industry Exemption for international aviation, shipping and refineries	Reimbursement via lower payroll taxes
Norway[2]	1991 Revised 1999	Petrol: $55.90 per ton CO2 Mineral Oil: $30.16 per ton CO2, Oil and gas in North Sea: $52.05 per ton CO2	Producers and importers of oil products Exemption for foreign shipping, fishing, external aviation	Reduce other taxes
Sweden[3]	1991 Revised 2004	CO2: $100 per ton 2004 increases: Gasoline: $0.02 per L Diesel: $0.04 per L Vehicle Tax Electricity: $0.002 per kWh (excludes industry)	Oil, coal, natural gas, liquefied petroleum gas, petrol, and domestic aviation fuel Reduced industrial rate Exemption for high-energy industries i.e. horticulture, mining, manufacturing and pulp/paper industry	Offset by income tax relief Est. revenue $523 million
Denmark[4]	1992 Revised 1999	Commercial $14.30 per ton CO2 Households $7.15 per ton CO2	Buildings	Reallocated as subsidies for energy efficiency activities and voluntary agreements

Germany[5]	1999 Revised 2000	1999 Gasoline: $0.04 per L Heating fuel: $0.03 per L Natural gas:$0.02 per kWh Electricity: $0.01 per kWh 2000-03 annual increases Gasoline: $0.04 per L Electricity: $0.003 per kWh	Electricity, heating fuel, natural gas, gasoline	Tax breaks for commuters; Reduce labor costs via pension contributions
Japan[6]	2001	Green taxation Subsidies for high efficiency automobiles	Vehicles	
UK	2001-	Electricity: $0.0084 per kWh Coal and Natural gas: $0.0029 per kWh Levy will rise with inflation annually beginning in 2007	Electricity generation includes nuclear Renewable exempt	Reduced National Insurance rate Fund for energy efficiency initiatives
Netherlands	2005	Fossil electricity: $0.08 per kWh for small consumers Renewable exemption: $0.04 per kWh Rates indexed to inflation.	Electricity and fuel consumption. Renewable sources with green certificate exempt.	Reduced income and corporate tax rates
City of Boulder, CO	Approved 2006 Start 2007 Expiration 2013	Electricity: (kWh) $.0022 for residential $0.0004 for commercial $0.0002 for industrial use. Max increases: $0.0049 for residential $0.0009 for commercial $0.0003 for industrial use	Electricity use	Funding for city's Climate Action Plan: Programs to increase energy efficiency, renewable energy use, reduce motor vehicle emissions, and take further steps to meeting Kyoto protocol targets

Australia: State of West Australia[7]	Under current consideration	$19.58 per ton CO2		
Canada: Province of Quebec[8]	2006	To be determined by Quebec Energy Board $1 Billion est. 6-yr revenue	Non-renewable fossil fuels sold in bulk to retailers	Green Fund: Public transportation, energy efficiency for buildings

[1] http://www.norden.org/pub/ebook/2001-566.pdf; 2 http://www.regjeringen.no/en/ministries/fin/Selected

3 http://pubs.acs.org/hotartcl/est/98/dec/hanis; 4 http://www.norden.org/pub/ebook/2001-566.pdf ; http://www.iea.org/textbase/pamsdb/detail.aspx; 5 http://www.iea.org/textbase/pamsdb/detail.aspx?

6 http://www.iea.org/textbase/pamsdb/detail.aspx?mode=cc;

7 http://www.news.com.au/story/0,23599,21171914-2,00;

8 http://www.cbc.ca/news/background/kyoto/carbon-tax.html

ANNEX 2 TO POLICY OPTIONS DESCRIPTIONS: PRINTOUTS OF SELECTED PORTIONS OF WORKSHEETS USED TO PREPARE ESTIMATES OF COSTS AND BENEFITS OF RESIDENTIAL, COMMERCIAL, INSTITUTIONAL AND INDUSTRIAL MITIGATION OPTIONS

Printouts below reflect status of analyses of options as of 6/5/2007

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

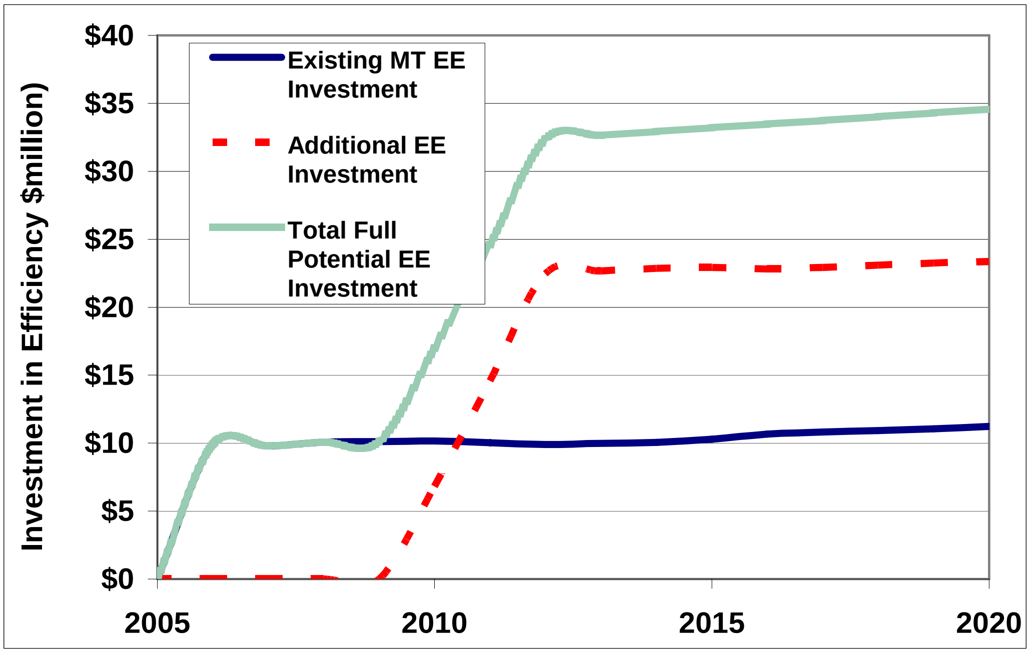
RCII-1 **Expand Energy Efficiency Funds**

Date Last Modified: 4/23/2007 D. Von Hippel/C. Lee

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2010**	
Electricity			
Current/expected Energy Efficiency Investments			
Extrapolating from the current rate of spending by MT utilities			
Implied fraction of electric utility revenues funding current PBF		**0.8428%**	
Temporary approximation calculated from NorthWestern Energy's 2005/2006 "trued-up" DSM spending ($3.2 million) on electricity efficiency programs, and assuming at present that all other electric utilities in MT had similar levels of energy efficiency spending. This assumption will need to be revisited as more data become available. (see "RCII-1 (MT DATA)" worksheet in this workbook.)			
At current rate of spending by NorthWestern Enegy on gas energy efficiency			
Implied fraction of gas utility revenues funding current spending		**0.5132%**	
Temporary approximation calculated from NorthWestern Energy's 2006 reported gas DSM spending of about $1.016 million (including administration expenses), and assuming at present that all other gas utilities in MT had similar levels of energy efficiency spending. This assumption will need to be revisited as more data become available. (see "RCII-1 (MT DATA)" worksheet in this workbook.)			
Year that current/expected action begins		**2006**	
Year that target is achieved (fully phased-in)		**2006**	
Fraction of Statewide Utility Sales Covered			
Residential		**100%**	Assumption
Commercial		**100%**	Assumption
Industrial		**100%**	Assumption
Full Cost-effective Potential Energy Efficiency Investments			
Annual reduction in sales achievable		**1.0%**	per year
Until results of electricity efficiency studies more specific to MT are obtained, the achievable efficiency potential is estimated based on the analysis of best practices and of other efficiency potential studies in the Western US (see WGA CDEAC EE , 2005). This analysis suggests a range from 0.8 to 1.0 percent total savings per year is achievable, and we used the high end of that range here (1.0%). These estimates are based on programs and policies that aim for cost-effectiveness for all measures. For this analysis, this level of savings is assumed from year of full ramp-in through 2025.			
Year that action begins		**2010**	
Year that target is achieved		**2012**	
Fraction of Sales by Sector Covered			
Residential		**100%**	Assumption
Commercial		**100%**	Assumption
Industrial		**100%**	Assumption
Levelized Cost of Electricity Savings		**$25**	$/MWh
*A report prepared for the Western Governors Association (CDEAC EE Report, 2006--See **Note 1**), which in turn is based on Funding and Savings for Energy Efficiency Programs in Program Years 2000 through 2004 (CEC Rogers, Messenger Bender 2005) and on The Fifth Northwest Electric Power and Conservation Plan (Northwest Power and Conservation Council 2005), cites an average levelized cost of electricity savings of $25/MWh. This is somewhat higher than the $21/MWh (nominal dollars, presumably 2005) cited by NorthWestern Energy in its filing before the MT PSC (Montana PSC Docket No.: D2005.5.88 07/12/06, available as http://psc.mt.gov/eDocs/DocketsAndOrders/D2005-5-88_6682d.pdf).*			
Electricity Savings per Program Investment (first year savings)		**6.0**	MWh/$1000 spent, or
		$167	$/MWh 1st yr savings
Based on rough average of several sources. Since 2000, NW utilities have achieved around 7 MWh/$1000 (T. Eckman, 2006, ttp://www.nwcouncil.org/energy/present/idaho.pdf), while CA utilities have averaged closer to 5 MWh/$1000 (M. Messenger, 2003, http://www.energy.ca.gov/reports/2003-09-24_400-03-022D.PDF).			
Avoided Delivered Electricity Cost		**$49**	$/MWh
See common assumptions ("Common Factors" worksheet in this workbook)			
Natural Gas Savings per Program Investment		**72,700**	MCF/yr per $million
		74,881	MMBtu/yr per $million
Based on average cost of gas DSM programs reported in Tegen, S. and Geller, H., 2006. Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org.			
Levelized Cost of Natural Gas Savings		**$2.1**	$/MMBtu
Based on the first year costs above and average measure lifetime assumption below			
Assumed average measure lifetime		**8**	years
Avoided Delivered Natural Gas Cost		**$6.5**	$/MMBtu
See common factors			

Other Data, Assumptions, Calculations		2010	2020/all	Units
Analysis				
RCII Electricity Sales	*(from inventory)*	14,283	15,684	GWh
Residential		4,245	4,329	GWh
Commercial		4,889	5,469	GWh
Industrial		5,150	5,885	GWh
Conversion Factor:GWh/Billion Btu			0.29306	
RCII Electricity Prices (statewide averages, real 2005 dollars)				
Residential		$78	$81	$/MWh
Commercial		$66	$70	$/MWh
Industrial		$49	$51	$/MWh
2005 electricity prices are from EIA (see "Retail_Prices_Elec" worksheet in this workbook). http://tonto.eia.doe.gov/dnav/ng/ Changes in sectoral electricity prices indexed to DOE EIA Annual Energy Outlook 2006 national forecast.				
Total Implied Electricity Revenues (RCII, statewide)		$906	$1,029	$million
Residential		$331	$350	$million
Commercial		$323	$380	$million
Industrial		$252	$299	$million
RCII Gas Sales	*(from inventory)*	60,107	63,216	Billion Btu
Residential		21,876	24,123	Billion Btu
Commercial		14,255	17,694	Billion Btu
Industrial		23,976	21,398	Billion Btu
Conversion Factor: Million Btu per Thousand Cubic feet			1.03	MMBtu/Mcf
RCII Gas Prices (statewide averages, real 2005 dollars)				
Residential		$9.12	$8.86	$/MMBtu
Commercial		$8.68	$8.08	$/MMBtu
Industrial		$7.01	$6.46	$/MMBtu
2005 gas prices are from EIA (see "NGPrices current" worksheet in this workbook). http://tonto.eia.doe.gov/dnav/ng/xls/ng_sum_lsum_dcu_SNC_a.xls. Changes in sectoral gas prices indexed to future gas prices from DOE EIA Annual Energy Outlook 2006 national forecast.				
Total Implied Gas Revenues (RCII, statewide)		$491	$495	$million
Residential		$199	$214	$million
Commercial		$124	$143	$million
Industrial		$168	$138	$million
Energy Efficiency Investment				
Recent Actions				
Fraction of Electricity Revenues Invested		0.8428%	0.8428%	
Efficiency Spending for Recent Actions (Electricity)		$7.6	$8.7	$million
Cumulative reduction in sales from existing investment		1.541%	4.463%	(Electric)
Fraction of Gas Revenues Invested		0.5132%	0.5132%	
Efficiency Spending for Recent Actions (Gas)		$2.5	$2.5	$million
Cumulative reduction in sales from existing investment		1.663%	4.536%	(Gas)
Full Potential Efficiency investment				
Target New Electricity Savings per Year		30.35	104.78	GWh
Fraction of Electricity Revenues Invested		0.6%	1.7%	
Implied Electricity Energy Efficiency investment per Year		$5.1	$17.5	$million
Target New Gas Savings per Year		131.76	442.06	Billion Btu
Fraction of Gas Revenues Invested		0.4%	1.2%	
Efficiency investment, New/Expanded (Gas)		$1.8	$5.9	$million

Additional Results	2010	2020	Units
Current/expected Energy Efficiency Investments			
Reduction in Electricity Use	220	700	GWh
as % of overall projected sales in that year	1.541%	4.463%	
Reduction in Generation Requirements	238	756	GWh
GHG Emission Savings from Electricity Use Reduction	**0.24**	**0.63**	$MMtCO_2e$
Reduction in Gas Use	999	2,868	Billion Btu
as % of overall projected sales in that year	1.663%	4.536%	
Reduction in Gas Consumption	999	2,868	Billion Btu
GHG Emission Savings from Gas Use Reduction	**0.05**	**0.15**	$MMtCO_2e$
Cumulative Emissions Reductions, Electricity (2007-2020)		**5.3**	
Cumulative Emissions Reductions, Gas (2007-2020)		**1.2**	
Cumulative Emissions Reductions, Electricity plus Gas (2007-2020)		**6.5**	
Full Cost-effective Potential Energy Efficiency Investments			
Reduction in Electricity Use from New/Expanded Investments	30	1,021	GWh
as % of overall projected sales	0.2%	6.5%	(Electric)
Incremental Reduction in Generation Requirements	33	1,102	GWh
GHG Emission Savings	**0.03**	**0.92**	$MMtCO_2e$
Reduction in Gas Use	132	4,315	Billion Btu
as % of overall projected sales in that year	0.2%	6.8%	
Reduction in Gas Consumption	132	4,315	Billion Btu
GHG Emission Savings from Gas Use Reduction	**0.01**	**0.23**	$MMtCO_2e$
Economic Analysis - New/Expanded Energy Efficiency Invesments			
Net Present Value, Electricity Savings (2007-2020)		**-$79**	$million
Cumulative Emissions Reductions, Electricity (2007-2020)		**5.4**	$MMtCO_2e$
Cost-Effectiveness, Electricity		**-$15**	$\$/tCO_2e$
Net Present Value, Gas Savings (2007-2020)		**-$61**	$million
Cumulative Emissions Reductions, Gas (2007-2020)		**1.2**	$MMtCO_2e$
Cost-Effectiveness, Gas		**-$49**	$\$/tCO_2e$
Incremental GHG Emission Savings, Electricity and Gas	**0.04**	**1.15**	$MMtCO_2e$
Net Present Value, Electricity Savings (2007-2020)		**-$141**	$million
Cumulative Emissions Reductions, Electricity plus Gas (2007-2020)		**6.6**	$MMtCO_2e$
Cost-Effectiveness, Electricity plus Gas		**-$21**	$\$/tCO_2e$



NOTES AND DATA FROM SOURCES

Note 1:

The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association,
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-2 Market Transformation and Technology Development Programs

Date Last Modified:	3/26/2007	D. Von Hippel/A Bailie/C. Lee

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2010**	
Savings from Alliance Programs			
Reduction in overall electricity use		**0.2%**	per year

Based on WGA (2005) - The Potential for More Efficient Electricity Use in the Western United States, Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association. This study estimates that market transformation programs could achieve reductions in electricity consumption of about 0.2% per year, based on programs and experience similar to those of the Northwest Energy Efficiency Alliance. See NEEA 2004 Annual Report. www.nwalliance.org/resources/documents/A_2004AR.pdf. These savings are in addition to those achieved through building energy codes and utility DSM programs (no double counting).

For Montana, a key implementation strategy could be support for and expansion of programs similar to NEEA's into areas of MT not now covered by those programs.

Assumed Cost of Market Transformation Program Savings		**$12**	$/MWh

From WGA EE Task Force study (2005), which cites the Retrospective Analysis of the Northwest Energy Efficiency Alliance (Violette, Ozog, and Cooney, 2003).

Avoided Electricity Cost		**$49**	$/MWh

See common assumptions.

Other Data, Assumptions, Calculations	2010	2020/all	Units
Total Statewide Electricity Sales	**14,283**	**15,684**	**GWh**

Results	2010	2020	Units
Total Net GHG Emission Savings	**0.03**	**0.30**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$43**	$million
Cumulative Emissions Reductions (2007-2020)		1.9	$MMtCO_2e$
Cost-Effectiveness		**-$23**	$/tCO_2e
TOTAL Reduction in Electricity Sales	29	329	GWh (sales)
as share of projected sales	0.2%	2.1%	
Reduction in Generation Requirements	31	354	GWh (generation)

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-3 **State Level Appliance Efficiency Standards and State Support for Improved Federal Standards**

Date Last Modified:	*3/26/2007*	*D. Von Hippel/A Bailie/C. Lee*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2010**	
Projected Electricity Savings from 15 Proposed Standards (in 2020)		**184**	GWh
Projected Natural Gas Savings from 15 Proposed Standards (in 2020)		**553**	million ft^3
Projected NPV Savings (to 2030, $2005)		**$185**	million

The above findings are drawn from ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards", http://www.standardsasap.org/stateops.htm and http://www.standardsasap.org/a062_mt.pdf. The NPV results were derived using a 5% discount rate, and electricity prices of 8.7c/kWh ($13.6/thousand cubic ft gas) residential and 6.9c/kWh ($11.7/thousand cubic ft gas) commercial. The resulting NPV savings are thus slightly higher than would be obtained using our avoided delivered electricity and gas cost estimates.

Adjustment factor for NPV timespan		**0.527**	

This is the ratio of NPV values from 2007-2020 vs. 2005-2030 for a constant net benefit starting in 2012.

Adjustment factor for different electricity and gas avoided costs		**0.563**	

Simple adjustment assumes the benefits are largely on the electricity side, and equals the ratio of incremental cost savings per MWh using the following values (appliance standards cost from WGA 2005; ASAP/ACEEE assumes average of res and comm):

Average cost of efficiency improvements via standards		**$12**	$/MWh
Average cost of electricity in ASAP/ACEEE study		**$78**	$/MWh
Avoided cost of electricity used here (res/comm avg)		**$49**	$/MWh

Other Data, Assumptions, Calculations	2010	2020/all	Units
National Savings	14	52	TWh

ASAP/ACEEE, 2006. Assume here same ratio of 2010 to 2020 savings in MT for electricity. All gas-saving standards come into force in 2012, so no 2010 gas savings

Results	2010	2020	Units
Electricity			
Reduction in Electricity Sales	50	184	GWh (sale
Reduction in Generation Requirements	54	198	GWh (gene
GHG Emission Savings	**0.05**	**0.17**	$MMtCO_2e$
Cumulative Emissions Reductions (2007-2020)		1.3	$MMtCO_2e$
Natural Gas			
Reduction in Gas Use	0	570	Billion BTU
GHG Emission Savings	**0.00**	**0.03**	$MMtCO_2e$
Cumulative Emissions Reductions (2007-2020)		0.20	$MMtCO_2e$
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.05**	**0.20**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$55**	$million
Cumulative Emissions Reductions (2007-2020)		1.5	$MMtCO_2e$
Cost-Effectiveness		**-$36**	$/tCO_2e$

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-4 **Building Energy Codes**

Date Last Modified: *5/1/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2008**	

Electricity	2010	2020/all	Units
Levelized Cost of Electricity Savings		**$37.2**	$/MWh
Based on 7 year payback as estimated in WGA CDEAC EE Report. (See Note 1, below.)			
Levelized Cost of Natural Gas Savings		**$4.7**	$/MMBtu
Based on 7 year payback as estimated in WGA CDEAC EE Report. (See Note 1, below.)			
Avoided Electricity Cost		**$49**	$/MWh
Weighted average over total 2007-2020 electricity savings for this policy in each sector. See common assumptions ("Common Factors" worksheet in this workbook).			
Avoided Natural Gas Cost		**$6.5**	$/MMBtu
See common assumptions ("Common Factors" worksheet in this workbook)			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Adjustment for Inclusion of Rennovated Residential Space as Well as New Under New Code Requirements. *(Currently set at 1.0 so that no rennovated residential space is included--need to ask an MT building professional for an opinion on this value.)*		**1.00**	
Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under New Code Requirements. *(Currently set at 1.5 so that about 1 unit of renovated space is included per unit of new space (initial assumption--see **Note 4**). It may be useful to get further information regarding this value.*		**1.50**	
Adjustment for Inclusion of New Industrial Space in Estimated Savings due to New Code Requirements (applied to total residential plus commercial savings) (See ***Note 3***)		**110.0%**	
Ratio of Electricity Savings to Gas Savings: Residential Sector	199	199	GWh/TBtu
Ratio of Electricity Savings to Gas Savings: Commercial Sector	316	316	GWh/TBtu
Estimated based on relative MT usage of electricity and gas by sector in 2004. Alternative factors could be derived from other sources to account for differeMTes in expected levels of electricity and natural gas savings.			

Results	2010	2020	Units
Electricity			
Recent Actions not included in forecast -- assume all recent savings are included in forecast			
Reduction in Electricity Sales: Residential	0	0	GWh (sales)
Red		0	GWh (sales)
Red		0	GWh (sales)
TOT		0	GWh (sales)
Reduction in Generation Requirements	0	0	GWh (generation)
GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$

These rows are not used currently but are retained in case there is need to estimate savings from current activities

Savings due to Additional Effort in RCII-4	2010	2020	Units
Reduction in Electricity Sales: Residential	10	101	GWh (sales)
Reduction in Electricity Sales: Commercial	11	104	GWh (sales)
Reduction in Electricity Sales: Industrial	2	20	GWh (sales)
TOTAL Reduction in Electricity Sales	23	225	GWh (sales)
Reduction in Generation Requirements	25	242	GWh (generation)
GHG Emission Savings	**0.03**	**0.20**	$MMtCO_2e$

Economic Analysis (for Electricity Savings due to Additional Effort in RCII-4)		
Net Present Value (2007-2020)	**-$9.6**	$million
Cumulative Emissions Reductions (2007-2020)	1.3	$MMtCO_2e$
Cost-Effectiveness	**-$7.44**	$\$/tCO_2e$

Natural Gas

Recent Actions not included in forecast			
Reduction in Gas Sales: Residential	0	0	Billion BTU
Reducti		0	Billion BTU
Reducti		0	Billion BTU
Reducti		0	Billion BTU
GHG Emission Savings	0	0.00	$MMtCO_2e$

These rows are not used currently but are retained in case there is need to estimate savings from current activities

Savings due to Additional Effort in RCII-4			
Reduction in Gas Sales: Residential	50	509	Billion BTU
Reduction in Gas Sales: Commercial	36	328	Billion BTU
Reduction in Gas Sales: Industrial	7	65	Billion BTU
Reduction in Gas Use	92	902	Billion BTU
GHG Emission Savings	0.00	0.05	$MMtCO_2e$

Economic Analysis (for Savings due to Additional Effort in RCI-6)		
Net Present Value (2007-2020)	**-$5.7**	$million
Cumulative Emissions Reductions (2007-2020)	0.3	$MMtCO_2e$
Cost-Effectiveness	**-$20.21**	$\$/tCO_2e$

Summary Results for RCII-4	2010	2020	Units
Recent Actions Not Included in Forecast (Current/planned building code changes)			
Electric GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Gas GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Total GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Total for Option (Natural gas and electricity)			
GHG Emission Savings	**0.03**	**0.25**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$15**	$million
Cumulative Emissions Reductions (2007-2020)		1.6	$MMtCO_2e$
Cost-Effectiveness		**-$9.73**	$\$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note on Overall Approach to Analysis

The analysis for this option is based on structure used by the Building Codes Assistance Project (see http://www.bcap-energy.org). The analysis uses existing energy consumption and parameters to account for savings due to energy used for space conditioning in different climates and the estimated impact of building codes.

From Mitigation Option Description, the goals of the option are

• Increase standards such that the minimum performance of new and substantially-renovated buildings, both commercial and residential, is at least 15% higher by 2010 than that required by today's building codes (IECC 2003, though IECC 2006 codes are under consideration, see below), and 30% higher by 2020.

This analysis estimates the savings from full enforcement of the existing MT building code (according to energycodes.gov, "The MT Building Code CouMTil has adopted the 2003 IECC with MT amendments effective July 1, 2006. The amendments include adoption of ASHRAE 90.1-2004. Chapter 11 of the 2003 IRC has also been adopted and includes MT amendments; the effective date for the new 2006 MT Residential Code has been delayed until July 1, 2007.", but other suggests that IECC 2006 code adoption will be considered in summer, 2007.
IECC is the International Energy Conservation Code.

For 2008, this analysis assumes that the 2006 code (based on IECC 2003) achieves energy savings of

residential	3%	, eg standard practice is equivalent to about 1998 IECC levels
commercial	6%	, eg standard practice is equivalent to about ASHRAE 2001 levels

This assumption is based on notes provided by the Building Codes Assistance Project
(see notes on cells in column T and V in table below)

For enforcement rates, the analysis assumes:

50%	rate of energy code enforcement currently, before mitigation action (no source for this estimate, needs review by TWG)
95%	rate of energy code enforcement with this mitigation option in place

These are rough estimates and more appropriate values for Montana are welcomed.

For 2010, this analysis assumes that the current national building code will be approximately IECC 2003, or the equivalent of MT's 2006 code. Thus the options will achieve

15%	savings, relative to 2008 improvements, by 2010, and
30%	savings, relative to 2008 improvements, by 2020.

Annual energy savings are estimated using the table below are result in estimated savings of

2008 (code enforcement)

residential	0.001	TWh
Commercial	0.001	TWh

2010 (15% energy savings)

residential	0.007	TWh
Commercial	0.005	TWh

The above values are based on energy and households in 2005, these values are adjusted to provide future savings based on increased number of houses. See below

	RESIDENTIAL							
STATE	**TOTAL HOUSING UNITS**	**NEW HOUSING UNITS AUTHORIZED BY PERMIT (PRIVATELY OWNED)**		**Ratio - new units / existing units**	**TOTAL ELECTRICITY ENERGY USE (TWh) 2005**	**Estimated Electric energy use, new residential units (TWh)**	**Electric space conditioning multiplier (see "HVAC and Fuel Mix" worksheet)**	**energy use for space conditioning - new res buildings (TWh)**
full enforcement of 2003 IECC								
MT	433,454	5097		0.0118	4.2	0.05	16.1%	0.0080
15% improvement								
MT						0.0488		

COMMERCIAL						ENERGY SAVINGS POTENTIAL (TWh)					
Ratio - new/existing	TOTAL ELECTRICITY ENERGY USE (TWh) 2005	Energy Intensity Correction Factor by Climate Zone and Vintage	Percentage of electric energy for Heating, Cooling, and Lighting	Commercial electric energy use for Heating, Cooling, & Lighting for new buildings (TWh)	STATE	Residential Savings Multiplier reflecting change from 2006 state code to 2004/2006 IECC.	Energy Savings Potential Residential New Construction	Energy Savings Potential Replacement Window	Commercial Savings Multiplier reflecting change from 2006 state code to ASHRAE 90.1-2004.	Energy Savings Potential Commercial New Construction	STATE
0.0124	4.5	1.13	0.54	0.03	**MT**	0.030	0.001	0.000	0.060	0.001	**MT**
				0.03	**MT**	0.150	0.007	N/A	0.150	0.005	**MT**

Incremental annual energy savings		2007	2008	2009	2010	2011
Residential	TWh	0	0.0010	0.0010	0.008	0.007
Commercial	TWh	0	0.0010	0.0010	0.005	0.005
Growth factor, population based relative to population growth from 2005 (energy savings based on 2005 data)			1.14	1.15	1.16	0.98
Factor to increase 2010 savings to match 2020 goal			100%	100%	100%	110%

Montana	New housing units	5,097	2005

The following parameters are used to adjust the total electricity consumption in the residential sector to electricity use for space conditioning (data from the Residential Energy Consumption Survey (EIA)). A parameter for the commercial sector is used to adjust estimates of commercial electric energy use for Heating, Cooling, & Lighting for new buildings for climate.

July 2002-June 2003 State Heating Degree Days (HDD)					
			Residential		**Commercial**
	HDD65	CDD65	RECS Climate Zone	% electric space conditioning	
MT	7525	252	1	16.1%	1.1309

Sources: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf
http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf

Energy Intensity Correction Factor by Climate Zone	
All Buildings	1.1538
>7000 HDD	1.1309
5500-7000	1.2408
4000-5499	1.0297
<4000	1.1986
>2000 CDD & <4000 HDD	1.1953

Household Electricity End Use					
	Climate Zone				
	<2000 CDD				>2000 CDD and <4000 HDD
	>7000 HDD	5500-7000 HDD	4000-5499 HDD	<4000 HDD	
	Quadrillion Btus				
Climate Category	**1**	**2**	**3**	**4**	**5**
Space-Heating	0.03	0.08	0.12	0.08	0.09
Electric AC (central & room)	0.02	0.08	0.11	0.11	0.30
Water Heating	0.04	0.06	0.08	0.07	0.11
Refrigerators	0.04	0.13	0.11	0.10	0.15
Other Appliance & Lighting	0.18	0.52	0.43	0.37	0.48
TOTAL	0.31	0.87	0.85	0.73	1.13
Percent Electric Space Conditioning	**16.1%**	**18.4%**	**27.1%**	**26.0%**	**34.5%**
Source: 2001 RECS (http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space)					

Additional Notes

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
The CDEAC report provides a cost of saved energy (electricity) based on an average 7-year payback for code improvements (page 42).

For Montana, the equivalent cost is estimated as follows for electricity and natural gas

Note 2:
Based on results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8_02.pdf, approximately 18% of industrial electricity use in the West Census region is used for HVAC, lighting, and "other facility support", with 6.7% of natural gas used for HVAC and "other facility support".

In Montana, as of 2005, total electricity use by sector was as follows (from Retail Sales of Electricity by State by Sector by Provider, downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	4,221,448	31%
Commercial	4,473,394	33%
Industrial	4,783,996	35%
Total	13,478,838	100%

Thus industrial use of electricity for non-process uses in Montana may be roughly 10.0% of total Residential and Commercial electricity use. This figure is used as an initial rule of thumb in estimating the contribution of savings from this policy from industrial sector measures.

Note 3:
The estimate of one unit of renovated space per unit of new construction in the commercial sector is an initial estimate only.
It is clear, however, that the renovation market represents a substantial opportunity for improving energy efficiency through code changes. A study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As a market with newer buildings, it is possible that Montana has less renovation per unit building activity than California.

Note 4:
Calculated based on July-2004 to July-2005 estimate of total housing units in Montana from http://www.census.gov/popest/housing/HU-EST2005.html (see "2005 Total Housing Units" worksheet in this workbook). Since this figure implicitly nets out demolitions, it may somewhat undercount new units. The source: http://www.census.gov/const/C40/Table2/t2yu200512.txt provides an estimate of 5,068 "New Privately Owned Housing Units Authorized", which may be somewhat of an over-estimate for total new housing units in Montana, as it would presumably include some permitted units not ultimately built. We use the former estimate at present as the basis for calculation of future growth in housing units.

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-5 **"Beyond Code" Building Design Incentives and Mandatory Programs**

Local Building Materials and Advanced Construction

Date Last Modified: *6/6/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2008**	
Based on goal set in Mitigation Option Design for RCII-7 (version dated 10/27/06) that reads "Ramp up program starting in 2007 to full effectiveness by 2012, except where noted otherwise".			

Electricity	2010	2020/all	Units
Levelized Cost of Electricity Savings		**$37**	$/MWh
As estimated for RCII-4. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCII-4.)			
Levelized Cost of Natural Gas Savings		**$4.7**	$/MMBtu
As estimated for RCII-4. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCII-4.)			
Avoided Electricity Cost		**$49**	$/MWh
See "AvCost" and "Common Factors" worksheets in this workbook.			
Avoided Natural Gas Cost		**$6.5**	$/MMBtu
See "NG prices aeo2006" and "Common Factors" worksheets in this workbook.			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings			
Average Electricity and Gas Savings Beyond Code Levels (new commercial and residential buildings)	**25%**	**50%**	
The description for this option currently includes the following: "Reduce per-unit-floor-area consumption of grid electricity and natural gas by 20% by 2020 in existing buildings, and by 50% in new buildings by 2020. Up to 10% of the targeted reduction for new homes can come from use of off-site electricity generation from renewable energy . These requirements should be phased in over time...". This is interpreted to mean that participating buildings will be on average 25 percent more efficient than code in 2010, and an estimated average of 50 percent more efficient than code in 2020.			
Note in particular that the level of savings shown here is beyond that already included in Option RCII-4, and thus already includes an improvement in efficiency relative to average current practice.			
Total Commercial Floorspace in Montana (million square feet)	**242**	**256**	
Estimated (see "NC_Activities_Est" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the South Atlantic region, extrapolated using projected Montana population as a driver.			
Est. area of new commercial space per year in MT (million square feet)	**1.8**	**1.2**	
Calculated based on annual floorspace estimates above.			
Total Residential Housing Units in Montana	**444,698**	**469,553**	
Assumes 2005 ratio of new homes to increase in population holds through 2020. Based on 2005 MT housing units as provided in U.S Census Bureau annual data, http://www.census.gov/popest/housing/HU-EST2005.html.			
Implied persons per housing units in Montana (for reference only)	**2.18**	**2.18**	
Estimated number of new residential units per year	**3,317**	**2,154**	
Calculated based on estimates above.			
Implied Average Electricity Consumption per Square Foot Commercial Space in Montana as of 2005 (see Note 2)		19.18	kWh/yr
Implied Average Natural Gas Consumption per Square Foot Commercial Space in Montana as of 2005 (see Note 2)		44.87	kBtu/yr
Implied Average Electricity Consumption per Housing Unit in Montana as of 2005 (see Note 2)		**9.85**	MWh/yr
Implied Average Natural Gas Consumption per Housing Unit in Montana as of 2005 (see Note 2)		**47.69**	MMBtu/yr

NEW BUILDINGS			
Electricity Use per New/Renovated Commercial Sq. Ft. After RCII-4 Application	**16.2**	**13.2**	kWh/yr
Reduces future per-unit electricity use based on savings from building code improvements (15 percent improvement by 2010, 30 percent by 2020) included in RCII-4.			
Nat. Gas Use per New/Renovated Commercial Sq. Ft. After RCII-4 Application	**35.4**	**25.9**	kBtu/yr
Assumes the same pattern of code improvement as for electricity use, as described above.			
Implied Electricity Use per New/Renovated Commercial Square Foot After RCII-4 Application, Relative to Average in Montana as of 2005	**84.3%**	**68.7%**	
Implied Natural Gas Use per New/Renovated Commercial Square Foot After RCII-4 Application, Relative to Average in Montana as of 2005	**78.8%**	**57.6%**	
Electricity Use per New/Renovated Residential Unit After RCII-4 Application	**7.4**	**5.0**	MWh/yr
Reduces future per-unit electricity use based on savings from building code improvements (15 percent improvement by 2010, 30 percent by 2020) included in RCII-4.			
Natural Gas Use per New/Renovated Residential Unit After RCII-4 Application	**35.5**	**23.3**	kBtu/yr
Reduces future per-unit electricity use based on savings from building code improvements (20 percent improvement by 2010) included in RCII-4.			
Implied Electricity Use per New/Renovated Residential Unit After RCII-4 Application, Relative to Average in Montana as of 2005	**75.4%**	**50.8%**	
Implied Natural Gas Use per New/Renovated Residential Unit After RCII-4 Application, Relative to Average in Montana as of 2005	**74.5%**	**48.9%**	
Date program of improvement of new buildings fully "ramped up"		2012	
Placeholder estimate pending TWG review.			
Fraction of new commercial buildings participating in program at full program level		25%	/yr
Fraction of new residential buildings converted included under program by 2020		25%	/yr
Implied fraction of new commercial floorspace included in program	**15.0%**	**25.0%**	/yr
Note that government-sector floorspace is covered under RCI-12.			
Implied commercial floorspace included in program (million square feet)	**0.271**	**0.293**	/yr
Implied fraction of new residential units included in program	**15.0%**	**25.0%**	/yr
Implied new residential units included in program	**498**	**539**	/yr
EXISTING BUILDIINGS			
Fraction of existing buildings (buildings existing as of 2005) upgraded under program		25%	
Date by which upgrading goal for existing buildings achieved		2020	
As included in goals for policy option.			
Date program of improvement of existing buildings fully "ramped up"		2012	
Assumed same as for new buildings.			
Fraction of existing buildings (buildings existing as of 2005) upgraded annually from 2012 on:		2.27%	
Adjust until the value at right ~ 0.25 (adjustment for lower penetration during ramp-in period)	0.2497		
Fraction of existing buildings (buildings existing as of 2005) upgraded annually:	**1.4%**	**2.3%**	
Electricity and Gas savings from upgrading existing commercial buildings		20%	
As included in goals for policy option.			
Electricity and Gas savings from upgrading existing residential buildings		20%	
As included in goals for policy option.			

CALCULATION OF SAVINGS

Required Elect/Gas Improvement in New Commercial and Residential Space After RCII-4 Policy Relative to Average in After Application of RCII-4 *Calculated based on inputs above.*	**25.0%**	**50.0%**	
Implied total electricity savings in new commercial buildings from RCII-5 *First-year savings--not cumulative.*	**1.10**	**1.93**	GWh/yr
Implied total gas savings in new commercial buildings from RCII-5 *First-year savings--not cumulative.*	**2.40**	**3.79**	GBtu/yr
Implied total electricity savings in new residential buildings from RCII-5 *First-year savings--not cumulative.*	**0.92**	**1.35**	GWh/yr
Implied total gas savings in new residential buildings from RCII-5 *First-year savings--not cumulative.*	**4.42**	**6.28**	GBtu/yr
Implied total electricity savings in existing commercial buildings from RCII-5 *First-year savings--not cumulative.*	**12**	**20**	GWh/yr
Implied total gas savings in existing commercial buildings from RCII-5 *First-year savings--not cumulative.*	**29**	**48**	GBtu/yr
Implied total electricity savings in existing residential buildings from RCII-5 *First-year savings--not cumulative.*	**11**	**19**	GWh/yr
Implied total gas savings in existing residential buildings from RCII-5 *First-year savings--not cumulative.*	**56**	**93**	GBtu/yr

Average Fraction of Improvement in Electric Energy Intensities from:

Energy Efficiency Improvement	83%	80%
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%
On-site Solar PV	1%	2%
On-site Biomass/Biogas/Landfill Gas Energy Use	1%	1%
Green Power Purchase (from off-site, beyond electricity supply RPS)	10%	10%

All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Average Fraction of Improvement in Gas Energy Intensities from:

Energy Efficiency Improvement	94%	91%
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%
On-site Solar PV	0%	0%
On-site Biomass/Biogas/Landfill Gas Energy Use	1%	2%
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%

All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under Program. *Currently set at 1.5 so that about 0.5 unit of renovated space is included per unit of new space (initial assumption). See Note 4. It may be useful to get further MT-specfic information regarding this value.*		**1.50**
Adjustment of Energy Use per Unit Floor Area for Commercial Buildings in Program Relative to Average Commercial Building in Montana *Placeholder assumption.*	1.00	1.00

Adjustment for Inclusion of Rennovated Residential Units as Well as New Under Program.	1.00	

Currently set at 1.0 so that no renovated space is included per unit of new space (initial assumption). It may be useful to obtain further MT-specfic information regarding this value.

Implied Cumulative Impacts of Option, New Commercial Space (Electricity savings)			
Energy Efficiency Improvement	2.9	25.1	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	0.2	1.8	GWh
On-site Solar PV	0.0	0.5	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	0.3	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	0.4	3.1	GWh
Implied Cumulative Impacts of Option, New Commercial Space (Natural Gas savings)			
Energy Efficiency Improvement	7.4	59.7	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	0.4	3.8	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.1	1.0	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Commercial Space (Electricity savings)			
Energy Efficiency Improvement	20.2	182.1	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	1.2	13.4	GWh
On-site Solar PV	0.2	3.3	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.2	2.2	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	2.4	22.3	GWh
Implied Cumulative Impacts of Option, Existing Commercial Space (Natural Gas savings)			
Energy Efficiency Improvement	53.6	483.5	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	2.9	31.3	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.6	7.8	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, New Residential Space (Electricity savings)			
Energy Efficiency Improvement	0.9	12.3	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	0.1	0.9	GWh
On-site Solar PV	0.0	0.2	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	0.2	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	0.1	1.5	GWh
Implied Cumulative Impacts of Option, New Residential Space (Natural Gas savings)			
Energy Efficiency Improvement	5.0	66.0	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	0.3	4.3	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.1	1.1	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Residential Space (Electricity savings)			
Energy Efficiency Improvement	19.1	171.8	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	1.1	12.6	GWh
On-site Solar PV	0.2	3.2	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.2	2.1	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	2.3	21.1	GWh
Implied Cumulative Impacts of Option, Existing Residential Space (Natural Gas savings)			
Energy Efficiency Improvement	104.6	943.8	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	5.6	61.2	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	1.1	15.3	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr

Additional Inputs to/Intermediate Results of Costs Analyses

Estimated annual levelized cost of solar hot water per unit output	**20.77**	**18.70**	$/MMBtu
Based on inputs to/results of solar hot water heating analysis included in other RCI options.			
Adjustment to solar thermal costs for inclusion of space heat/cooling measures	1.00	1.00	
Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.			
Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling	**65.91**	**59.32**	$/MWh
Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling	**14.54**	**13.09**	$/MMBtu
Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).			
Estimated annual levelized cost of on-site Solar PV	**223**	**129**	$/MWh
Based on inputs to/results of solar PV analysis included in 7B-RCI.			
Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use		3.19	$/MMBtu
Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be i			
Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity		0.75	
Placeholder assumption.			
Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment		2.00	
Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.			
Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas	**28.95**	**28.95**	$/MWh
Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)	25.00	20.00	$/MWh
Placeholder assumption, but should be linked to assumptions for relevant ES options, if necessary.			

Results	2010	2020	Units
Electricity (Conventional)			
Reduction in Electricity Sales: Residential	24	226	GWh (sales)
Reduction in Electricity Sales: Commercial	28	254	GWh (sales)
TOTAL Reduction in Electricity Sales	52	480	GWh (sales)
Reduction in Generation Requirements	56	516	GWh (generation)
GHG Emission Savings	**0.06**	**0.43**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$9**	$million
Cumulative Emissions Reductions (2007-2020)		2.8	$MMtCO_2e$
Cost-Effectiveness		**-$3.16**	$/t$CO_2e$
Natural Gas			
Reduction in Gas Use, Residential Sector	117	1,092	Billion BTU
Reduction in Gas Use, Commercial Sector	65	587	Billion BTU
TOTAL Reduction in Gas Sales	182	1,679	Billion BTU
GHG Emission Savings	**0.01**	**0.09**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$8**	$million
Cumulative Emissions Reductions (2007-2020)		0.54	$MMtCO_2e$
Cost-Effectiveness		**-$14.52**	$/t$CO_2e$
Biomass/Biogas/Landfill Gas Fuel Use			
Added GHG Emissions from Biomass Fuels Use	**0.00001**	**0.00012**	$MMtCO_2e$
Cumulative added Emissions from Biomass Fuels (2007-2020)		0.0007	$MMtCO_2e$

Summary Results for RCII-5		2010	2020	Units
Total for Option (Natural gas and Electricity less Biomass)				
GHG Emission Savings		**0.07**	**0.52**	$MMtCO_2e$
Net Present Value (2007-2020)			**-$16.8**	$million
Cumulative Emissions Reductions (2007-2020)			3.4	$MMtCO_2e$
Cost-Effectiveness			**-$4.98**	$\$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
See Note 1 in RCII-4 worksheet in this workbook.

Note 2:

Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "MT_Activities_Est" worksheet in this workbook.

Following data on electricity sales in Montana as of 2005 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	4,221,448	31%
Commercial	4,473,394	33%
Industrial	4,783,996	35%
Total	13,478,838	100%

For natural gas consumpation, consumption data from the USDOE EIA downloaded from http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

	Sales (Million Cubic Feet of Natural Gas)			
	Residential	Commercial	Industrial	Total
2005	19,834	10,162	398	30,394
Fraction of 2005 Total	65%	33%	1%	100%

Note 3:

The estimate of 0.5 unit of renovated space per unit of new construction in the commercial sector is a rough assumption.
It is likely that the ratio of commercial space undergoing major renovation to new commerial space will fluctuate year by year, and it may be necessary to get a more specific figure for this parameter. It is clear, however, that the renovation market represents a substantial opportunity for improving energy efficiency through code changes. A study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As California includes a significant fraction of older buildings in its building stocks, renovations may be a smaller fraction of building activity in Montana.

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-10 **Industrial Energy Audits and Recommended Measure Implementation**

Date Last Modified: 4/25/2007 D. Von Hippel

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2009	
Levelized Cost of Electricity Savings from Technical Assistance Recommendations			
Industrial Sector		$15.1	$/MWh
Estimated based on assumptions below. Payback period is an average of the average payback range of 2.5 to 3 years cited by John Campbell of NorthWestern Energy as consistent with an industrial energy efficiency resource of 40 to 84 MW for Montana as a whole. The average measure lifetime shown below is a rough assumption for industrial-sector measures. The levelized cost is calculated as the annual payment required per MWh saved over the lifetime of the efficiency improvements, using a real discount rate of 5 percent/yr.			
Levelized Cost of Natural Gas and Other Fuels Savings			
Industrial Sector		$2.05	$/MMBtu
Assumes s			
Assumed ave. simple payback, Industrial Sector energy efficiency improvements		2.75	years
Assumed average lifetime for Industrial Sector energy efficiency improvements		12	years
Average estimated industrial electricity rates in MT, 2010 to 2020		$49	$/MWh
Average estimated industrial gas rates in MT, 2010 to 2020		$6.59	$/MMBtu
Implied average cost of industrial sector electric efficiency improvements		$134	$/(MWh/yr)
Investment per unit annual savings			
Implied average first cost of industrial sector gas efficiency improvements		$18.13	$/(MMBtu/yr)
Investment per unit annual savings			
Avoided Electricity Cost		$49	$/MWh
Levelized value--See "Common Factors" worksheet			
Avoided Natural Gas Cost		$6.5	$/MMBtu
Levelized value--See "Common Factors" worksheet			
Avoided LPG Cost		$11.0	$/MMBtu
Avoided Oil Cost		$12.5	$/MMBtu
Potential Cost-effective Energy Savings from Implementing Recommended Measures		10%	
Within the range of the industrial energy efficiency resource of 40 to 84 MW for Montana as a whole as estimated by John Campbell, assuming a load factor of about 80 percent and year 2005 Montana industrial electricity use. This value is assumed to be applicable for both electricity and natural gas measures.			
Fraction of Potential Energy Savings Achieved Annually Under Option		8%	
Program target.			
First Year in which Full Program Savings Achieved		2010	
Years between first year that program results accrue and first year in which full progam savings are achieved are years in which program effort is phased in.			
Annual Technical Assistance Visits: Residential Sector		-	
Annual Technical Assistance Visits: Commercial Sector		-	
Esimated Annual Audits: Industrial Sector	364	364	
For reference only, not an input. Calculated based on program assumptions.			
Total Technical Assistance Visits Over Life of Program		4,183	

Other Data, Assumptions, Calculations	2010	2020/all	Units
Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings			
Fraction of Potential Energy Savings Achieved Annually Under Option	8.0%	8.0%	
Industrial Sector			
Estimated Industrial-sector (Electricity) Customers	4,547	4,547	
Average annual growth in customer numbers, 2005 to 2020		0.0%	
Initial estimate--USDOE EIA data on industrial customer count in Montana since 1990 seems to fluctuate significantly year to year, and is probably not a true reflection of the actual number of industrial customers in the state.			
Estimated Total Industrial Sector Energy Use			
Electricity	5,150	5,886	GWh
Natural Gas	23,976	21,398	Billion Btu
LPG	1,170.3	1,159.4	Billion Btu
Oil (Distillate Oil)	13,104.3	12,982.6	Billion Btu
Average energy consumption per industrial (electricity) customer			
Electricity	1,132.7	1,294.4	MWh
Natural Gas	5,272.9	4,706.0	MMBtu
LPG	257.4	255.0	MMBtu
Oil (Kerosene and Distillate Oil)	2,882.0	2,855.2	MMBtu
Average Savings from Application of Measures from Technical Assistance Visits			
Electricity		10%	
Natural Gas and Other Fuels		10%	
As noted above.			
Include LPG and Oil in analysis?		NO	
Estimated Savings From Application of Measures (first-year savings, not cumulative)			
Electricity	41.2	47.1	GWh
Natural Gas	191.8	171.2	Billion Btu
LPG	-	-	Billion Btu
Oil (Kerosene and Distillate Oil)	-	-	Billion Btu

Results	2010	2020	Units
Electricity Savings			
Reduction in Electricity Sales: Industrial	62	505	GWh (sales)
TOTAL Reduction in Electricity Sales	62	505	GWh (sales)
Reduction in Generation Requirements	66	543	GWh (generation)
GHG Emission Savings	**0.07**	**0.46**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$63**	$million
Cumulative Emissions Reductions (2007-2020)		3.0	$MMtCO_2e$
Cost-Effectiveness		**-$21.18**	$\$/tCO_2e$
Natural Gas and Other Fuel Savings			
Reduction in Natural Gas Use: Industrial	94	1,917	Billion BTU
TOTAL Reduction in Natural Gas Sales	**94**	**1,917**	Billion BTU
Reduction in LPG Use: Industrial	0	0	Billion BTU
TOTAL Reduction in LPG Sales	**0**	**0**	Billion BTU
Reduction in Oil Use: Industrial	0	0	Billion BTU
TOTAL Reduction in Oil Sales	**0**	**0**	Billion BTU
GHG Emission Savings	**0.00**	**0.10**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$30**	$million
Cumulative Emissions Reductions (2007-2020)		0.6	$MMtCO_2e$
Cost-Effectiveness		**-$49.86**	$\$/tCO_2e$

Summary Results for RCII-10	2010	2020	Units
Total for Policy (Electricity, Natural Gas and Other Fuels)			
GHG Emission Savings	**0.07**	**0.56**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$93**	$million
Cumulative Emissions Reductions (2007-2020)		3.6	$MMtCO_2e$
Cost-Effectiveness		**-$25.93**	$\$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.

The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-11 **Low income and rental housing energy efficiency programs**

Date Last Modified: *6/6/2007 D. Von Hippel*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2009**	
First Target: Achieve		**30%**	
Energy savings in		**50%**	
of eligible homes (household incomes less than 150 percent of Federal Poverty level) by the year		**2015**	
Ramp-up of First Target Program Complete by		**2011**	
Second Target: Achieve		**50%**	
Energy savings in		**75%**	
of eligible homes by the year		**2020**	
Start year for second target program		**2012**	
Ramp-up of Second Target Program Complete by		**2015**	
Average Cost per Home ($2005) to achieve first target		**$4,000**	
Rough estimate provided by Kane Quenemoen of MT DEQ (personal communication), based on an extrapolation of current program experience (an average of about 22 percent savings with an investment of $2700.			
Average Cost per Home ($2005) to achieve second target (directly)		**$6,500**	
Estimate provided as a starting point for analysis (range, $6000 - $7000) by Kane Quenemoen of MT DEQ (personal communication). Note that this value may change over time as homes with more severe energy-efficiency problems are weatherized, and the remaining pool of potential participants has more moderate energy use, on average, than those already treated. Future changes in technology could also, of course, affect future costs.			
Average Cost per Home ($2005) to "upgrade" from first to second target		**$2,500**	
Difference of costs above (but placeholder estimate).			
Of the above, average amount per Home ($2005) spent on health and safety measures with limited impact on energy efficiency		**$1,100**	
Estimate provided by Kane Quenemoen of MT DEQ (personal communication), based on current program experience.			
Average Lifetime of Efficiency Improvements		25	years
Assumption, but consistent with long-lived weatherization investments.			
Avoided Electricity Cost		**$49**	$/MWh
Levelized value--See "Common Factors" worksheet			
Avoided Natural Gas Cost		**$6.5**	$/MMBtu
Levelized value--See "Common Factors" worksheet			
Avoided Distillate Oil Cost		**$12.5**	$/MMBtu
Avoided LPG Cost		**$11.0**	$/MMBtu
Avoided Wood Cost		**$3.2**	$/MMBtu

Other Data, Assumptions, Calculations	2010	2020/all	Units
Total number of homes in Montana	444,698	469,553	
Uses 2005 number of housing units (from US Census data) as starting point, and with number of households assumed to grow at the same rate as population (See "MT_Activities" worksheet in this workbook)..			
Fraction of Montana homes (total, not just "occupied") meeting income eligibility requirements in 2005		**20.33%**	
Fraction of Montana homes occupied by renters but with households NOT meeting income eligibility requirements in 2005		**14.63%**	
Annual average change in eligible fractions, 2006 to 2020		0.0%	
Implied fraction of households eligible for program	34.96%	34.96%	
*Uses 2005 fraction of Montana residents below 150 percent of Federal powerty level. See **Note 1**, below. (Also see "US Poverty Data" worksheet in this workbook. Data from U.S. Bureau of the Census,http://pubdb3.census.gov/macro/032006/pov/new46_135150_01.htm.)*			
Implied number of households eligible for program net of those participating in existing program	146,959	138,648	
Makes the simplifying assumption that those housing units that have participated in existing MT DEQ low-income housing program from 2006 on are not eligible for the expanded program. See below for assumptons on the existing program.			
Annual Average Energy Use per Household in (based on inventory estimates)			
Electricity	9.55	9.22	MWh
Natural Gas	49.78	51.98	MMBtu
Distillate Oil	2.27	2.19	MMBtu
LPG	7.79	7.52	MMBtu
Wood	3.74	3.10	MMBtu
Currently assumes that average energy use in low-income households is similar to the average energy use (for all fuels) in all households in MT. In fact, low income homes are likely to be both smaller (and thus require fewer energy services) then average homes, but are likely also less efficient--the data are not presently at hand to judge how these countervailing factors might balance (or not).			
Fraction of eligible households meeting first target annually after start-up		8.3%	
Fraction of eligible households meeting first target annually	5.56%	0.00%	
Cumulative faction of eligible households meeting first target	8.33%	50.00%	
Number of households participating annually for first target	8,149	-	
Total number of households meeting first target by 2020		71,709	
Fraction of eligible households meeting second target annually after start-up		10.0%	
Fraction of eligible households meeting second target annually	0.00%	10.00%	
Cumulative faction of eligible households meeting second target	0.00%	75.00%	
Number of households participating annually for second target	-	13,249	
Total number of households meeting second target by 2020		103,986	
Assumed "cap" on total fraction of households participating:		75%	
Implied number of households "upgraded" from first to second target		32,278	
"Upgraded" households distributed over last 6	years of program		
Number of households "upgraded" annually from first to second target	-	5,380	
Number of households annually meeting second target directly (not upgraded)	-	7,870	
Annual Average Energy Savings per Household reaching first target			
Electricity	2.86	2.77	MWh
Natural Gas	14.93	15.60	MMBtu
Distillate Oil	0.68	0.66	MMBtu
LPG	2.34	2.25	MMBtu
Wood	1.12	0.93	MMBtu

Annual Average Energy Savings per Household upgrading to second target			
Electricity	1.91	1.84	MWh
Natural Gas	9.96	10.40	MMBtu
Distillate Oil	0.45	0.44	MMBtu
LPG	1.56	1.50	MMBtu
Wood	0.75	0.62	MMBtu
Annual Average Energy Savings per Household reaching second target directly			
Electricity	4.77	4.61	MWh
Natural Gas	24.89	25.99	MMBtu
Distillate Oil	1.14	1.10	MMBtu
LPG	3.90	3.76	MMBtu
Wood	1.87	1.55	MMBtu
First-year (not cumulative) Energy Savings for Households reaching first target			
Electricity	23.34	-	GWh
Natural Gas	121.69	-	Billion Btu
Distillate Oil	5.56	-	Billion Btu
LPG	19.05	-	Billion Btu
Wood	9.14	-	Billion Btu
First-year (not cumulative) Energy Savings for Households upgrading to second target			
Electricity	-	9.92	GWh
Natural Gas	-	55.93	Billion Btu
Distillate Oil	-	2.36	Billion Btu
LPG	-	8.09	Billion Btu
Wood	-	3.34	Billion Btu
First-year (not cumulative) Energy Savings for Households reaching second target directly			
Electricity	-	36.28	GWh
Natural Gas	-	204.55	Billion Btu
Distillate Oil	-	8.62	Billion Btu
LPG	-	29.58	Billion Btu
Wood	-	12.20	Billion Btu
Total Annual Investment Costs for all improvements	$ 32,598	$ 64,602	$ thousand
Includes health and safety-related measures with limited impact on energy use.			
Annual Investment Costs for energy-efficiency-related improvements	$ 23,633	$ 50,028	$ thousand
Net of health and safety-related measures with limited impact on energy use.			
Implied levelized cost of saved energy for households reaching first target			
Electricity	$ 72	$ 74	$/MWh
Calculated only for electricity, because the same investment also yields savings for other fuels.			
Implied levelized cost of saved energy for households upgrading to second target			
Electricity	$ 93	$ 96	$/MWh
Implied levelized cost of saved energy for households reaching second target directly			
Electricity	$ 80	$ 83	$/MWh
Implied first-year levelized cost of saved energy for households reaching first target in that year	$ 1,676,839	$ -	
Implied first-year levelized cost of saved energy for households upgrading to second target in that year	$ -	$ 954,239	
Implied first-year levelized cost of saved energy for households reaching second target directly in that year	$ -	$ 3,015,238	
Implied cumulative levelized cost of all participating households	$ 2,520	$ 47,955	$ thousand

Assumptions for Existing Low-income Weatherization Program (Recent Actions)

Number of homes weatherized per year	1700
Fractional energy savings in existing houses under current program	22%

Estimates based on recent MT DEQ program accomplishments provided by Kane Quenemoen of MT DEQ (personal communication).

Results	2010	2020	Units
Electricity Savings--Existing Program			
Reduction in Electricity Sales: Residential	18	53	GWh (sales)
TOTAL Reduction in Electricity Sales	18	53	GWh (sales)
Reduction in Generation Requirements	20	57	GWh (generation)
GHG Emission Savings	**0.02**	**0.05**	$MMtCO_2e$
Natural Gas and Other Fuel Savings--Existing Program			
Reduction in Natural Gas Use: Residential	92	283	Billion BTU
Reduction in Distillate Oil Use: Residential	4	13	Billion BTU
Reduction in LPG Use: Residential	15	43	Billion BTU
Reduction in Wood Use: Residential	7	20	Billion BTU
GHG Emission Savings from above	**0.01**	**0.02**	$MMtCO_2e$
Electricity Savings--Expanded Program			
Reduction in Electricity Sales: Residential	35	597	GWh (sales)
TOTAL Reduction in Electricity Sales	35	597	GWh (sales)
Reduction in Generation Requirements	38	643	GWh (generation)
GHG Emission Savings	**0.04**	**0.54**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**$61**	$million
Cumulative Emissions Reductions (2007-2020)		3.4	$MMtCO_2e$
Cost-Effectiveness		**N/A**	$/tCO_2e$
Natural Gas and Other Fuel Savings--Expanded Program			
Reduction in Natural Gas Use: Residential	182	3,256	Billion BTU
Reduction in Distillate Oil Use: Residential	8	143	Billion BTU
Reduction in LPG Use: Residential	29	491	Billion BTU
Reduction in Wood Use: Residential	14	216	Billion BTU
GHG Emission Savings from above	**0.01**	**0.21**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020) (Avoided cost savings only)		**-$102**	$million
Cumulative Emissions Reductions (2007-2020)		1.3	$MMtCO_2e$
Cost-Effectiveness		**N/A**	$/tCO_2e$

Summary Results for RCII-11	2010	2020	Units
Total for Policy (Electricity, Natural Gas and Other Fuels)			
GHG Emission Savings	**0.05**	**0.75**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$41**	$million
Cumulative Emissions Reductions (2007-2020)		4.7	$MMtCO_2e$
Cost-Effectiveness		**-$8.75**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1

Montana demographics - by income level

Source: U.S. Census Bureau, Current Population Survey, 2006 Annual Social and Economic Supplement.
From: http://pubdb3.census.gov/macro/032006/pov/new46_100125_01.htm
and http://pubdb3.census.gov/macro/032006/pov/new46_135150_01.htm.

	All income levels	Below 100% of Poverty	Below 150% of Poverty
	(thousands of persons)		
Montana population (2005 data)	926	128	219
Percentage of population	100%	14%	23.7%

ratio of 150% poverty to 100% poverty:
1.711

Total Occupied Housing Units in MT, 2005:	368,268
Total Occupied Rental Housing Units in MT, 2005:	113,810

(From 2005 American Community Survey, downloaded from http://factfinder.census.gov; see "US Poverty Data" worksheet in this workbook).

Implied number of housing units occupied by households with income below 150% of poverty level in MT as of 2005: 87,096

Data Source for Poverty Status x Rental Status Estimates

Geographic Summary Level - State
Geographic Areas - State in [Montana]
Demographic Universe - Renter Occupied Housing Units
Demographic Characteristics - Person Poverty Status Recode (12) in [Less than 25%; 25.0% to 49.9%; 50.0% to 74.9%; 75.0% to 99.9%; 100.0% to 124.9%; 125.0% to 134.9%; 135.0% to 149.9%; 150.0% to 184.9%; 185.0% to 199.9%; 200.0% to 249.9%; 250.0% to 299.9%; 300.0% or more]

State	Person Poverty Status Recode (12)	Metrics Count	Cumulative totals, 2000
Montana	**Less than 25%**	6,023	Households
	25.0% to 49.9%	5,294	under
	50.0% to 74.9%	9,055	150% of
	75.0% to 99.9%	10,116	poverty level
	100.0% to 124.9%	9,872	
	125.0% to 134.9%	3,646	
	135.0% to 149.9%	5,875	49,881
	150.0% to 184.9%	11,750	Households
	185.0% to 199.9%	3,690	over
	200.0% to 249.9%	11,391	150% of
	250.0% to 299.9%	9,459	poverty level
	300.0% or more	24,796	61,086
	Total	110,967	
Total		110,967	

Source: U.S. Census Bureau, Census 2000 Sample Data File

Data users who create their own tabulations using data from the Census 2000 Sample Data File should cite the Census Bureau as the source of the original data only.

Individuals for whom poverty status is determined. Poverty status was determined for all people except institutionalized people, people in military group quarters, people in college dormitories, and unrelated individuals under 15 years old.

Above Sent by Pam Harris of the Census and Information Center, Montana Department of Commerce, attached to email to Greg Powell of Pembina/CCS on June 6, 2007 with subject "RE: Montana census data"

From above, year 2000 fraction of households in rental housing with income over 150 percent of poverty level
55.0%

Assuming that this ratio holds for the year 2005 as well, the number of rental housing units in MT occupied by households with incomes above 150% of the poverty level is estimated at: 62,651

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis
RCII-12 **State Lead by Example**

Date Last Modified:	*5/22/2007 D. Von Hippel/A Bailie*	

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2010	
Based on goal set in Policy Option Design for RCII-12 (version dated 5/1/07).			
Electricity			
Levelized Cost of Electricity Savings		$37	$/MWh
Based on estimate in WGA CDEAC EE Report. (See Note 1, below.) Although this estimate is based on building efficiency improvements driven by code changes, it is on the order of estimates for the costs of efficiency improvements for "beyond code" changes included in a recent report by the Southwest Energy Efficiency Project (SWEEP--see Note 2). Value here adjusted for NC prices based on 7-year payback estimated in WGA CDEAC EE Report. (See Note 1 in RCI-4.)			
Levelized Cost of Natural Gas Savings		$4.7	$/MMBtu
As estimated for RCII-4. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCII-4.)			
Bulk Purchase Program:			
Fraction of State agency electricity demand addressed by bulk purchasing program		10%	
Placeholder estimate--target not yet provided by TWG/CCAC.			
Fraction of all-sector (excluding government) electricity demand addressed by bulk purchasing program		0%	
Policy assumed to cover government demand only.			
Average lifetime of devices included in bulk purchasing program		10	years
Placeholder estimate--designed to be an average between longer-lived equipment such as water heaters and air conditioners, and shorter-lived devices such as computers.			
Fractional savings from bulk purchase program relative to standard-efficiency equipment, appliances, and other devices.		20%	
Placeholder estimate, but consistent with an average of fractional savings possible with many different types of higher-than-standard efficiency appliances, equipment, and other devices.			
Assumed Cost of Bulk Purchase Program Savings		$12	$/MWh
Pending receipt of more specific information, assumed to be similar to the cost of market transformation programs. Figure used is the same as used in RCII-2 worksheet in this workbook (From WGA EE Task Force study (2005), which cites the Retrospective Analysis of the Northwest Energy Efficiency Alliance (Violette, Ozog, and Cooney, 2003).)			
Target Year for Achieving Purchase Level		2020	
Placeholder Estimate pending input from TWG, but consistent with timing of building efficiency improvement element.			
Avoided Electricity Cost		$49	$/MWh
See "AvCost" and "Common Factors" worksheets in this workbook.			
Avoided Natural Gas Cost		$6.5	$/MMBtu
See "NG prices aeo2006" and "Common Factors" worksheets in this workbook.			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings from Beyond-code Building Improvements			
Average Electricity and Gas Savings Beyond Code Levels (new government buildings)	9%	9%	
The description for this option currently includes the following: "Reduce per-unit-floor-area consumption of grid electricity and natural gas by 20% by 2020 in existing buildings, and by 40% in new buildings by 2020. These requirements should be phased in over time." The values shown above for these parameters are initial assumptions.			
Note in particular that the level of savings shown here is beyond that already included in Option RCII-4, and thus already includes an improvement in efficiency relative to average current practice.			
Total Commercial Floorspace in Montana (million square feet)	242	256	
Estimated (see "MT_Activities_Est" worksheet in this workbook) based on USDOE EIA CBECS (commercial survey) data for the Mountain region, extrapolated using projected Montana population as a driver.			

Electricity Use per New/Renovated Commercial Sq. Ft. After RCII-4 Application	**16.2**	**13.2**	kWh/yr

Based on application of RCI-4 (15-30% efficiency improvement)--see calculations and notes in "RCI-4" worksheet in this workbook. with ultimate savings of 15 percent relative to current building codes by 2010, and 30 percent by 2030.

Nat. Gas Use per New/Renovated Commercial Sq. Ft. After RCII-4 Application	**35.4**	**25.9**	kBtu/yr

Assumes the same pattern of code improvement as for electricity use, as described above.

Implied Electricity Use per New/Renovated Commercial Square Foot After RCII-4 Application, Relative to Average in Montana as of 2005	**84.3%**	**68.7%**
Implied Natural Gas Use per New/Renovated Commercial Square Foot After RCII-4 Application, Relative to Average in Montana as of 2005	**84.3%**	**68.7%**

Required Net Elect/Gas Use per Square Foot New Government Space	First Year	**75%**
After RCII-4 Policy Relative to Average in Montana in 2005	In 2020	**60%**

Placeholder estimate, to be revised in consultation with TWG (based on pattern of improvement implied by meeting specifications in RCII-12 Option Design).

Required Net Elect/Gas savings per Square Foot Existing Government Space After RCII-4 Policy Relative to Average in Montana in 2005	**1.8%**	**20.0%**

Based on "20 percent improvement by 2020" as noted in RCII-12 Option Design.

Government floorspace (including leased) by year (million square feet)	**74**	**78**	
Implied total electricity savings in existing buildings from RCII-12	**25**	**297**	GWh/yr
Implied total gas savings in existing buildings from RCII-12	**60**	**695**	GBtu/yr

Average Fraction of Improvement in Electric Energy Intensities from:

Energy Efficiency Improvement	91%	80%
Solar Thermal Energy (hot water/space heat/space cooling)	3%	5%
On-site Solar PV	1%	3%
On-site Biomass/Biogas/Landfill Gas Energy Use	2%	4%
Green Power Purchase (from off-site, beyond electricity supply RPS)	3%	8%

All "placeholder" assumptions, but based on RCII-12 goal "Require 25% of energy use to be generated from renewable sources by 2025 in new and existing buildings. These goals may be met through any combination of on-site generation and "green power" purchases." On-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Average Fraction of Improvement in Gas Energy Intensities from:

Energy Efficiency Improvement	95%	80%
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%
On-site Solar PV	0%	0%
On-site Biomass/Biogas/Landfill Gas Energy Use	0%	13%
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%

All "placeholder" assumptions, based on goal cited above, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under New Code Requirements.	**1.50**

Currently set at 1.5 so that about 0.5 unit of renovated space is included per unit of new space (initial assumption). See Note 4. It may be useful to get further MT-specfic information regarding this value.

Adjustment of Energy Use per Unit Floor Area for State/State-funded Buildings Relative to Average Commercial Building in Montana	1.00	1.00

Placeholder assumption.

Adjustment to Include Floor Area of New/Renovated space occupied by state and local government agencies in leased buildings.	1.20	1.20

Placeholder assumption.

Fraction of New/Renovated Commercial Space in Government Buildings		25.4%	

This estimate includes state-owned buildings plus local government buildings, including schools. Estimate is based on the fraction of commercial-sector floorspace in state and local-owned government buildings in the Mountain region, as described in CBECS 2003 data (see "MT_Activities_Est" worksheet in this workbook), pending receipt of MT-specific data.

Adjustment to Exclude Floor Area of New/Renovated State/State-funded buildings not included in option.	1.00	1.00	

Placeholder assumption. Reduce below 1.0 if, for example, the option is designed to exclude small or special-use buildings.

Implied Annual Square Feet New Building Space Covered by Policy (million)	**0.83**	**0.54**	
Implied Cumulative Impacts of Option, New Government Space (Electricity savings)			
Energy Efficiency Improvement	**1.14**	**9.20**	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	**0.04**	**0.41**	GWh
On-site Solar PV	**0.01**	**0.20**	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	**0.02**	**0.31**	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	**0.04**	**0.55**	GWh
Implied Cumulative Impacts of Option, New Government Space (Natural Gas savings)			
Energy Efficiency Improvement	**2.59**	**19.84**	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	**0.14**	**1.31**	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	**0.00**	**1.23**	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Government Space (Electricity savings)			
Energy Efficiency Improvement	**23.17**	**237.64**	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	**0.76**	**14.85**	GWh
On-site Solar PV	**0.25**	**8.91**	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	**0.51**	**11.88**	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	**0.76**	**23.76**	GWh
Implied Cumulative Impacts of Option, Existing Government Space (Natural Gas savings)			
Energy Efficiency Improvement	**56.60**	**556.02**	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	**2.98**	**48.65**	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	**0.00**	**90.35**	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr

Additional Inputs to/Intermediate Results of Costs Analysis for Building Improvements

Estimated annual levelized cost of solar hot water per unit output	**20.77**	**18.70**	$/MMBtu

Based on inputs to/results of solar hot water heating analysis prepared by CCS.

Adjustment to solar thermal costs for inclusion of space heat/cooling measures	1.00	1.00	

Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.

Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling	**65.91**	**59.32**	$/MWh
Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling	**14.54**	**13.09**	$/MMBtu

Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).

Estimated annual levelized cost of on-site Solar PV	**223**	**129**	$/MWh

Based on inputs to/results of solar PV analysis included in RCI-10.

Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use		**3.19**	$/MMBtu

Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be increased.

Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment		2.00	
Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.			
Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas	**28.95**	**28.95**	$/MWh
Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)	25.00	15.00	$/MWh
Placeholder assumptions.			
Implied use of biomass/biogas/landfill gas by year	**2.42**	**146.83**	Billion Btu

Inputs to/Intermediate Results of Analysis of Bulk Purchase Element

Government Building Electricity Use	1,390	1,188	GWh
Net of efficiency measures from other programs and options. Does not currently include local government electricity use.			
Fractional implementation of Bulk Purchase Program targets	9.1%	100.0%	
Annual Savings from Bulk Purchase Program (not cumulative)			
State Agency Program	0.3	2.4	GWh
All-sectors (non-State) Program [not included in this policy]	0.0	0.0	GWh

Results	2010	2020	Units
Electricity (Conventional), Building Improvement Elements			
Reduction in Electricity Sales: Residential (not included here)	0	0	GWh (sales)
Reduction in Electricity Sales: Commercial (government)	27	308	GWh (sales)
TOTAL Reduction in Electricity Sales	27	308	GWh (sales)
Reduction in Generation Requirements	29	331	GWh (generation)
GHG Emission Savings	**0.03**	**0.28**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$7**	$million
Cumulative Emissions Reductions (2007-2020)		1.8	$MMtCO_2e$
Cost-Effectiveness		**-$3.72**	$\$/tCO_2e$
Electricity Savings Through Bulk Purchase Program			
Reduction in Electricity Sales: Residential (not included here)	0	0	GWh (sales)
Reduction in Electricity Sales: Commercial (government)	0	15	GWh (sales)
TOTAL Reduction in Electricity Sales	0	15	GWh (sales)
Reduction in Generation Requirements	0	16	GWh (generation)
GHG Emission Savings	**0.00**	**0.01**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$1.4**	$million
Cumulative Emissions Reductions (2007-2020)		0.06	$MMtCO_2e$
Cost-Effectiveness		**-$22.47**	$\$/tCO_2e$
Natural Gas			
Reduction in Gas Use	62	717	Billion BTU
GHG Emission Savings	**0.00**	**0.04**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$3**	$million
Cumulative Emissions Reductions (2007-2020)		0.2	$MMtCO_2e$
Cost-Effectiveness		**-$15.17**	$\$/tCO_2e$
Biomass/Biogas/Landfill Gas Fuel Use			
Added GHG Emissions from Biomass Fuels Use	**0.00001**	**0.00045**	$MMtCO_2e$
Cumulative added Emissions from Biomass Fuels (2007-2020)		0.0020	$MMtCO_2e$

Summary Results for RCI-12	2010	2020	Units
Total for Policy (Natural gas and electricity less biomass)			
GHG Emission Savings	**0.03**	**0.31**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$11.4**	$million
Cumulative Emissions Reductions (2007-2020)		2.0	$MMtCO_2e$
Cost-Effectiveness		**-$5.55**	$\$/tCO_2e$
Total for Policy Less Bulk Purchase Program			
GHG Emission Savings	**0.03**	**0.30**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$9.9**	$million
Cumulative Emissions Reductions (2007-2020)		2.0	$MMtCO_2e$
Cost-Effectiveness		**-$5.01**	$\$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

In the WGA CDEAC EE report, Building Code improvements were effectively modeled in two steps. The first, assumed to be effectively a baseline action, in the context of this study, but called the "Current Activities" case, brought codes up to recent IIEC levels as follows:

"In particular, we assume adoption of a recent version of the IECC leads to 5% electricity savings on average in states in colder or moderate climates, and 13% savings in homes in very hot climates (AZ, TX, and NV). Regarding commercial buildings, we assume adoption of the code leads to 10% electricity savings in moderate and colder states, and 15% savings in very hot states (Kinney, Geller, and Ruzzin 2003). For California, we used estimates of the electricity savings from building code upgrades adopted in 2001 and 2005 (Mahone, et al. 2005). These savings levels are prior to the adjustment for savings realization mentioned in Table V.1" [Quote from footnote, page 40]

The second increase, to the CDEAC "Best Practices" Scenario, included the following improvements:

"This [Best Practices] scenario assumes that the International Energy Conservation Code, 2004 version, is adopted in 2007 in all states except California, as California has its own more stringent standard. It is assumed that state and/or local building energy codes are upgraded in 2011 (3% improvement) and in 2015 (additional 6% improvement). This scenario also assumes that compliance and enforcement are improved and that a 90% savings realization rate is achieved. Finally, we assume that California's current building energy codes will be upgraded in 2009 (3%), 2013 (6%) and 2017 (3%)." [Quote from page 41]

The CDEAC report provides a cost of saved energy (electricity) of 4.74 cents/kWh,
in 2005 dollars, based on an average 7-year payback for code improvements (page 42).

Note 2:

The Southwest Energy Efficiency Project's (SWEEP) Report
Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices
includes state-by-state estimates of the potential savings from two scenarios of building code and "beyond code" efficiency improvements.

Note 3:
Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "MT_Activities_Est" worksheet in this workbook.

Following data on electricity sales in Montana as of 2005 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	4,221,448	31%
Commercial	4,473,394	33%
Industrial	4,783,996	35%
Total	13,478,838	100%

For natural gas consumption data from the USDOE EIA downloaded from
http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

	Sales (Million Cubic Feet of Natural Gas)			
	Residential	Commercial	Industrial	Total
2005	19,834	10,162	398	30,394
Fraction of 2005 Total	65%	33%	1%	100%

Note 4:
The estimate of 0.5 unit of renovated space per unit of new construction in the commercial sector is a rough assumption.
It is likely that the ratio of commercial space undergoing major renovation to new commerial space will fluctuate year by year, and it may be necessary to get a more specific figure for this parameter. It is clear, however, that the renovation market represents a substantial opportunity for improving energy efficiency through code changes. A study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As California includes a significant fraction of older buildings in its building stocks, renovations may be a smaller fraction of building activity in Montana.

Estimate of Mitigation Option Costs and Benefits for Montana RCII GHG Analysis

RCII-13 **Metering Technologies with opportunity for load management and choice**

Date Last Modified: *5/21/2007 D. Von Hippel/Michael Lazarus*

Key Data and Assumptions	2010	2020/all	Units
The following calculation estimates GHG emissions reduction from only one element of RCII-13, inverted block tariff structures. Other elements of provide GHG emissions reductions largely through supporting other policies in the RCII and Energy Supply sectors.			
First Year Results Accrue		**2009**	
Savings from Smart Meters and related rate structures for Residential Consumers			
Reduction in Residential Electricity Use		**8%**	
TWG members familiar with this technology suggest potential savings of 8 to 10 percent of consumption. A review of smart metering-related studies and pilot installations (Smart meters: commercial, regulatory and policy drivers, by Gill Owen and Judith Ward of Sustainability First, dated March 2006, Appendicies document "Appendix 2 – Smart metering experience and studies", p. 19 to 34 in document available as http://www.sustainabilityfirst.org.uk/docs/smartmeterspdfappendices.pdf) suggests potential savings in a similar range.			
Cost of Smart Meters per Meter		**$200**	
Assumed Cost of Implementation of Tariffs for Smart Meters		**$0**	$/MWh
In practice, there are likely to be some costs associated with smart meter tariff structures, including program costs, changes to billing systems, and possibly (in some cases) changes to metering or meter-reading systems. These costs are not explicitly accounted for in this analysis, but are likely to be quite small relative to the electricity cost savings achieved through the policy.			
Avoided Electricity Cost (Residential)		**$49**	$/MWh
See common assumptions.			
Target Number of Smart Meters Installed Under Pilot Program		**45,000**	
End Date of Pilot Program		**2011**	
Target Fraction Additional Residential Consumers Using Smart Meters, Full Program		**30%**	
Placeholder Assumption.			
Start Date of Full Program		**2012**	
Full Phase-in Date of Full Program		**2020**	

Other Data, Assumptions, Calculations	2010	2020/all	Units
Residential Electricity Sales	**4,245**	**4,329**	**GWh**
Residential Customers	**456,073**	**481,564**	
Implied Consumption per Customer	**9.31**	**8.99**	**MWh**
Cumulative Number of Installed Meters Under Pilot Program	**30,000**	**45,000**	
Cumulative Number of Installed Meters Under Full Program	**-**	**144,469**	
Factors for Annualizing Capital Costs (Residential Smart Meters)			
Interest Rate (real)		7%	/yr
Economic Life of Meter *(Rough estimate)*		15	years
Implied Annualization Factor		10.98%	%/yr
Implied Annualized Cost of Meters		$ 21.96	/meter-yr
Intermediate Cost Results, Pilot Program			
Total up-front meter costs for meters installed in each year	**$ 3,000**	**$ -**	thousand
Annualized Meter Costs	**$ 659**	**$ 988**	thousand
Intermediate Cost Results, Pilot Program			
Total up-front meter costs for meters installed in each year	**$ -**	**$ 3,328**	thousand
Annualized Meter Costs	**$ -**	**$ 3,172**	thousand

Results	2010	2020	Units
Electricity			
TOTAL Reduction in Electricity Sales, Pilot Program	22	32	GWh (sales)
Reduction in Generation Requirements, Pilot Program	24	35	GWh (generation)
TOTAL Reduction in Electricity Sales, Full Program	0	104	GWh (sales)
Reduction in Generation Requirements, Full Program	0	112	GWh (generation)
Totals for Pilot Program			
Total Net GHG Emission Savings, Pilot Program	**0.02**	**0.03**	$MMtCO_2e$
Net Present Value (2007-2020), Pilot Program		**-$5**	$million
Cumulative Emissions Reductions (2007-2020), Pilot Program		0.4	$MMtCO_2e$
Cost-Effectiveness, Pilot Program		**-$13**	$\$/tCO_2e$
Totals for Full Program			
Total Net GHG Emission Savings, Full Program	**0.00**	**0.09**	$MMtCO_2e$
Net Present Value (2007-2020), Full Program		**-$6**	$million
Cumulative Emissions Reductions (2007-2020), Full Program		0.5	$MMtCO_2e$
Cost-Effectiveness, Full Program		**-$11**	$\$/tCO_2e$
Totals for Policy (Pilot plus Full Programs)			
Total Net GHG Emission Savings	**0.02**	**0.12**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$10**	$million
Cumulative Emissions Reductions (2007-2020)		0.9	$MMtCO_2e$
Cost-Effectiveness		**-$12**	$\$/tCO_2e$