Building Solutions

Opportunities for Coloradans to Save Energy and Money through Efficient Home Heating

CoPIRG Foundation

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Table of Contents

Executive Summary

Coloradans are paying increasingly steep prices to heat their homes each winter. Since 2002, residential electricity prices have climbed 25 percent and natural gas prices have risen by more than 70 percent. As a result, Coloradans spent about $500 million more on home heating this past winter than we spent just five years ago.

To help homeowners with their bills, Colorado should improve home heating energy efficiency. Because heating accounts for more than half of all energy used in a typical Colorado home, heating efficiency improvements can have a big impact.

Efficiency measures from high-performance furnace systems to improved weatherization can directly save families money. Moreover, reduced demand for energy will reduce energy prices, benefiting everyone in the state.

Improving home heating efficiency can reduce energy bills for Colorado families.

- Statewide, Colorado families would have saved on the order of $400 million this past winter if they had all retrofitted their homes with effective weatherization and efficient heating equipment.* That equals about one-third of statewide heating energy costs.

- For example, a family living in a typical Colorado home built in 1980 could save nearly $600 per year by choosing a high-efficiency furnace and high-efficiency windows instead of standard models, by installing a programmable thermostat and improved insulation, and by sealing air leaks in heating ducts and in the outer shell of the home.

- The upgrades would cost about $3,900 to perform. However, the resulting energy savings would pay off the initial investment in six years, delivering net savings of more than $12,000 over the useful lifetime of the upgrades. That's an annual return on investment of 15 percent—better than many options in the stock market.

*Savings estimates for individual efficiency measures partially overlap and are not 100 percent additive.

A variety of readily available technologies and practices can dramatically reduce home heating energy use. For example:

- **High-efficiency furnaces**, meeting Energy Star combustion standards and incorporating high-efficiency fans, use up to 20 percent less gas and up to 65 percent less electricity than a new minimum-efficiency furnace. If Colorado required all new furnaces to meet this level of performance, the state could save 12 billion cubic feet of natural gas and reduce electricity consumption by 270 million kilowatt-hours (kWh) in the year 2030. That's enough gas to meet the annual needs of about 150,000 typical Colorado households, and enough electricity to supply more than 33,000 Colorado homes.

- **Improved insulation, high-efficiency windows and air-sealing** can reduce the amount of heat that escapes from a home during cold weather, cutting heating energy consumption by 20 percent in a typical home. Achieving this level of savings statewide would conserve 17 billion cubic feet of natural gas per year, reducing total natural gas consumption in Colorado by 4 percent.

- **Repairing and sealing ductwork** that carries heated air from a furnace throughout the home can reduce heating energy use in a typical home by 15 percent. At this level of savings statewide, Colorado would conserve enough natural gas to meet the heating needs of 100,000 families.

- **Programmable thermostats** can help time heating energy use for when it is most needed in the home, reducing heating energy use by another 10 to 15 percent. If every home in the state used a programmable thermostat to

Improving the efficiency of home heating is one of many steps Colorado can take to reduce energy consumption and benefit consumers. Some additional steps are listed below.

- Xcel Energy should aim to capture more of the potential electricity and gas savings in its service territory. In August 2008, Xcel proposed an electricity savings target equivalent to 0.6 percent to 0.8 percent of annual sales, and a gas savings target equivalent to about 0.1 percent of annual sales. While this effort will make a huge difference, Xcel can go further. In leading states, energy efficiency supplies most new electricity needs—cutting projected consumption by 1 to 2 percent each year at a cost of less than 3 cents per kWh.

- The state should adopt energy efficiency program requirements for municipal and cooperative utilities.

- The state should encourage the spread of renewable energy technologies, such as geothermal heat pumps and passive solar design, to make even larger energy savings possible.

reduce heating energy consumption, statewide natural gas consumption would fall about 2 percent.

Improving home energy efficiency will reduce energy prices and stimulate the economy, benefiting everyone.

- Every 1 percent reduction in natural gas demand reduces market prices by 0.8 to 2 percent below forecast levels.

- Money saved through efficiency programs can then be spent on other goods and services, creating jobs and stimulating the local economy. For example, in 2002 the Southwest Energy Efficiency Project forecast that a comprehensive 18-year efficiency effort could create 12,200 jobs in Colorado.

To improve home heating energy efficiency, Colorado should:

- Apply for a waiver from the federal government to adopt strong minimum efficiency standards for residential furnaces and furnace fans and lobby the federal government to adopt such standards nationwide;

- Expand the scope and funding of weatherization assistance programs, including programs aimed at assisting low-income families;

- Require local jurisdictions to strengthen building energy codes, ensuring that all new homes across the state meet or exceed Energy Star performance standards;

- Provide financial incentives and technical assistance to encourage high performance new construction and building renovation; and

- Establish a goal for all new homes to achieve net zero-energy performance by 2030.

Introduction

No matter how much energy prices rise, the Graham family in South Boulder hardly notices a blip on their energy bill. That's because their home is outfitted with many of the most effective energy-saving technologies, from efficient appliances to highly effective insulation.[1] The family uses 80 percent less electricity than a typical Colorado household, and no natural gas.[2] The Grahams participated in the 2007 Tour of Solar and Green Homes put on by the Center for Resource Conservation, demonstrating how homeowners can take more control over their energy usage.

The Graham home in South Boulder uses highly efficient technologies, such as this "heat mirror" window, to practically eliminate winter heating costs. (Credit: Ecofutures Building, Inc.)

"Like most of the houses in Table Mesa and Martin Acres," wrote the Grahams in an event brochure, "our home originally had single-pane windows and no insulation in the walls, since natural gas was readily available and inexpensive when these homes were built in the '60s and '70s. The result was that in the winter the house was cold, and in the summer we experienced a brick-oven effect."[3]

In 2007, the Grahams completed an extensive retrofit of the home. They added high-quality insulation to the attic and the walls, enhanced the building envelope, sealed air leaks, and installed high-performance "heat mirror" windows. They designed the project to take full advantage of passive solar heat in the winter. Additionally, they installed solar hot water and electricity panels on their roof.[4] As a

result, the home has become much more comfortable, while practically eliminating the monthly energy bill.

Policy-makers can learn a lot from the Grahams as they look for ways to ease the plight of families across Colorado, who have been paying growing amounts of money to heat their homes over the last five years. Considering Xcel Energy's March 2008 request to further increase the price of electricity and natural gas, we shouldn't expect heating costs to come down any time soon.

The quickest, cheapest and most effective way to help Colorado families with rising energy prices is to increase home energy efficiency. Improved efficiency will directly lower the family energy bill. Moreover, improved efficiency benefits everyone statewide by lowering energy prices, creating new jobs, and boosting the local economy.

With sound public policies aimed at expanding the reach of such energy efficiency measures across Colorado, our state leaders can help families maintain a warm and comfortable place to live—without breaking the bank.

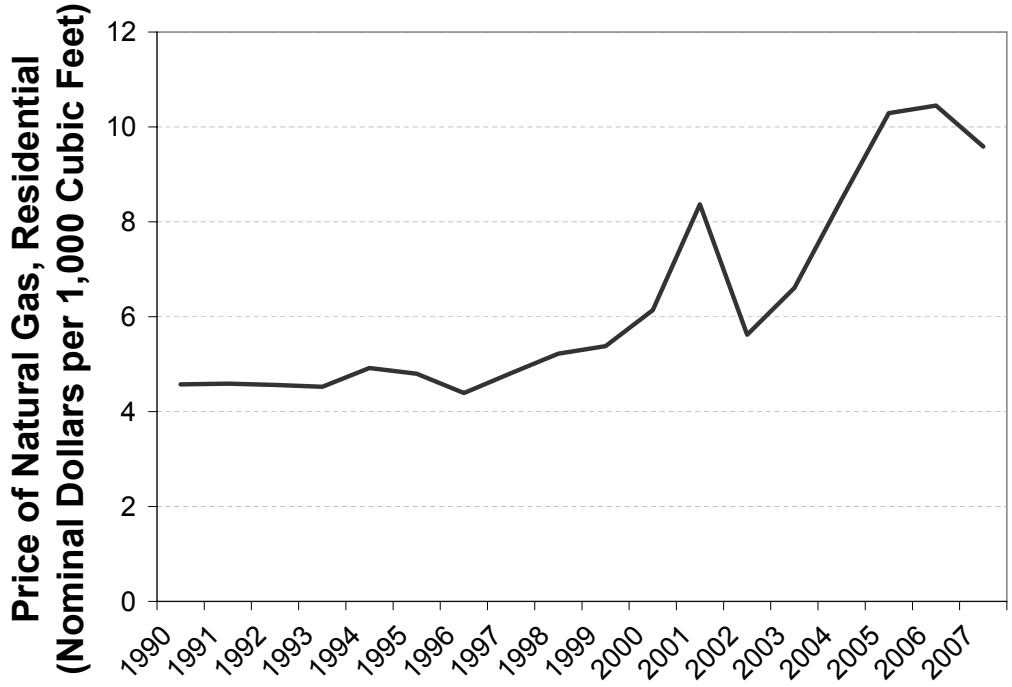
The Rising Cost of Energy

Coloradans are paying increasingly steep prices to heat their homes.

Natural gas has become more expensive as demand inches closer toward available supply. Since 2002, residential natural gas prices have risen by more than 70 percent.[5] (See Figure 1.)

Colorado's natural gas prices have historically been lower than the national average, due to the proximity of gas fields in and around the Rocky Mountains. However, new pipeline capacity has linked Colorado's

Figure 1: Residential Natural Gas Prices on the Rise in Colorado[7]



gas fields to more expensive markets in other states, driving up local prices. In 2003, energy companies doubled the capacity of the Kern River pipeline, which carries gas from Wyoming and Colorado to California. And in 2008, the Rockies Express pipeline opened, potentially delivering up to 1.8 billion cubic feet of natural gas per day to the Midwest, where gas can fetch higher prices.[6]

Increasing demand for natural gas for electricity production has also contributed to higher prices. Electricity generators often use gas to power the grid during periods of high demand for electricity.

At the same time, residential electricity prices have climbed 25 percent since 2002, driven in part by higher prices for natural gas.[8] (See Figure 2.) As a result, the average Colorado household now pays about $150 more for electricity per year.[9]

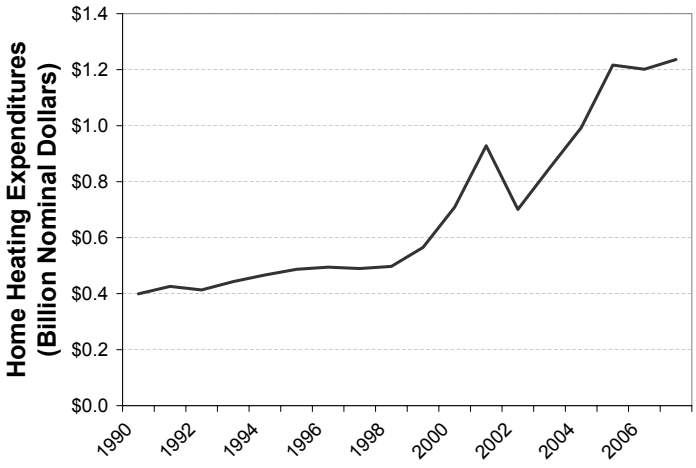
As a result of these price increases, Coloradans spent about $500 million more on home heating this past winter than we did just five years ago.[11] (See Figure 3.) Per capita, the average family saw the annual cost of home heating rise by 60 percent from 2002 to 2007 (increasing $220).[12]

Many families are having trouble keeping up with the cost increases. From 2003 to 2006, Xcel Energy (Colorado's largest utility company) reported a 357 percent increase in unpaid energy bills.[14]

There appears to be no relief in sight. On March 17, 2008, Xcel filed a request to further increase gas and electricity prices with the Colorado Public Utilities Commission.[15] The utility requested a 15 percent increase in electricity rates and a 4 percent increase in natural gas rates. Xcel claimed the increase was necessary because wholesale natural gas prices paid by the company had nearly quadrupled since fall 2007.[16] The utility said it needs to raise $86 million from customers in the second quarter to cover the higher costs.[17]

Figure 2: Residential Electricity Rates Have Significantly Increased Since 2002[10]

Figure 3: Rising Home Heating Costs in Colorado[13]



Opportunities to Improve Home Heating Efficiency

Reducing energy use is the fastest and most effective way for homeowners to get relief from high energy prices. Energy efficiency measures can help homeowners get similar or better levels of comfort and function from their homes, while spending less on electricity and natural gas.

Opportunities to improve the energy efficiency of Colorado homes abound. In the typical home, heating holds the largest potential for cost-effective energy savings, since heating accounts for more than half of all home energy consumption.[18]

Despite dramatic improvements to the energy efficiency of the typical home since the energy crises of the 1970s, most homes —both new and existing—can be heated far more efficiently. According to the U.S. Census Bureau, more than 1 million homes in Colorado were built before 1980.[19] Most of these homes were built before the state first established building energy efficiency codes in 1977.[20] While some of these homes have been retrofitted since they were first built, many are targets for energy efficiency improvements. Moreover, many newer homes have been built that waste substantial amounts of energy—providing still more opportunities to reduce heating energy consumption.

Additionally, about one-third of Colorado residences are rental properties.[21] Since renters typically pay the energy bills, property owners have little incentive to install energy efficiency improvements. These locations are also likely to offer many opportunities to improve energy efficiency.

Improved insulation, high-efficiency windows and weather-stripping can reduce the amount of heat that escapes from a home during cold weather. And high-efficiency furnaces and boilers can ensure that less fossil fuel is wasted in the production of heat for homes. New homes can also be built to incorporate strong energy efficiency performance from the start. This technology and know-how is ready to deploy today.

Furnaces and Ducts

Furnaces and ducts provide a major opportunity to improve the efficiency of space heating in homes.

Home Heating Energy Use in Colorado

Heating is the largest source of energy consumption in the average home in the Mountain region (of which Colorado is a part), accounting for 54 percent of total energy use—most of it in the form of natural gas.[22] (See Figures 4 and 5.) Reducing energy use for home heating can thus have a large impact on overall residential energy use in the state.

Figure 4: Residential Energy Consumption in the Mountain Region[23]

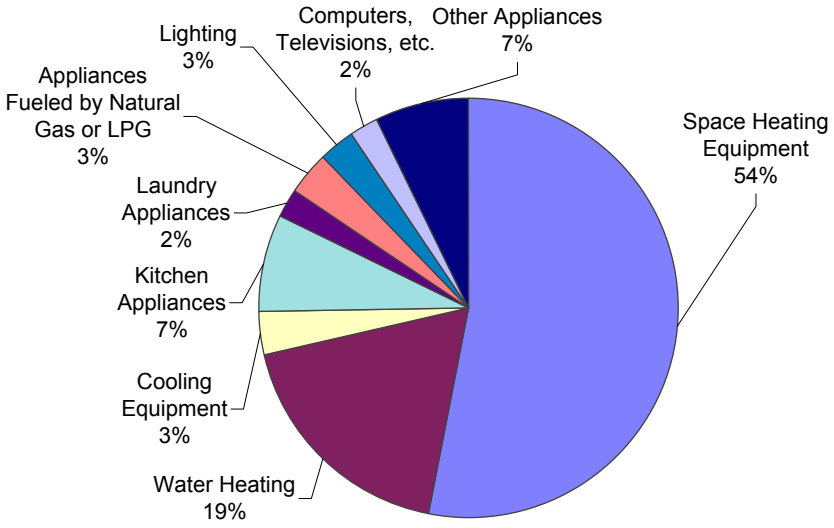
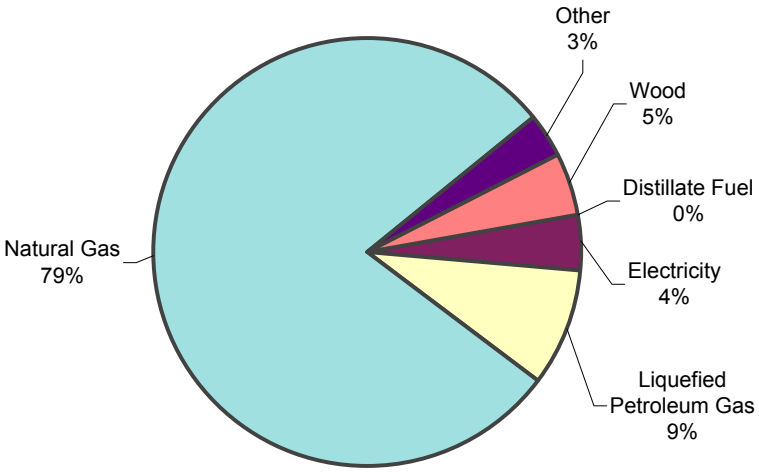


Figure 5: Fuel Use for Heating in the Mountain Region[24]



Older furnaces that rely on a constantly burning pilot light can waste as much as 45 percent of the fuel they use.[25] In contrast, high-efficiency models can improve energy performance by 40 percent or more.[26] About one-third of all homes in Colorado have furnaces that are 20 years old or older —representing a large opportunity for energy savings.[27]

There are differences even among new furnace models. A high-efficiency furnace (such as a model meeting Energy Star standards) uses 20 percent less fuel than basic furnaces built to the minimum federal efficiency standard.[28] A typical homeowner in Colorado with a minimum efficiency furnace could save about 120 therms of natural gas a year by installing a high-efficiency model.[29] For the average homeowner, this would reduce annual natural gas consumption by about 14 percent.[30]

If all new furnaces sold today met Energy Star standards (or a 90 percent minimum fuel utilization rating), in 2030 the state could save 124 million therms of natural gas (or 12 billion cubic feet).[31] To put this in perspective, this amount of energy could meet the annual gas needs of about 150,000 typical Colorado households.[32] Expressed another way, this amount of natural gas is equivalent to 10 percent of Colorado's residential natural gas usage in 2006.[33]

Furnace Fans

Most home heating systems also include fans, driven by electricity, that circulate warm air from the furnace through ducts in a home (and also cool air in homes with central air conditioning systems). These fans are among the largest users of electricity in a typical U.S. home, consuming about 1,250 kWh of electricity per year, or about 12 percent of home electricity consumption.[34]

Inefficient fans in older furnaces can be replaced with more efficient models to save electricity. Energy savings on the order of 65 percent are possible, making furnace fan improvements one of the largest available opportunities for energy savings.[35] A Colorado homeowner with a typical minimum-efficiency furnace could save 440 kWh of electricity per year by upgrading to a furnace with a high-efficiency fan.[36]

By ensuring that all new furnace systems come with high-efficiency fans, Colorado could save increasing amounts of electricity, reaching 272 gigawatt-hours (GWh) in the year 2030.[37] This level of savings would be enough to meet the annual electricity needs of more than 33,000 typical Colorado households, reducing forecast electricity demand in 2030 by about 0.3 percent.[38]

Duct

Ductwork that carries warmed air throughout a home offers another opportunity for efficiency improvement. A typical duct system loses about 30 percent of the heat produced by a furnace while distributing warmed air to rooms within a home.[39] Leaks through joints in the duct system are the primary culprit.

Professionally repairing and sealing the ductwork, and insulating ductwork in unfinished spaces, can reduce heating energy use in a typical home by 15 percent.[40]

If all homes in the state improved duct performance, on average, by this amount, Colorado would save 9 billion cubic feet of natural gas per year.[41] This level of savings could meet the heating needs of 100,000 typical families.[42]

Thermostat

Additional savings are possible with improved home heating system controls such as programmable thermostats. These thermostats—which allow residents to match their heating energy use more closely with their actual needs—are very cost-effective. Saving energy through a programmable thermostat is about 80 percent less expensive than buying the same amount of natural gas.[43]

The U.S. Environmental Protection Agency estimates that a properly used Energy Star programmable thermostat can reduce heating energy consumption by 10 to 15 percent.[44]

If every home in the state used a programmable thermostat to reduce heating energy consumption at this level, statewide natural gas consumption would fall more than 9 billion cubic feet per year.[45] That is equivalent to about 2 percent of Colorado's total natural gas consumption.[46]

Weatherization

Improving the thermal efficiency of homes can significantly reduce the use of natural gas for heating. Many homes, especially older ones, have inadequate insulation, leaky seals on windows and doors, or other gaps in the building envelope that allow heat to escape. Typically, at least half of all heating energy loss travels through the exterior walls, floor and roof of a home.[47]

Nationally, homes built before 1940 consume more than twice as much energy for space heating when compared to homes built after 1980, even without taking into account that newer homes are also likely larger in size.[48]

Nearly 60 percent of homes in Colorado were built before 1980, and about 10 percent of homes were built before 1940.[49] Many of these homes have inadequate insulation and weatherization.

The thermal efficiency of these homes can be improved with better insulation, higher performance windows, and weather stripping or caulking that seals leaks in order to trap heat within the home. Professionals are now able to do more than just caulk or tape doors and windows. Using

New Home Construction

New home construction offers another opportunity to reduce residential energy consumption. By implementing quality construction practices, installing the most efficient appliances and equipment, and incorporating high-efficiency design, new homes can be built to use substantially less energy than older homes.

For example, the Alliance to Save Energy estimates that implementing and enforcing the most recent and most effective building energy codes for residential and commercial buildings nationwide could save 0.85 quadrillion BTU of energy annually by 2020—or about 2 percent of the total energy consumed in homes and businesses in 2005.[56]

But requiring new residential construction to meet current energy codes is just the tip of the iceberg for the energy savings that can be achieved in new homes. New homes meeting federal Energy Star energy efficiency standards provide energy savings of at least 15 percent compared with the most recent (and most stringent) residential model building code.[57]

Nationally, 12 percent of new homes in 2006 were built to Energy Star specifications.[58] However, Colorado fell below average. In 2006, Energy Star homes made up between 3 and 11 percent of Colorado's new homes.[59] By improving the penetration of Energy Star homes in the new home market, Colorado could reduce electricity and natural gas usage in the residential sector.

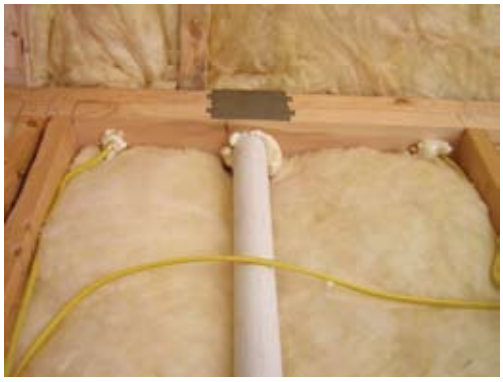
Renewable Energy, Combined Heat and Power and Net Zero-Energy Homes

Through straightforward upgrades such as the ones described above, Coloradans can dramatically reduce their energy consumption. But even greater savings are possible—particularly in new homes—through the use of on-site renewable energy technologies and technologies that combine the production of heat and electricity in a home.

Renewable energy technologies like passive solar heating or geothermal heat pumps can add to potential energy savings in the home heating sector. These technologies extract heat from the sun or from the ground to help maintain a comfortable home environment—reducing the need for natural gas or electricity. In addition, small-scale combined heat and power technologies can provide homes with on-site heat and electricity generation.

Builders are now incorporating advances like these in "zero-energy homes" in which fossil fuel purchases are virtually eliminated. Dozens of these homes already exist in Colorado, including the Skinner home in Broomfield, the Graham home in Boulder, the Gregerson home in Longmont, the Leonardi residence in Denver's Indian Hills, the Moore home in Evergreen, the Kracauer home in North Boulder and the Abramson residence in Longmont.[60]

Expanding the number of net zero-energy homes will be a key tool for Colorado's future. Many architects and builders are joining together to work toward a goal of making all new buildings operate without the need for fossil fuels by the year 2030.[61]



Home weatherization measures, like proper insulation, can shave heating fuel use in a typical home by 20 percent. (Credit: VEIC)

infrared imaging and blower tests, professionals can identify the biggest problem areas and target improvements to have the most impact.[50]

Overall in a typical home, air sealing, insulation and window replacements can reduce heating energy consumption by 20 percent.[51] Achieving a 20 percent reduction in home heating energy consumption would cut statewide natural gas consumption by 4 percent, saving:[52]

- 17 billion cubic feet of natural gas, and
- 270 GWh of electricity.

Potential Savings Statewide

A combination of all of these measures, reaching across the state, could have a major impact on home heating energy consumption.

In 2005, Colorado used about 110 trillion BTU of energy for residential space heating.[53] Most of this energy was in the form of natural gas—about 86 billion cubic feet.[54]

Statewide, if all Colorado families had retrofitted their homes with efficient furnaces, duct sealing, weatherization and programmable thermostats, as described in the sections above, Colorado would have used about 40 billion cubic feet less natural gas last year.[55] That amount of energy is roughly one-third of the energy used for home heating in Colorado.

Savings on this level would have significant benefits for the finances of individual homeowners, and the economy of the state as a whole. We explore these impacts in the next section of the report.

Economic Impacts of Improved Heating Efficiency

Energy efficiency saves consumers money on their electricity and gas bills. Energy efficiency programs help consumers use less energy, which directly translates into monetary savings.

Statewide, Colorado families would have saved on the order of $400 million this past winter if they had all retrofitted their homes with effective weatherization, highly efficient furnaces, and programmable thermostats. That level of savings would have largely negated the increased expenditure for home heating that has occurred since 2002, about one-third of statewide heating energy costs. Even greater savings would be possible through the use of passive solar design, geothermal heat pumps, and other renewable energy approaches.

Investments in efficiency can also make energy cheaper—not just for those who make the investments, but for the entire economy. By reducing demand, energy efficiency programs can put downward pressure on the price of electricity and natural gas. The resulting savings can then help create jobs and boost the local economy.

Energy Savings in a Typical Colorado Home

Energy savings through efficiency directly translate into lower electricity and gas bills. These ongoing savings can far outstrip the increased cost of a higher efficiency furnace or a weatherization job, delivering net savings over time.

Consider a homeowner living in a typical Colorado home built in 1980.[62] This hypothetical home is 1,850 square feet and has an unfinished basement. It has wood-framed walls, which are insulated at a performance level of R-11 (a measurement of the heat-trapping effectiveness of the insulation, where larger values indicate higher performance). The home has 183 square feet of window surface, and the windows are double-paned and sit in aluminum frames. The attic is insulated at a performance level of R-19.

Last winter, this homeowner would have paid $1,050 for heating.[63] However, this homeowner could reduce his or her heating costs by more than half by making energy efficiency upgrades, including:

- installing a programmable thermostat,
- repairing and sealing ductwork,
- sealing air leaks,
- choosing a new Energy Star furnace over a minimum-efficiency model,
- choosing high-efficiency windows over minimum-performance windows, and
- adding insulation to the floor and attic.

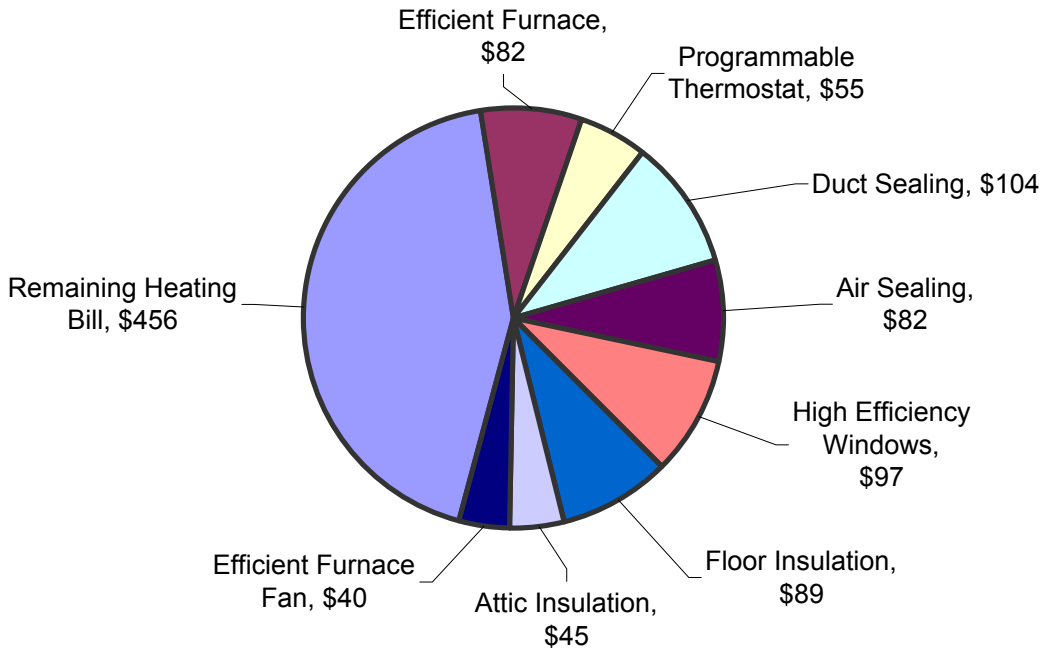
With these upgrades, the homeowner could save about $600 on energy costs every year, at 2007 gas and electricity prices.[64] (See Figure 6 and Table 1.) The upgrades would cost around $3,900 to perform.[65] However, energy bill savings would pay off this initial investment in six years. Overall, the efficiency measures would yield more than $12,000 in total savings over their lifetimes, for a return on investment of about 15 percent.[66] That rate of return is better than many investment options on the stock market—and less risky.

This example is meant to be illustrative of a typical Colorado home. Clearly, not all of these options will be feasible for every homeowner. For example, replacing a relatively new furnace or relatively new set of windows will have a higher up-front cost premium, since the existing equipment could last longer without replacement. These measures would then have a longer pay-back period. Individual homeowners should evaluate the costs and benefits of potential efficiency measures based on the specific conditions in their home.

Efficient Furnaces

An individual homeowner replacing an old furnace in the typical Colorado home described above would spend about $578 more to purchase a high-efficiency model compared to a minimum-efficiency model.[68]

Figure 6: Potential Savings from Efficiency Measures for a Colorado Family Living in a Typical 1980 Home[67]



However, energy savings would pay off that initial investment in less than four years. The new furnace would reduce the homeowner's annual natural gas consumption by 120 therms and electricity consumption by 440 kWh. This translates into gas bill savings of about $110 per year and electricity bill savings of $40.[69]

Over the 18 year life of the furnace, if gas and electricity prices stay constant at 2007 levels, the consumer would save about $2,700 on energy bills, yielding a net savings of about $2,150. If energy prices increase in future years, the savings would be even greater.

Programmable Thermostats

At a one-time cost of $70, a homeowner could install a programmable thermostat and use it to reduce the indoor temperature of the house by 4 degrees F when residents are away during the workday, or when residents are asleep at night.

This measure would reduce a homeowner's annual heating bill by $74, paying off the initial investment in just one year. Over the lifetime of the thermostat, it would save more than $1,100 on heating bills.[70]

Duct Sealing and Repair

Hiring a professional to repair and seal ductwork within the home would cost around $300. Professional contractors can reduce total leakage to less than 10 percent.

In return, the improved efficiency of the ductwork would reduce annual heating bill costs by around $140, paying off the initial investment in two years. Over the lifetime of the job, energy savings would exceed $2,100.[71]

Air Sealing

For $400, a homeowner could hire a professional to identify and seal air leaks within the home, reducing air leakage by 25 percent or more.

This measure would reduce annual heating expenditures by $110, paying off the initial investment in four years. Over the lifetime of the air sealing work, total energy cost savings would equal $3,300.[72]

Table 1: Estimated Costs and Benefits of Individual Efficiency Measures for a Typical Colorado Homeowner*

Efficiency Measure	Up-Front Cost Premium	Annual Energy Savings	Payback Time	Net Savings Over Measure Lifetime
Replace an old furnace with a high-efficiency model	$578	$150	3.9 years	$2,150
Install a programmable thermostat	$70	$74	1.0 years	$1,030
Repair and seal ductwork	$300	$140	2.1 years	$1,800
Seal home air leaks	$400	$110	3.6 years	$2,900
Replace old windows with high-efficiency models	$560	$130	4.3 years	$3,440
Insulate a basement ceiling	$1,100	$120	9.2 years	$2,500
Add insulation to the attic	$850	$60	14 years	$950

*Savings estimates for individual efficiency measures partially overlap and are not 100 percent additive.

High-Efficiency Windows

When replacing windows in a home, choosing high-efficiency products can improve home energy performance.

For example, triple-paned windows in a wood frame, with a special heat-trapping coating (low-E) and argon gas-filled interior would cost about $560 more than standard replacement windows. These windows would reduce the annual heating bill by more than $130, paying off the initial investment in four years. Over the lifetime of the windows, energy bill savings would total nearly $4,000.[73]

Improving Insulation

Adding insulation to the floor above the basement to reach a heat-trapping performance level of R-38 would cost about $1,100. This measure would reduce home heating expenditures by about $120 a year, paying off the initial investment in nine years. [74] Over the long-haul, the added floor insulation would save $3,600 on energy bills, for a return on investment of about 10 percent.[75]

Adding insulation to the attic, achieving a heat-trapping performance of R-60, would cost about $850. Each year, this measure would save about $60 on heating bills, paying off the initial investment in 14 years.[76] Over the life of the insulation, the homeowner would save $1,800, achieving a 6 percent return on the investment.[77]

Consumer Savings, Statewide

Earlier, we estimated that if Colorado homeowners had prepared for the past winter with comprehensive home energy efficiency upgrades, including high-efficiency furnaces, weatherization and programmable thermostats, the state would have used about 40 billion cubic feet less natural gas for heating during the past year.[78]

At 2007 prices, that level of gas savings would be worth on the order of $400 million, largely negating the increased expenditure for home heating that has occurred since 2002.[79]

Even greater levels of savings are possible with distributed generation and renewable energy technologies, such as passive solar design, geothermal heat pumps, and residential combined heat and power.

Reduced Natural Gas Prices

Improved home energy efficiency would benefit Colorado businesses and industry, as well as Colorado families. Part of that benefit would take the form of reduced natural gas prices.

Energy experts at the Lawrence Berkeley National Laboratory (LBNL) estimate that for every 1 percent reduction in national natural gas demand, natural gas prices fall by 0.8 percent to 2 percent below forecast levels.[80] This can have a big effect on the national economy. For example, the LBNL researchers estimated that if America deployed a national energy efficiency effort (coupled with a renewable energy standard), consumers would have saved $73 billion from 2003 to 2020 (net present value).[81]

Energy efficiency can have a rapid effect on energy prices. The American Council for an Energy-Efficient Economy estimates that a policy path that reduces U.S. natural gas demand by 4 percent in five years would slash wholesale natural gas prices by one quarter, saving the American economy $100 billion in return for a $30 billion government and private-sector investment.[82]

Job Creation

Improved home energy efficiency would also help create jobs for Coloradans. Money

saved by consumers through efficiency programs can then be spent for other goods and services, creating jobs and stimulating the local economy.

Energy efficiency investments also create jobs directly. Workers are necessary to improve insulation and sealing of homes; skilled architects and builders are required to perform energy efficient new construction and remodeling; and trained manufacturing workers are needed to build energy-efficient appliances.

A variety of studies have attempted to quantify these impacts. For example:

- According to a 2002 report by the Southwest Energy Efficiency Project, Colorado could boost employment by 12,200 and increase workers' wages $280 million in the year 2020 through improved energy efficiency.[83]

- Across the United States, according to a 2005 study by the U.S. Public Interest Research Group, a strategy to boost efficiency, in addition to renewable energy, could create as many as 154,000 new jobs and increase net wages by $6.8 billion.[84]

Improved Economic Stability

Improved home energy efficiency would also reduce Colorado's exposure to price spikes, supply disruptions and other repercussions of our reliance on fossil fuels, helping to improve economic stability.

Rate increases, such as those that have affected Colorado's electricity and gas consumers in the past few years, would have smaller consequences in a highly efficient system. Energy efficiency could also insulate Colorado from the impacts of unpredictable events, like the damage Hurricane Katrina caused to natural gas drilling infrastructure in the Gulf of Mexico in 2005.

Policy Recommendations

Improving energy efficiency is the quickest and cheapest way to blunt the impact of rising energy prices in Colorado.

Energy efficiency can deliver concrete results for Colorado homeowners, businesses, industries, local governments, and civic institutions. By reducing energy waste in buildings and infrastructure, energy efficiency programs can deliver substantial energy savings. All energy customers in the state will benefit from reduced energy costs and a stronger economy, whether they participate directly in an efficiency program or not.

In order to improve the efficiency of home heating, Colorado should:

Apply for a waiver from the federal government to adopt strong minimum efficiency standards for residential furnaces and furnace fans and lobby the federal government to adopt such standards nationwide.

In the late 1980s, Congress directed the U.S. Department of Energy (DOE) to establish and regularly update a national minimum standard for residential furnace efficiency. DOE set the first standard in 1992, requiring furnaces to meet or exceed 78 percent Annual Fuel Utilization Efficiency (or AFUE).[85] However, DOE has failed to strengthen the standard appreciably to date. The DOE issued an updated standard in December 2007, more than 10 years behind schedule.[86] DOE only increased the standard by 2 percent, to 80 percent AFUE and the rule will not go into effect until November 2015.[87] Moreover, the rule does not take into account furnace electricity use.

A stronger upgrade would have achieved far larger savings of natural gas and electricity. For example, requiring new furnaces to meet Energy Star standards (or 90 percent AFUE) would save more than 3 trillion cubic feet of natural gas in the next 24 years—enough energy to heat four out of five U.S. homes for one year—and net consumers $11 billion in savings.[88]

However, states may apply to DOE for a waiver in order to implement more stringent furnace performance standards. Through 2007, four states (Maryland, Massachusetts, Rhode Island and Vermont) have adopted tougher standards, applying for a waiver from federal preemption. Other states, such as New Jersey and New Hampshire, are considering similar action.[89]

To reduce natural gas and electricity consumption from home furnaces, Colorado should apply for a waiver from DOE and require new furnaces used in the state to meet or exceed Energy Star performance. Additionally, Colorado should apply for a waiver to require furnaces to include highly efficient fans that account for no more than 2 percent of the total energy consumed by the furnace.

If the DOE denies a waiver, Colorado should create incentives to encourage builders and consumers to choose high-efficiency furnaces wherever possible. Qualifying furnaces are widely available. At least 420 furnace models from 15 different manufacturers meet or exceed this level of performance.[90] In 2004, one-third of national furnace sales qualified for the Energy Star label.[91] And in colder states, 8 to 16 percent of furnace sales already include high-efficiency fans.[92]

Expand weatherization assistance programs for existing homes, including assistance for low-income families.

Colorado currently operates several weatherization assistance programs. The Energy Saving Partners program and the Low-Income Energy Assistance Program (LEAP) are both focused on assisting low-income households to lower energy costs through efficiency upgrades. During the 2006-2007 fiscal year, these programs invested $4 million to provide services to 22,000 households, providing more than $2 in lifetime energy savings for every dollar spent.[93]

In April 2008, the state also launched a new program, Insulate Colorado, aimed at improving residential insulation and air-sealing to International Energy Conservation Code (IECC) 2006 standards. The program will reach consumers through a state-sponsored marketing campaign, and involve local governments and contractors. The program will also provide targeted financial rebates for homeowners who upgrade their insulation to IECC 2006 standards. The rebates will cover 20 percent of the cost of hiring a certified contractor to do the job, up to a maximum of $300.[94] However, the program is under-funded. At maximum rebate levels, the program will run out of money after only 3,000 home upgrades.[95]

Colorado should expand its weatherization programs. Additional measures should include rebates for home energy audits, duct sealing, programmable thermostats, new furnaces with efficiency performance higher than 90 percent AFUE, and insulation improvements above and beyond IECC 2006 standards. Rebates should be commensurate with the impact of the measure in terms of reduced consumption of natural gas and electricity. The expanded program should also include a wider marketing campaign and wider involvement of home retrofit contractors.

Funding levels for the expanded weatherization program should be set at a level sufficient to capture all cost-effective home heating efficiency potential. Funding should come from an efficiency surcharge on gas customers' energy bills. The charge should apply to all customer classes and fund programs that benefit all classes. Particular attention should be devoted to assistance for low-income households, which are disproportionately impacted by rising energy costs.

Strengthen residential building energy codes and ensure that they are adequately enforced.

Building codes are a crucial leverage point in reducing energy consumption. State building codes regulate the construction of residential and commercial buildings and generally include standards to ensure minimum levels of energy efficiency. Colorado currently does not have a statewide residential building energy code. However, 32 cities and counties have adopted standards, including Denver and Boulder.[96]

The state does not require local governments to update their building codes on a set schedule. However, in May 2007, the legislature required all cities and counties with building codes to update the codes to the 2003 International Energy Conservation Code (IECC).[97] Much greater levels of energy efficiency are possible beyond the 2003 IECC, and the state has the authority to set a stronger minimum standard.

To capture this potential, Colorado should require all new homes statewide to meet or exceed federal Energy Star standards. The state should also provide technical and financial assistance for local jurisdictions to enforce the building codes.

The state should update its residential energy code at least once every three years, aiming to require all new construction to achieve net zero-energy performance by 2030.

The Bigger Picture

Improving the efficiency of home heating is one of many steps Colorado can take to reduce energy consumption and benefit consumers. Additional policy measures abound.

- Xcel Energy should aim to capture more of the potential electricity and gas savings in its service territory. In August 2008, Xcel filed an application with the Colorado Public Utilities Commission for approval of a suite of energy efficiency programs for implementation in 2009 and 2010 to comply with energy efficiency rules issued by the PUC.[98] In the filing, Xcel proposed an electricity savings target equivalent to about 0.6 percent of annual sales from 2009 programs and 0.8 percent of annual sales from 2010 programs.[99] However, the gas savings target is equivalent to only about 0.1 percent of annual sales. In leading states, energy efficiency supplies most new electricity needs, cutting projected consumption by 1 to 2 percent each year at a cost of less than 3 cents per kWh.[100] And, according to studies of energy efficiency potential reviewed by the American Council for an Energy-Efficient Economy (ACEEE) a typical state could reduce gas consumption by 0.5 percent below forecast levels per year—and more, given that rising gas prices make more efficiency measures economically attractive.[101]

- The Colorado Public Utilities Commission has jurisdiction over investor-owned utilities only. Many municipal and cooperatively owned utilities offer less in the way of energy efficiency programs to their customers. The state should adopt energy efficiency program requirements for municipal and cooperative utilities, to ensure that all utility customers in the state can benefit more fully.

- The state should encourage the spread of renewable energy technologies, such as geothermal heat pumps and passive solar design, to make even larger energy savings possible.

Notes

1. Ecofutures Building, Inc., *ZEH Comparison Chart*, downloaded from www.ecofuturesbuilding.com/building_ZEH on 10 April 2008.

2. The home consumes less than 1,500 kWh for backup heat during the course of a year: Ecofutures Building, Inc., *ZEH Comparison Chart*, downloaded from www.ecofuturesbuilding.com/building_ZEH on 10 April 2008; in comparison, the average Colorado household uses more than 8,000 kWh per year: U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006 – State Data Tables*, 26 October 2007.

3. John and Vicky Graham, *The Model Remodel*, downloaded from www.conservationcenter.org/e_solarhometour.htm on 10 April 2008.

4. Ibid.

5. U.S Department of Energy, Energy Information Administration, *Colorado Natural Gas Prices*, 28 March 2008.

6. Paul Foy, "Pipelines Unlocking Bounty of Rocky Mountain's Natural Gas Promise to Even Out National Prices," *Associated Press*, 15 March 2008; Ed Quillen, "The New Gas Wars in Colorado: Are Two State Senators Honestly Concerned About Controlling the Cost of Natural Gas in Colorado?" *The Denver Post*, 23 March 2008.

7. See note 5.

8. U.S. Department of Energy, Energy Information Administration, *Colorado Electricity Profile*, March 2007; 2007 data point from: U.S. Department of Energy, Energy Information Administration, *Electric Power Monthly*, March 2008.

9. Derived by dividing residential electricity revenue by number of residential customers for 2002 and 2006: U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006 – State Data Tables*, 26 October 2007.

10. See note 8.

11. Calculated using typical proportion of residential electricity and natural gas consumption used for home heating, per: U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004; multiplied times residential natural gas and electricity consumption per U.S. Department of Energy, Energy Information Administration, *Colorado*

Natural Gas Consumption by End Use, 28 March 2008; U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006 – State Data Tables*, 26 October 2007; and U.S. Department of Energy, Energy Information Administration, *Electric Power Monthly*, March 2008; translated into expenditure amounts using nominal electricity and natural gas prices from notes 5 and 8. Additional expenditure data for distillate fuel, liquefied petroleum gas and wood from Energy Information Administration, U.S. Department of Energy, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, 1 June 2007.

12. Approximated per-capita costs using number of retail electricity customers in Colorado per note 9, *Electric Power Annual 2006*; applied to total home heating costs calculated as per note 11.

13. See note 11.

14. Cathy Proctor, "More Coloradans Struggle to Pay Xcel Energy Bills," *Denver Business Journal*, 24 March 2008.

15. Ibid.

16. Ibid.

17. "Xcel Proposes Higher Electricty, Natural Gas Bills," *Denver Business Journal*, 17 March 2008.

18. All estimates of residential energy consumption in this report refer to energy consumed on site and exclude energy losses during the generation and transmission of electricity. U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004.

19. U.S. Census Bureau, *American FactFinder, DP-4 Profile of Selected Housing Characteristics: 2000*, downloaded from factfinder.census.gov on 20 February 2008.

20. 1977: Colorado Energy, *Building and Energy Codes*, downloaded from www.coloradoenergy.org/codes/ on 20 February 2008.

21. U.S. Census Bureau, *American FactFinder QT-H1 General Housing Characteristics:2000*, downloaded from factfinder.census.gov on 20 February 2008.

22. See note 18.

23. Ibid.

24. Ibid.

25. American Council for an Energy-Efficient Economy, *Consumer Guide to Home Energy Savings: Condensed Online Version*, *Heating Systems: Furnaces and Boilers*, September 2005.

26. Ibid.

27. Based on U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey*, Table HC3-1a, Space Heating by Mountain Census Division, 2004.

28. See note 25.

29. Andrew DeLaski, Appliance Standards Awareness Project, personal correspondence, 22 January 2008.

30. An average Colorado household uses 850-860 therms (or around 83,000 cubic feet) of natural gas per year. Estimated by dividing the 2002-2006 average residential consumption of natural gas by the number of residential customers, per: U.S. Department of Energy, Energy Information Administration, *Natural Gas Consumption by End Use* and *Number of Natural Gas Consumers*, updated 27 March 2008.

31. Appliance Standards Awareness Project and American Council for an Energy-Efficient Economy, *Annual State-by-State Energy Savings in 2030 from Efficiency Standards for Furnaces and Boilers*, December 2006; available at www.standardsasap.org.

32. See note 30.

33. See note 30, *Natural Gas Consumption by End Use*.

34. Steven Nadel et al., American Council for an Energy-Efficient Economy and Appliance Standards Awareness Project, *Leading the Way: Continued Opportunities*

for New Appliance and Equipment Efficiency Standards, March 2006.

35. Ibid.

36. See note 29.

37. See note 31.

38. Savings translated into number of homes using 2002-2006 residential electricity consumption divided by number of customers, per U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006*, 26 October 2007; Projected electricity consumption in 2030 extrapolated from Colorado Energy Forum, *Colorado's Electricity Future: A Detailed Look at the State's Electricity Needs and Electricity's Economic Impacts*, September 2006.

39. Lawrence Berkeley National Laboratory, *Home Energy Saver: The First Web-Based, Do-It-Yourself Energy Audit Tool*, available at hes.lbl.gov, used on 3 April 2008.

40. Jennifer Thorne, American Council for an Energy-Efficient Economy, *Residential Retrofits: Directions in Market Transformation*, December 2003.

41. Based on applying 15 percent savings to estimated fuel use for home heating, derived from regional residential heating end-use consumption percentage estimates contained in: Energy Information Administration, U.S. Department of Energy, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004, and total residential gas consumption estimates contained in: Energy Information Administration, U.S. Department of Energy, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, 1 June 2007.

42. See note 30.

43. The cost of saved energy through a programmable thermostat is about $0.17 per therm, compared to a retail price of natural gas on the order of $0.90 per therm: Midwest Energy Efficiency Alliance, *Midwest Residential Market Assessment and DSM Potential Study*, March 2006.

44. See note 39.

45. Based on applying 10 percent savings to estimated fuel use for home heating, per note 41.

46. See note 30, *Natural Gas Consumption by End Use*.

47. See note 39.

48. U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey, Table CE2-6u: Space-Heating Energy Consumption and Expenditures by Square Feet and Usage Indicators*, April 2004.

49. See note 19.

50. See note 39.

51. See note 40.

52. Based on applying 20 percent savings to estimated fuel use for home heating, per note 41.

53. Total residential heating energy consumption from residential fuel consumption estimates in: U.S. Department of Energy, Energy Information Administration, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, 1 June 2007; multiplied by percentage of fuel used for residential space heating in the Mountain Census Division, per: U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004.

54. Ibid.

55. Estimated by applying savings sequentially. For example, widespread furnace retrofits could reduce gas consumption for the average homeowner by 14 percent, saving 12 billion cubic feet of natural gas statewide. Duct sealing could reduce gas consumption by about 15 percent, after the impact of the furnace upgrade, saving about 11 billion cubic feet of natural gas statewide. Weatherization

could reduce gas consumption by another 20 percent after the impact of the first two measures, saving another 13 billion cubic feet of natural gas. And finally, programmable thermostats could save another 10 percent after the impact of all previous measures, saving about 5 billion cubic feet, for a total impact of 40 billion cubic feet.

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60. See note 2, Ecofutures Building, Inc.

61. Edward Mazria and his organization Architecture 2030 have issued a challenge to all architects and builders nationwide: make all new buildings operate without the need for fossil fuels in 20 years. For more information, see www.architecture2030.org.

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64. Ibid.

65. Ibid.

66. Ibid.

67. Ibid.

68. A high-efficiency model achieves 90 percent AFUE; a minimum efficiency model achieves 80 percent AFUE. Andrew DeLaski, Appliance Standards Awareness Project, personal correspondence, 22 January 2008. Using Colorado energy prices, similar savings estimates can be derived from: U.S. Environmental Protection Agency, *Life-Cycle Cost Estimate for an Energy Star Qualified Gas Residential Furnace*, downloaded from www.energystar.gov on 8 April 2008.

69. At 2007 Colorado average residential price of natural gas, about $9.60 per 1,000 cubic feet: U.S Department of Energy, Energy Information Administration, *Natural Gas Summary: Colorado*, 31 October 2007; and average residential price of electricity, about 9.2 cents per kWh: U.S. Department of Energy, Energy Information Administration, *Electric Power Monthly*, March 2008.

70. See note 63.

71. Ibid.

72. Ibid.

73. Ibid.

74. Ibid.

75. Ibid.

76. Ibid.

77. Ibid.

78. See note 55.

79. Calculated dollar savings using fuel savings estimate per note 55 and energy prices per notes 5 and 8.

80. Ryan Wiser, Mark Bolinger and Matt St. Clair, U.S. Department of Energy, Lawrence Berkeley National Laboratory, *Easing the Natural Gas Crisis: Reducing Natural Gas Prices through Increased Deployment of Renewable Energy and Energy*

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82. William Prindle, American Council for an Energy-Efficient Economy, *Senate Energy and Natural Resources Committee Natural Gas Conference: Proposed Policy Solutions*, January 2005.

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86. Andrew deLaski et al., Appliance Standards Awareness Project, *New U.S. Standard for Home Furnaces Is a Turkey: Missed Opportunity to Cut Energy Bills and Global Warming Emissions – Agency Admits it Did Not Adequately Consider Higher Standards* (press release), 19 November 2007.

87. United States Federal Register, 10 CFR Part 430, *Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnaces and Boilers; Final Rule*, 19 November 2007.

88. See note 86.

89. All states but Massachusetts: see note 86; Massachusetts: North Carolina State University, *Database of State Incentives for Renewables and Efficiency: Massachusetts: Appliance Efficiency Standards*, 27 June 2007.

90. See note 34.

91. Ibid.

92. Ibid.

93. State of Colorado, Governor's Energy Office, *State Funded Energy Efficiency Services for Colorado's Low-Income Households: First Annual Report to the Colorado General Assembly*, 1 October 2007.

94. Chris Fuller, Andy Cordova and Eric Stern, Colorado Governor's Energy Office, *2008 Insulate Colorado Program: Insulation Contractor Seminars* (presentation), April 2008; available at www.colorado.gov/energy.

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97. Colorado House Bill 2007-1146, signed into law 3 May 2007.

98. Xcel Energy, *2009/2010 Demand-Side Management Biennial Plan*, *Electric and Natural Gas*, *Public Service Company of Colorado*, filed before the Colorado Public Utilities Commission, Docket No. 08A-366EG, August 2008.

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101. Ibid, *The Technical*, *Economic*, *and Achievable Potential for Energy Efficiency in the U.S.—A Meta-Analysis of Recent Studies*.