Advancing Energy Efficiency in Calgary

February 2014

ALBERTA
Energy Efficiency Alliance

THE CITY OF CALGARY

Who we are

The **Alberta Energy Efficiency Alliance** is a multi-sector organization that collects and provides input on energy efficiency issues to the provincial government. Our members include energy utilities, municipalities, oil and gas companies, consulting firms, product and service providers and non-profits. All of these organizations recognize the important role energy efficiency has in responsible energy production and consumption.

You can find out more about us at **www.aeea.ca**.

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Introduction

Energy efficiency improvements are among the most effective strategies for reducing energy costs and our impact on the environment. They can also be a net creator of jobs and economic activity, while improving business and household resiliency to changes in the economy, and buoying a city's reputation.[1,2,3] Existing energy efficiency opportunities in Calgary are present in all sectors — residential, commercial, and industrial. The City of Calgary (the City) has recognized this in its Community Greenhouse Gas (GHG) Reduction plan, which designates *energy efficiency and conservation* as one of the four key focus areas in the near term. Through the use of aggressive energy efficiency programs and policies, GHG emissions could be reduced in Calgary by up to 9% compared with the business-as-usual case in 2020, which would aid in meeting the reduction target in the Community GHG Reduction Plan of 20% below 2005 levels.

This report provides a review of the current state of energy efficiency in Calgary buildings and industrial facilities, and provides a focused look at ways to reduce energy use in Calgary through efficiency and conservation.

Energy use in Calgary

Current energy use, greenhouse gas emissions and costs

Energy use in Calgary is a reflection of the city's urban form, its economy and its climate. Transportation — the use of gasoline and diesel fuels — is a major component of the city's energy demand, as shown in Figure 2 below. This owes much to the city's low density, manifested in its high proportion of single-family homes situated in suburban communities. In comparison, transportation energy demand in the city of Vancouver (population density in 2011 of approximately 5,250 per square kilometre), transportation energy demand is nearly one-third that of the city of Calgary's (population density in 2011 of approximately 1330 per square kilometre).[4]

The city's commercial and industrial sectors account for roughly 13% and 16%, respectively, of total community energy demand. This reflects the city's vibrant economy, with a gross domestic product (GDP) per capita of $50,603 — the highest amongst Canada's major cities.[5]

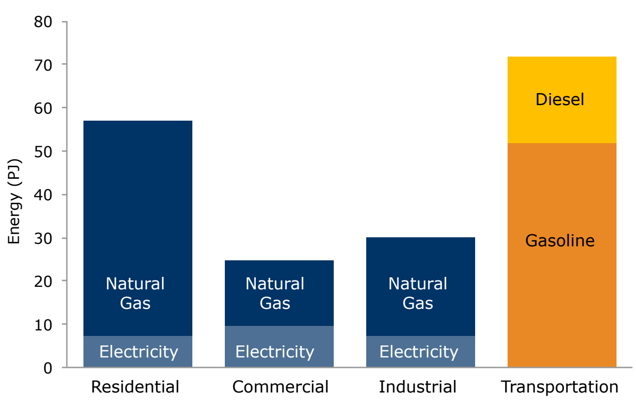

Figure 2: Community-wide energy demand in the City of Calgary, 2011

The residential sector represents approximately 31% of community energy demand, due predominantly to the use of natural gas for hot water and space heating. In Vancouver, which has a milder climate than Calgary, per capita residential energy demand is 55% lower than in Calgary.[6]

A breakdown of the sources of GHG emissions in Calgary provided in the Community GHG Reduction Plan is shown in Figure 3. Over half — approximately 55% — of Calgary`s GHG emissions can be attributed to electricity consumption in residences, commercial buildings and industry, while almost 13% of the emissions are associated with natural gas combustion. The remaining GHG emissions are primarily due to fuel consumption in passenger and freight vehicles.

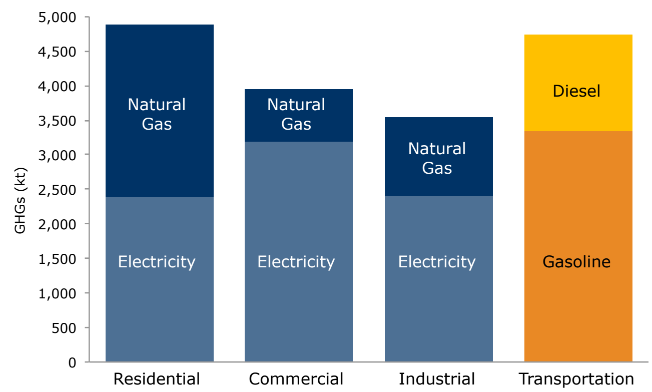

Figure 3: Community-wide greenhouse gas emissions in the City of Calgary, 2011

When comparing Figures 2 and 3, a marked increase in the magnitude of GHGs attributable to electricity relative to electricity's share of energy demand is observed; while electricity is roughly 13% of total energy demand, it contributes to 55% of Calgary's community-wide GHG emissions. GHG emissions from electricity consumption are so much higher in Calgary than any other emission source because Alberta's electricity grid is supplied primarily by coal-fired power plants (see Box 1 for an explanation on how energy demand relates to GHG emissions). This results in a GHG intensity for electricity that is roughly six times greater per unit of energy consumed than the combustion of natural gas for space heating.

Box 1

The relationship between energy and greenhouse gas emissions

It is estimated that over 60% of global GHG emissions are attributable to energy consumption.[7] This relationship is due to the underlying nature of our energy system, and its predominant dependency on fossil fuels.

Primary energy sources based on fossil fuels, such as coal, oil and natural gas, are formed when carbon-based material (plant and animal matter) is compressed and exposed to heat over millions of years. As these primary sources are generally not usable in the form that they are found in nature, they are converted to *secondary energy* to be used in the forms recognizable in our economy (electricity, gasoline, diesel, refined natural gas, etc.). These secondary energy types are then converted to *tertiary energy*, which are also called energy services (space heating, motive energy, etc.). However, in the conversion processes from primary to secondary, and secondary to tertiary energy, the release of GHG emissions occurs.

Converting energy often requires combustion. For example, in converting coal to electricity, it must be ground into a powder-like material and combusted in a high-pressure boiler, creating steam, which in turn drives a turbine. This combustion process involves the oxidation of the carbon inherent in the fuel, which is then converted to carbon dioxide — the dominant GHG from energy.

It's important to note that consuming energy from different fuels will release different amounts of greenhouse gases, depending on both the conversion technology and the fuel type. For example, the combustion of coal leads to more GHG emissions when compared to burning the equivalent amount of energy in natural gas, due to the differences in the chemical nature of the two fuels. Additionally, conversion of fossil fuels to electricity is inherently inefficient, with only 30–35% of the chemical energy contained within the primary energy source being recovered as electricity. As a result, for every unit of electricity generated, roughly three times that amount of natural gas or coal energy must be combusted and thus three times the amount of GHGs are emitted than if the coal or natural gas were simply combusted in a boiler (as an example).

In a 2008 United Nations Environment Programme report assessing GHG emissions amongst global cities, Calgary was one of the highest on a per capita basis.[8]

In addition to the significant environmental cost of Calgary`s energy consumption, there is high economic impact as well; it is estimated that over $3.2 billion was spent in 2011 to provide the energy within Calgary to businesses and residents (see Figure 4). Energy efficiency gains have the potential to reduce this amount in addition to reducing GHG emissions.

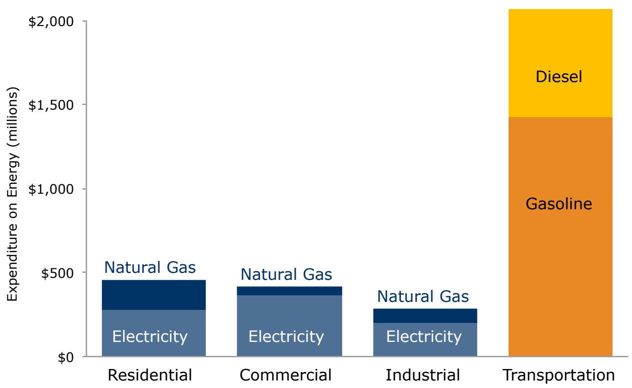

Figure 4: Energy expenditures in Calgary, 2011

Includes variable charges only for electricity and natural gas. Assumes retail prices of $0.096/kWh of electricity, $3.60/GJ of natural gas and $1.04/litre of gasoline and $1.24 per litre of diesel based on 2011 rates.[9]

State of energy efficiency in Calgary

Residential buildings

Residential energy use represents just over a quarter of community energy consumption and GHG emissions. Household expenditures on energy amounted to over $450 million in 2011. Efficiency gains in households present a significant opportunity for reducing total energy demand in the city. One measure of efficiency for residential buildings is the EnerGuide for Homes (EGH) rating. This rating focuses on energy requirements for space conditioning and hot water (which make up approximately 43% and 15% of residential energy demand in Calgary, respectively) and scores homes based on their performance on a scale of 0 to 100. A score of 100 is calculated for a home that requires no purchased energy, while a score of 0 represents a home with no insulation and a high degree of air leakage. A score of 80 would correspond to R-2000 guidelines, which are a Canadian benchmark of efficient modern homes.[10] The EGH score is a valuable metric when comparing the energy efficiency of various households, as it adjusts for climate and provides a single number to represent how efficient a home's entire set of energy systems are.

Data from EnerGuide for Homes energy audits provides a number of ways to compare the energy efficiency of homes in Calgary to other Canadian cities.

From houses that were assessed between 2006 and 2013, the energy efficiency of Calgary's single-family detached (SFD) homes (prior to retrofits) is in the middle of the pack compared with other mid-sized[11] Canadian cities for which data was available (shown in Figure 5). The average audited SFD house in Calgary had an EGH rating of 60.6, compared with 58.4 in Edmonton and 62.8 in Regina (the highest average SFD rating of the cities examined here). Single-family attached (SFA) homes performed slightly better than SFDs, with an average rating of 64.3. Both SFA and SFD homes EnerGuide scores are substantially lower than 80, which was mentioned previously as a target for an efficient home.

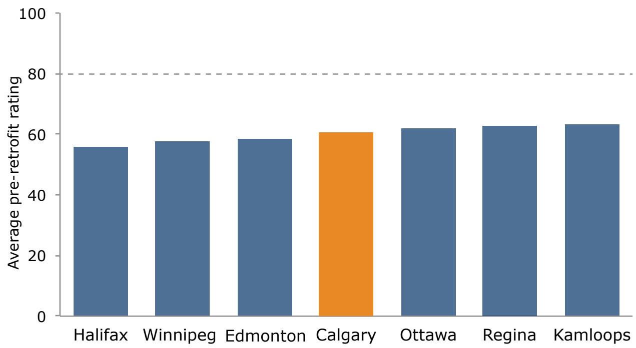

Figure 5: Average EnerGuide for Homes ratings for existing houses

Although new homes constructed in Calgary have higher EGH ratings relative to the existing housing stock, there is considerable room for improvement when compared to new homes being constructed in other mid-sized cities, as shown in Figure 6 below. It should be noted that only new construction that has been EGH certified are captured in this data (generally the highest-performing new buildings). The data below suggests that even the most efficient buildings being built in Calgary between 2008 and 2012 are still below the EGH 80 benchmark identified earlier.

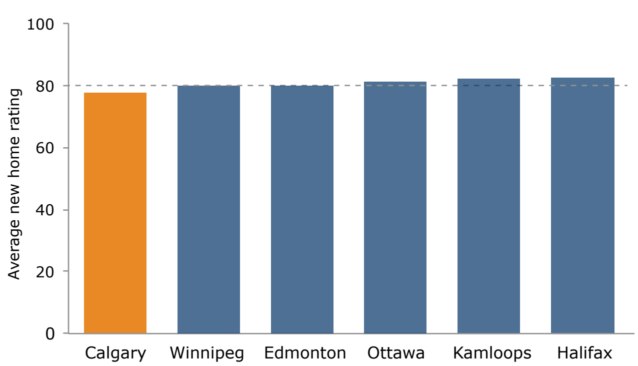

Figure 6: Average EnerGuide ratings for new homes built between 2008 and 2012

Calgary also trails most other mid-sized cities in terms of the percentage of homes that have been retrofitted in recent years (Figure 7).

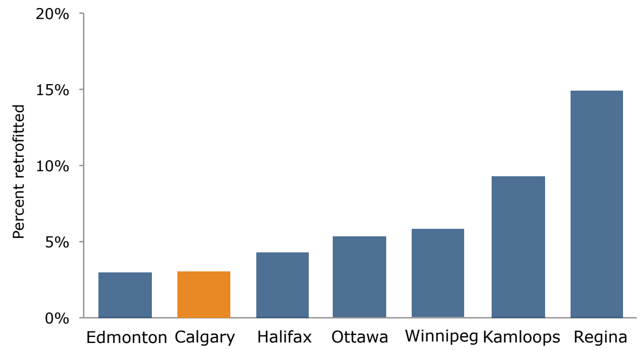

Figure 7: % of homes retrofitted using an EnerGuide for Homes post retrofit audit (2006–2013)[12]

While space conditioning and water heating account for the majority of energy demand in Calgary households, residential appliances also use a significant portion — approximately 11%.[13] A marked increase in appliance efficiency has been observed over the past 25 years (as shown in Figure 8) with the average energy consumption for certain appliance types coming close to the Energy Star rating for those appliance types. Therefore, as all major appliances reach a similar level of energy efficiency (for a given appliance type), it is expected that the average energy use for major appliances will not vary greatly from city to city over time.

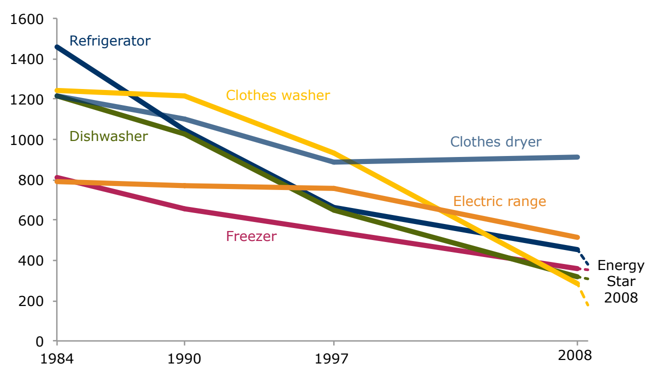

Figure 8: National average annual energy consumption of common household appliances by year of manufacture[14]

Commercial buildings

The commercial sector represents another major opportunity for reducing energy demand in Calgary. Commercial buildings consume less than residential buildings in terms of overall community energy demand (13% versus 31%), however they still contributed to almost one-quarter of the city's total GHG emissions in 2011. This is related to the sector's higher reliance on electricity than the other sectors assessed, since electricity has a greater carbon intensity than other types of energy used in Calgary.

A breakdown of GHG emissions related to commercial energy consumption is provided in Figure 9. Space heating, equipment operations, and lighting account for the vast majority of commercial energy use. Commercial energy use translated into nearly 27% of the total cost of energy demand in the city (excluding industrial energy costs).

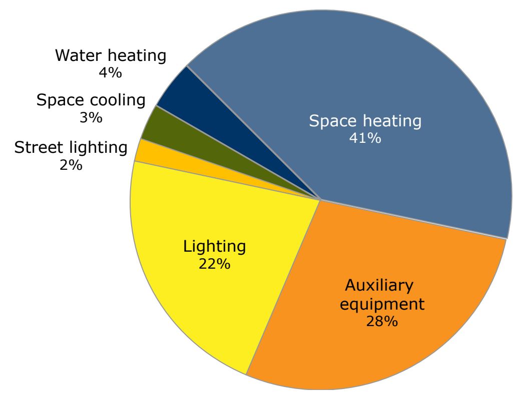

Figure 9: GHG emissions by end use in commercial buildings in Alberta (2007)

An Energy Benchmarking Report released by REALpac in 2011 provides energy use intensity comparisons for office buildings in different cities across Canada.[15] These results, normalized to account for weather, gross floor area, energy sources, end uses and occupancy, can be used to show the relative efficiency levels of buildings across the country. This report suggests that the average energy use intensity (EUI) from a sample of 40 office buildings in Calgary was roughly 350 kWh/m². Calgary's average is similar to that observed in Vancouver's sample set (355 kWh/m²) but higher than offices in Toronto (300 kWh/m²). For comparison, the new Manitoba Hydro Place office building in Winnipeg, which is LEED Platinum certified, has an EUI of 88 kWh/m², while the average Canadian office building has an EUI of approximately 380 kWh/m². [16]

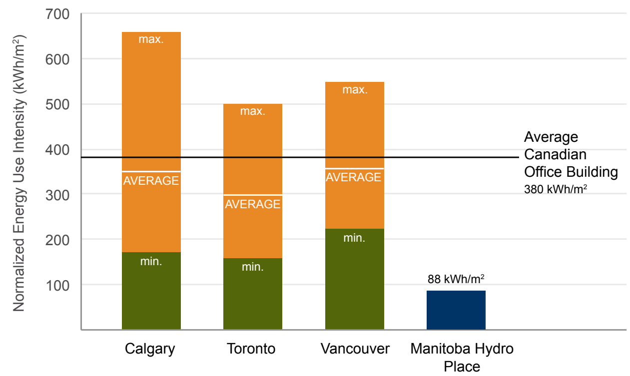

Figure 10: Normalized energy use intensity from a sample of office buildings (2009)

The results of the REALpac report demonstrate that on average, energy use in Calgary office buildings is slightly below the national score, although some of the buildings surveyed that have much higher energy intensities as well (seen by the high "max" level). When comparing even the minimum energy demand observed in participating office buildings in Calgary to Manitoba Hydro's highly efficient office in Winnipeg (88 kWh/m²), it is evident that there is considerable room for energy efficiency improvements in Calgary's office buildings.

Industrial

The industrial sector was responsible for 16% of community energy consumption in 2011, and produced 21% of total GHG emissions. There are over 1700 manufacturing firms in the City of Calgary, with the largest sectors including fabricated metal, machinery, printing, furniture and food manufacturers.[17] It is estimated that energy efficiency in these sectors could be improved between 15% and 35% given measures that are currently "economic"[18] (see Table 1). In a 2010 study by the Canadian Manufacturers and Exporters (CME), economic energy efficiency measures were defined as those that resulted in a positive net present value when examined over their operative life (considering capital costs, operating & maintenance costs and avoided fossil energy consumption), with a discount rate of 8% applied. Energy efficiency measures included improvements to process / thermal equipment, installation of air curtains, heat recovery from flue gas and processes, and optimization/addition of process controls.[19] Data presented in Table 1 provide CME estimates of the potential savings if the improvements with a positive net present value were implemented.

Table 1: Potential energy efficiency improvements for industrial facilities in Calgary[20]

<table>
<tr><th>INDUSTRIAL SUB-SECTOR</th><th>TOTAL FIRMS IN CALGARY</th><th>EMPLOYMENT (APPROXIMATE)</th><th>2010 ENERGY INTENSITY (MJ / $2002)</th><th>POTENTIAL ECONOMIC ENERGY SAVINGS</th></tr>
<tr><td>Chemical</td><td>52</td><td>1800</td><td>21.1</td><td>27%</td></tr>
<tr><td>Petroleum & Coal Products</td><td>23</td><td>2600</td><td>96.7</td><td>25%</td></tr>
<tr><td>Non-Metallic Mineral</td><td>66</td><td>2900</td><td>7.6</td><td>26%</td></tr>
<tr><td>Primary Metal</td><td>22</td><td>1900</td><td>51.4</td><td>35%</td></tr>
<tr><td>Fabricated Metal</td><td>277</td><td>8400</td><td>2.9</td><td>19%</td></tr>
<tr><td>Food</td><td>125</td><td>6100</td><td>5.3</td><td rowspan="3">13%</td></tr>
<tr><td>Beverage</td><td rowspan="2">12</td><td rowspan="2">2300</td><td>2.9*</td></tr>
<tr><td>Tobacco</td><td>0.7</td></tr>
<tr><td>Transportation Equipment</td><td>46</td><td>1000</td><td rowspan="2">2.1**</td><td rowspan="2">17%</td></tr>
<tr><td>Machinery</td><td>235</td><td>12400</td></tr>
<tr><td>Plastics and Rubber</td><td>57</td><td>3600</td><td>15.0</td><td>15%</td></tr>
<tr><td colspan="5">Other Manufacturing</td></tr>
<tr><td>Furniture Products</td><td>127</td><td>4600</td><td>2.6</td><td rowspan="11">18%</td></tr>
<tr><td>Wood Products</td><td>87</td><td>3800</td><td>9.3</td></tr>
<tr><td>Electric Equipment</td><td>35</td><td>770</td><td>1.9</td></tr>
<tr><td>Printing</td><td>171</td><td>3200</td><td>2.1</td></tr>
<tr><td>Computer & Electronic</td><td>84</td><td>4400</td><td>0.9</td></tr>
<tr><td>Leather & Allied Products</td><td>4</td><td>40</td><td>1.7</td></tr>
<tr><td>Textile Mills</td><td>11</td><td>110</td><td>5.6</td></tr>
<tr><td>Paper</td><td>16</td><td>1000</td><td>62.1</td></tr>
<tr><td>Clothing</td><td>33</td><td>330</td><td>0.9</td></tr>
<tr><td>Textile Product Mills</td><td>30</td><td>330</td><td>4.3</td></tr>
<tr><td>Miscellaneous</td><td>230</td><td>2700</td><td>2.2</td></tr>
</table>

*Average of beverage manufacturing & breweries

**Average of motor vehicle gasoline engine, electrical, steering, suspension, brake system, transmission/power train, seating & interior trim, metal stamping & other motor vehicle parts manufacturing

The CME report focused on the industrial sector found that the majority of facilities studied had implemented fewer than half of the best practice solutions for energy efficiency. The top five barriers to energy efficiency improvements in the industrial sector were identified as:[22]

Financing of energy efficiency projects

- Payback period for energy efficiency projects are too high, or return on investment is too low.

Commitment to energy management

- The company has a lack of human resources to focus on energy management.
- Production is the dominant focus, and energy management is not seen as a production element.

Transaction costs

- Too much effort to access assistance, funding and incentives from programs.

Perceived risk/reward

- Do not know what performance of energy efficiency opportunities / products will be when screening opportunities.

Barriers to energy efficiency

Despite the potential economic and environmental benefits for various energy efficiency initiatives, a number of non-economic barriers need to be overcome before their full potential can be realized. These barriers are common to all jurisdictions to varying degrees and can include the lack of appropriate price signals, product and service availability, lack of energy literacy and awareness, capital financing, technology development and commercialization, transaction costs, perceived risks and rewards, split or disconnected incentives, and institutional or regulatory barriers.[21]

The following section will explore the potential to overcome some of these barriers in Calgary, and to improve energy efficiency and conservation in Calgary's building sector.

Options for improving energy efficiency

It is clear that Calgary's homes and workplaces all have the potential to significantly reduce their energy consumption, saving both GHG emissions and costs. The following section describes some of the most promising options for improving energy efficiency[23] and lowering energy bills through changes to equipment and behaviour in homes and businesses in Calgary.

Residential buildings

In Calgary, 14% of total GHG emissions can be attributed to space heating and cooling, with two-thirds of these emissions coming from residential buildings. As discussed previously, residential energy demands in Calgary are relatively high when compared to other mid-sized cities in Calgary and present a large opportunity for potential retrofits or other energy efficiency programs.

The demand for heating and cooling can be reduced through the construction of efficient building envelopes (i.e., walls, roofs, windows and foundations) and the installation of efficient heating and cooling systems. Common features of efficient buildings include high levels of insulation, air sealing (to prevent the escape of air that has already been heated or cooled), windows that reduce heat loss in winter and heat gain in summer, lower window-to-wall ratios, and high-efficiency heating, cooling and ventilation systems (such as radiant floors and variable speed drives).

The potential energy savings from these types of initiatives depend on both the size of the building and whether the improvements are applied at the design stage for new buildings or as retrofits for existing buildings.

New houses

Over the past 17 years, heating efficiency in new houses in Alberta has increased by approximately 12% on a square metre basis.[24] However, dwellings in Alberta have also been getting bigger over this time. The Office of Energy Efficiency estimates that homes built between 2000–2010 have a 25% larger floor area compared to those built in the 1960s and 1970s. As a result, the energy use per dwelling has not changed significantly.

Energy efficiency improvements such as better insulation, airtight windows and heat exchangers combined with more efficient furnaces could reduce energy use in a typical new house in Calgary by 25%, according to the Canadian Urban Institute.[25] If Calgary required such improvements in all new houses, such as through building code requirements, the city could reduce GHG emissions by up to 124 thousand tonnes in 2020, or 2.4% of total residential energy emissions.

Existing houses

Other jurisdictions have realized energy efficiency improvements of 10% (on average) for home renovation programs, although some studies estimate that improvements of up to 25% are possible.[26]

Home energy retrofits, such as increasing the air-tightness of the building envelope or increasing attic or exterior wall insulation, can reasonably be undertaken at a cost between 3–9% of a typical (non-energy) home renovation, resulting in energy savings of between $200 and $3,000 per year. The costs of such energy renovations can often be recovered within six years, with some individual measures being paid back in as little as one to three years.[27]

A comprehensive program to encourage energy retrofits in Calgary's existing homes could reduce GHG emissions by up to 234 thousand tonnes in 2020, or almost 5% of residential emissions.

Lighting and appliances

In the residential sector, electricity consumed by appliances and lighting accounts for approximately 31% and 11% respectively of total residential GHG emissions in Alberta, as illustrated in Figure 11.

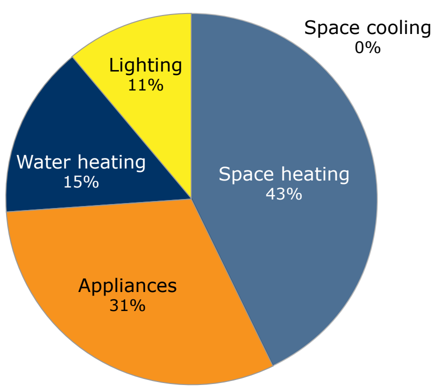

Figure 11: GHG emissions by end use in residential buildings in Alberta (2007)

Through the use of energy efficiency programs targeting residential lighting and appliances, Calgary could potentially expect GHG reductions of up to 10% in 2020 (5% from lighting and 5% from appliances).

This could potentially result in GHG reductions of up to 500 thousand tonnes in the residential sector.

Commercial buildings

New large buildings

Efficiency gains can be achieved in Calgary's new commercial buildings through a number of design considerations, including lower window-to-wall ratios, lighting improvements, the utilization of high performance building envelopes and the incorporation of more efficient space conditioning technologies (chilled beams, radiant heating/cooling, four-pipe fan coil systems, etc.).[28] Case studies in other jurisdictions have demonstrated energy efficiency improvements of 25% for large commercial or institutional buildings when compared with conventional construction practice, with some new buildings achieving significantly higher savings — up to 60%.[29]

Typically, the benefits realized by energy efficient buildings can be seen as net positive, with cost savings from energy bills, operation and maintenance savings. As well, several studies have shown health and productivity benefits for 'green' or energy efficient buildings:[30]

- Good daylighting can increase productivity by 13%, retail sales by 40%, and school test scores by 5% (conversely, high glare reduces performance by 15–21%).
- Better quality ventilation can increase productivity by 4–17% and reduce sickness by 9–50%.

Requiring that all new large buildings in Calgary meet energy efficiency standards could help reduce GHG emissions by up to 84 thousand tonnes in 2020 — the equivalent of 1% of total emissions from the commercial sector.

Existing large buildings

Some studies have estimated savings of up to 25% are possible in existing large buildings through renovations and retrofits.[31] This may be an optimistic estimate; the performance of more widespread residential retrofit programs typically suggest that an average reduction of 10% may be a more reasonable expectation.

A study of the potential for energy efficiency of existing private commercial buildings in the United States estimated that over a 10-year time frame, investments in energy efficiency for this sector would return energy bill savings that are 42% higher than the initial investment.[32]

In Calgary, a program to renovate existing large buildings with energy efficiency improvements could lead to GHG reductions of up to 131 thousand tonnes in 2020, or 1.3% of total emissions from the commercial sector.

Lighting and appliances

While space and water heating account for the majority of energy use in both residential and commercial buildings, electricity used in appliances, lighting and other electrical equipment also represent a large share of total energy consumption in Calgary.

In 2007, the electricity consumed by lighting, auxiliary equipment and auxiliary motors in the commercial sector in Alberta was approximately 32% of total commercial energy consumption.[33]

Some examples of energy efficient lighting and appliance programs for commercial operations include the following:

- Lighting retrofits in commercial office buildings that replace overhead lighting with more efficient bulb technology have achieved energy savings of between 26 and 39%. A higher level of energy savings (up to 67%) may be achievable through space redesign that reduces the number of lighting fixtures. In addition to the replacement of overhead lighting, modifications to 'secondary' light sources (i.e. light used in common areas, washrooms and exit signs) can result in savings of up to 75% from the norm.[34]
- In terms of energy savings from appliances, Energy Star labeled equipment can save up to 75% of electricity use for computer and monitor equipment and 40% for photocopier systems. Upgrading refrigeration units to high-efficiency multiplexed compressors can generate energy savings of up to 25%. Doors and covers for refrigerated display cases can provide refrigeration electricity savings of 20–30% over open display cases.[35]

In the commercial sector, savings from efficiencies of up to 7.5% in 2020 could be achieved (3% for lighting, 3% for appliances and 1.5% for motors and HVAC (heating, ventilation and air conditioning)). This could potentially result in GHG reductions of up to 500 thousand tonnes in the residential sector and 395 thousand tonnes in the commercial sector.

Industrial equipment and processes

Industrial processes are estimated to be responsible for approximately 21% of GHG emissions in Calgary with two-thirds of these emissions from electricity use and the remainder from natural gas use. Industrial processes and associated energy consumption vary considerably from industry to industry; however, different studies have estimated the energy efficiency potential of the industrial sector in general by assessing individual industrial processes and drawing relevant conclusions.

A 2010 report on energy efficiency in Alberta's industrial and manufacturing industries evaluated 44 facilities in the province and found that the majority had implemented less than half of the best practice solutions for energy efficiency.

"If all the economically feasible energy efficiency best practices are implemented, as per the Economic Potential scenario, the reduction in GHG emissions is estimated to be 4.3 million tonnes CO2e (or almost 23 percent) less compared to the Reference Case in 2020."[36]

A study by the International Energy Agency identified energy savings of 10–15% for the industrial sector, with about half the savings estimated to come from motor systems while the remainder is a combination of combined heat and power, steam systems, process integration, increased recycling and energy recovery. A study of the U.S. economy estimated that implementing energy efficiency measures that are economically feasible could reduce industrial emissions by 18% by 2020.[37]

Energy efficiency improvements in industrial settings within Calgary could reach 600 thousand tonnes in 2020, or 13% of industrial sector emissions.

A number of effective approaches to improve efficiency in every sector of Calgary's energy demand have been presented above. Ways to achieve the widespread adoption of these measures are outlined in the next section.

How to advance energy efficiency in Calgary

Reducing barriers and encouraging the adoption of energy efficient products and behaviours is central to the promotion of both low energy and low carbon economies.[38] A common strategy that jurisdictions typically take towards advancing the adoption of energy efficient systems is through a market transformation approach.[39,40]

Market transformation occurs when a market makes a sustained transition from one set of products, services and behaviours to another, as shown in Figure 12. In general, market transformation is achieved with the following steps:

- creating new products, services and behaviours, and having them enter the market (commercialization),
- providing incentives to increase market penetration over time, and
- updating codes and standards once a certain level of market penetration is achieved.

Education and outreach supports all stages of market transformation.

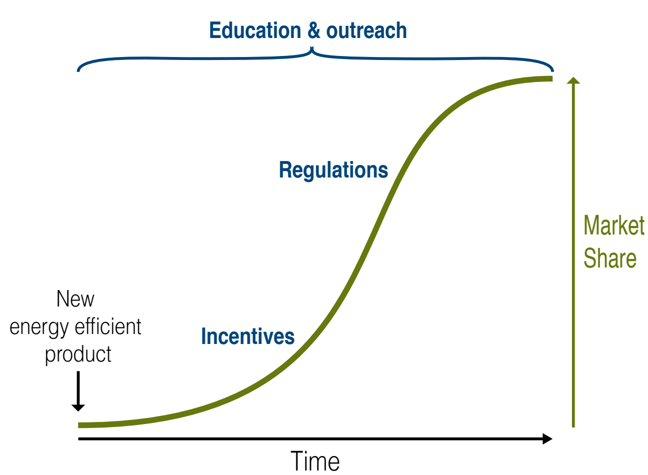

Figure 12: Market transformation steps

This approach combines the advantages of both incentives and regulations while overcoming their weaknesses (e.g., regulations are difficult to enact until capacity is built in the marketplace, and incentives are difficult to maintain permanently). Permanent price signals, such as taxes, are another way to create self-sustaining market transformation if applied properly.

It should be noted that market transformation is also an ongoing process of continuous improvement and not a one-time process for a given sector. In fact, several steps in the market transformation process are often happening at any given time.

As shown in Figure 13 below, marketplaces are typically made up of a set of high performers, middle performers and minimum performers. High performers and middle performers can be motivated by information and incentives — essentially 'pulling' the market to higher performance. This section of the marketplace is where the innovators, early adopters, as well as the early and late majority, of new, superior technologies are found. Minimum performers are typically only motivated by minimum standards or regulations, making up the laggards in adopting new technologies. By pulling a portion of the marketplace towards more efficient products, services and behaviours, new standards can then be introduced to 'push' the rest of the marketplace forward — creating lasting market transformation. The cycle then begins again with new products, services, behaviours, outreach programs and incentives to pull the market forward; then new standards can push the curve forward once again.

The rate of adoption of energy efficient technologies in Calgary's residential, commercial and industrial sectors (discussed above) suggests that these sectors are all in the stage between market introduction and broader commercialization. The barriers discussed earlier require incentives and eventually regulation to ensure the broader adoption of lower energy technologies and practices; this will eventually result in lower costs of adoption and will allow Calgary to position itself as a national leader in energy efficiency.

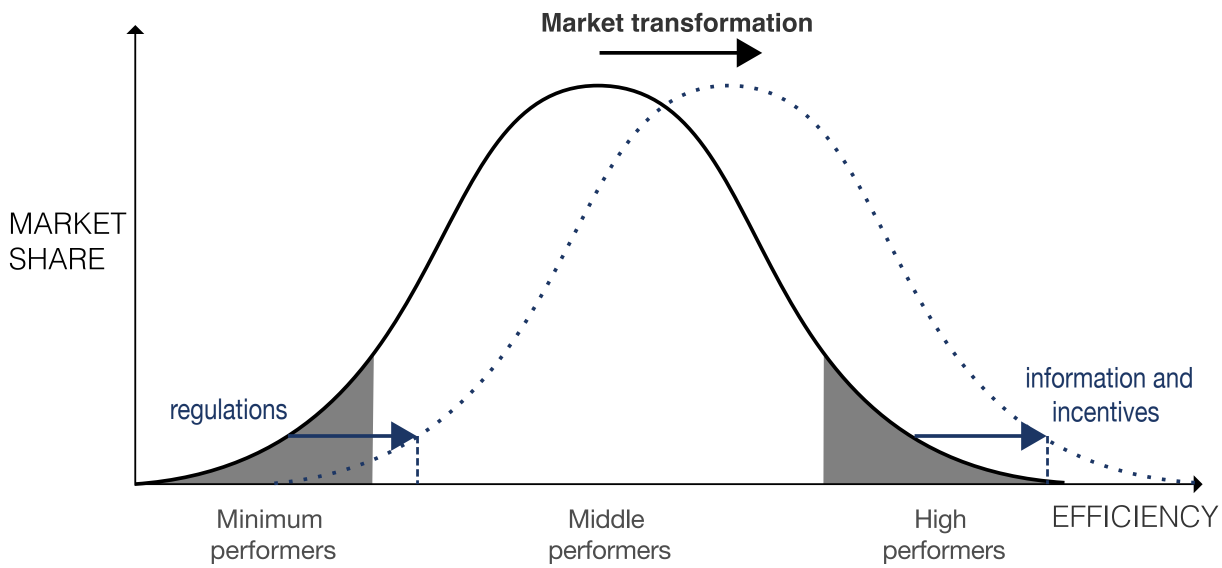

Figure 13: Market transformation model

Primary energy efficiency opportunities for Calgary

Through the work to develop the Calgary Community GHG Reduction Plan, a number of actions were identified that could be taken to directly reduce GHG emissions through energy efficiency and conservation. These actions lie on different parts of the market transformation curve, and can generally be categorized into information programs, incentives, and regulations. Specifically, there are six opportunities that were listed in the Calgary Community GHG Reduction Plan that the city of Calgary can undertake that have the ability to lead to notable city-wide GHG reductions. These six opportunities were selected because they are within the authority of The City, and have been demonstrated in other jurisdictions to be able to achieve notable wide-scale energy savings.

Information programs

Consumer feedback systems

Energy savings from consumer feedback systems have been documented at a cost as low as US$0.03 per kWh saved.[41]

Energy labelling of houses at time of sale

In Denmark, mandatory energy labelling for houses at time of sale has been partially attributed to an increase in energy efficiency actions.[42]

Incentives

Incentives for energy efficiency upgrades

Energy efficiency incentives coupled with an education program have been modeled to reduce energy demand in Alberta by 4% and 2% in the residential and commercial sectors respectively, by 2025. Industrial energy demand could potentially be reduced by 1.4% under a similar approach.[43]

Regulatory approaches

Requirement for energy audits of large industrial facilities

Mandatory energy audits have been found to save companies 5–10% of their energy costs. In some jurisdictions they are required for large facilities, typically above 11,000 GJ of energy use. As the energy saving projects themselves are voluntary and audits are typically a small part of the cost of energy saving projects, such mandatory energy audit programs are therefore considered to have had a positive net economic benefit for companies.[44]

Regulations for higher energy efficiency in buildings and industrial facilities

Higher energy efficiency standards for commercial and residential buildings have been shown to reduce energy demand significantly in a number of different countries (10–30% depending on the measures mandated).[45]

Regulations targeting industry have the potential to reduce emissions up to approximately 20%.[46]

Requirement for southward orientation of new buildings

Energy consumption can be reduced by up to 20% through orientation optimization of low-energy solar homes. The opportunity to impact house orientation is available for homes built in new neighbourhoods (i.e., without pre-existing road infrastructure that dictates building orientation).[47]

Next steps

This report has provided an examination of the state of energy consumption and efficiency in the City of Calgary, as well as the implications that different efficiency initiatives might have in terms of GHG emission reductions. All sectors — residential, commercial, and industrial — exhibit a strong potential for improving energy conservation, which can be enabled through a market-based approach to transform the nature of city-wide energy consumption. In these early stages of this market transformation (where Calgary and much of Canada find themselves), government engagement through incentives and regulations will be key in setting the pace of energy efficient technology and behaviour adoption.

Based on the opportunities identified for notable city-wide improvements in energy efficiency and conservation, it is recommended The City of Calgary undertake an assessment to prioritize the six options identified above to determine level of focus over the short, medium and long term.

Notes

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