

Chapter 3

Residential, Commercial, and Industrial Sectors

Overview of GHG Emissions

The residential, commercial, and industrial (RCI) sectors are between them the third largest direct source of gross greenhouse gas (GHG) emissions in Colorado, if emissions from the generation of the electricity they consume are not included. Direct use of oil, natural gas, coal, and wood in the RCI sectors accounted for an estimated 21.2 million metric tons (MMt) of carbon dioxide equivalent (CO₂e) (18%) of gross GHG emissions in 2005.¹ Energy-related direct emissions result principally from the on-site combustion of natural gas, with smaller contributions by on-site combustion of coal and oil. The release of CO₂ and fluorinated gases (hydrofluorocarbons [HFCs], perfluorocarbons [PFCs]) during industrial processing, the use of sulfur hexafluoride (SF₆) in the utility industry, and the leakage of HFCs from refrigeration and related equipment accounted for an additional 2.9 MMtCO₂e in 2005. Including industrial process emissions, the RCI sectors are directly responsible for about one-fifth of Colorado's current gross GHG emissions (24.0 MMtCO₂e in 2005).

Considering only the direct emissions that occur within buildings and industries, however, ignores the fact that nearly all electricity sold in the state is consumed as the result of residential, commercial, and industrial activity. If the emissions associated with producing the electricity consumed in Colorado are considered, RCI activities are associated with over half (about 55%) of the state's gross GHG emissions.² The State's future GHG emissions therefore will depend heavily on future trends in the consumption of electricity and other fuels in these sectors. Figure 3-1 shows historical and projected RCI GHG emissions by fuel and source, and illustrates the large fraction of RCI emissions associated with electricity use. RCI emissions associated with electricity and natural gas use are expected to rise by roughly 35% between 2005 and 2020, from around 60 MMtCO₂e in 2005 to about 80 MMtCO₂e in 2020.

Key Challenges and Opportunities

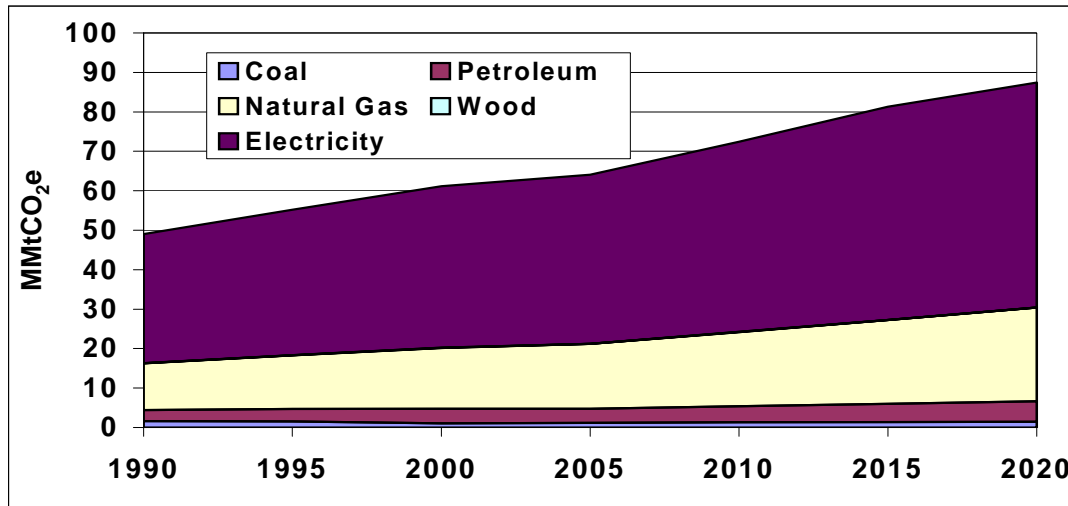
The principal means to reduce RCI emissions include improving energy efficiency, substituting electricity and natural gas with lower-emission energy resources (such as solar water heating, passive solar heating, and geothermal heat pumps), and various strategies to decrease the emissions associated with electricity production (see Chapter 4, Energy Supply). The state's relatively limited pursuit of energy efficiency until recent years offers abundant opportunities to reduce emissions through programs and initiatives to improve the efficiency of buildings, appliances, and industrial practices. At the same time, Colorado faces high growth in population (relative to the national average) and new construction, underscoring the importance of

¹ Emissions estimates from wood combustion include only nitrous oxide (N₂O) and methane (CH₄). Carbon dioxide emissions from biomass combustion are assumed to be "net zero", consistent with US EPA and Intergovernmental Panel on Climate Change (IPCC) methodologies, and any net loss of carbon stocks due to biomass fuel use should be accounted for in the land use and forestry analysis.

² Gross emissions here denote GHG emissions from activities in Colorado, adjusted for exports of electricity, oil, and gas, but not including consideration of estimated "sinks" of GHGs in the forestry and land-use sectors.

integrating energy efficient design principles into buildings that will contribute GHG emissions for many years to come, while still reducing the carbon footprint of the existing stock.

Figure 3-1. Historical and projected residential, commercial, and industrial (RCI) GHG emissions from fuel consumption in Colorado, 1990 to 2020



Colorado has already taken important steps in this direction. Two recently-passed pieces of legislation are particularly relevant for the RCI sectors: HB07-1146 and HB07-1037. HB07-1146 requires Colorado jurisdictions with building codes to adopt the 2003 IECC standard. HB07-1037 directs gas and electric investor-owned utilities (IOUs) to implement additional or new energy efficiency programs. This law requires electric companies to reduce a certain amount of energy consumption and peak demand by 2018. The energy and demand reduction for electric IOUs are set equal to 5% of the energy consumption and peak in 2006. HB07-1037 also requires gas companies to spend 0.5 % of their annual revenue on energy efficiency programs. Aside from these recent legislative actions, Xcel Energy has committed to implementing expanded and new demand-side management (DSM) under a recent legal settlement. These actions indicate growing momentum for improving energy efficiency and reducing GHG emissions.

There are significant opportunities to reduce GHG emissions growth attributable to the RCI sectors in Colorado, including updating building codes on a regular basis, expanding DSM efforts in areas with pre-existing programs and implementing DSM in areas that do not, and promoting beyond code building practices. The Climate Action Panel (CAP) has also identified significant opportunities to reduce GHG emissions through policies addressing electricity production such as tapping into Colorado’s bountiful wind and solar resources (these are detailed in Chapter 4).

Overview of Policy Recommendations and Estimated Impacts

The CAP recommends a set of 11 policies for the RCI sector that offer the potential for significant GHG emission reductions in the state. The GHG emissions reduction for nine of these policies were quantified, and the costs per ton of GHG avoided were quantified for seven. The nine policy recommendations with estimates for potential avoided GHG emissions could lead to emissions savings from reference case projections of:

- 15 MMtCO₂e per year by 2020, and
- cumulative savings of over 86 MMtCO₂e from 2007 through 2020.³

The seven recommended policies for which costs were quantified could result in net cost savings of over \$150 million through the year 2020 on a net present value (NPV) basis.⁴ The weighted average cost of these policies is a net savings of \$2 per MMtCO₂e.

Among the CAP members present and voting, nine recommendations were accepted by unanimous consent, one by super majority (5 or fewer objections) and one by simple majority. These recommendations and results are summarized in Table 3.1. For each of two recommendations (RCI-1 and RCI-6), at least one CAP member expressed qualifications about support for the recommendation, but did not object to it.

The explanations of the objections and the qualified votes of approval are included in the detailed policy recommendations in Appendix E.

Recommended policies RCI-1, 2, 3, 4, 5, 6, 7, and 11 are all focused on DSM, but are distinguished by their different approaches, their focus on varied types of energy use, or the specific energy users they target. RCI-1 and RCI-5 involve implementing general DSM programs on a widespread basis. In contrast, RCI-2 targets state and local government buildings, and RCI-6 focuses on existing commercial and industrial buildings. RCI-4 covers the government, residential, and commercial sectors but focuses on incorporating energy efficiency into the design of new buildings. RCI-7 implements a specific technology (smart meters coupled with time-of-use rates) to increase awareness of energy consumption in the private sector. The goal of RCI-11 is to build an incentive for reducing energy use into electricity rates without collecting additional revenues.

Both RCI-8 and RCI-9 involve energy production at the site of use. RCI-8 involves promoting renewable energy systems, and RCI-9 focuses on increased implementation of combined heat and power in the state. Recommended policy RCI-10 provides free technical assistance to businesses for reducing carbon emissions in several areas, including renewable energy, energy efficiency, water, transportation, and solid waste.

Policies RCI-1, 2, 5, 6, 7, 8, 9, 10, and 11, as well as commercial and residential components of RCI-4, are all structured to provide incentives for energy efficiency or other measures to reduce GHG emissions. RCI-3 (building codes) and the government component of RCI-4 involve mandatory implementation of measures to reduce energy consumption.

³ Note that these savings figures were calculated relative to a baseline that does not include emission savings from recent actions such as HB07-1037 and a recent Xcel settlement, discussed in the text. However, the reference case forecast does include the effect of these actions. Note also that the emissions savings and costs of a number of the policy recommendations were not quantified.

⁴ The net cost savings, based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs, are shown in constant 2005 dollars. All NPV analyses here use a 5% real discount rate.

Table 3-1. Summary list of RCI policy recommendations

	Policy Recommendation	GHG Reductions (MMtCO ₂ e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO ₂ e)	Climate Action Panel Action
		2012	2020	Total 2007–2020			
RCI-1	Expand demand side management programs of all electric and gas utilities, ramped up to reduce energy use by 1% per year by 2013.	0.6	5.2	24	–\$853	–\$32/ton	Unanimous Consent (Several qualified approvals)
RCI-2	Revolving loans to reduce energy use in state and local government buildings.	0.2	0.5	3.7	–\$67	–\$18/ton	Super Majority (1 objection)
RCI-3	Upgrade the state’s energy requirements for local building codes every 3 years, and improve enforcement of building codes.	0.3	2.7	13.0	N/A	N/A	Unanimous Consent
RCI-4 (total)	Targets and programs for beyond-code reductions in energy use in new government, residential, and commercial buildings.	1.0	2.4	20.4	\$1,550	\$76/ton	Unanimous Consent
	<i>Government subtotal:</i>	<i>0.4</i>	<i>0.6</i>	<i>6.0</i>	<i>\$348</i>	<i>\$58/ton</i>	
	<i>Commercial subtotal:</i>	<i>0.5</i>	<i>1.4</i>	<i>11.2</i>	<i>\$1,219</i>	<i>\$109/ton</i>	
	<i>Residential subtotal:</i>	<i>0.2</i>	<i>0.4</i>	<i>3.2</i>	<i>–\$17</i>	<i>–\$5/ton</i>	
RCI-5	Inverted electricity block rates for all residential and commercial consumers to fund utility energy efficiency programs.	1.6	6.7	38.2	–\$1,135	–\$30/ton	Majority (7 objections)
RCI-6	Low interest loans to fund energy efficiency retrofits for commercial and industrial buildings.	0.5	1.8	11.7	–\$334	–\$28/ton	Unanimous Consent (2 qualified approvals)
RCI-7	Electricity smart metering with time-of-use rates and in-home or in-office displays for all residential, commercial, and industrial consumers.	2.0	2.6	25.4	–\$844	–\$33/ton	Unanimous Consent
RCI-8	Tax credits for renewable energy systems in new and existing residential, commercial, and industrial buildings.	N/A	N/A	N/A	N/A	N/A	Unanimous Consent
RCI-9	Promote commercial and industrial combined heat and power (CHP) systems.	0.3	1.4	8.3	–\$25	–\$3/ton	Unanimous Consent
RCI-10	Statewide program for voluntary GHG reductions by businesses.	0.6	1.0	4.5	N/A	N/A	Unanimous Consent
RCI-11	Inverted electricity block rates for all residential and commercial consumers, recovering only cost of service.	N/A	N/A	N/A	N/A	N/A	Unanimous Consent
	Sector GHG reduction total of 9 analyzed policies after adjusting for overlaps among policies	3.7	15	86	N/A	N/A	
	Sector cost-effectiveness total of 7 analyzed policies with cost analysis after adjusting for overlaps among policies				–\$153	–\$2 /ton	

GHG = greenhouse gas; MMtCO₂e = million metric tons of carbon dioxide equivalent; MWh = megawatt hours.

Negative cost numbers indicate cost savings.

The cost (savings) shown are calculated in terms of net present value in constant 2005 dollars, using a 5% annual real discount rate for the period 2008 through 2020. Capital investments are represented in terms of levelized or amortized costs through 2020.

There is overlap in the expected emissions reduction and cost among some of the policies within the RCI sector. Many of the policies in the RCI sector affect similar types of energy use, although some policies (such as RCI-1) are defined by their usage reduction goals, while others (such as RCI-2, financing for energy efficiency improvements in state and local government buildings) are defined by addressing a specific type of energy use. Overlaps are expected to occur where policies have no specific funding mechanisms that would set them apart from other measures to reduce energy use. RCI-5, for example, which involves increasing block rates set to generate revenue to support aggressive DSM, is expected to subsume the electricity component of RCI-1 which is defined solely in terms of a usage reduction goal. In contrast, natural gas savings targets (part of RCI-1), financing for government building efficiency improvements (RCI-2), incentives for incorporating beyond-code energy efficient design in new government, residential, and commercial buildings (RCI-4), and financing retrofits for commercial and industrial buildings (RCI-6) each have dedicated funding sources and thus do not overlap. Encouraging implementation of combined heat and power (CHP) systems (RCI-9) is not a DSM program so it does not overlap with the various DSM policies. Implementing the Climate Wise program statewide (RCI-10) is self-funded and is expected to have much of its impact on non-electricity energy consumption. Similarly, RCI-3 focuses on building efficiency codes for new structures and is unlikely to overlap with other policy options.

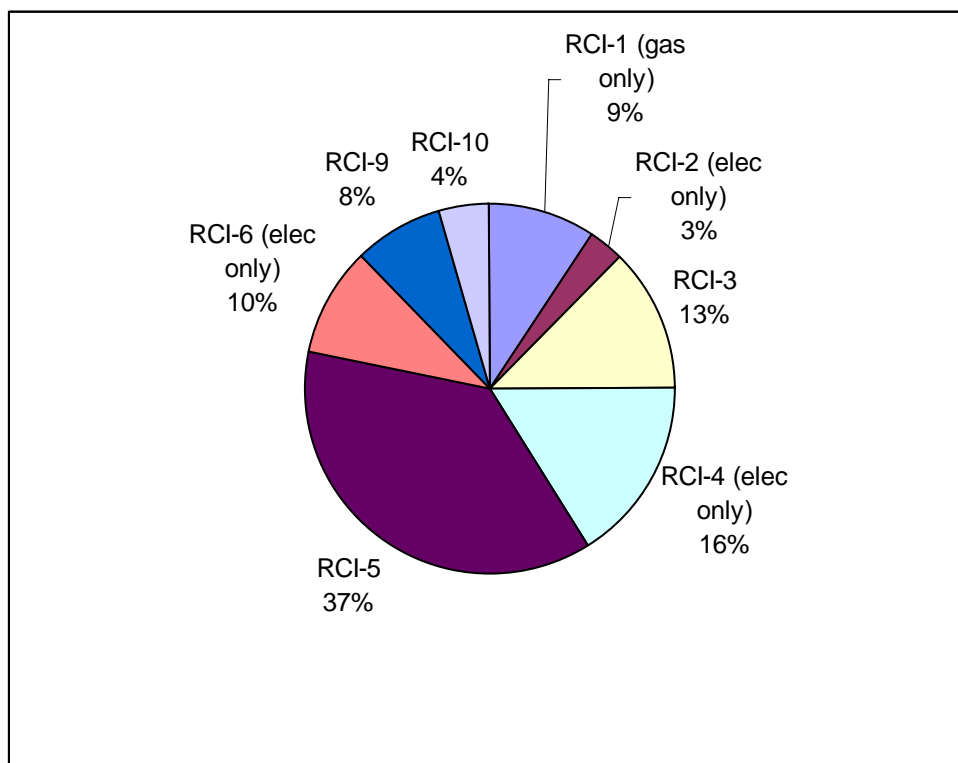
Between sectors, the recommended policies for the RCI sectors decrease overall electricity demand and thereby reduce the impact of the renewable portfolio standard (RPS) recommended under ES-2. ES-2 requires that a certain percentage of electricity sales come from renewable sources (see chapter 4). RCI-8 may also overlap with ES-2 and provide no incremental benefit, as new renewable energy sources on buildings would qualify towards this policy option.

See Appendix D, Methods of Quantification, for additional description of overlaps among sectors and of analyses of the cumulative GHG reductions from the combined effects of the CAP policy recommendations that were quantified.

The CAP policy recommendations described briefly here, and in more detail in Appendix E, result not only in significant emissions and costs savings, but offer a host of additional benefits as well. These benefits include reduction in spending on energy by homeowners and businesses; reduced risk of power shortages, energy price increases, and price volatility; and improved public health as a result of reduced pollutant emissions by power plants.

Figure 3-2 shows the breakdown of impacts of the recommended RCI policies, taken together, in terms of avoided GHG emissions (2007–2020).

Figure 3-2. Percent of avoided greenhouse gas emissions by policy



Residential, Commercial, and Industrial Policy Descriptions

The RCI sectors include emissions reduction opportunities related to improving energy use efficiency and using lower GHG energy sources.

RCI-1 Expanded Energy Efficiency and Demand Side Management

The CAP recommends, by unanimous vote of those members present and voting, with several votes of qualified approval, that Colorado increase the efficiency of electricity and natural gas use in the state through increased investment in DSM programs. Energy efficiency is the lowest cost resource for reductions in electricity and natural gas use by the residential, commercial and industrial sectors. Improving energy efficiency is a “win-win” strategy—it saves consumers and businesses money; it reduces the need for costly and controversial new power plants; it cuts pollution emissions when less fuel is burned in a home, commercial building, factory, or power plant; and it lowers energy imports. There is a long track record of cost effective energy efficiency initiatives, typically called DSM, at the local, state and regional levels in areas around the country. There is vast potential for improving the energy efficiency of homes, appliances, businesses and industry in Colorado.

The goal of this policy is to bring the total demand reduction of two recent DSM actions (House Bill 07-1037, enacted in 2007, and a commitment to additional DSM action by Xcel Energy as

part of a legal settlement) plus new, additional DSM activities in the state to a 1% reduction per year by 2013, and continuing at that rate through 2020. In the year 2020, about one-third of the goal of this policy would be achieved by those two recent actions and about two-thirds by the new actions contemplated to achieve the goal. The policy would apply to the entire state's gas and electric producers, suppliers, and customers. Because some rural cooperatives or municipal utilities do not have existing DSM programs, a five year ramp-in is recommended to allow time to establish infrastructure.

RCI-2 Energy Efficiency in Buildings Owned by State and Local Governments

Revolving loan funds are proven and effective tools for promoting energy efficiency in state and local government facilities. This policy would facilitate investment by public agencies in energy efficiency improvements by providing zero interest loans. Utility cost savings would provide cash flow for repayment of principle, so that the cost of the program would be limited to interest payments and loan administration. In addition to saving energy dollars, participating governments will demonstrate leadership in conservation principles.

The CAP recommends, by supermajority vote of those present and voting, with one objection, the use of a revolving fund providing zero-interest loans to achieve a 20% reduction in energy use by buildings owned by state and local governments, including schools. Measures would be implemented in stages over a five-year period.

RCI-3 Strengthening and Enforcement of Building Codes

Stronger building energy codes can be a very effective way to eliminate the least efficient energy approaches in new or renovated buildings. The International Energy Conservation Codes (IECC), updated every three years through an exhaustive consensus process involving a large number of code officials and building experts, have become a widely accepted standard. Many Colorado jurisdictions have adopted the 2003 IECC standard, and more will do so as a result of legislation (HB07-1146) recently signed by the Governor. The IECC must be enforced, however, and enforcement can be spotty in many building jurisdictions. Building code jurisdictions need to be encouraged to enforce the IECC with training, technical support and education. Enforcement is a critical element in the success of any code, but it may be particularly important for the success of policies that must be undertaken during planning and construction, such as RCI-4.

The CAP recommends, by unanimous vote of those members present and voting, a gradual increase in energy efficiency code for new construction in Colorado following the progress of the IECC, backed up by strong, consistent enforcement measures.

RCI-4 Planning and Design

The CAP recommends, by unanimous vote of those members present and voting, aggressively pursuing energy conservation through attention to building design, to ensure that the next generation of buildings in Colorado produces much lower GHG emissions per unit of utility. The CAP suggests a policy of mandating building design to a very high efficiency standard for

government-owned buildings, and aggressively encouraging voluntary efforts to design residential homes and non-government commercial buildings to very high efficiency standards. Specifically, this policy would:

- Mandate that of all new construction and major renovations of government-owned buildings, including schools and publicly-owned hospitals, 30% reduce energy consumption 37% consistent with LEED™ Gold and the other 70% reduce energy consumption 30% consistent with LEED Silver.
- Encourage voluntary efforts to attain a 15% reduction in energy consumption by new residential homes consistent with the Energy Star “high performing” standard (see HPH100.org for definition). The goal is to reach 70% of new residential units.
- Promote voluntary efforts to achieve a 50% to 70% reduction in energy consumption (with increasing in stringency over time) through the design of new commercial buildings. The goal is to reach 70% of new commercial buildings.

Property tax credits can be leveraged for promoting voluntary residential and commercial efforts. Other approaches should be considered to gain participation by state and local governments.

RCI-5 Inverted Block Rates to Fund Energy Efficiency

The CAP recommends, by majority vote of those members present and voting (with seven objections), use of a tiered, increasing surcharge on electricity rates to simultaneously provide a source of funding for energy efficiency and a financial incentive to adhere to high energy efficiency (low energy intensity) standards. Unlike a traditional public benefits charge, the surcharge would grow with increasing use above target levels, and high efficiency consumers would pay no surcharge.

The CAP recommends that these rates be applied to the Residential and Commercial sectors, statewide (consistent with the implementation mechanisms established by HB07-1037, but municipal utilities and cooperatives would have the alternative of participating in a System Benefits Charge.) Under this policy, proceeds above cost-of-service recovery would be used to fund residential and commercial energy efficiency programs. It is suggested that surcharge energy use thresholds be consistent with recent utility experience with inverted block rates, e.g., Southern California Edison’s Residential Baseline Allocation.

RCI-6 Retrofitting Existing Buildings for Energy Efficiency

Existing commercial and industrial buildings account for roughly 20% of GHG emissions. Because many buildings are extremely inefficient, small efficiency upgrades can result in dramatic reductions in GHG emissions in addition to economic savings. Energy efficiency upgrades can yield significant cost savings to participating businesses, improving competitiveness of businesses and the state. Providing incentives for energy efficiency upgrades can stimulate local business development in energy performance analysis and energy efficiency, as well as reducing GHG emissions and other air pollution.

The CAP recommends, by unanimous vote of those members present and voting, with two votes of qualified approval, that the state provide short-term, low- or no-interest loans to businesses to offset the initial costs of energy efficiency improvements in existing privately owned (e.g., non-municipal) commercial, industrial, and institutional buildings. This policy would seek to reach 5% of buildings per year by 2017, with each participant reducing energy use per square foot by 25% over five years. It could also create low- or no-interest loans to energy service companies who contract with commercial and industrial clients to implement energy-savings measures.

RCI-7 Pricing and Purchasing

Providing electricity consumers with timely, accessible feedback on energy use and cost information can result in reductions in energy use of 4% to 15%. Additionally, smart metering can save operating and maintenance expense to electric utilities and their customers by 1) reducing labor cost due to remote meter reading, 2) enabling better outage management, and 3) providing more accurate meter reading and consumption forecasting.

The CAP recommends, by unanimous vote of those members present and voting, further investigation into implementing smart metering in Colorado, combined with time-of-use rate schedules and in-home displays, to enable electricity consumers to better manage energy use. Specifically, the CAP recommends:

- A legislatively-prescribed Colorado Public Utilities Commission study of a mandatory investor-owned utility program combining advanced metering infrastructure, time-of-use electricity rates, and end-user energy displays. The study would weigh the energy cost savings, peak reduction benefits, and GHG benefits against the cost of the program. Costs would be considered from both the customer and the utility perspective. The study would use Colorado-specific assumptions to determine the most cost-effective technologies and programs to apply by customer class, and
- Based upon the results of the study, adoption of mandatory time-of-use rates for all commercial and industrial customers, as well as residential customers, and
- Installation of advanced metering infrastructure with two way communications (smart meters), and
- Installation of end-user energy displays with hourly usage, pricing, and GHG emissions display capabilities, and
- Allowing full recovery for the costs of the program through the utility ratemaking process if the program is proven cost-effective.

RCI-8 Renewable Energy Systems on New and Existing Buildings

Renewable energy, when combined with energy efficiency measures, can dramatically lower CO₂ emissions from energy production required to heat, light, cool, and otherwise power new and existing residential, commercial, and industrial buildings. Efforts to promote the installation of active and passive renewable energy systems, such as passive solar heating and cooling, domestic solar hot water, and wind, will complement many other efforts being recommended by the CAP.

The CAP recommends, by unanimous vote of those members present and voting, that the state promote wider use of active and passive renewable energy systems on all buildings through education and financial incentives in the form of tax credits to businesses, homeowners, and residential rental property owners who install proven and reliable renewable energy systems.

Systems to be included in the mix of renewable energy technologies include passive solar heating, solar hot water, concentrated solar thermal, photo-voltaic solar (PV) on buildings not already covered by the existing RPS, and geothermal (ground-source heat pumps), and possibly other emerging technologies. The CAP recommends that the proposed tax incentives be awarded only to individuals and businesses that have significantly reduced energy consumption prior to or concurrent with system installation.

The policy design includes an educational campaign to assist individuals and businesses in understanding the renewable energy options and requirements of the program. In addition, short-term, low-interest loans from the state and/or tax credits will be available to businesses, and tax credits will be available to homeowners and residential rental property owners, for energy-efficiency upgrades (to enlarge the pool of homeowners, residential property owners, and businesses eligible to take advantage of the renewable energy system tax credit).

RCI-9 Energy Delivery

Combined heat and power (CHP) refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. Western Governors' Association (WGA) analysis shows that CHP is an affordable, efficient, clean, and reliable piece of the puzzle for meeting the Western region's energy needs while substantially reducing carbon emissions. The recovered thermal energy can be used for space heating, hot water, steam, air conditioning, water cooling, product drying, or for nearly any other thermal energy need. The end result is significantly more efficient than generating electric and thermal energy separately. In fact, many CHP systems are capable an overall efficiency of more than 80%—double that of conventional systems.

CHP faces barriers to widespread adoption, including inadequate information, institutional barriers, high transaction costs for small projects, high financing costs because of lender unfamiliarity and perceived risk, “split incentives” between building owners and tenants, and utility-related policies like interconnection requirements, high standby rates, and exit fees.

The CAP recommends, by unanimous vote of those members present and voting, further study by the Governor's Energy Office into in-state CHP potential, and implementation of WGA's recommendations with the goal of facilitating the development of 50% of the economic CHP potential.

RCI-10 Implementing Climate Wise Statewide

The CAP recommends, by unanimous vote of those members present and voting, implementing a state-wide, voluntary business program featuring free technical assistance and continuous support as a means for reducing carbon emissions through reductions in energy, water,

transportation, and solid waste, emulating the success of Fort Collins’ “Climate Wise” program. In addition to supporting local businesses and stimulating economic development, the Climate Wise model seeks to facilitate business participation in other programs, thus resulting in additional indirect emissions reductions. The policy complements many of the energy efficiency, waste-diversion, and transportation policies being recommended by the CAP and would implement a state-wide clearinghouse to provide support for start-up of similar outreach, technical assistance, and recognition programs as requested by cities, counties, or agencies state-wide. This program may ultimately be linked to existing and future efforts managed by the Governor’s Energy Office.

RCI-11 Cost of Service Inverted Block Rates

The CAP recommends, by unanimous vote of those members present and voting, that the state consider implementing increasing block rates that would solely be structured to recover cost of service, as in traditional ratemaking. Such a policy might encourage greater levels of energy efficiency based on a price elasticity effect. In contrast to RCI-5, this policy would provide no excess funds to specifically promote energy efficiency programs.