

ENERGY EFFICIENCY: FINDING LEADERSHIP OPPORTUNITIES

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SUMMARY

Between 1995 and 2011, the population of Alberta increased by roughly 40 per cent, but energy use in the province grew much faster, with a 62 per cent increase over the same period. In the industrial sector, the province's largest energy consumer, demands grew 110 per cent. In mining and oil-and-gas extraction specifically, energy use over that period soared, growing by 355 per cent.

That remarkable growth in energy consumption creates a particular challenge for Alberta Premier Alison Redford, who in 2011 ordered her ministers to develop a plan that “would make Alberta the national leader in energy efficiency and sustainability.” The province is still waiting.

The incentives to become more energy efficient are not particularly strong in Alberta. The province's terrain and size favour larger and less-efficient vehicles. Energy in the province is abundant, so there is little cause for concern over energy security. And energy is relatively affordable, particularly for a population that is more affluent than the Canadian average. There is little pressure on Albertans to radically alter their energy consumption behaviour.

Yet, improved energy efficiency could position businesses in Alberta to become even more globally competitive, in addition to leading to improved air quality and public health. And for a province racing to keep up with growing energy demand, effective measures that promote conservation will prove much cheaper than adding yet more expensive infrastructure to the energy network.

Many other jurisdictions have already provided examples of methods Alberta could employ to effectively promote energy conservation. First, Alberta must set hard targets for its goals to save energy, and then monitor that progress through transparent accounting, measuring and reporting. The provincial government can also nurture a culture of energy conservation, by formally and publicly recognizing leadership in efficiency improvements in industry and buildings, and by issuing an annual “premier's report card,” making public the progress on province-wide efficiency efforts.

For a province that continues to enjoy growth in business and population, updated guidelines around new building codes have been proven to improve energy efficiency. And there remains a significant opportunity for Alberta to improve efficiency in its commercial and industrial sectors, the largest users of energy, by providing government incentives to replace ageing equipment with more efficient technology. Alberta is also well suited for a shift toward more combined heat and power generation plants, which can repurpose generated heat that is otherwise wasted, significantly reducing energy demand and costs. And in a province awash in natural gas, incentives to encourage travel using compressed or liquefied natural gas vehicles could serve to boost energy efficiency in the transportation sector as well.

Alberta is fortunate in that it has abundant energy and prosperity, making improved energy efficiency a matter of choice, rather than — as in some jurisdictions — one of urgent necessity. It is, however, a choice that Alberta has enough reasons, and resources, to make. All it requires is the will.

[†] The authors wish to acknowledge the helpful comments of the anonymous referees.

INTRODUCTION

On November 4, 2011, Alberta Premier Alison Redford mandated ministers to “develop a plan that would make Alberta the national leader in energy efficiency and sustainability.”¹ While defining “national leader” is subjective in such areas, there are many opportunities to make Alberta’s energy efficiency policy the most comprehensive in Canada.

This report is intended to identify the common characteristics of energy efficiency initiatives. Understanding such characteristics would be helpful in developing a framework for employing energy efficiency as an important component of Alberta’s energy strategy.

The report provides a review of various energy efficiency initiatives in Canada, the United States and some other jurisdictions. The common components of the studied initiatives are identified, and their implementation frameworks are discussed.

The organization of the report is as follows. In the following section, historical energy use in Alberta is reviewed. This is followed by a review of common concepts, definitions and the practice and challenges of measuring the effectiveness of energy efficiency initiatives. A discussion of the common motivations for energy efficiency initiatives is provided, followed by known barriers to implementing energy efficiency initiatives. Common components of energy efficiency initiatives — namely: standards and regulations, energy efficiency targets, financial assistance, and public information — are also discussed. A section is then devoted to reviewing energy efficiency programs in Canada and some other jurisdictions. The programs are distinguished as targeted programs, which include transportation and appliances and equipment, and infrastructure improvements, which include combined heat and power production and building efficiency. A final section provides a summary of the report and six recommendations for Alberta.

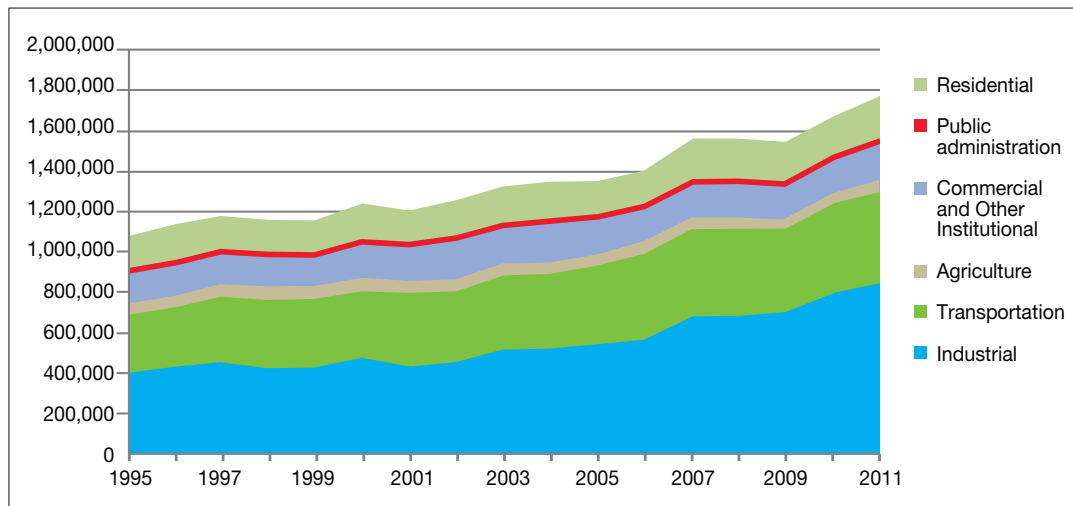
ENERGY USE IN ALBERTA

In order to provide some context for the discussion of energy efficiency policy in Alberta, we first outline historical energy use. Between 1995 and 2011, energy use (primary and secondary) in Alberta grew by 62 per cent. Figure 1 shows energy use over this period, by sector of the Alberta economy.² The majority of growth in energy use is due to the industrial sector, where energy use increased by 110 per cent; its share of total energy use increased from 37 per cent in 1995 to 48 per cent in 2011. The second-highest increase was in the transportation sector, with a 57 per cent increase in energy use. However, the transportation sector’s share of total energy use was the same in 2011 as it was in 1995, at 26 per cent. The other two major energy-use sectors in Alberta are commercial and residential, both of which saw declines in their share of total energy use, despite increases in total energy use of 17 per cent for commercial and 26 per cent for residential.

¹ Alberta Energy Efficiency Alliance, *Becoming The National Leader In Energy Efficiency*, March 2012, <http://www.aeea.ca/pdf/EE%20Opportunities%20for%20Alberta%20Mar%202012-final.pdf>.

² The sectors defined by Statistics Canada are: industrial (manufacturing, mining, oil and gas extraction, forestry and construction), transportation (airlines, marine, pipeline, road, rail and retail pump sales), agriculture (including hunting and fishing), residential (all personal residences including farm homes), public administration (federal, provincial and municipal governments), and commercial and other institutional (final consumers other than those listed previously). See: Statistics Canada, CANSIM Table 128-0016 (footnotes) for additional details.

FIGURE 1: TOTAL PRIMARY AND SECONDARY ENERGY USE BY SECTOR



Source: Statistics Canada, CANSIM Table 128-0016

Within the industrial sector, by far the largest energy-use increase was in mining and oil and gas extraction, with an increase of 355 per cent. Compare this to manufacturing, where energy use decreased by four per cent. The share of total energy use by mining and oil and gas extraction increased from 12 per cent in 1995 to 32 per cent in 2011. Manufacturing's share decreased from 24 per cent in 1995 to 14 per cent in 2011. Given the large amounts of energy used by mining and oil and gas extraction, manufacturing and transportation, there is clearly scope for energy efficiency or conservation measures to reduce energy use.

Overall, energy use in Alberta is 52 per cent natural gas, 17 per cent diesel, 13 per cent motor gasoline, 12 per cent primary electricity, three per cent natural gas liquids and two per cent aviation fuel. Use of diesel has increased slightly from 12 per cent in 1995 to 17 per cent in 2011, and electricity use decreased from 16 per cent to 12 per cent. We now turn to energy fuel use by each of the sectors of Alberta's economy.

Agriculture

Energy use in the agricultural sector consists primarily of natural gas, electricity, motor gasoline and diesel fuel oil. In 2011, diesel fuel oil accounted for 51 per cent of total energy use, followed by motor gasoline (29 per cent), primary electricity (13 per cent), natural gas (seven per cent) and natural-gas-plant liquids (one per cent). The only change over the period 1995 to 2011 was decreased use of natural gas and increased use of motor gasoline. The heavy use of refined energy products suggests energy efficiency initiatives would be best suited to reducing the use of these energy forms, perhaps through capital-replacement initiatives.

Commercial and Other Institutional

Energy use in the commercial sector consists primarily of natural gas and electricity. In 2011, natural gas accounted for 50 per cent of total energy use, followed by primary electricity (34 per cent) and refined petroleum products (11 per cent). Within refined petroleum products, diesel fuel oil accounted for five per cent of total energy use, while motor gasoline accounted for three per cent and aviation turbo fuel two per cent.

Industrial

Energy use in the industrial sector is dominated by natural gas, which had a 74 per cent share in 2011. This has increased from 66 per cent in 1995. Other energy sources used by the industrial sector are primary electricity (12 per cent), natural gas liquids (five per cent) diesel fuel oil (eight per cent), and coal (one per cent). Electricity use decreased from 24 per cent in 1995, while the shares of the other energy sources remained relatively constant.

Interestingly, manufacturing accounted for 81 per cent of natural gas use in the industrial sector in 1995, but this share decreased to 29 per cent in 2011. This corresponds to the share of mining and oil and gas increasing from 19 per cent to 70 per cent over the same period. The industrial composition has clearly changed, with natural gas use within the manufacturing sector decreasing by 15 per cent, and natural gas use in mining and oil and gas increasing almost nine-fold.

Public Administration

In the public administration sector, energy sources are split between natural gas (42 per cent in 2011), diesel fuel oil (25 per cent) and primary electricity (19 per cent). Motor gasoline accounted for seven per cent, and aviation turbo fuel eight per cent. Use of natural gas and electricity was relatively stable between 1995 and 2011, while use of diesel doubled from 12 per cent of total energy use in 1995, and aviation fuel use fell from 26 per cent.

Residential

Residential energy use is almost entirely natural gas; it accounted for 79 per cent of total energy use in 2011, and averaged 84 per cent of total use between 1995 and 2011. Primary electricity accounted for 20 per cent of total use in 2011, which was up from 13 per cent in 1995. Natural-gas-plant liquids accounted for one per cent of total use. There was also use of kerosene, light fuel oil and coal, but these sources accounted for a very small amount of energy use — hundredths or thousandths of a percent.

Transportation

The transportation sector relies heavily on refined petroleum products as an energy source, with 86 per cent of total energy use in 2011 accounted for by motor gasoline (42 per cent) and diesel (44 per cent). Other sources were natural gas (seven per cent) and aviation fuel (six per cent). Use of natural gas decreased from 18 per cent in 1995, and there was a corresponding increase in diesel use from 25 per cent in 1995. Electricity's share also decreased from two per cent in 1995 to 0.5 per cent in 2011.

DEFINITIONS AND MEASUREMENTS OF ENERGY EFFICIENCY

Definitions and Interpretations

The following terms and definitions that are commonly used in energy efficiency literature:

- **Demand Side** – Any event that occurs on the consumer side of an energy production, bulk transportation and distribution system.
- **Energy Conservation** – Often, energy conservation results directly in a reduction in overall energy demand while keeping the useful output constant. For example, in the electric system, this is both in terms of yearly energy and peak power requirements, while for the transportation sector this is in terms of a decreased demand for fuel.
- **Energy Systems** – Typically complex systems, such as electrical power systems, that convert, transport, and deliver energy to consumers.
- **Energy Efficiency** – Efficiency is the ratio of useful output per unit of input, and energy efficiency relates to the efficiency of components and facilities used to explore, produce, bulk transport, and distribute energy, as well as those devices that use energy. When discussing energy systems, increasing energy efficiency is done either by keeping the consumption of input energy constant and increasing the amount of useful output, or by keeping the amount of useful output constant and decreasing the consumption of input energy.
- **Energy Efficiency Program** – An energy efficiency program is any program — be it a rebate offer, subsidy, information campaign, or other incentive — used to promote the adoption, retention, or use of energy efficiency measures.
- **Energy Efficiency Resource Standard (EERS)** – An EERS is comparable to renewable energy standards in which utilities must increase the share of renewable or alternative energies in their portfolio. EERSs require utilities to reduce energy consumption³ for providing the same services. Since utility energy consumption is directly linked with the energy demand of their customers, EERSs necessarily involve a reduction in end-user energy consumption.
- **Energy Efficient Device** – An energy efficient device is a device (for example, a light bulb, appliance, or other installed component) that has a diminished energy use compared to a reference device — often the previously installed device or previously standard device — while performing at or above the required level.
- **Energy-use Intensity** – Energy-use intensity is a measure of how much energy is consumed by a country to run its economy (i.e., energy per economic-output unit). Countries with similar standards of living can be compared, with a lower energy-intensity value indicating a more energy efficient country. Comparative considerations such as climate and industry mix should be taken into account during the comparison.

³ Center for Climate and Energy Solutions, “Energy Efficiency Standards and Targets,” July 2012, <http://www.c2es.org/us-states-regions/policy-maps/energy-efficiency-standards>.

- **Gigawatt-hour (GWh)** – Gigawatt-hour is a measure of energy production or use, used mainly in the electricity sector. It is easiest to examine in terms of demand, where one gigawatt-hour (1 GWh) is the equivalent electricity consumed by 140 average Alberta homes during one year. Alberta’s electric energy use for 2012 was 72,918 GWh.^{4,5,6}
- **HVAC** – Heating, ventilation, and air conditioning. These systems are used to regulate temperature and humidity, typically in medium and large industrial buildings along with office buildings.

Measuring Energy Efficiency

In March 2012, the Alberta Energy Efficiency Alliance published a discussion paper on leadership in energy efficiency,⁷ based on the views of a wide range of stakeholders, in which significant energy efficiency potential in the province was identified. The report also emphasized that a variety of measures may be used to evaluate energy efficiency leadership, including, energy use per capita, energy efficiency regulations, the size of incentive programs, and the level of innovation being undertaken with regard to energy efficiency policies and programs.

Evaluations of energy efficiency programs often tend to focus on “input” measures, such as the amount of money spent, and the number of policies related to energy efficiency. While input measures do provide value in assessing the commitment to energy efficiency, additional focus should be placed on “output” measures, such as energy savings and potentially deferred capital costs. However, it must be noted that output measures are generally much more difficult to quantify, especially when considering policies that impact a broad consumer base.

The amount of electricity saved as a result of implementing efficiency programs is not always easy to quantify because of the inconsistency in the way the savings are measured, including establishing accurate consumption baselines. Most measures of energy efficiency are estimated based on replacements of equipment or changes to building envelope standards. When an older appliance is replaced with a newer, higher-efficiency unit, an approximate difference in energy consumption is calculated. This value is then taken over the lifetime of the new unit, assuming the previous unit would have been run for the entire period at a decreased efficiency. The difference accumulated over the new appliance lifetime is the energy savings. This savings can be expressed in terms of avoided generation — i.e., a generator does not have to run as often to produce energy for this device — for electricity systems, or in terms of volume for natural gas or fuel. The Efficiency Valuation Organization has been promoting a set of standards for measuring and documenting energy efficiency improvements.⁸

⁴ Government of Alberta, Ministry of Energy website, “What is Electricity?” <http://www.energy.alberta.ca/Electricity/684.asp>.

⁵ AESO Long Term Transmission Plan, June 2012, http://www.aeso.ca/downloads/AESO_2012_LTP_Appendices.pdf.

⁶ Government of Alberta, Ministry of Energy website, “Electricity Statistics,” <http://www.energy.alberta.ca/Electricity/682.asp>.

⁷ Alberta Energy Efficiency Alliance, “Becoming The National.”

⁸ Efficiency Valuation Organization website, http://www.evo-world.org/index.php?option=com_content&view=article&id=74&Itemid=84&lang=en.

Additionally, when measuring the outcomes of energy efficiency programs, some energy savings that would have occurred even without energy efficiency programs are often counted. These savings are sometimes referred to as “free-riders” and tend to enhance the savings reported. On the other hand, there are savings that are not attributed to the program that would not have been observed without the implementation of the programs. These savings are referred to as “free-drivers,” and tend to reduce the reported savings from their actual values.

Most sources on energy efficiency cited in this report use different methods of measuring efficiency based on available information. This fact makes it difficult to draw consistent conclusions for similar programs. Nevertheless, this report evaluates energy efficiency measures that have been reported by various jurisdictions and accordingly makes recommendations for energy efficiency policy in Alberta, where applicable.

MOTIVATION FOR ENERGY EFFICIENCY

Most consumers pursue energy efficiency to save money, reduce the cost of goods sold, or reduce emissions to improve air quality and the environment. In addition to these goals, policy-makers use energy efficiency to enable a wide range of desirable social, engineering, and economic goals, normally focused around long-term resource adequacy. Energy efficiency is also often seen as an alternative tool to address long-term energy-demand concerns, compared to building new infrastructure.

Many energy efficiency programs primarily target the end use of the electrical energy sector, since improvements in the production or use of electricity can yield up to three times as much resource savings when compared to increased efficiency in use of other energy forms. In the electric energy sector, efforts to install and integrate demand-side management measures such as smart meters, pricing incentives, new regulations, and new technology deployment offer the potential to reduce system costs and pass on savings to consumers. Furthermore, energy efficiency initiatives can positively reinforce other public programs, such as improving air quality for urban areas, improving personal health, and improving overall competitiveness for employment and export opportunities.

Examples of the motivation for increasing energy efficiency include:

1. Energy efficiency reduces greenhouse gas emissions. According to the International Energy Agency, energy efficiency comprises a significant portion of the emission reductions needed to reach a sustainable level of GHG emissions.⁹ This has led to international commitments to reduce emissions in addition to those already existing at a regional level to improve local air quality. Most energy efficiency measures are directly linked with emissions reductions and various independent studies¹⁰ show these measures are cost-effective in achieving the reduction goals.

⁹ International Energy Agency, “World Energy Outlook Executive Summary,” 2009, <http://www.iea.org/textbase/npsum/weo2009sum.pdf>.

¹⁰ Real Prospects for Energy Efficiency in the United States, http://www.nap.edu/catalog.php?record_id=12621.

2. Rising energy prices put pressure on energy-intensive economies and jeopardize their competitiveness. The relationship between energy efficiency and economic competitiveness has been acknowledged in several regional, national, and international reports including:
- **Maine:** "...perhaps the single most effective action to enhance Maine's business climate and economic competitiveness is to aggressively increase the energy efficiency of Maine's economy..."¹¹
 - **Massachusetts:** Gross state production would have been lower by almost five per cent in 1997 if the energy intensity was the same as in 1977. The energy intensity improvements have been attributed to energy efficiency programs and measures in place since the 1980s.¹²
 - **Australia:** Energy efficiency was identified as a crucial factor in positioning Australia's exports in the global market.¹³
 - **Ireland:** The National Energy Efficiency Action Plan 2009–2020 envisioned energy efficiency as a critical factor to improve the country's competitiveness by reducing the need for imported fuels, decreasing the need for investment in new energy-supply infrastructure and addressing the urgent need to cut emissions.¹⁴
 - **International Chamber of Commerce (ICC):** "ICC members are convinced that energy efficiency makes good business sense and is certainly a factor in enhancing competitiveness."¹⁵

All of these reports build on the notion that consuming less energy while simultaneously providing the same service or making the same good within a regime of rising energy prices is a critical factor for global competitiveness.

In 2004, Canada's energy intensity (energy used per unit of GDP) was 240 per cent greater than that of Japan, Norway, or the United Kingdom and about 140 per cent greater than that of the United States or Australia.¹⁶ In comparison with these other developed countries with similar standards of living, the greater energy intensity of Canada's economy could

¹¹ Energy Efficiency, Business Competitiveness, And Untapped Economic Potential in Maine, Muskie School of Public Service, University of Southern Maine and Margaret Chase Smith Policy Center, University of Maine, efc.muskie.usm.maine.edu/docs/Energy_Efficiency.pdf.

¹² Mark Bernstein et al., "The Public Benefit of Energy Efficiency to the State of Massachusetts," RAND Corporation, http://www.rand.org/pubs/monograph_reports/MR1588.html.

¹³ Australian Government, Department of Industry, Report of the Prime Minister's Task Group on Energy Efficiency, October 2010, <http://www.climatechange.gov.au/~media/submissions/pm-taskforce/report-prime-minister-task-group-energy-efficiency.pdf>.

¹⁴ Government of Ireland, Department of Communications, Energy and Natural Resources, Maximising Ireland's Energy Efficiency: The National Energy Efficiency Action Plan 2009 – 2020, http://www.dcenr.gov.ie/nr/rdonlyres/fc3d76af-7ff1-483f-81cd-52dcb0c73097/0/neeap_full_launch_report.pdf.

¹⁵ International Chamber of Commerce, "ICC policy statement on energy efficiency: a world business perspective," January 5, 2007, [http://www.iccwbo.org/Advocacy-Codes-and-Rules/Document-centre/2007/ICC-policy-statement-on-energy-efficiency--a-world-business-perspective-\(2007\)-\(EN/FR\)](http://www.iccwbo.org/Advocacy-Codes-and-Rules/Document-centre/2007/ICC-policy-statement-on-energy-efficiency--a-world-business-perspective-(2007)-(EN/FR)).

¹⁶ Shigeru Suehiro, "Energy Intensity of GDP as an Index of Energy Conservation," The Institute of Energy Economics, August 2007, <http://eneken.ieej.or.jp/en/data/pdf/400.pdf>.

potentially make Canadian industries more sensitive to energy prices. Improving energy efficiency also makes households — especially the low-income quintiles who spend a greater proportion of their income on energy bills,^{17,18} — and businesses more economically resilient with respect to increasing energy costs. While Alberta's future global competitiveness will depend on many factors, energy efficiency will directly impact the cost of doing business and therefore the strength of the economy.

3. Energy efficiency is a more cost-effective approach than building new energy infrastructure to meet energy-demand growth. When considering electricity in particular, it has been demonstrated that the price per avoided-energy unit of even the most expensive energy efficiency measure is lower than the market price for electricity in many western economies.¹⁹
4. Energy security²⁰ has become a major issue for energy-importing economies, considering the unresolved political instabilities in the Middle East and the increasing demand for the same energy resources from emerging economic powers (i.e., China and India).^{21,22}
5. Energy efficiency programs and policies can create jobs, potentially supporting or supplementing other social goals. In 2011, the U.S. government announced the Better Building Initiative, which sets a national target of improving energy efficiency in commercial buildings by 2020.²³ With nearly \$4 billion in financial assistance committed by the U.S. government, it estimates that this program will create 114,000 jobs and reduce the energy bill for American businesses by \$40 billion per year. Independently, it was estimated that about 3.4 per cent of all Californian employment opportunities in 2020 will come from jobs related to industries that provide new renewable energy generation and storage, recycling, education/awareness and compliance, and manufacturing natural and sustainable products.²⁴

These arguments all support the idea that improving energy efficiency leads to economic benefits for a society. The most forceful example to support this conclusion is from the state of California, which has been sustainably and continuously investing in energy efficiency programs and initiatives since the '70s. Through these programs, California has reduced its per capita energy consumption by 40 per cent compared with the U.S. average, while yielding an economic benefit estimated to be from \$875 to \$1,300 per capita from 1977 to 1995 (in year 1998 constant dollars).²⁵

¹⁷ Statistics Canada, Table 2020405, "Upper income limits and income shares of total income quintiles, by economic family type, 2010 constant dollars, annually," CANSIM (database), using CHASS (distributor).

¹⁸ Statistics Canada, Table 2030022, Survey of household spending (SHS), household spending, by household income quintile, annually (dollars), CANSIM (database), using CHASS (distributor).

¹⁹ National Research Council, *Real Prospects for Energy Efficiency in the United States* (Washington, D.C.: The National Academies Press, 2010), http://www.nap.edu/catalog.php?record_id=1262.

²⁰ Energy security is the ability for a country to have continual access to energy resources.

²¹ United States Energy Security Council website, http://www.usesc.org/energy_security/.

²² U.K. Government website, "Maintaining UK Energy Security," <https://www.gov.uk/government/policies/maintaining-uk-energy-security--2>.

²³ U.S. White House, "President Announces Nearly \$4 Billion in Public and Private Investments in Building Upgrades as Part of Better Buildings Initiative," http://www.whitehouse.gov/sites/default/files/bbi_factsheet_final_clean_12-1-2011.pdf.

²⁴ Bonny Graybill, "California's Green Economy," Presentation, California Green Workforce Coalition, July 9, 2010, <http://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/CaliforniaGreenEconomy-070910.pdf>.

²⁵ Mark Bernstein et al., "The Public Benefit of California Investments in Energy Efficiency," RAND Corporation report, prepared for the California Energy Commission, March 200, www.rand.org/pubs/monograph_reports/2005/MR1212.0.pdf.

BARRIERS TO IMPLEMENTING ENERGY EFFICIENCY PROGRAMS

Generally, western economies have a high potential for improving energy efficiency; however, despite the benefits, there are various barriers to successfully implementing energy efficiency measures that need to be understood when developing energy efficiency policy. A number of common barriers are described below:

1. **Lack of information:** The lack of information and skills among business and the general public impacts energy efficiency improvements in different sectors. For example, lack of information may simply lead to missing an opportunity to invest in more energy efficient goods when purchasing a good with a long lifetime (e.g., a house or an appliance). Similarly, lack of skills in correctly estimating the payback period of certain energy efficient technology may prevent its spread for a number of years.²⁶
2. **Split incentives:** Often referred to as the principal-agent problem, this arises in situations where the benefits of improving energy efficiency are not the same across stakeholders. This is most prevalent in a landlord-tenant arrangement, where each stakeholder may have different incentives in investing in energy efficiency depending on the agreement surrounding energy payments.
3. **The up-front capital cost of energy efficiency measures:** Although many consumer energy-efficiency measures recover the capital costs through cost savings within a reasonable time period, the up-front costs may exceed consumer resources. In particular, lack of financing options may hinder the adoption of energy efficiency improvements by the low-income segment of society.
4. **Embedded cultural, behavioural, structural, and environmental factors:** These can include regional behaviours such as utility use, or vehicle preference. For example, air conditioners are more prevalent in southern Alberta than in the north; the eastern provinces of Canada use more fuel-oil heating than the west; and driving highly fuel-efficient small vehicles is more common in densely populated areas and temperate regions than in sparsely populated or very cold regions. Failure to consider such factors can reduce the effectiveness of many energy efficiency programs.
5. **Difficulty in verifying and quantifying the potential infrastructure benefits:** While it is straightforward to understand and quantify the direct monetary benefits of some efficiency measures (e.g., replacing an incandescent light bulb with a more energy efficient compact fluorescent bulb), it is complex for others. For instance, cutting electricity demand through energy efficiency will certainly defer network and infrastructure upgrades or the need for new generation supply, and will therefore lower utility costs. However, it is difficult to quantify and verify these benefits to a residential electricity consumer.
6. **Externalities:** This barrier refers to the unintentional influence of other factors on energy efficiency decisions. For example, low energy prices or a high fixed cost on energy bills may impact financial decisions regarding adopting energy efficiency measures. The share of non-energy components on a typical electricity bill is often significant²⁷ and energy

²⁶ Australian Government, Report of the Prime Minister's.

²⁷ Government of United Kingdom, Office of the Gas and Electricity Markets, "Updated household energy bills explained," February 2013, <http://www.ofgem.gov.uk/Media/FactSheets/Documents1/household-bills.pdf>.

efficiency measures impact only the cost of energy, leading to longer payback periods than might be expected. In the case of Alberta, as the relative cost of transmission of electricity in the province is expected to grow,²⁸ this barrier may be significant if transmission prices are not set proportional to energy usage.

7. **Management Systems and Monitoring:** Oversight in terms of fund distribution, double-counting of benefits, and consistency of performance is often very difficult to manage. Monitoring and enforcement of building codes is often referenced as an example of a barrier to the success of energy efficiency policies and programs. While jurisdictions may adopt effective energy efficiency codes for buildings, if insufficient tools and resources are made available to inspectors, the codes may have minimal impact.
8. **Policy and Competing Industries:** Energy efficiency can potentially impact the future profitability and growth of merchant power-generation companies, and power and gas utilities. A related issue is clarity on who has the responsibility or a market reason to implement energy efficiency programs in areas where competitive power and gas distribution markets exist. Lack of an effective policy framework to deal with such issues is considered a challenge to the successful implementation of energy efficiency.
9. **Lack of training and on-going education:** Energy efficiency programs have been shown to have the best success when those who are involved in end-use implementation stages are well engaged and educated. Failure to include contractors and trades-workers who understand new approaches and programs has been one of the reasons for unsuccessful energy efficiency programs.

COMMON COMPONENTS OF ENERGY EFFICIENCY INITIATIVES

Energy efficiency initiatives usually share a number of common components, including, standards and regulations, energy efficiency targets, financial assistance and public information and education. A review of these components is provided next.

Standards and Regulations

Setting realistic standards and regulations to improve energy efficiency is a common step among regions that have shown leadership in this area. Standards are a voluntary set of requirements and regulations are stipulated by legislation or administrative fiat. Legally, a standard's requirements only become mandatory if the standard is formalized as a regulation. For example, a regulatory measure is an energy code for new buildings that must be complied with by law, whereas adherence to the requirements of LEED (the Leadership in Energy and Environmental Design that defines energy-performance benchmarks) is a matter of organization and individual choice.²⁹ Often, governments will regulate a minimum performance standard, with various levels of additional voluntary compliance (e.g., Energy Star³⁰).

²⁸ Alberta Electric System Operator, "Cost of Transmission," <http://www.aeso.ca/transmission/23722.html>.

²⁹ Enermodal Engineering website, "LEED Explained," <http://www.enermodal.com/leed-explained.html>.

³⁰ Energy Star website, <http://www.energystar.gov>.

Standards and regulations normally require only a small financial commitment of public money, instead shifting the bulk of the cost to the marketplace. Concerns with standards can include transition uncertainty, the impact on economic activity in some sectors, and the initial and continued level of compliance.

Energy Efficiency Targets

Another component of energy efficiency initiatives is to set efficiency targets. Energy efficiency targets are a flexible mechanism that set certain levels of future energy demands to be avoided through efficiency and energy conservation. Energy efficiency targets are applied at international, national, or regional levels, often with the regional targets highlighting state or provincial commitments to energy efficiency.

Internationally, many jurisdictions have taken several steps to improve energy efficiency. For example, in 2007, heads of European Union states and governments discussed a 20 per cent reduction in energy consumption by year 2020. This led to a binding 20 per cent energy efficiency improvement mandate for member countries by 2020, which was voted for by the European Parliament in 2012.³¹

On a national level, China set a target in 2009 to improve its energy intensity by 40 per cent by 2020.³² Energy intensity is a measure of energy efficiency, which basically indicates how much energy would be used for producing goods. In 2011, the United States set a national target of 20 per cent improvement in the energy efficiency of commercial buildings by 2020.³³

In 2008, Canadian provinces and territories committed to achieving a 20 per cent increase in energy efficiency by 2020.³⁴ The anticipated avenues of improvement were mainly through improvements to building codes, expanding minimum performance requirements to a variety of products, green building policies for new government-funded facilities, and home energy audits and retrofit assistance. Various provinces have developed their own efficiency targets, many of which are accompanied by programs that will be discussed in subsequent sections:

- **Ontario:** Ontario has a target for 7,100 MW (28 TWh³⁵) of avoided generation by 2030, and estimates that it had avoided 1,837 MW³⁶ in 2010.
- **British Columbia:** The BC Energy Plan of 2009 set a target of 50 per cent of incremental energy needs to be met through conservation.³⁷ BC Hydro also has a number of targets related to energy conservation and efficiency.³⁸

³¹ European Commission website, “Energy Efficiency,” http://ec.europa.eu/energy/efficiency/index_en.htm.

³² Australian Government, Report of the Prime Minister’s.

³³ *ibid.*

³⁴ The Council of the Federation website, “July 16–18 — Quebec,” <http://www.councilofthefederation.ca/en/meetings-events/41-2008/102-july-16-18-2008-quebec>.

³⁵ TWh — Terawatt-hour; 1 TWh = 1,000 GWh.

³⁶ Government of Ontario, Ontario’s Long-Term Energy Plan: Building Our Clean Energy Future, (Toronto: Queen’s Printer for Ontario, 2010).

³⁷ Government of British Columbia, The BC Energy Plan: A Vision for Clean Energy Leadership, <http://www.energyplan.gov.bc.ca/bcep/default.aspx?hash=4>.

³⁸ BC Hydro, Annual Report 2011, http://www.bchydro.com/about/accountability_reports/financial_reports/annual_reports.html.

- **Newfoundland and Labrador:** Newfoundland and Labrador's 2011 Energy Efficiency Action Plan included targets related to overall energy usage, reduction of regional energy consumption by 20 per cent, and increasing the percentage of energy efficient government vehicles.³⁹

In the U.S., 27 states (as of April 2012) had EERS (Energy Efficiency Resource Standard) policies in place. Many of the policies are enforced by monetary penalties and a requirement that the shortfall be made up for before the policy deadline. Arizona, Hawaii, and Massachusetts' policies are considered to be national leaders:

- **Arizona:** In 2009, Arizona set mandatory targets for both electric and gas utilities. In the electricity sector, the target is to save 1.25 per cent of the previous year's energy sale through the use of energy efficiency measures in 2011, ramping up to two per cent in 2014. The goal is to reach a cumulative 20 per cent savings relative to 2005 sales. Utilities must meet at least 75 per cent of the required savings in any year.⁴⁰ For the gas sector, the goal is to reach six per cent savings by 2020.⁴¹
- **Hawaii:** The state has set a goal to reduce annual electricity use by 40 per cent of its 2007 electricity sales by 2030. Interim targets for years 2015, 2020 and 2025 are to be established.⁴²
- **Massachusetts:** The Green Communities Act of 2008 set EERS targets for both electricity and natural gas in Massachusetts. The efficiency plan of 2010–2012⁴³ sets an annual savings target of 2.4 per cent for electricity and 1.15 per cent for natural gas.

Energy efficiency targets are highly varied in type and area of influence. They can be designed to be far-reaching by applying them to the overall economy, to target specific resource areas by setting goals for utilities, or to be specific to governmental areas. Targets often leave the methods of reaching them to the marketplace, which can often promote the development of energy efficiency programs.

While setting targets is a step in the right direction, it is important to ensure those targets are reached. Mechanisms need to be in place to continuously assess the impact of ongoing programs and accordingly revise the approaches and policies. For example, in Europe, and after the 20 per cent energy efficiency improvement target by 2020 was discussed at the heads-of-governments level in 2007, it was later argued that reaching that target based on existing measures was not likely.⁴⁴ This led to the approval of the 20 per cent binding obligation for the member countries based on a revised set of measures and approaches.

³⁹ Government of Newfoundland and Labrador, Moving Forward, Energy Efficiency Action Plan 2011, http://www.exec.gov.nl.ca/exec/ccceet/2011_energy_efficiency_action_plan.html.

⁴⁰ Sandy Glatt and Beth Schwentker, "State Policy Series: Impacting Industrial Energy Efficiency; State Energy Efficiency Resource Standards Analysis" (Washington, D.C.: U.S. Department of Energy, July 2010).

⁴¹ Center for Climate and Energy Solutions, "Energy Efficiency Standards."

⁴² *ibid.*

⁴³ The Commonwealth of Massachusetts, Department of Public Utilities, January 28, 2010, <http://www.env.state.ma.us/dpu/docs/electric/09-116/12810dpuord.pdf>.

⁴⁴ European Commission, "Summary of the Impact Assessment," Commission Staff Working Document (Brussels: European Commission, August 3, 2011), <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:0280:FIN:EN:PDF>.

One clear drawback of targets is that they are often unclear or vague regarding the way the target will actually be achieved, potentially leading to very high or unrealistic costs to realize the goal. Energy targets should be defined clearly and their jurisdiction should be clear. Also, measures of success and a mechanism for standard assessment and documentation⁴⁵ of achievements should be in place.

Financial Assistance

Assisting the end user with some form of financial assistance is another common component of energy efficiency initiatives. Financial assistance encompasses all monetary aid in terms of financing or rebates or any other funding made available to eligible entities. Financing and rebates, or refunds, could be provided by the government or private firms, such as utilities, with the difference being that financing is a complete repayment of the loaned monies, while rebates are monies given only once a pre-subscribed set of requirements have been met.

Rebates are a common approach for government and utility energy-efficiency initiatives. Examples include consumer-appliance and heating/cooling-equipment replacement programs. Rebate programs often increase the penetration of energy efficiency appliances/equipment in terms of volume; however, most equipment upgrades are still determined by the normal replacement cycles due to high capital costs.

Financing options are used to further incentivize adoption of energy efficiency measures where the savings are realized over a number of years, or where the costs associated with the adoption of the energy efficiency measure might be a potential barrier as discussed before.

Financial incentives by the government may appear in the form of provision of direct loans, grants, and tax credits. These financial incentives generally lower the initial cost of energy efficient products and thus, accelerate market transformation.

In Canada there are several examples of financing and loan programs. For example, from August 2010 to March 31, 2011, Saskatchewan provided a financial loan, up to \$15,000, for the purchase of Energy Star furnaces, boilers and other high-efficiency natural gas appliances.⁴⁶ Saskatchewan currently offers other financial programs, including a commercial HVAC financial program.⁴⁷ Manitoba offers a “Power Smart Residential Loan” of up to \$7,500 for energy-efficiency-based upgrades, including windows, doors, heating equipment, and ventilation.⁴⁸ Similar programs are available in several other provinces in Canada.

⁴⁵ Efficiency Valuation Organization, “International Performance Measurement and Verification Protocol,” January 2012, <http://www.energync.net/Portals/14/Documents/Utility%20Savings%20Initiative/PC/IPMVP%20vol1%202012.pdf>.

⁴⁶ SaskPower, “The Energy Star Loan Program,” http://www.saskpower.com/save_power/residential/programs_and_offers/energy_star_loan.shtml.

⁴⁷ SaskEnergy, “Commercial HVAC Program,” <http://www.saskenergy.com/business/hvac.asp>.

⁴⁸ Manitoba Hydro, Power Smart Residential Loan, http://www.hydro.mb.ca/your_home/power_smart/residential_loan/index.shtml.

Public Information and Education

Educating the public and spreading the word is another common aspect of energy efficiency initiatives. Public awareness and information about energy efficiency play a critical role in the success of not just particular programs, but also individual choices that are independent of the programs. For example, public awareness campaigns associated with energy efficient appliances and lighting encourages adoption of these measures regardless of whether a program is currently in effect to provide financial assistance.

While many public information programs are related to the promotion of specific energy efficiency programs and measures, an example of a program designed to specifically target the spread of public information is British Columbia's provision of Certified Energy Advisors. The advisers provide homeowners with a personalized report showing the best ways to reduce energy use, reduce utility costs and increase home resale value. Homeowners can use this information to help them decide which upgrades make the most sense for their home and budget.⁴⁹

A recent report⁵⁰ on the role of information labels has found that providing the consumer with simple information on the economic value of energy efficiency is the most effective factor in changing consumer behaviour in making energy efficient choices.

ENERGY EFFICIENCY PROGRAMS

Energy efficiency programs take many forms. In this report, we have chosen to separate them into targeted programs, which often involve standards along with financial incentives to encourage adoption of an initiative, and infrastructure improvements, which do not often involve any financial considerations, focusing instead on standards, regulations, and public awareness. In this section, we will give an overview of country and regional spending on energy efficiency programs, and then examine targeted programs and infrastructure improvements each in further detail.

⁴⁹ BC Hydro, "Certified Energy Advisors," http://www.bchydro.com/powersmart/builders_developers/new_home_program/news_features/certified_energy_advisors.html.

⁵⁰ Richard A. Newell and Juha Siikamäki, "Nudging Energy Efficiency Behavior: Role of Information Labels," Duke Environmental and Energy Economics Working Paper Series, Working Paper EE13-03, August 2013, <http://sites.nicholasinstitute.duke.edu/environmentaleconomics/files/2013/08/WP-EE-13-03-PDF.pdf>.

Overview

In this section, a review of provincial and utility-led programs in Canada is presented. Some relevant initiatives from the United States are also presented. While in some areas the government or the utility administers energy efficiency initiatives, some other areas have established independent agencies to co-ordinate and administer such initiatives. Examples are the Efficiency Nova Scotia Corporation,⁵¹ C3 in Alberta⁵² and Energy Trust of Oregon.⁵³

PROVINCIAL PROGRAMS IN CANADA

All Canadian provinces and territories have energy conservation and efficiency programs, which generally target residential, commercial and industrial customers. The 2012 Energy and Mines Ministers' Conference report⁵⁴ provides highlights for energy efficiency success stories across Canada and contextualizes the value of energy efficiency programs and policy for Canada.

A continuing survey conducted by the Canadian Energy Efficiency Alliance (CEEA)⁵⁵ provides an example of a rating system for the programs and policies across Canadian provinces and territories. In the CEEA report, the performance grades are determined by applying a weighted evaluation to a number of sectors including buildings (energy codes), transportation, leadership initiatives, public awareness programs, and policy development. We have converted their ratings from the academic scores of A, B, C, D, etc., into adjusted percentages (an A+ converts to 100 per cent) in Table 1 for ease of comparison. While such a tool does provide a relative rating, it does not account for regional influences such as income levels, age of housing and manufacturing stock, and the provincial share of energy-intensive industries.

TABLE 1: COMPARATIVE RATING OF PERFORMANCE FOR ENERGY EFFICIENCY (ADJUSTED TO PERCENTAGES)⁵⁶

	2009	2007	2005	2004	2004	2001	2000	Average
Alberta	77	30	30	30	53	40	47	44
British Columbia	93	100	70	70	70	63	40	72
Manitoba	100	100	93	93	63	40	53	77
Newfoundland and Labrador	40	30	23	0	23	30	47	28
Nova Scotia	77	77	63	70	70	63	47	66
Ontario	100	93	77	40	47	30	53	63
Quebec	100	93	70	77	93	86	77	85
Saskatchewan	63	77	63	47	23	0	0	39

⁵¹ Efficiency Nova Scotia Corporation website, <http://www.energyncs.ca/who-we-are/>.

⁵² C3 website, "about us," <http://c-3.ca/about-us/>.

⁵³ Energy Trust of Oregon website, "about us," <http://energytrust.org/about/>.

⁵⁴ Energy and Mines Ministers' Conference, Moving Forward on Energy Efficiency in Canada: Achieving Results to 2020 and Beyond, September 2012, http://oee.nrcan.gc.ca/sites/oee.nrcan.gc.ca/files/files/pdf/EMC_Report_e.pdf.

⁵⁵ CEEA, National Energy Efficiency Report Card, 2010.

⁵⁶ CEEA, National Energy.

From Table 1, it can be seen that many of the provinces have recently increased their energy efficiency actions. These grades cannot be directly linked to a large number of programs or effective programs, but the inference can be made based on data from the Canadian Energy Efficiency Program Study,⁵⁷ represented in Table 2. This table gives the provincial energy conservation and efficiency program spending and per capita provincial program spending in 2010 for selected provinces and territories. Based on this data, the difference in spending on energy conservation and efficiency programs across Canada is large, both in terms of absolute numbers and per capita dollars. British Columbia and Quebec lead the nation in terms of spending — reflected in the highest scores in Table 1 — on average and over recent years. Additionally, Manitoba has very high per capita spending and this is also seems reflected in its CEEA grade. It is important to note that Table 2 omits some of Alberta’s recent provincial spending, including a \$60-million fund dispensed over three years,⁵⁸ which may explain the grade/spending mismatch relative to other provinces (e.g., Nova Scotia).

TABLE 2: ENERGY EFFICIENCY PROGRAM SPENDING IN SELECT CANADIAN PROVINCES⁵⁹

Province	Program Spending	Per Capita Program Spending
Alberta	\$0.4 million	\$0.10
British Columbia	\$163.3 million	\$36.04
Manitoba	\$32.6 million	\$26.39
Newfoundland and Labrador	\$6.2 million	\$12.22
Nova Scotia	\$22.7 million	\$24.10
Ontario	Not available	\$17.67 (2009)
Quebec	\$282.3 million	\$35.71
Saskatchewan	\$9.9 million	\$9.47

While program spending is not available for Ontario in Table 2, it plans to spend \$12 billion on energy conservation over the next 20 years, generating approximately \$27 billion worth of energy-use avoidance for ratepayers.⁶⁰ As well, it is important to note that several provincially owned utilities manage energy efficiency initiatives, such as BC Hydro, Manitoba Hydro, and Quebec Hydro. In jurisdictions where utilities are not government owned, such as Alberta, energy efficiency programs initiated by the government are managed by independent entities (e.g., C3 in Alberta).

Provincial energy efficiency policies and programs have had a very positive impact on Canada’s energy efficiency, with estimated improvement in energy efficiency being 23.5 per cent (from 1990 to 2009) resulting in \$26.8 billion in savings in 2009.⁶¹ The estimated energy

⁵⁷ Canadian Energy Efficiency Program Study, Final report, The Government of Newfoundland and Labrador’s Office of Climate Change, Energy Efficiency and Emissions Trading (IndEco Strategic Consulting Inc and Hollett & Sons Inc., 2011).

⁵⁸ C3 Annual Report 2011, http://issuu.com/c3-energy.ideas.change./docs/c3_progress_report_2011.

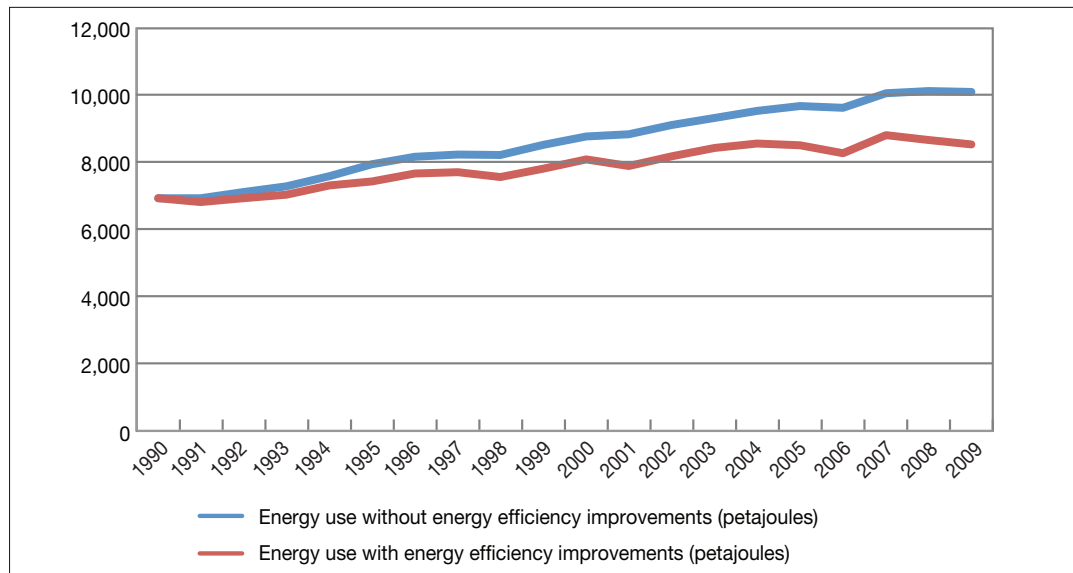
⁵⁹ Canadian Energy Efficiency Program Study, Final report.

⁶⁰ Ontario Power Authority website, “Evaluation Reports,” <http://www.powerauthority.on.ca/evaluation-measurement-and-verification/evaluation-reports>.

⁶¹ Natural Resources Canada, Office of Energy, “Energy Efficiency Trends in Canada, 1990 to 2009, Fact Sheet,” <http://oee.nrcan.gc.ca/publications/statistics/trends11/factsheet/summary.cfm?attr=0>.

savings across Canada from energy efficiency programs and policies is illustrated in Figure 2 (based on data from Natural Resources Canada).⁶² Technological advances providing increased energy efficiency were not intentionally included in the estimated energy savings from the energy efficiency programs.

FIGURE 2: CANADIAN ENERGY CONSUMPTION WITH AND WITHOUT (MODELED) ENERGY EFFICIENCY PROGRAMS⁶³



UTILITY-LED PROGRAMS

Utility-led energy efficiency programs funded by ratepayers include a variety of financial programs, technical services and audits, and public awareness campaigns. Utility customers fund these types of programs through a slight increase in their energy rate or a small charge on their bill as prescribed by individual utility cost-recovery plans. Although the local regulator may drive and support these programs by effective regulations and policies, it normally refrains from funding them.

Utility companies deliver a significant portion of total secondary energy (electricity and/or refined fuels such as natural gas), leading them to be a potentially suitable avenue for impacting a significant portion of energy consumption. Energy efficiency programs led by utilities have primarily focused on electricity and natural gas. However, since electricity programs often yield three times as much primary energy savings compared to natural gas programs, natural gas efficiency programs budgets tend to range from one-third to one-tenth of those for electric-efficiency programs. Given this, we will focus exclusively on utility-funded programs for electric-energy efficiency.

⁶² *ibid.*, Appendix A, <http://oee.nrcan.gc.ca/publications/statistics/trends11/appendix-a.cfm?graph=1&attr=0>.

⁶³ *ibid.*

In the United States, utility-funded electricity-sector energy efficiency program expenditures reached US\$4.2 billion in 2010.⁶⁴ Over the period of 2004 to 2010, there was an annual average growth of 38 per cent in program budgets across the U.S., with annual spending projected to reach US\$7.5 billion by 2020.⁶⁵ Three states that have been recognized as leaders in energy efficiency programs are:

- **Vermont:** Funded by ratepayers,⁶⁶ the budget for electric-efficiency programs in Vermont (Efficiency Vermont) was US\$30.75 million, US\$35.4 million and US\$40.7 million for 2009, 2010, and 2012 respectively.⁶⁷ In 2010, the state's reported annual energy saving was 117 GWh.
- **Massachusetts:** Similar to Alberta, generation and retail markets are not owned by the state and operate in a competitive manner. Distribution companies administer energy efficiency programs, which are funded through a monthly systems-benefits charge (about 0.25 cents/kwh). In 2008, the Green Communities Act required utilities to plan their electric- and gas-efficiency programs for three-year periods. Statewide, electric-efficiency programs for the period of 2010–2012 had an estimated cost of US\$1.6 billion.⁶⁸ In 2010, Massachusetts reported energy savings of 628.7 GWh with a cost of US\$301.9 million.⁶⁹
- **California:** Investor-owned and publicly owned utilities administer efficiency programs under the oversight of the California Public Utilities Commission and use an electricity surcharge to fund most of the program costs. Over the period of 2006 to 2010, close to US\$3.1 billion was spent on electric energy efficiency programs. In 2011, California budgeted US\$1.53 billion for electric-efficiency programs, a 30 per cent increase compared to the 2010 budget of US\$1.16 billion, which reported savings of 4,600 GWh.^{70,71}

Utilities have also reported energy savings for individual programs, though the costs for each program are difficult to determine due to shared administration costs. Examples of these programs are from Ontario:

- **Cool Savings Rebate Program:** designed to increase the market penetration of energy efficient residential HVAC equipment. The savings were reported to be 31 GWh per year in 2010.⁷²

⁶⁴ Adam Cooper and Lisa Wood, Summary of Ratepayer-Funded Electric Efficiency Impacts, Budgets and Expenditures, Institute for Electric Efficiency Brief (January 2012).

⁶⁵ Galen Barbose, Charles Goldman, and Jeff Schlegel, "The Shifting Landscape of Ratepayer-Funded Energy Efficiency in the U.S.," Lawrence Berkeley National Laboratory, Prepared for the Office of Electricity Delivery and Energy Reliability Permitting, Siting, and Analysis Division, U.S. Department of Energy (October 2009).

⁶⁶ Efficiency Vermont website, <http://www.encyvermont.com/Index.aspx>.

⁶⁷ State of Vermont, Public Service Board website, "Energy Efficiency Utility Program Budgets: EEU Program Budgets for 2009-2011," <http://psb.vermont.gov/utilityindustries/eeu/generalinfo/budgets>.

⁶⁸ 2010–2012 Massachusetts, Joint Statewide Three-Year Electric Energy Efficiency Plan; National Grid, NSTAR, Unital, Western Massachusetts Electric, Cape Light Compact; October 29, 2009.

⁶⁹ Massachusetts, State Energy Efficiency Policy Database, <http://www.aceee.org/energy-efficiency-sector/state-policy/massachusetts/193/all/191>.

⁷⁰ Cooper and Wood, Summary of Ratepayer-Funded.

⁷¹ Energy Incentive Programs, California, http://www1.eere.energy.gov/femp/financing/eip_ca.html.

⁷² IndEco Strategic Consulting Inc., 2010 Cool Savings Rebate Program Evaluation, prepared for Ontario Power Authority, September 9, 2011.

- **Refrigerator Roundup:** an ongoing initiative to reduce the number of older, inefficient appliances. The savings were reported to be 39 GWh per year for the appliances collected in 2010.⁷³

It can be seen from individual utilities programs that annual savings appear quite small, but are more significant when considered on a regional (provincial or state) basis and accumulated over years.

The two main sources of earning for power companies are selling energy in the retail market and generating and distributing electricity. Thus, without effective policies, the traditional utility structure has no economic incentive in promoting energy efficiency. To remove this sale disincentive, three mechanisms exist. First, the regulator needs to ensure that utilities are able to recover the direct costs of energy efficiency programs. This is normally done by approving “system benefit charges,” that are collected from the ratepayers. The second mechanism is to devise policies that allow the utilities to recover the lost revenue resulting from efficiency improvements. In this category, a very common approach is called “decoupling,” where a utility’s profit is decoupled from sales.⁷⁴ This mechanism has particularly been in place in jurisdictions where investor-owned utilities dominate. The regulator allows the utilities to recover a reasonable profit from their investment in utility businesses, regardless of sales, through rate increases or surcharges. As of August 2010, 40 U.S. states had decoupling policies in place in one way or another.⁷⁵ Finally, the third mechanism is to reward utilities for reaching energy efficiency goals.

Targeted Programs

Targeted programs are defined in this report as any program that focuses its awareness campaigns, financial aid, or standards on specific aspects of a sector. These are often best seen in the areas of transportation (vehicle rebates or fleet education), and appliances/equipment (lights, fridges, or heating equipment) discussed in the following sections.

TRANSPORTATION

The transportation sector considered in this report is limited to public, commercial, and industrial transportation including commercial trucking, passenger cars, light trucks, and fleet vehicles. Trains, airplanes, and other forms of transportation are excluded due to their national or international operation, making programs difficult to administer.

⁷³ M. Sami Khawaja et al., 2010 Great Refrigerator Roundup Program - Impact Evaluation, The Cadmus Group, Inc., Prepared for Ontario Power Authority, August 31, 2011.

⁷⁴ Decoupling For Electric and Gas Utilities: Frequently Asked Questions (FAQ); The National Association of Regulatory Utility Commissioners; Grants and Research Department; September 2007.

⁷⁵ Columbia Gas of Massachusetts, Revenue Decoupling in the Massachusetts Experience, August 24, 2010, http://www.northeastgas.org/pdf/j_ferro_2010.pdf.

The transportation sector's share of energy consumption is about 28 per cent⁷⁶ in the United States, 30 per cent⁷⁷ in Canada and 22 per cent in Alberta.⁷⁸ Starting after the Arab oil embargo of the '70s, the United States federal government tried to improve transportation energy efficiency with the Corporate Average Fuel Economy (CAFE) regulations.⁷⁹ According to the latest CAFE regulations, auto manufacturers are required to improve fleet-wide fuel efficiency of passenger cars, light trucks, and other passenger vehicles by about five per cent each year from 2012 to 2016. This is equivalent to a final fleet-wide fuel-economy requirement of 35.5 miles per gallon (6.6 L/100 km). Furthermore, the proposed regulations for model years 2017–2025 are expected to increase the fleet-wide fuel efficiency to 54.5 miles per gallon (4.3 L/100 km) by 2025.⁸⁰ As an added benefit, it has been concluded in a report by the Reason Foundation that policies that target higher fuel efficiency are likely to be cost-effective in significantly reducing greenhouse gas emissions in the transportation sector.⁸¹

In addition to federal regulations, state and provincial governments also have policies that promote energy efficiency improvement in the transportation sector. By region:

- **Alberta:** Trucks of Tomorrow (May 2009–December 2011) — A public awareness and financial-aid campaign. Alberta spent \$2 million to encourage commercial vehicle operators to adopt fuel-efficient technologies. It is estimated that this program has led to an annual saving of 14.5 million litres of fuel.⁸²
- **British Columbia:** Greenhouse Gas Reduction (Vehicle Emission Standards) Act — A set of provincial emissions regulations that raised its emission standards equal to those in California's 2004 regulations.^{83,84}

⁷⁶ American Council for an Energy Efficient Economy website, "Transportation Sector: Vehicles and Systems Efficiency," <http://www.aceee.org/portal/transportation>.

⁷⁷ Natural Resources Canada website, "Energy Use Data Handbook Table," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/aaa_ca_2_e_5.cfm?attr=0.

⁷⁸ Natural Resources Canada website, "Comprehensive Energy Use Database, 1990 to 2010," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/list.cfm?attr=0.

⁷⁹ National Highway Traffic Safety Administration, "Fuel Economy," <http://www.nhtsa.gov/fuel-economy/>.

⁸⁰ National Highway Traffic Safety Administration, "We Can't Wait: Obama Administration Proposes Historic Fuel Economy Standards to Reduce Dependence on Oil, Save Consumers Money at the Pump," Press Release, November, 16, 2011, <http://www.nhtsa.gov/About+NHTSA/Press+Releases/2011/We+Can't+Wait:+Obama+Administration+Proposes+Historic+Fuel+Economy+Standards+to+Reduce+Dependence+on+Oil,+Save+Consumers+Money+at+the+Pump>.

⁸¹ David T. Hartgen et al., Impacts of Transportation Policies on Greenhouse Gas Emissions in U.S. Regions, Reason Foundation Policy Study, November 2011, http://reason.org/files/cost_effectiveness_policies_reduce_greenhouse_gas_emissions.pdf.

⁸² C3 Annual Report 2011, http://issuu.com/c3energy.ideas.change/docs/c3_progress_report_2011.

⁸³ British Columbia Greenhouse Gas Reduction (Vehicle Emissions Standards) Act, <http://www.leg.bc.ca/38th4th/amend/gov39-2.htm>.

⁸⁴ British Columbia, Ministry of Environment, "B.C. Working with California to Reduce Vehicle Emissions," Press Release, December 17, 2009, http://www2.news.gov.bc.ca/news_releases_2009-2013/2009ENV0044-000785.htm.

- **Ontario:** Drive Clean⁸⁵ — A mandatory vehicle-emissions program that tests emissions of all used vehicles upon sale, and when renewing vehicle registration or licence plates. Significant reductions in various pollutants have been reported as a result of this program.⁸⁶
- **Ontario, Quebec, British Columbia:** Electric Vehicle Purchase Incentives — Financial aid campaigns run separately by these three provinces aim to reduce the amount of fuel consumed by passenger vehicles by providing rebates for purchasing electric vehicles. The incentives can be up to \$8,500 depending on the province and vehicle type purchased (full electric, plug-in hybrid, hybrid, etc.).⁸⁷
- **California:** Motivated by the transportation sector accounting for approximately 40 per cent of the state’s greenhouse gas emissions⁸⁸ and additional air-quality issues, the California Air Resources Board has implemented many of the standards for the purposes of reducing air pollution. A concomitant decrease in energy use with these standards is a welcome benefit for a state with nearly 50 per cent of energy use in transportation and a strong overall commitment to energy efficiency, and that has nearly 50 per cent of its energy use coming from the transportation sector.⁸⁹ Particular programs include:
 - Zero Emission Vehicle (ZEV) program⁹⁰ and Executive Order B-16-2012:⁹¹ these programs effectively create a demand and supply network for ZEVs.
 - High Occupancy Vehicle (HOV) lanes: single occupants are allowed to use HOV lanes if they are using a “clean-air vehicle.”⁹²

⁸⁵ Ontario Ministry of the Environment website, “Drive Clean,” http://www.ene.gov.on.ca/environment/en/category/drive_clean/index.htm.

⁸⁶ ERG, “Evaluation of Ontario Drive Clean Program,” Report for the Ontario Ministry of the Environment, July 18, 2005, http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_076074.pdf.

⁸⁷ Electric Mobility Canada, “Hybrid and Electric Vehicle Incentives: A Canadian Overview,” <http://www.emc-mec.ca/files/CanadianFundingProgramforEVs-Updated-JBApril2011.pdf>.

⁸⁸ Governor of the State of California, Executive Order B-16-2012, March 23, 2012, <http://www.gov.ca.gov/news.php?id=17472>.

⁸⁹ California Energy Commission, Fuels and Transportation Division website, <http://www.energy.ca.gov/transportation/>.

⁹⁰ California Environmental Protection Agency website, “Zero Emission Vehicle (ZEV) Program,” <http://www.arb.ca.gov/msprog/zevprog/zevprog.htm>.

⁹¹ Governor of the State of California, Executive Order B-16-2012.

⁹² California Environmental Protection Agency website, “Eligible Vehicle List,” <http://www.arb.ca.gov/msprog/carpool/carpool.htm>.

One policy initiative related to energy efficiency and transportation that is gaining increased attention around the world is the use of natural-gas-fueled vehicles⁹³ and the development of compressed-natural-gas (CNG) and liquefied-natural-gas (LNG) transportation corridors.^{94,95,96,97,98,99,100} It is expected that CNG distribution networks on key transportation corridors could have a significant positive energy efficiency impact, reduce transportation-related greenhouse gas emissions, and also reduce transportation costs.

In March 2013, the City of Calgary launched a pilot project to examine compressed-natural-gas (CNG) technology in fueling transit buses.¹⁰¹ The pilot will run for 12 to 15 months to allow for evaluating vehicle performance in all types of weather.

APPLIANCES AND EQUIPMENT

Along with lighting programs, appliance- and equipment-efficiency programs are often considered easier and longer-lasting routes to enhancing overall energy efficiency than are other energy efficiency programs. Appliance efficiency standards have been in place since the mid-'70s in some jurisdictions and now are relatively common at national and state/province levels. To better illustrate the breadth and type of programs in effect, we have chosen to focus on Canadian programs.

In a 2009 report,¹⁰² the Canadian federal government reported that significant efficiency increases had been achieved for several major household appliance types between 1990 and 2007. Clothes washers, which achieved a decrease of 76 per cent, had the largest decrease in energy usage, with dishwashers second at 65 per cent. To help consumers with identifying energy efficient models, all appliances manufactured or imported into Canada must be labeled with an EnerGuide label and those that meet higher efficiency standards are labeled with an Energy Star label under the 1992 Energy Efficiency Act.¹⁰³

⁹³ Encana Corporation website, "Compressed Natural Gas," <http://www.encana.com/natural-gas/transportation/compressed-natural-gas.html>.

⁹⁴ Blue Corridor website, "2012 Natural Gas Vehicle Rally by the Numbers," <http://www.bluecorridor.org/blue-corridor-2012-natural-gas-vehicle-rally-by-the-numbers/>.

⁹⁵ The Indian Express, "Soon, two 'Green' CNG corridors between Lucknow and Delhi," April 8, 2010, <http://www.indianexpress.com/news/soon-two--green--cng-corridors-between-lucknow-and-delhi/601747>.

⁹⁶ Joshua Wolfson, "EnCana looks to boost CNG in Wyoming," Billings Gazette, May 15, 2011, http://billingsgazette.com/news/state-and-regional/wyoming/article_bd3ee84c-a012-54db-a55c-56ecca41199c.html.

⁹⁷ Encana Corporation website, "Natural Gas and Transportation," <http://www.encana.com/natural-gas/transportation/>.

⁹⁸ Nathan Vanderklippe, "EnCana seeks natural gas highway network," The Globe and Mail, April 23, 2012, <http://m.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/encana-seeks-natural-gas-highway-network/article1406922/?service=mobile>.

⁹⁹ Encana Corporation website, "Liquefied Natural Gas," <http://www.encana.com/natural-gas/transportation/liquid-natural-gas.html>.

¹⁰⁰ Chester Dawson, "Back to the Future for Canada's West Coast LNG Hopes," The Wall Street Journal, Canada Real Time blog, August 6, 2013, <http://blogs.wsj.com/canadarealtime/2013/08/06/back-to-the-future-for-canadas-west-coast-lng-hopes/>.

¹⁰¹ Calgary Transit website, "Calgary Transit to Pilot Compressed Natural Gas (CNG) Buses," <http://www.calgarytransit.com/html/natural-gas.html>.

¹⁰² Natural Resources Canada website, "Energy Consumption of Major Household Appliances Shipped in Canada, Summary Report, Trends for 1990–2007," December 2009, <http://oee.nrcan.gc.ca/publications/statistics/cama09/foreword.cfm?attr=4>.

¹⁰³ Government of Canada, Natural Resources Canada website, What is EnerGuide, <http://oee.nrcan.gc.ca/node/6043>.

Individual provinces have many initiatives to assist people with the higher capital costs that usually accompany energy efficient devices. We have chosen just a few for this report:

- **Saskatchewan:** From August 2010 to March 2011, Saskatchewan offered a loan program that provided financial aid of up to \$15,000 to consumers who purchased Energy Star furnaces, boilers, or other high-efficiency natural gas appliances.¹⁰⁴
- **Manitoba:** Currently, the “Power Smart Residential Loan” offers homeowners up to \$7,500 for energy efficiency upgrades including windows, doors, and heating and ventilation equipment.¹⁰⁵
- **British Columbia:** BC Hydro also offers rebates through a mail-in program for the purchase of Energy Star appliances, with rebates ranging from \$25 to \$75.¹⁰⁶ Another utility, FortisBC, offers constant-value rebates and rebates based on a percentage of the price premiums for the installation of high-efficiency appliances.¹⁰⁷
- **Alberta:** C3, a non-governmental organization, administered for the government of Alberta almost \$17 million in appliance-energy-efficiency programs since 2011 and reports almost 8.5 GWh of avoided electricity,¹⁰⁸ which is roughly equivalent to 8,500 tons of carbon dioxide avoided in the thermal-dominated electricity-generation sector of Alberta.
- **Quebec:** Gaz Métro, a natural-gas utility, has three main energy efficiency programs. They offer an incentive of \$30 on the purchase of a programmable electronic thermostat when installed by one of their partners, a \$250 incentive for the installation of a tank-less water heater and a \$700 incentive for qualified high-efficiency boilers.¹⁰⁹ Hydro Quebec’s energy efficiency programs include incentives for lighting, electronic thermostats, three-element electric water-heaters, and a refrigerator-recycling program.¹¹⁰
- **Ontario:** In addition to the Cool Savings rebate program and the refrigerator roundup program mentioned in mentioned earlier, the Ontario Power Authority (OPA) leads some of Ontario’s energy conservation initiatives. On behalf of the government, the programs include a voucher program that provides up to \$650 for residents who purchase and install eligible replacement central heating and cooling equipment, a program to automatically control air conditioners, and a program to offer consumers discounts on energy efficient products.^{111,112,113} Overall, the Ontario government claims that \$1.7 billion was spent on conservation programs from 2006 to 2010. These programs generated over 1,700 MW of peak-demand savings and will result in \$3.8 billion in avoided costs.¹¹⁴

¹⁰⁴ SaskPower, “The Energy Star Loan Program,” http://www.saskpower.com/save_power/residential/programs_and_offers/energy_star_loan.shtml.

¹⁰⁵ Manitoba Hydro, “Power Smart Residential Loan,” http://www.hydro.mb.ca/your_home/power_smart/residential_loan/index.shtml.

¹⁰⁶ BC Hydro website, “Appliances,” http://www.bchydro.com/rebates_savings/appliance_rebates.html?WT.mc_id=rd_saveboth.

¹⁰⁷ FortisBC website, <http://www.fortisbc.com/Pages/default.aspx>.

¹⁰⁸ C3 Annual Report 2011.

¹⁰⁹ Gaz Metro website, “Energy-Efficiency-Programs,” <http://www.gazmetro.com/clients-residentiel/forfaits-programmes/programme-efficacite.aspx?culture=en-ca>.

¹¹⁰ Hydro-Quebec website, “Energy Efficiency,” <http://www.hydroquebec.com/residential/efficacite.html>.

¹¹¹ SaveOnEnergy website, <https://saveonenergy.ca/Consumer/Programs/Instant-Rebates/Printable-COUPONS.aspx>.

¹¹² SaveOnEnergy Conservation Programs, Ontario Power Authority, <https://saveonenergy.ca/>.

¹¹³ SaveOnEnergy website, “All Incentives,” <https://saveonenergy.ca/Consumer/All-Incentives.aspx>.

¹¹⁴ Government of Ontario, Ontario’s Long-Term Energy Plan: Building Our Clean Energy Future (Toronto: Queen’s Printer for Ontario, 2010).

Aside from the residential programs, a number of the provinces have programs for commercial customers. Some of the programs include:

- **Saskatchewan:** Currently offering a loan program targeting commercial purchasing of energy efficient HVAC equipment.¹¹⁵
- **British Columbia:** Currently offering the Product Incentive Program, which targets energy efficiency in small to medium-sized businesses, and in 2011 cost \$8.7 million (including the financial incentives and rebates, as well as administration), resulting in 276 GWh in lifetime energy savings.¹¹⁶
- **Ontario:** Currently offering many programs including ones for lighting, energy-audit funding, the Commercial and Institutional Retrofit Incentive Initiative, and demand-response programs.
- **Alberta:** The Alberta Energy Efficiency Assessment Program (EEAP)¹¹⁷ targeted at small and medium-sized corporations related to goods manufacturing.^{118,119}

Ontario has a strong track record of independent audits of its incentives, allowing for a number of lessons to be learned. A study of Ontario's Commercial and Institutional Retrofit Incentive Initiatives program¹²⁰ found it was generally successful, but confusion between different incentive initiatives caused confusion in the marketplace. Additionally the process of receiving incentives was cited as a barrier for some participants. Together, these indicate the need for clear and effective communication and administration plans. The report also found that retrofit contractors play a critical role in the success of the programs, as they would often promote energy efficiency options when their client did not specify one. Further, contractors reported that they found useful energy efficiency options that were not covered in the existing programs, suggesting that retrofit contractors can play a critical role in defining the scope of retrofit-incentive initiatives. The review also indicated that the Ontario Power Authority had not established a consistent and accurate set of measurement and verification protocols for all retrofit-incentive initiatives. It was also noted that the current initiatives tended to promote easier measures (lighting retrofits) versus measures with longer paybacks but more significant long-term savings.

¹¹⁵ SaskEnergy website, "Commercial HVAC Program," <http://www.saskenergy.com/business/hvac.asp>.

¹¹⁶ IndEco Strategic Consulting Inc., "In-depth review of energy efficiency programs," IndEco report B1642, July 22, 2011.

¹¹⁷ Productivity Alberta, Energy Efficiency Assessment Program, <http://www.productivityalberta.ca/tools/eeap>.

¹¹⁸ Productivity Alberta, "Find Productivity in Energy Efficiency," <http://findproductivity.in/energyefficiency/>.

¹¹⁹ Productivity Alberta, "Industrial Energy Efficiency Toolkit," <http://www.productivityalberta.ca/tools/energy-efficiency>.

¹²⁰ Ontario Power Authority, Final Report: Cross-Cutting Commercial and Institutional (C&I) Retrofit Incentive Initiatives 2009-2010 Evaluation Report, September 12, 2011.

The evaluation of OPA's Multifamily Retrofit program found that most measures taken were related to lighting (62 per cent) and Energy Star appliances (13 per cent), which were considered effective but relatively simple energy efficiency measures.¹²¹ The 2010 report recommended that incentives for lighting and appliances should be reduced, or should require coupling with other major measures. As found in other evaluations, communications and marketing was listed as an area that requires improvement.

While many provinces have established energy efficiency programs for appliances and equipment, they may not be performing as well as they could be.¹²² Any new programs should focus on the bundling of education, easy measures (such as lighting), and major measures (such as retrofits or heating), as well as being very clear in marketing and communications.

Infrastructure Improvements

In contrast to targeted programs, infrastructure improvements are usually programs that cover a broader range of areas within a sector. Two distinct examples are the use of combined heat and power generation, and building efficiency.

COMBINED HEAT AND POWER

Combined heat and power (CHP) generation offers a more efficient alternative to conventional electricity generation, as it uses waste heat for other functions such as providing heating, hot water or absorption chilling, thereby increasing efficiency. Compared to the 30-to-45 per cent efficiency of conventional electricity generation in thermal power plants, CHP efficiency can be as high as 80 per cent.¹²³ The potential impact of CHP is a direct function of the existing generation portfolio in a particular jurisdiction. For example, British Columbia, Manitoba, and Quebec, all have predominately hydro-based generation systems, making them poorly suited for large scale CHP. However, for systems such as Alberta's, where electrical energy is largely based on coal-fired thermal units, the impact of CHP can be very large. While the installed capacity of natural gas- and coal-based generation is similar in Alberta, the coal-based units tend to be "base-load" units, which are normally "on," whereas natural-gas-based units are peaking units; therefore, from an energy perspective, coal-based units provide the bulk of our electrical energy. Alberta's electricity-generation mix and energy production is graphically illustrated as percentages of total capacity and energy production for 2012 in Figure 3.¹²⁴ It is clearly shown that, while coal units and gas units are similar in terms of installed capacity (about 41 per cent), coal generation is the dominant supplier of energy compared to gas (53 per cent versus 37 per cent, respectively).

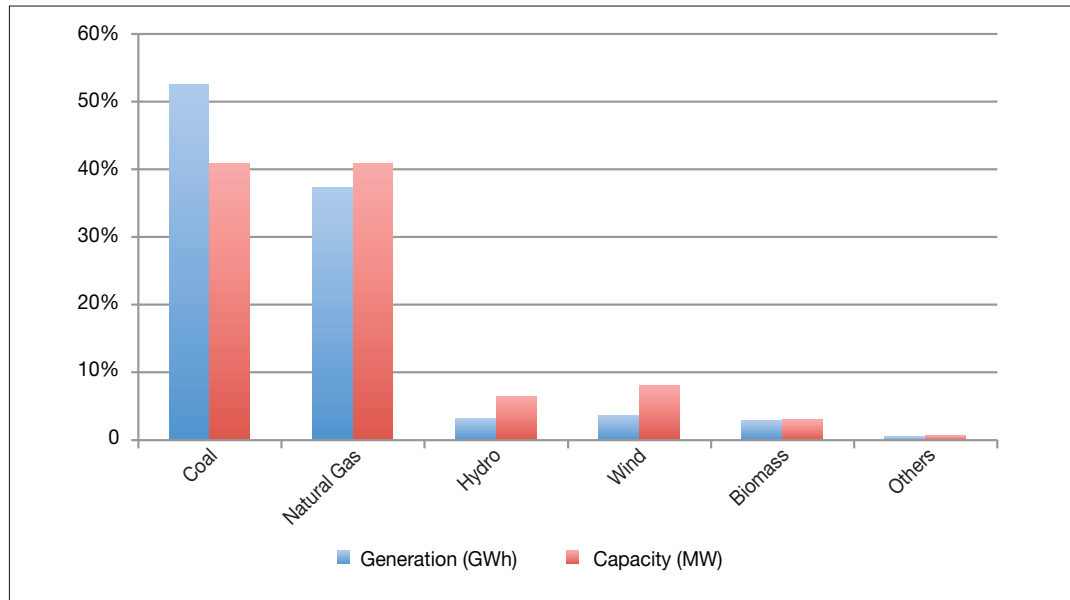
¹²¹ The Cadmus Group, Inc., 2009–2010 OPA Multifamily Retrofit Programs Evaluation Report, prepared for the Ontario Power Authority, September 23, 2011.

¹²² Environmental Commissioner of Ontario, Restoring Balance – Results: Annual Conservation Progress Report — 2011 (Volume 2), January 8, 2013, <http://www.eco.on.ca/uploads/Reports-Energy-Conservation/2012v2/12CDMv2.pdf>.

¹²³ Environmental Protection Agency website, "Efficiency benefits of CHP," <http://www.epa.gov/chp/basic/efficiency.html>.

¹²⁴ Alberta Energy website, "Electricity Statistics," <http://www.energy.alberta.ca/Electricity/682.asp>.

FIGURE 3: ALBERTA GENERATION CAPACITY AND ENERGY PRODUCTION BY FUEL SOURCE (2011)



Combined-cycle (CC) natural gas generation is a natural option for new natural-gas-based generators where there is no demand for heat that could be captured from CHP units. The efficiency of CC units can reach 50 to 60 per cent.¹²⁵ By utilizing the heat that cannot be used to generate electricity, efficiencies can reach 80 per cent. Additionally, the diversification of markets (heat and electricity) without a significant increase in production costs can drop the price of each good, making a combined heat and power plant more competitive. The use of heat in industrial processes also tends to encourage a plant to operate as base-load generation, which, as shown in Figure 3, is typically a demand met by coal. By increasing the competitiveness of natural gas and offsetting coal plants, electricity costs will decrease, emissions can be reduced, and the economy's energy intensity overall will decrease.

Compared to other jurisdictions, Alberta is very well suited to take advantage of the benefits of CHP. In addition to the potential for creating a heat distribution system for Calgary and Edmonton's cores, Alberta's oilsands industry has very large heat demand (especially with the rising use of in-situ techniques), effectively making the region an ideal candidate for utilizing the heat that can be generated from a large-scale deployment of CHP units. In areas where there is a high demand for heat, such as dense urban centres or in dense industrial zones, concepts such as a thermo-grid could be developed.

One drawback of CHP units is that the heat needs to be utilized locally, often within 50 km of generation, to avoid excessive heat losses and piping costs. Again, Alberta is well positioned, as recent government commitment to transmission upgrades¹²⁶ would allow for generation near industrial load centres (where heat can be utilized) and transmission of electrical energy throughout the province.

¹²⁵ NaturalGas.org, "Electric Generation Using Natural Gas," http://www.naturalgas.org/overview/uses_electrical.asp.

¹²⁶ Government of Alberta, Electric Statutes Amendment Act, 2009, http://www.assembly.ab.ca/ISYS/LADDAR_files/docs/bills/bill/legislature_27/session_2/20090210_bill-050.pdf.

Driven by a desire to increase security and reliability of supply, reduce greenhouse gas emissions, and increase energy efficiency — as well as falling natural gas fuel costs and significant reductions in operating costs — Alberta is already seeing growth in combined-cycle and CHP generators. The University of Calgary recently commissioned a CHP unit.¹²⁷ This project will allow the university to cut CO₂ emissions by 80,000 tons and save \$3.5 million in annual energy costs.¹²⁸

A March 2012 Canadian Industrial Energy End-Use Data and Analysis Centre report, *A review of Existing Cogeneration Facilities In Canada*, concluded:

“Canadian cogeneration capacity is concentrated in regions with high electricity prices, access to the electricity grid and robust industries with high simultaneous demand for electricity and thermal energy. In particular, retail access in Alberta has stimulated the development of large-scale, utility-owned cogeneration.”¹²⁹

In 2008, the U.S. Environmental Protection Agency issued a partnership report outlining many models for incentive programs for CHP.¹³⁰ At the utility level, CHP plants are already being developed in Alberta, such as at the Bonnybrook Energy Centre.¹³¹ In Alberta, the industrial and commercial sectors account for most energy use, with many medium- and large-scale individual users. This situation makes combined-cycle and CHP initiatives very promising in terms of energy efficiency, emission reductions, and industry efficiency. Gas-based generation is fast-reacting and dispatchable, allowing it to be paired with non-dispatchable renewable energy growth (solar and wind) which are both variable in their output.

¹²⁵ NaturalGas.org, “Electric Generation Using Natural Gas,” http://www.naturalgas.org/overview/uses_electrical.asp.

¹²⁶ Government of Alberta, Electric Statutes Amendment Act, 2009, http://www.assembly.ab.ca/ISYS/LADDAR_files/docs/bills/bill/legislature_27/session_2/20090210_bill-050.pdf.

¹²⁷ University of Calgary website, “Central Heating and Cooling Plant Project Overview,” <http://www.ucalgary.ca/fmd/development/CHCP>; and <https://www.ucalgary.ca/fmd/videos/cogeneration>.

¹²⁸ University of Calgary website, UToday, “Cogeneration plant on-time and on-budget,” August 2010, <http://www.ucalgary.ca/news/utoday/august19-2010/cogeneration>.

¹²⁹ John Nyboer and Steve Groves, *A review of Existing Cogeneration Facilities In Canada*, Canadian Industrial Energy End-use Data and Analysis Centre, prepared for Natural Resources Canada and Environment Canada, March 2012, http://cieedac.sfu.ca/media/publications/Cogeneration_Report_2012_Final.pdf.

¹³⁰ U.S. Environmental Protection Agency, *Combined Heat and Power Partnership*, October 2008, http://www.epa.gov/chp/documents/utility_incentives.pdf.

¹³¹ Enmax website, “Bonnybrook Energy Centre,” <https://www.enmax.com/generation-wires/generation/natural-gas-powered/bonnybrook-energy-centre>.

BUILDING EFFICIENCY

Buildings account for approximately 30 per cent of all energy consumed in Canada,¹³² and 40 per cent of total energy consumed in the U.S.¹³³ Because buildings represent such a large percentage of energy consumption, they are a natural focus for energy efficiency initiatives. Beyond the targeted heating, appliance, and lighting initiatives discussed earlier, buildings tend to be difficult and expensive to retrofit, reducing the ability of energy efficiency measures to be adopted in the future. To mitigate issues with retrofitting buildings, effective construction codes are required.

In the U.S., household energy consumption decreased by 31 per cent from 1978 to 2005, even though houses tended to be larger and have fewer occupants.¹³⁴ Table 3 shows energy efficiency indicators in the Canadian residential sector in 1990 and 2009.¹³⁵ Even with increases in key indicators, such as size or floor-space cooled,¹³⁶ per-house energy usage decreased over the measured period. This energy-use decrease can be largely attributed to improved building energy efficiency, as well as the improving energy efficiency of appliances and heating/cooling systems. However, energy savings would have been greater if, for example, house size had not increased. Programs are now being developed to include energy efficiency on Multiple Listing Service (MLS) house listings.¹³⁷

TABLE 3: CANADIAN RESIDENTIAL SECTOR ENERGY EFFICIENCY INDICATORS (1990 AND 2009)¹³⁸

Indicator	1990	2009
Occupancy	2.8 people per household	2.5 people per household
Size	116 m ² of living space	129 m ² of living space
Number of Households	9.9 million households	13.4 million households
Number of Appliances	15 appliances per house	21 appliances per house
Floor-space cooled	23 per cent of occupied floor space	44 per cent of occupied floor space

¹³² Natural Resources Canada website, “CanmetENERGY,” <https://www.nrcan.gc.ca/energy/offices-labs/canmet/5715>.

¹³³ Michael Sciortino et al., The 2011 State Energy Efficiency Scorecard, American Council for an Energy-Efficient Economy Report Number E115 (October 2011).

¹³⁴ U.S. Energy Information Administration, “What’s new in our home energy use?, Residential energy consumption survey (RECS),” March 29, 2011, <http://205.254.135.7/consumption/residential/reports/2009overview.cfm>.

¹³⁵ Natural Resources Canada, “Energy Efficiency Trends in Canada, 1990 to 2009,” <http://oee.nrcan.gc.ca/publications/statistics/trends11/factsheet/summary.cfm?attr=0>.

¹³⁶ A measure used to determine how much of the house is cooled by mechanical equipment, such as air conditioners.

¹³⁷ City Green Solutions website, “Home Energy Efficiency Ratings Can Now be Included on MLS,” Press Release, Aug. 8, 2011, <http://www.citygreen.ca/home-energy-efficiency-ratings-can-now-be-included-mls>.

¹³⁸ Natural Resources Canada, “Energy Efficiency Trends.”

Building energy codes set the minimum energy efficiency requirements for new and renovated buildings. In the United States, the Department of Energy (DOE) not only posts residential and commercial building energy codes in each of the U.S. states, it also determines the impact of new codes on energy performance. The DOE recently examined the International Energy Conservation Code (IECC)-2009 and concluded that this set of energy codes would achieve 14 per cent greater energy savings than the 2006 IECC currently in use.¹³⁹ Additionally, in 2012 the DOE provided a comprehensive document comparing the IECC-2012 with the ANSI/ASHRAE 90.1-2010 standards so that individual states could develop an energy code that best suited their needs.¹⁴⁰ Under the American State Energy Program, states must develop a building code for all commercial or residential buildings that achieve energy savings at least as great as the most recent IECC release, and develop a plan to assert compliance with their code in order to receive funding under the American Recovery and Reinvestment Act.¹⁴¹

Building codes should be coupled with compliance testing over the lifespan of the building to fully assess the impact on energy efficiency goals. In the U.S., the State Energy Program requirements also come with the requirement of assessing compliance, with common grounds for assessment developed by the DOE.¹⁴² This is particularly important for new standards where the energy savings are difficult to measure and verify.

Adoption of appropriate building codes reaches a large portion of the energy-use market and has the potential for large energy efficiency improvements. However, these measures should come with targeted compliance dates and methods for assessing compliance to ensure energy savings are achieved.

The Empire State Building retrofit program, launched in 2009, with a target of reducing energy consumption by 38 per cent, is an example of successful building energy efficiency. The impact assessment reports for years 2011 and 2012 show that the efficiency targets were surpassed in both years.¹⁴³

The Alberta government is currently in the process of adopting the National Energy Code for Buildings (NECB), and energy efficiency requirements for houses and small buildings in the National Building Code, published in 2011 and 2012, respectively.¹⁴⁴

¹³⁹ U.S. Department of Energy website, "Building Energy Codes Program," <http://www.energycodes.gov/resource-center/eLearning>.

¹⁴⁰ U.S. Department of Energy, Comparison of Standard 90.1-2010 and the 2012 IECC with Respect to Commercial Buildings, September 2011, http://www.energycodes.gov/sites/default/files/documents/2012IECC_ASHRAE%2090%201-10ComparisonTable.pdf.

¹⁴¹ "Explanatory Statement on Section 410, Recovery Act (HR1) by National Building Community Stakeholders," November 2009, <http://www.iccsafe.org/gr/Documents/IECC-Toolkit/Section410.pdf>.

¹⁴² U.S. Department of Energy website, "Building Energy Codes Program: Compliance Toolkit," <http://www.energycodes.gov/resource-center/ace/compliance>.

¹⁴³ Clinton Climate Initiative et al., "Innovative Empire State Building Program Saves Millions, Establishes New Energy Efficiency Model Nationwide," Press Release, June 24, 2013, http://www.esbnyc.com/documents/press_releases/2013_06_24_ESB_Year_Two_Press_Release.pdf.

¹⁴⁴ Government of Alberta, Municipal Affairs website, "Information on Energy Codes Proposed for Adoption in Alberta," http://www.municipalaffairs.alberta.ca/CP_Energy_Codes_Information.cfm.

SUMMARY AND RECOMMENDATIONS

Canada has been active in energy efficiency policy and initiatives; however, significant energy resources and a generally strong economy have undermined the motivation for energy efficiency actions that are as strong as those in other jurisdictions. For example, California has been extremely aggressive with respect to energy efficiency and clean-energy policies and initiatives, driven by high energy prices, local pollution issues, and energy dependency on other jurisdictions. Another example is Ontario, also a high energy-price regime, where changes in attitudes towards climate change coupled with energy-import dependency, and a stressed electricity network, are driving the current government to invest significantly in energy efficiency. In all cases, economic evaluation is critical to ensure programs are sustainable and provide appropriate utilization of public or ratepayer funds.

In the long term, increasing energy efficiency will lead to a more globally competitive business sector. As with taxes, wages, and market potential, new businesses will consider energy costs and efficiency in making their decision to locate or grow. This is particularly true if the energy portion of the power bill is significant, compared to the “other charges” portion.

From a social-welfare perspective, energy efficiency has a stronger impact on medium- and lower-income families, where energy costs represent a greater portion of their income and expenditures.^{145,146} Lowest income households have the greatest need for the best energy efficiency to reduce variable costs, but often have limited control over the efficiencies (for example, if they rent or lack input into the construction of purchased homes) or lack sufficient capital for renovations or energy efficient appliances. Without effective energy efficiency programs and policies, a growing portion of the population can be effectively energy poor, suffering from energy poverty.

From the discussion in previous sections it is clear that any steps towards becoming a leader in energy efficiency must involve a multi-faceted approach and can involve:

- **Targets** — Energy efficiency targets are relatively straightforward to set. Energy targets generally promote public awareness, whereas the cost of implementing energy efficiency targets is mostly passed to the marketplace. Special care must be taken to ensure targets are reachable with reasonable costs to prevent failure.
 - Targets for reduction of residential energy sales would encourage utilities to adopt energy efficiency programs, funded by the ratepayers.
 - Targets for reducing greenhouse gases in the transportation sector must be accompanied by financial-aid programs that are funded by government, or credit/regulation programs for manufacturers, to be effective.
 - Targets for energy production would be effective for promoting the use of combined heat and power in commercial or industrial sectors, but would either need to be accompanied with an incentive or special considerations in existing infrastructures (such as carbon-dioxide-emissions requirements).

¹⁴⁵ Statistics Canada. Table 2020405 – Upper income limits and income shares of total income quintiles, by economic family type, 2010 constant dollars, annually, CANSIM (database) using CHASS (distributor).

¹⁴⁶ Statistics Canada. Table 2030022 – Survey of household spending (SHS), household spending, by household income quintile, annually (dollars) (table), CANSIM (database), using CHASS (distributor).

- **Building Efficiency** — Building-efficiency guidelines and codes are simple to set but hard to implement and monitor. Nevertheless, having stricter building codes tends to improve energy performance in the building sector.
- **Communication** — Programs and targets must be clear in their purpose, incentives, compliance, and requirements. Without clear communication, public awareness and uptake will suffer.
- **Combination** — Many programs involving quick and easy energy-savings provide small benefits. By adjusting requirements to combine easy energy-savings with more in-depth measures, savings can be greater without negative impacts on uptake or public awareness.
- **Accounting, Measurements, and Reporting** — Initial and continual evaluations of the energy system will allow for verifiable results, leading to public recognition and evaluation of the cost-effectiveness of various programs. Using third-party evaluations, as Ontario does, is perceived as more reliable.¹⁴⁷
- **Managing business disincentives** — Policies and/or entities need to be established to administer energy efficiency initiatives such that the natural disincentive of lost revenue for energy utilities is mitigated and managed.

This report relies on experiences in other jurisdictions throughout North America to offer lessons and to establish the limits and benefits of schemes to include energy efficiency in long-term energy-planning efforts. While we have benefitted from observing these programs, in the end, adapting energy efficiency measures in a jurisdiction such as Alberta involves tailoring them to the existing and expected built environment and the unique climatic conditions that exist here.

Moreover, successful implementation of energy efficiency measures ultimately involves cost-effective measures that can produce visible and measurable returns over time, with a minimal ongoing behavioural response. For instance, much of the available gain from dedicated uses such as appliances or automatic motors comes from the operating characteristics of newer technology. Similarly, with the increasing distribution of smart-meter technology, programming the time of appliance use to coincide with lower-cost energy periods can flatten load curves and make power dispatch more predictable and affordable.

Co-ordinating and standardizing municipal functions such as building inspection — to make sure that HVAC systems, window fitment and insulation are properly installed — can yield benefits that are continuous, permanently shifting the overall demand curve for energy sources such as natural gas for heating. When rural land use is considered, such as habitation for aboriginal-Canadians or other dispersed residents, the application of energy efficiency tools can not only improve the quality of life, but can also have profound long-term health benefits as well. In this, the government and the building industry can create long-term ongoing and refresher courses in building construction and inspection that will reinforce many of the energy efficiency objectives we have cited here.

¹⁴⁷ Ontario Power Authority website, “Evaluation Reports.”

In the end, Alberta is a unique geographic region. The distances traveled and nature of the terrain favour larger and less-efficient vehicles, running counter to sound long-term demand management. The population is relatively affluent, a desirable characteristic that subtly pushes back against efficiency in energy use, since costs are a smaller fraction of net income. Finally, even with high monthly bills during cold months, the relative cost of energy is not large enough to force consumers to radically change their behaviour. For those changes to take place, we need leadership that recognizes the need and policies, incentives and technology that match consumer needs with long-term energy efficiency benefits.

RECOMMENDATION 1

Recognize leadership within Alberta in energy efficiency. Develop a “Premier’s Award in Energy Efficiency” for residential, community, utility, commercial, and industrial leadership in energy efficiency. In addition, have a prize category for innovation (cross-sector) and a contest for university and colleges. Examples of contests could be to address building challenges in remote settlements, or a model similar to the California Leading Edge Student Competition.¹⁴⁸ These awards would go beyond the Alberta Emerald Foundation awards,¹⁴⁹ as they would have a specific focus on energy efficiency, providing a provincial version of the National Canadian Industry Program for Energy Conservation Awards.¹⁵⁰ New Brunswick recently opened the call for nominations for its fifth-annual Premier’s Awards for Energy Efficiency.¹⁵¹ These include awards for commercial, industrial, small and medium-sized industrial, residential and community achievement.

Recognition can be used to drive a positive environment for energy efficiency. It also ensures that energy efficiency will receive high visibility across the various sectors. The cost for such an initiative is relatively low, and allows engagement where industry can lead the direction of energy efficiency projects.

As part of the premier’s award, there should be recognition that Alberta has fairly distinct climate zones (far north, north and south), and conditions vary between them in terms of lighting, heating and cooling and overall energy efficiency (the ratio of energy demand versus retention over some standard time period). The awards should be divided into two groups in each sector: best gains in existing buildings, and best “measured” gains for new construction. This last category is aimed at the use of LEED standards that appear to perform well on paper but do not always live up to expectations in their field performance.

Finally, create a premier's report card for an annual report to residents on province-wide performance.

¹⁴⁸ New Buildings Institute website, “Leading Edge Student Design Competition,” <http://www.leadingedgecompetition.org/>.

¹⁴⁹ Alberta Emerald Foundation website, “22nd Annual Emerald Awards,” <http://emerald.foundation.ca/emerald-awards/about>.

¹⁵⁰ Natural Resources Canada website, “CIPEC Leadership Awards,” <http://oee.nrcan.gc.ca/industrial/cipec/10941>.

¹⁵¹ Government of New Brunswick website, “Nominations open for energy efficiency awards,” Press Release, February 15, 2013, http://www2.gnb.ca/content/gnb/en/news/news_release.2013.02.0125.html; and Efficiency New Brunswick website, “Premier’s Awards,” http://www.energycanada.ca/home/premier-s-awards_1.html.

RECOMMENDATION 2

Adopt and enforce a leading energy efficient building code. Energy efficiency ratings should be developed for residential, commercial and industrial buildings, to better inform potential occupants of the operating costs of such facilities. Ratings systems such as LEED should be made mandatory for all buildings (residential and commercial).

Given Alberta's significant growth, building codes can have a very positive long-term impact on energy consumption. Often those parties who are responsible for the construction of new homes and buildings will not be the same as those who will occupy and pay utility costs. Having leading building codes removes this mixed relationship.

While a national energy building code has many advantages, one caution that should be heeded with a national code is the high variance in climate and geography across Canada. It is important that the code adopted and enforced in Alberta is well suited for Alberta's climate.

Building codes need to be coupled with compliance testing over the lifespan of the building. New buildings should be tested when construction is completed and again at fixed periods for an agreed-upon duration. Testing should be comprehensive, for example including an entire house/building leak test. The government should ensure there is an adequate infrastructure for the actual verification of compliance to building codes (testing), which can be accomplished through a mix of public and private approaches.

Included in the building code should be recommend standards and processes for implementing the next round of smart meters for consumers (these will allow cross-programming with appliances rather than simply reporting usage).

Strike a special committee on Alberta energy efficiency and develop a model ordinance based on "change" in the existing standards. By this we mean that we are sensitive to the fact that the installed base of appliances and utilities represent a large capital stock, and only when trigger or threshold conditions are met would new standards or incentives come into play to start to upgrade or refit existing hardware. This same committee should take on the task of recommending a new energy "rating system" for standard evaluation and comparison of new and retrofit buildings in terms of combined energy efficiency and "livability."

Another consumer-based improvement is providing life-cycle cost estimates for consumers when choosing new appliances, by working with major outlets (Home Depot, Lowes, Rona etc.) to develop a new standard as well as labelling and information resources .

In addition, provide incentives for the two major utilities and rural co-operatives to acquire, and train personnel in the use of, thermal imagery that can reveal heat losses from buildings, and improve the efficiency with cost-effective facility re-fitting or re-design.

RECOMMENDATION 3

Develop a suite of heating and cooling energy efficiency programs for the commercial and industrial sectors. The capital cost of industrial and commercial energy efficiency equipment can be a barrier to participation because of the length of payback periods. Programs would likely be in the form of financial support, and would require an effective communications plan. The program should be set up with the assumption that it will largely be utilized by those that need to replace equipment at the end of its life-cycle, versus early replacement strictly for energy efficiency reasons. Therefore, the main aim of the program should be to encourage those in the market for new equipment to select energy efficient options. As presented in the report, there is significant potential energy savings with respect to heating and cooling. Further, the commercial and industrial sectors are the largest energy users in the province.

Create an incentive program for buying back industrial light-fittings (or subsidizing replacements) to match new energy efficient technology when savings exceed 30 per cent of the performance value of existing lighting. Increase the incentive value of the above with a public waste-control program to retire, recycle and replace, so that waste facilities are not overwhelmed with toxic materials and waste control is not an impediment to acting.

RECOMMENDATION 4

Develop a suite of energy efficiency programs to promote combined heat and power generation. Alberta is very well suited for large-scale integration of combined heat and power generation. Financial programs, using the right discount rates, can result in significant direct and indirect benefits to Alberta. Combined heat and power programs can significantly reduce operating costs, as there is increased energy efficiency associated with waste-heat utilization, and there are no losses or capital costs associated with bulk-power transmission. As previously commented, this does not necessarily hold when the cost of building additional hot-water distribution systems are taken into account.

RECOMMENDATION 5

Develop a policy platform with Alberta's cities, including a standing provincial/municipality committee on energy efficiency standards and policies.

Engagement with key stakeholders will be critical for wide-scale success in energy efficiency. This will also increase public visibility of the emphasis being placed on energy efficiency by the government. This group could lead to a recommendation to include building efficiency on MLS listings. In addition, creating a program where utilities display and compare consumer utility demand and performance (in aggregate, or by region or neighborhood, so as to not reveal exact locations), would serve as a reference for new buyers.

Cities have the opportunity to engage in programs to encourage energy efficient retrofitting by providing loans to households and businesses for upgrades, with the loans repaid via higher property taxes.¹⁵²

¹⁵²This is similar to the programs used to fund neighbourhood-specific upgrades, such as back-alley pavements.

Initiate a “dark-light” cities program. Create an award for the building manager in the commercial sector who adopts (and adapts) his or her building’s lighting system for overnight conditions to include motion-sensors, soft light in corridors and “minimal-throughput” ventilation in overnight hours.

RECOMMENDATION 6

Review appropriate opportunities to support the development of a compressed-natural-gas (CNG) and liquefied-natural-gas (LNG) transportation network — in particular, in main LNG-transportation corridors, such as between Edmonton and Calgary, and LNG corridors for long-distance transportation and export. While there is already some development of such networks, proposed programs might focus on reducing the cost barriers to purchasing CNG vehicles or the installation of CNG filling stations.

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ISSN

1919-112x SPP Research Papers (Print)
1919-1138 SPP Research Papers (Online)

DATE OF ISSUE

January 2014

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