DEMAND SIDE MANAGEMENT POTENTIAL IN CANADA: ENERGY EFFICIENCY STUDY

–Summary Report–

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1. INTRODUCTION

This report summarizes the findings of a high-level study to estimate the achievable demand-side management (DSM) potential in Canada. The study was conducted for the Council of Energy Ministers demand-side management (DSM) Working Group with the goal of bringing DSM to the forefront of the energy and economic policy discourse in the country. The DSM Working Group comprises representatives from the federal government (Natural Resources Canada), provincial governments, the utility industry, major energy users, and non-governmental organizations.

The report culminates a comprehensive analysis of three key sectors of the economy: industrial, residential and commercial/institutional (hereafter, referred to as commercial). The study comprised three important scenarios, reference case (business-as-usual), economic potential and achievable potential; each of those milestones are documented in separate reports which are presented in appendices as follows:

- Reference Case Report-Appendix A
- Economic Potential Report-Appendix B
- Achievable Potential Report-Appendix C.

This report summarizes the findings of these three reports.

The study findings indicate that the total achievable reduction in energy demand in 2025 for the industrial, residential and commercial sectors could be reduced by between 3% and 10%. as a result of a diverse mix of policy instruments.[1] Moreover, this savings range means that achievable energy management can meet 16% to 56% of the projected energy demand growth to 2025. The estimated reduction in energy demand is due to a mix of energy efficiency, cogeneration and fuel substitution measures, driven by a range of policy instruments. This range of achievable potential savings, as determined from this study, represents a credible contribution to meeting Canada's long-term energy supply needs.

The study was conceived as a high level, policy oriented exercise and, as such, the outputs should been seen as the foundation for future dialogue. This dialogue should further examine how to advance DSM to the forefront of energy policy circles and, hopefully, bring direction, certainty and action to the policy concepts presented herein, or to alternative policy mixes.

The study findings should not be taken as the platform for DSM program design. For some jurisdictions the study findings are based on aggregated regional data and do not necessarily reflect the actual situation of the individual jurisdictions within the region. Therefore, while the study provides a sound indication of DSM potential on a national basis, it is not intended to provide all details sufficient for the development of specific programs to meet the needs of individual jurisdictions.

This summary report is organized according to the following subsections:

[1] The term "demand" used in the report refers to the demand for purchased energy to meet energy service needs.

- This introductory section, which includes the study context and scope.
- The method employed.
- The results which present the empirical outputs for the achievable and economic potential scenarios.
- Discussion of the results.

1.2. STUDY SCOPE

The study scope is defined as follows:

- **Sector Coverage:** The study addresses three sectors: residential, commercial/institutional (referred to as commercial) and industrial. Energy supply sectors (electricity, upstream oil and gas and coal) are not included in the study.

- **Geographical Coverage**: The study results are presented for seven provinces and regions, including British Columbia and the territories, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Atlantic region.

- **Energy Types:** All energy types are covered including natural gas, electricity, refined petroleum products and other fuels such as biomass.

- **DSM Coverage:** For this study, DSM includes energy efficiency, fuel substitution, cogeneration and distributed generation. Cogeneration (or combined heat and power) produces both electricity and useful thermal energy simultaneously from the same fuel (or fuels). The analysis considers all technologies that are expected to be commercially viable through to 2025.

  How the DSM Impact is Reported: The DSM scenarios analyzed in the study comprise energy efficiency, fuel substitution, cogeneration and distributed generation measures that affect changes in end-use energy demand among the three studied sectors. This has a resulting effect on the amount of purchased and non-purchased energy supply required by these sectors. The study reports the total effect of the measures on energy demand, meaning that the outputs take into account both reduced secondary energy demand and changes in the mix of primary energy demand. No attempt was made in this study to relate the electricity savings to peak or average demand reduction.

- **Jurisdictions:** DSM and energy efficiency measures are contemplated for utilities and for all levels of government in Canada (including municipal, provincial and federal).

- **Study Period**: This study covers a 25-year period. The base year is 2000, with milestone periods at 5-year increments: 2005, 2010 2015, 2020, and 2025.

- **Metrics Used to Present Results**: All of the national levels results are presented in metric energy units.[2]

[2] The factors used to convert to common units are: NG: 39.8MJ/m3, Fuel Oil (light): 38.68 GJ/m3, propane: 25.53 GJ/m3 (0.02553 GJ / litre), electricity: 0.0036 GJ / kWh

1.3 STUDY CONTEXT

During the past 25 years, governments at all levels, together with both natural gas and electric utilities, have delivered a wide array of market interventions in an effort to reduce overall demand for energy by residential, industrial, or commercial energy users. The energy efficiency of most equipment and buildings in Canada has steadily improved. Moreover, between 1990 and 2004, the energy intensity of industrial production declined. by 30%.[3]

Notwithstanding these performance improvements, energy demand continues to climb for all sectors. Between 1990 and 2003, secondary energy use increased 22 percent, from 6,951 to 8,457 petajoules (PJ).[4] What is happening is that the effects of economic activity, namely, the growth of the housing and commercial building stock, larger homes, the market penetration of more energy using devices, and industrial production growth together offsets the effects of energy efficiency improvements. Hence, the energy demand curve continues to show an upwards trajectory. A difficult question for this study is how much and at what speed we can affect this trend and, consequently, bend the slope of the curve. Key challenges exist and two dimensions to this challenge are worth noting here.

At the risk of over-simplification, a good portion of the DSM "low hanging fruit" has already been attained in all three sectors, i.e., many of the lower cost, short payback measures have been implemented. This includes, for example, the penetration of higher efficiency appliances, motors and lighting. Unless economic circumstances change considerably, the potential that remains will be more difficult to capture for several reasons, including: i) the target sub-markets become more challenging, e.g., small commercial, mid- and high-rise apartments, small and medium sized industry and ii) the solutions can become more complex, e.g., moving to process integration and balance of plant measures in industry; getting industry and commerce to effectively apply corporate energy management systems as the foundation for ongoing, sustainable and strategic management of energy.

Equally important is the degree to which policy can influence the adoption of greater energy efficiency in the economy by addressing fundamental market barriers. Experience with market intervention over the past two decades has shown that, while many energy efficiency opportunities can be shown to be cost-effective, when the monetary value of energy savings is assessed against the initial capital cost outlays, consumers and firms forego apparently cost-effective investments in energy efficiency. Energy users appear to discount future savings of energy-efficiency investments at rates well in excess of market rates for borrowing or saving. This has often been referred to as the energy-efficiency "gap".[5] Exhibit 1.1 lists some of the

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[3] Based on gross output. This is for 'Total Industry' (NAICS 100000). 'Total Manufacturing Industry' (NAICS 100001) shows a similar trend. Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC), *Development of Greenhouse Gas Intensity Indicators for Canadian Industry, 1990 to 2004* , Burnaby: Simon Fraser University, 2005.

[4] Office of Energy Efficiency, *Energy Efficiency Trends in Canada, 1990 to 2003*, Ottawa: Natural Resources Canada, 2005.

[5] For example, see A. Jaffe and R. Stavins, "The Energy-Efficiency Gap: What Does it Mean?" *Energy Policy* 22, 10 (1994): 804-810; J. Scheraga, "Energy and the Environment: Something New under the Sun?" *Energy Policy* 22, 10 (1994): 811-818; R. Sutherland, "The Economics of Energy Conservation Policy," *Energy Policy* 24, 4 (1996): 361-370.

cross-cutting barriers, market behaviours and failures identified in the literature to explain why the take up of energy-efficiency is lower than expected.

Exhibit 1.1: Explanations for Lower than Expected Energy Efficiency Investment

Category	Explanation
Price Signals	• Energy pricing at levels that do not integrate externalities associated with the cradle to grave lifecycle (full cost accounting). • Energy pricing signals that do not reflect real-time costs.
Consumer Awareness and Preferences	• Awareness that energy efficiency opportunities & products exist • Awareness of benefits – cost and co-benefits. • Consumer technical ability to assess the options. • Consumer offsetting preferences (e.g., large single detached homes). • Lack of public perception/understanding of infrastructure needs/ resource constraints/ the functionality, cost, drivers and challenges are unknown to the public.
Product and Service Availability	• Local or national product availability. • Existence of a viable infrastructure of trade allies. • Vendor or trade ally awareness of the efficiency options and their understanding of the technical issues.
Technology and Innovation	• An energy efficient technology may not be a perfect substitute for another, accepted technology for an end-use. • An energy efficient technology may not be cost-effective for all consumers, even if it is cost-effective for the average consumer. • Lack of enabling tools and techniques to facilitate market adoption of sustainable energy solutions.
Financing	• Access to appropriate financing. • Uncertain future energy prices, combined with the irreversible nature of energy efficiency investments. • Size of required energy efficiency investment vs. asset base. • Payback ratio – actual vs. required.
Transaction Costs	• Level of effort/hassle required to become informed, select products, choose contractor(s) and install.
Perceived Risk/Reward	• Level of perceived risk that the energy efficient product may not perform as promised. • Level of positive external/personal recognition for "doing the right thing" by installing the efficiency measure(s).
Split Incentive/Motivation	• Level to which the incentives of the agent charged with paying for the energy efficiency measure are aligned with those of the person(s) that would benefit.
Institutional and Regulatory	• Codes or standards that prohibit implementation of innovative energy efficient technologies. • Limited horizontal cooperation/coordination to integrate policies and implementation. • Municipal policies and land planning processes that supported, even encouraged, development of greenfield areas and subsidized the practice through low development fees. • Disconnect between longevity of infrastructure and short-term horizons on crucial decisions, such as budget allocations for maintenance and rehabilitation and rate structures.

2. METHOD EMPLOYED

2.1 MODELLING PLATFORM

The analysis was conducted using the CIMS model, supported by Marbek DSM tools and databases.[6] CIMS is an integrated energy-economy model that simulates technology acquisition in the economy over time. Technologies are represented in unique sub-models that meet energy service demands in the residential, commercial, transportation, electricity supply, and industry sectors. It is therefore possible to specifically represent the evolution of a technology, or group of technologies, in a forecast and to alter model inputs to simulate alternative forecasts and policy scenarios.

The take-up of DSM technologies in CIMS is driven by a model construct that tries to reflect the financial and non-financial considerations affecting energy user decisions and choices. CIMS is a platform for a competition among various DSM technologies. While the engine for this competition is the minimization of annualized life cycle technology costs, energy user decisions not only depend on recognised financial costs (capital, energy and other operating and maintenance costs), but also respond to:

- Identified differences in non-financial preferences (e.g. differences in the quality of lighting from different light bulbs).
- The preferences of firms and households with respect to the risk of newness and risk of irreversible investments. Thus the lifecycle cost is calculated with effective 'private' discount rates that are revealed from market data.[7]
- The non-deterministic nature of market behaviour. Market shares are allocated among technolgoies probabilistically according to a *variance parameter*.[8]

The preference parameters in CIMS are set using a combination of literature review, original survey research, expert judgment, and model validation.

2.2 THE STUDY SCENARIOS

2.2.1 Scenario Definitions

In this project CIMS was applied to develop four scenarios: a reference case, an economic potential, and two achievable potential scenarios. Given that energy systems in Canada differ significantly by region, the national potential for energy demand reduction is derived from the analysis of regional potentials (rather than a single national potential). This is done according to the disaggregation currently available in the CIMS model. Unique sub-models represent British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and a combined Atlantic region. The CIMS model is not currently set up to model the Atlantic region on a provincial basis and, therefore, the analysis of the

[6] The CIMS model is developed by the Energy and Materials Research Group and Simon Fraser University.
[7] Revealed discount rates cover both of these factors because the new technologies of interest to energy-economy modellers are those that increase energy efficiency through irreversible, long payback investments.
[8] In contrast, the optimizing models will tend to produce outcomes in which a single technology gains 100% market share of the new stocks.

Atlantic region potential does not reflect the diversity of energy systems, fuel availability, prices and mix, and electricity prices in the Atlantic provinces.[9]

The scenarios are defined as follows:

- **Reference Case**: A projection of energy demand to 2025, in the absence of any new and incremental institutional market interventions after 2005. It is the baseline against which the scenarios of energy savings are calculated. The reference case includes "natural conservation", i.e., changes in end use efficiency due to stock replacement, energy prices and other factors over the study period that are projected to occur in the absence of new and incremental market interventions.

- **Economic Potential**: An estimate of the energy demand that would occur if all equipment and building envelope energy management actions that pass a 'Total Resource Cost' test were implemented in the target markets. These actions are applied at either natural stock turn-over or retrofit rates.

- **Achievable Potential**: An estimate of the energy demand that would occur as a result of market intervention to influence the take up of energy management actions. The potential is estimated in two policy scenarios. The first focuses on the response from subsidies to specifically target the uptake of actions identified in the 'Total Resource Cost' test in the Economic potential. The second scenario includes the energy demand response to broader based policy instruments, land-use measures and 'aggressive' building and equipment standards and renewables subsidies.

2.2.2 Reference Case Elaboration

The reference case forecast is strongly influenced by three factors: energy prices, economic growth, and the saturation and mix of energy using equipment in the existing buildings and industrial stock. The CIMS base year in all regions is calibrated to within +/-5% of the latest 2000 energy supply and demand data from Statistics Canada and, consequently, 2000 is the start year of the study analysis. The most critical challenge was to update the pricing assumptions to ensure a robust and credible modeling foundation.

Prior to this study, the energy prices in CIMS were based on Natural Resources Canada (NRCan)'s *Canada's Emissions Outlook: An Update 2000* which is, of course, outdated. At the time when the Reference Case was to be constructed, NRCan had not yet completed a new national energy use and price forecast. With the support of the DSM Working Group, the consulting team decided to completely update the energy price schedule in CIMS. After consultations with the DSM Working group, we adopted the price forecasts of one of the two scenarios embodied in the National Energy Board (NEB)'s *Canada's Energy Future*, referred to as the "Techno-Vert" scenario.[10]

[9] The Atlantic region accounts for 7% of the end-use energy (in 2000) for sectors represented in the study.

[10] National Energy Board, *Canada's Energy Future" Scenario's for Supply and Demand to 2025*. (Supply Push and Techno-Vert scenarios). http://www.neb-one.gc.ca/energy/SupplyDemand/2003/index_e.htm

The NEB scenarios represented the only recent forecast available with provincial and sectoral coverage. The Techno-Vert scenario was selected as the more realistic of the two options because: i) it projects higher energy prices and ii) due to the higher energy prices it embodies a higher rate of "natural conservation". Exhibit 2.1 presents the national prices in the Techno-vert forecast.[11] Interestingly, even under the more aggressive price forecast, it shows declining or stable price trends over the study period.

Exhibit 2.1: Techno-vert National Energy Prices

Canada						
	2000	2005	2010	2015	2020	2025
Residential ($1995/GJ)						
Electricity	$21.24	$21.08	$22.51	$21.95	$21.35	$20.52
Natural Gas	$7.60	$8.90	$9.33	$9.10	$8.87	$8.62
Light Fuel Oil	$12.83	$11.67	$12.77	$12.65	$12.51	$12.38
Commercial ($1995/GJ)						
Electricity	$17.21	$18.83	$19.85	$19.35	$18.76	$17.92
Natural Gas	$6.27	$7.80	$8.23	$8.02	$7.79	$7.52
Light Fuel Oil	$12.99	$11.05	$11.50	$11.61	$11.81	$11.67
Heavy Fuel Oil	$7.18	$5.24	$5.22	$4.99	$4.64	$4.02
Industrial ($1995/GJ)						
Electricity	$12.39	$13.32	$14.02	$13.66	$13.22	$12.63
Natural Gas	$4.19	$5.59	$6.02	$5.76	$5.51	$5.23
Heavy Fuel Oil	$5.42	$5.11	$5.06	$4.83	$4.59	$4.31
Coal	$2.36	$2.30	$2.25	$2.25	$2.25	$2.36

There was also considerable effort invested to review and update the DSM technologies in the CIMS sub-models. The update addressed the following parameters: i) coverage of DSM technology candidates, ii) energy performance and iii) installed costs.

2.2.3 Economic Potential Scenario

The economic potential is defined as a future in which energy efficiency investments are adopted by all producers and consumers (at the rate of technology stock turn-over and/or accelerated take-up through retrofit opportunities), if the life cycle cost (LCC) of the investment is lower than the long-run cost of energy supply. In the economic potential, three major parameters affect the life cycle cost competition and, therefore, drive the economic potential: i) the energy long run marginal cost (LRMC) used for screening the economics of the candidate technologies ii) the discount rate and iii) the variance parameter.

The LRMC valuation combines the costs of generation, production, transmission and distribution and is a two step exercise: i) separate valuation methods are employed to establish the LRMCs for electricity versus natural gas and Refined Petroleum Products and ii) a carbon liability value is added to all of the energy forms.

[11] The regional price forecasts from this scenario were adopted in CIMS.

In CIMS, the electricity LRMC value is derived to estimate the supply price of a new combined cycle gas turbine (CCGT) in each jurisdiction to which is added the costs of transmission and distribution, while taking into account line losses. Among other things, the supply price estimates are regionalized by setting the CCGT variable fuel cost in each 5-year period at the regional market price for industrial natural gas. Again, as this is a high level, policy oriented study, it does not fully capture all of the regional and provincial realities and drivers affecting long run power generation baseload and peaking supply. We recognize that the CCGT option will not necessarily apply to all regions. A carbon price of $15 / t CO_2e is also incorporated into the energy prices (based on the carbon content of the affected fuels) as a financial cost liability that is considered in a full calculation of the long run marginal cost.[12]

As the economic potential is a societal perspective, the life cycle cost analysis uses a **social discount rate** of 10% real for all regions and technologies. The technology competitions which occur in the reference case and achievable potential projections use a schedule of private discount rates that are typically much higher than the social discount rate. Changing the discount rate from a private to a social perspective has two effects in the competition of technologies in CIMS. First, more energy efficiency measures are likely to pass the life cycle cost test generating a positive net present value. Second, among the larger number of measures that become candidates for competition, an increasing number of higher performing measures are selected as the least cost option.

CIMS contains a variance parameter ('v') that represents sensitivity of the technology adoption to relative life cycle costs. A high v value means that the technology with the lowest life cycle cost captures almost all of the market for new equipment stock, a "winner takes all result". A low v value means that new equipment market shares are distributed more evenly among competing technologies, even if their lifecycle costs are different. The value of the v factor is set low for the economic potential scenario thereby enabling only the least cost measure to be selected. Most DSM studies model the economic potential with the highest performing measures included that pass the economic cost test. The due diligence conducted during the CIMS modeling reveals that in most instances the highest performing measures are selected.

2.2.4 Achievable potential

Two achievable potential scenarios are modelled in this study, referred to as **achievable scenario 1- DSM Status Quo** and **achievable scenario 2-DSM Aggressive**. These scenarios represent considerably different visions of how various policy instruments may

[12] There is evidence that utilities commissions are beginning to force the internalization of greenhouse gas (GHG) liabilities such that these are now part of the real energy cost structure faced by utilities in their decision-making. We have included a price of $15 / t CO_2e in the modelling that is incorporated into the energy prices based on the carbon content of the affected fuels. This price was chosen as this has already been approved in at least one jurisdiction for utility investment analysis (by the BC Utilities Commission for BC Hydro). It also reflects the commitment from the Canadian government to the Large Final Emitters (LFE) group that their GHG reduction cost compliance will not exceed this value. Note that this liability does not represent an estimate of the full externality cost of GHG or other emissions. It is simply a financial cost liability that is considered in a full calculation of LRMC, recognizing that all cost estimates have present and future uncertainties associated with them.

be brought to bear on the residential, industrial and commercial/institutional markets during the study period.

Scenario 1: DSM Status Quo

DSM Status Quo assumes a continuation of approximately the current levels and types of market interventions by government and utilities. A scan undertaken during the study revealed that current annual energy efficiency expenditures by government and utilities amount to between $400 million and $500 million per annum.[13] Moreover, the majority of the energy efficiency program costs borne by utilities fall into the category of subsidies of one form or another. Not surprisingly then, most utility reported annual energy savings are attributed to the effect of these subsidies, in the vicinity of 75% of total reported savings.[14] Government program costs are more broadly distributed, among subsidies, energy performance standards development and administration, information and R&D. Consequently, reported energy savings from government initiatives are attributed more broadly to the foregoing mix of instruments, particularly due to energy performance standards.

In consultation with the CGA client group, the DSM Status Quo scenario was designed as a combination of subsidies and information/voluntary programs, with the major driver in the scenario assumed to be the subsidy instruments. Financial subsidy is a policy instrument designed to reduce the energy management investment cost to a level commensurate to the business and consumer hurdle rates. Subsidies for energy management continue to be a prevalent means of delivering DSM in Canada and elsewhere. As discussed in the Economic Potential report, there is a considerable gap between the social and private discount rates for energy management. Hence, the argument is that if a particular energy management measure passes a societal cost test, then it is legitimate to use subsidies to induce market take-up of the measure.[15]

The inclusion of energy performance standards was considered for this policy mix, since they are certainly part of the current DSM landscape in Canada. Mandatory energy performance standards are presently focused on improving equipment performance levels, less so on building performance. It was posited that there remains a considerable upside for enhanced performance standards and, consequently, it was decided to include this policy instrument in the second, more aggressive scenario.

[13] This estimate is based on a scan of the following documents:
i) NRCan "Improving Energy Performance in Canada-Report to Parliament Under the Energy Efficiency Act Fiscal 2004-05, Appendix 1". The estimate for federal expenditures is about $165 million per year.
ii) Canadian Electricity Association and Natural Resources Canada, Description and Results of Energy Management Programs-A survey Of Programs Operated By Electric Utility Companies in Canada, March 2003 and Update in October 2003.
iii) Indeco in association with B. Vernon and Associates, *DSM Best Practices-Canadian Natural Gas utilities Best Practices in Demand-Side Management*, undertaken for the Canadian Gas Association, 2005.

[14] This is based on in-house data/files plus a small selection of telephone conversations with gas and electric utility officials.

[15] Another way of looking at this is that, if the cost of delivering the energy management measure is less than the social cost of the displaced energy form, then it is an economically legitimate investment from the standpoint of society.

The subsidy schedule targeted the energy efficient technologies identified in the economic potential at rates consistent with current observed utility incentive levels (10%-35% of the measure cost).[16] The effect of the information/voluntary programs was modelled exogenously as a multiplier applied to the results based on utility and NRCan estimates of program effectiveness.

Scenario 2: DSM Aggressive

Scenario 2, DSM Aggressive, models the achievable potential to 2025 as a vision of how to more effectively address market barriers and failures and consequently expand and accelerate the energy management effect in the economy over this period. The scenario includes new and expanded policy instruments involving all levels of government, utilities and the private sector that can capture a greater array of options. It also assumes that policies could do more to address fundamental changes that need to be made regarding urban land use intensity and form which, in turn, will affect needed changes to foster sustainable infrastructure. The DSM Aggressive scenario comprises the following policy elements:

- An aggressive application of energy efficiency standards, for both end-use equipment and buildings.

- Subsidies to energy efficiency technologies. These are applied as a complementary instrument to subsidies. The same subsidy levels used for DSM Status Quo were applied but at a different rate of application. The technologies eligible for subsidy application fall into two categories: i) those that will be affected by the standards and ii) those that will not be affected by the standards.
- The energy efficiency standards are introduced at varying schedules during the study period. Consequently, the subsidies are applied to the technologies to be affected by standards in year one of the study period and continue to be applied only until the technology is affected by the performance standard. The subsidies are applied to the technologies, not affected by standards, in year one of the study period and continue during the study period.

- An aggressive subsidy policy directed to induce a greater market penetration of some renewable energy technologies for on-site applications, which would have an incremental fuel substitution effect towards renewable energy, relative to the reference case forecast. The focus is on-site renewables applications to replace secondary energy consumption of gas and refined petroleum products and to reduce electric power purchases. While this is characterized as an aggressive renewables policy, conceptually it corresponds well to efforts internationally. There are many examples worldwide of government, at all levels, instituting aggressive renewable energy policies and programs. For example, the California Public Utilities Commission (PUC) recently voted to adopt the California Solar Initiative (CSI), which will provide up to $2.9 billion in incentives toward solar development over 11

[16] These represent energy efficiency investments whose life cycle cost of the investment is lower than the long-run cost of energy supply. This is roughly equivalent to targetting those investments that ‘pass’ a Total Resource Cost test.

years. One of the goals this initiative is to install 3,000 MW of solar power capacity by 2017, making it the largest solar program in the U.S.[17]

- Application of marginal cost pricing in electricity. This seeks to simulate the effects of advancing from a monopoly average cost pricing regime for electricity to a regime that embodies marginal cost pricing. In practice, a marginal cost policy instrument could be manifested in a number of ways: regulators requiring this for electricity pricing, or some form of time-of-use pricing measured and reported on a real time basis. This policy only applies to electricity because the other energy prices already represent marginal cost pricing as their prices are determined in competitive markets. This policy is modelled in CIMS by revising the electricity price forecast used in the simulation. The same long run marginal electricity price forecasts are used as calculated for the economic potential.

- A $15/tonne CO_2e price adder for all fuels based on the carbon content of the affected fuels. This is representative of mechanisms that are starting to be used by energy utilities to price or cost GHG emission reductions for use in planning, acquisition, project development or operational decisions. These mechanisms include: i) government instituted "safety valves" or price assurance relating to CO_2 regulation, ii) resource planning GHG "adders" and iii) energy acquisition GHG bid price adjustments

- Changes to shares of projected housing types (low rise versus mid- to high-rise) to mimic the potential effects of aggressive urban land use policy instruments. The percentage of single detached dwellings was reduced in absolute terms by 25% in 2025. This considers the largely untapped area of land use as a means to reduce the environmental footprint of communities, particularly in the urban centres where 80% or more of the Canadian population resides. In terms of affecting reductions of energy consumption, sustainable land use policy instruments can generate the following possible outcomes: i) reduced average energy use per dwelling or building, ii) reduced transportation energy use. This scenario deals with the challenge of reducing average energy use per dwelling.

There is a wide range of possible policy instruments to affect land use change in municipalities, which taken together, can affect: i) the type and amount of land use, ii) the intensity of use within the land boundary, iii) the spatial distribution and location of use (e.g., degree of sprawl).

To summarize, the aggressive DSM scenario includes:

- Energy efficiency subsidies. These are the same as scenario 1, except they are retargeted where regulation is applied to the same energy end-use.
- Marginal cost pricing for electricity.

[17] California PUC website, CSI includes $2.5 billion in rebates for existing homes, businesses and public buildings, to be managed by the PUC and funded through revenues collected from gas and electric utility distribution rates. The California Energy Commission (CEC) will manage another $350 million in rebates targeted for new residential construction, utilizing funds already allocated to the CEC to foster renewable projects between 2007 and 2011.

- A carbon liability. A shadow price of $15/tonne CO_2e is applied to all energy price forecasts.
- An aggressive schedule of legislatively backed advanced minimum energy performance targets for both equipment and buildings.
- Renewable subsidies. These are targetted at the residential and commercial sectors and in particular solar hot water heaters, solar photovoltaic and geo-exchange, which are subsidized at 30%, 40% and 15% of installed capital cost respectively.
- Changes in the shares of projected housing types (low rise versus mid- to high-rise). The percentage of single detached dwellings was reduced in absolute terms by 25% in 2025.

Exhibit 2.2 summarizes how the mix of policy instruments was applied in both of the achievable potential scenarios; the dark shaded area indicates application of the instrument.

Exhibit 2:2: Summary of Policies Instruments Applied in Each Scenario

Policy Instruments	Scenario 1	Scenario 2
Subsidies-energy efficiency schedule	■	■
Subsidies-renewables schedule		■
Information	■	■
Regulation & Standards		■
Marginal cost pricing		■
Carbon liability		■
Change in dwelling type shares		■

3. RESULTS

3.1 REFERENCE CASE FORECAST

Exhibits 3.1 to 3.3 show the national reference case scenarios for the commercial, residential and industrial sectors respectively. Since the CIMS base year in all regions is calibrated to within +/- 5% of the latest 2000 energy supply and demand data from Statistics Canada, the Reference Case forecast runs from 2000 to 2025.

The high level national results by sector are as follows:

- Across all sectors, energy demand is forecast to increase by 23% amounting to an average annual increase of 0.85%. The forecast growth occurs despite a projected decline in energy intensities (energy demand per unit of output) in all sectors. The activity effects of economic growth offset the energy performance improvements. There is no significant change in fuel shares among the major energy forms used in these sectors.

- **Commercial/Institutional.** Exhibit 3.1 shows a total energy demand increase of 353 PJ over the study period, amounting to an annual increase in consumption of 1.14%. The model results also show that the fuel shares remains relatively constant in the commercial sector, with natural gas increasing from 51% to 55% by 2025, and electricity's share falling slightly from 42% in 2000 to 37% in 2025. Energy intensity shows a small improvement over time with an average annual change (or decrease) of 0.56%.

- **Residential.** Exhibit 3.2 shows a total energy demand increase 279 PJ over the study period, amounting to an average rate of less than one percent annually. Once again the split between fuels remains relatively constant. The share of natural gas fluctuates around 48%, and the share of electricity rises slightly from 36% to 39%. Annual growth rates for both fuels are in the order of 1% annually whereas growth in refined petroleum products (RPP) is lower (0.36%) and other fuels (wood) decline about 0.8% annually. Energy intensity show an improvement slightly greater than the commercial sector and in the order of 0.59% annually;

- **Industrial**. Exhibit 3.3 shows that in the industrial sector total energy demand rises from 2,714 PJ in 2000 to 3,296 PJ in 2025, or at a rate of 0.78% annually. In this sector natural gas and electricity both exhibit declines in their fuel share , although the absolute demand for both these fuels continues to rise throughout the forecast period. Refined petroleum products and the other fuels listed see a slight increase as a percent of the total energy demand. The industrial sector forecast represents manufacturing and metals and mineral mining, and does not include energy supply sub-sectors (upstream oil and gas, coal mining and electricity supply sub-sectors). Construction and forestry are also not included.

Exhibit 3.1: Reference Case Energy Demand (PJ), Commercial Sector

	2000	2005	2010	2015	2020	2025	Average Annual Change
Total Energy	1,075	1,130	1,192	1,275	1,352	1,431	1.15%
Electricity	448	462	477	500	519	540	0.75%
Natural Gas *	548	584	626	680	732	785	1.45%
Refined Petroleum Products	79	85	88	95	101	106	1.15%

*Natural gas includes Propane.

Exhibit 3.2: Reference Case Energy Demand (PJ), Residential Sector

	2000	2005	2010	2015	2020	2025	Average Annual Change
Total Energy	1,384	1,419	1,444	1,501	1,576	1,663	0.74%
Electricity	497	516	529	557	600	643	1.04%
Natural Gas	659	676	692	722	753	795	0.75%
Refined Petroleum Products	132	135	134	138	142	145	0.36%
Wood	96	92	89	85	81	79	-0.77%

Exhibit 3.3: Reference Case Energy Demand (PJ), Industrial Sector

	2000	2005	2010	2015	2020	2025	Average Annual Change
Total Energy	2,714	2,785	2,931	3,053	3,154	3,296	0.78%
Electricity	670	676	716	728	738	757	0.49%
Natural Gas*	922	920	925	945	960	999	0.32%
Refined Petroleum Products	161	166	177	191	206	220	1.24%
Coal, Petroleum Coke, Waste Fuels, Off gases	463	514	567	607	653	700	1.67%
Wood Waste/ Spent Pulping Liquor	498	509	546	582	596	619	0.88%

*Natural gas includes propane and other liquefied petroleum products

3.2 ECONOMIC POTENTIAL RESULTS

The consulting team has diverging opinions concerning what is signified by the economic potential. Marbek generally accepts and uses the term 'economic potential' to represent an economic upset, a performance ceiling to which energy efficiency market interventions can be targeted. Conversely, MKJA prefers a term like *techno-economic potential,* in recognition that the "economic potential" is usually not all economic for the individual investor or society, and does not in itself represent an economic performance ceiling. MKJA's position is that the analysis of economic potential rarely accounts for the different costs of competing technologies in terms of their risks or the quality of service.

Notwithstanding these differing views, the results indicate a significant potential for energy demand reduction. Exhibits 3.4 and 3.5 present the economic potential results for all sectors combined. In 2025, the total reduction in energy demand for all three sectors amounts to 918 PJ, a 14% reduction relative to the reference case. This savings impact is equivalent to about 60% of the total aggregate increase in energy consumption in the three sectors between 1990 and 2003. It also amounts to about $10.5 billion in operating savings for industry, businesses and consumers in 2025. relative to the reference case forecast of energy demand.

The economic potential scenario comprises a significant fuel substitution effect due to cogeneration applications in all three sectors, the largest application having been modelled in the commercial sector. As elaborated in the ensuing sections, when the sectoral cogeneration effect is netted out, the economic potential results are generally conservative when compared to recent DSM studies conducted in Canada.

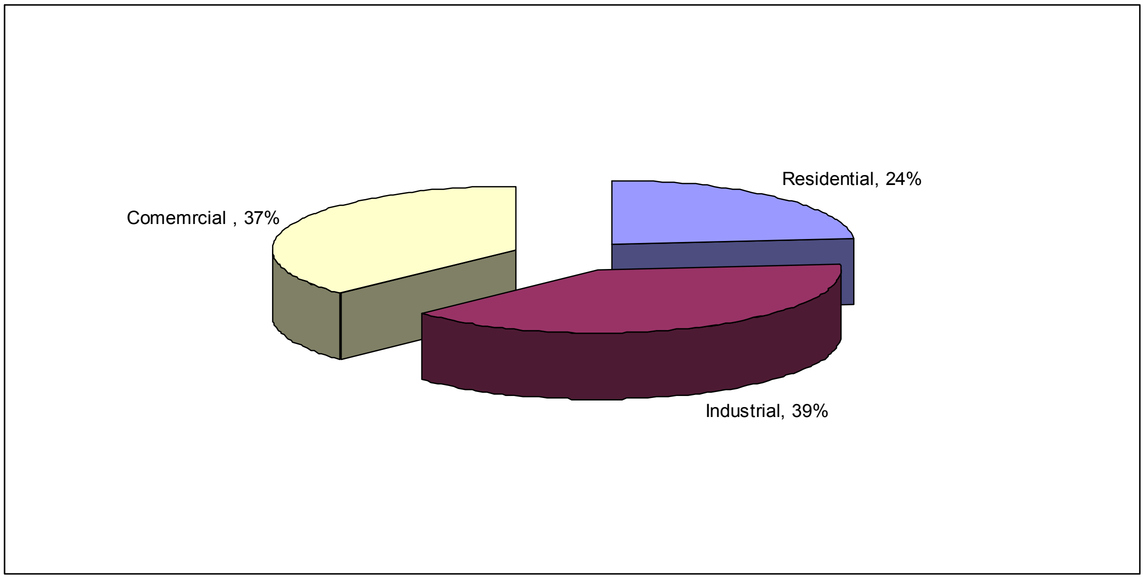
Under the economic potential scenario nearly 40 TWh of electricity will be produced from cogeneration. Nearly 60% of the cogeneration load is attributed to the commercial sector, another 28% in industry.

About 50% of the total energy demand reduction in 2025 is attributed to electricity reduction. Of this amount, about 30% is due to added cogeneration supply. Natural gas savings represent about 28% of the total reduction in 2025 and represent a larger savings when the cogeneration effect is netted out.

Exhibit 3.4: All Sectors National Economic Potential Energy Demand Reduction by Milestone Year and Fuel (PJ)

	2010	2015	2020	2025
Total Energy Demand Savings (PJ)	417.0	613.7	767.6	917.8
% Savings Relative to Reference Case	7%	11%	13%	14%
Electricity (PJ)	184.1	285.1	379.3	466.4
% Savings Relative to Reference Case	11%	16%	20%	24%
Natural Gas (PJ)	157.7	209.0	228.6	250.0
% Savings Relative to Reference Case	7%	9%	9%	10%
Refined Petroleum Products (PJ)	21.6	29.0	39.0	47.6
% Savings Relative to Reference Case	5%	7%	9%	10%
Wood Waste/ Spent Pulping Liquor (PJ)	39.5	57.7	69.0	76.7
% Savings Relative to Reference Case	6%	9%	10%	11%
Coal, Petroleum Coke, Waste Fuels, Off gases (PJ)	13.9	33.0	51.8	77.1
% Savings Relative to Reference Case	2%	5%	8%	11%

Exhibit 3.5: National Economic Potential by Sector Share of Energy Reduction in 2025



3.3 ACHIEVABLE POTENTIAL RESULTS

The achievable potential is a measure of how a target market might respond to one or more market interventions designed to expand and accelerate market take-up of energy management measures. The rationale for market interventions is to address one or more barriers and failures which impede market take-up of these measures to the level of what is economically viable, today and in the future, when market circumstances are expected to change. As noted, two achievable potential scenarios were analyzed: DSM Status Quo and DSM Aggressive.

3.3.2 Overall Impacts

Exhibits 3.6 to 3.9 present the overall impact of the two scenarios. In 2025 the total reduction in energy demand ranges from 182 PJ to 647 PJ, a 2.9% to 10.1% range in energy demand reduction relative to the reference case forecast. The average annual growth rate in energy demand slows to 0.68% in scenario 1 and 0.36% in scenario 2, relative to 0.85% in the reference case. Using the projected energy market prices used in the Reference Case forecast, the achievable potential savings amounts to a range of $3.2 billion to $15.7 billion in energy operating cost savings in 2025 relative to the reference case forecast. The projected energy demand reduction under scenario 2 is equivalent to about 64% of the total aggregate increase in energy consumption in the three sectors between 1990 and 2003.

Exhibit 3.6: Total End-use Energy Demand by Scenario, All Sectors

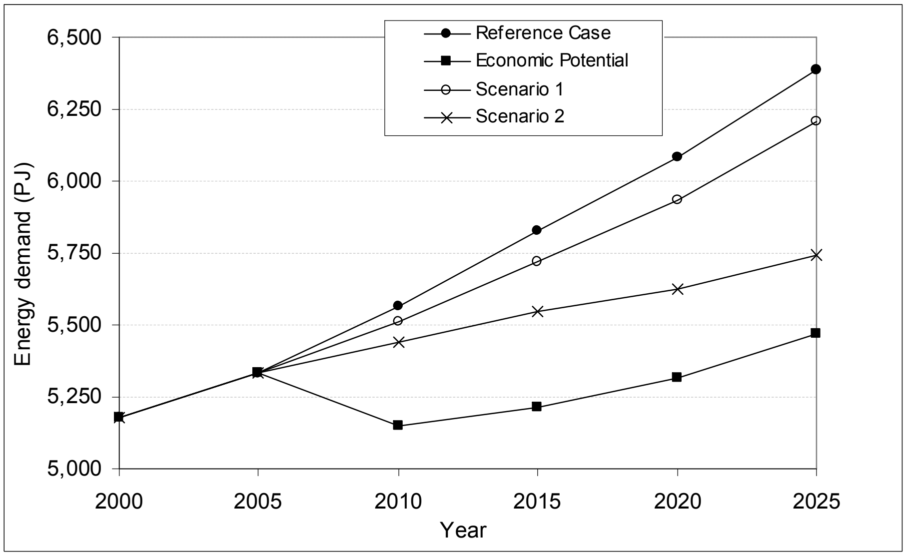


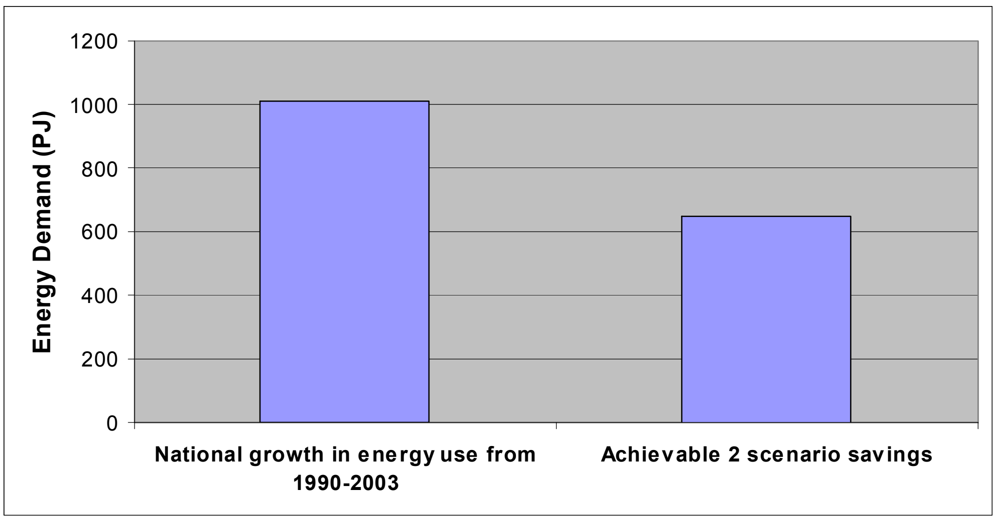
Exhibit 3.7: Energy Demand, by Milestone Year: Achievable Potential Scenarios vs. Reference Case and Economic Potential

Annual Consumption (PJ/yr)				
All Sectors				
Base Year	Reference Case	Economic Potential	Achievable Scenario 1	Achievable Scenario 2
2000	5176	5176	5176	5176
2005	5335	5335	5335	5335
2010	5567	5150	5512	5441
2015	5829	5215	5719	5548
2020	6082	5315	5935	5627
2025	6389	5471	6207	5742

Exhibit 3.8: Energy Savings by Milestone Year: Achievable Potential Scenarios vs. Reference Case and Economic Potential

Year	Annual Savings (PJ/yr)			Savings as Percentage of Reference Case Demand		
	Economic Potential	Achievable Potential		Economic Potential	Achievable Potential	
		Scenario 1	Scenario 2		Scenario 1	Scenario 2
2010	417	55	125	7.49%	0.99%	2.25%
2015	614	110	281	10.53%	1.88%	4.82%
2020	768	147	455	12.62%	2.42%	7.49%
2025	918	182	647	14.37%	2.85%	10.13%

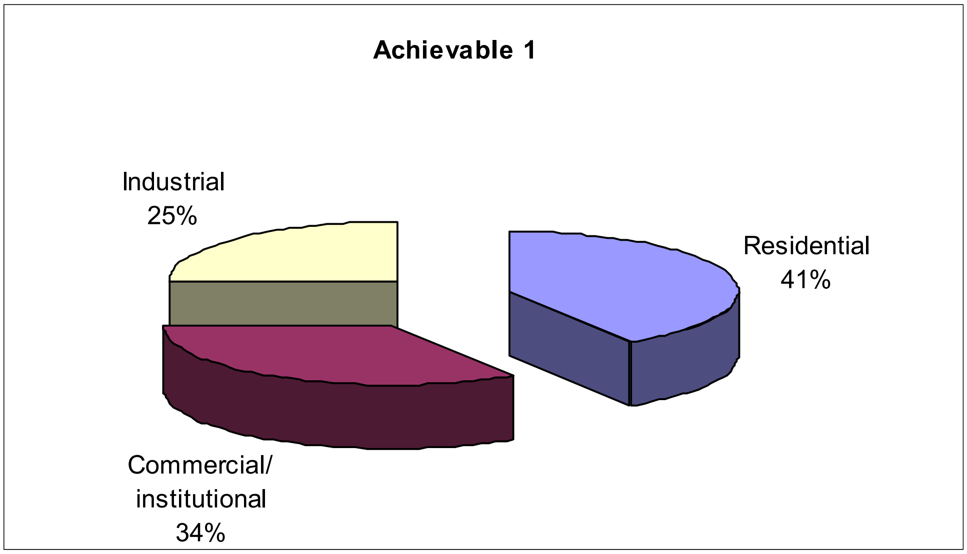
Exhibit 3.9: Comparison of Achievable Potential Scenario 2 Savings and 1990-2003 Energy Demand Growth

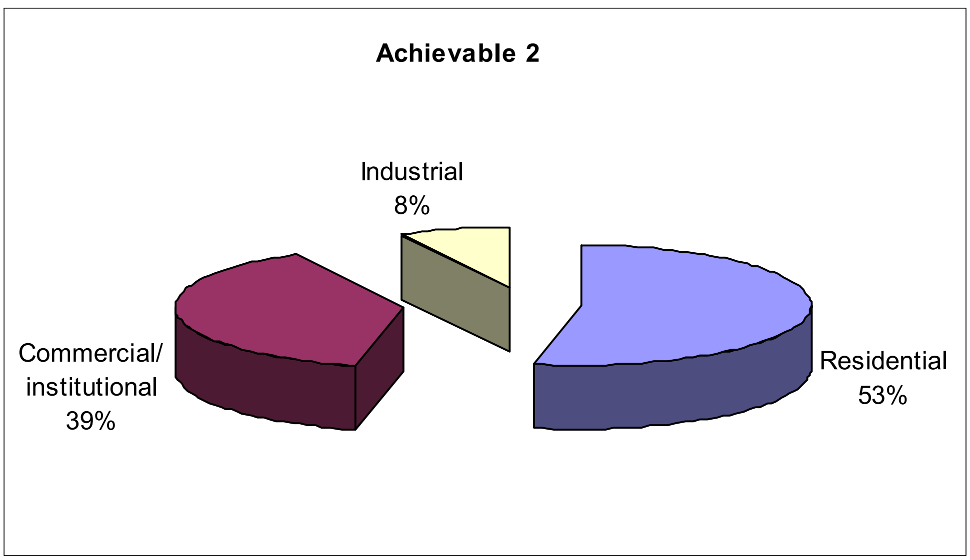


3.3.3 Sector Contributions to Savings Potential

Exhibit 3.10 illustrates how the distribution of the DSM potential in 2025, among the three sectors, changes according to each of the achievable potential scenarios. It's evident that industry's share of the total energy demand reduction declines substantially as we move from the DSM Status Quo to the DSM Aggressive scenarios. Conversely, the share of this saving attributed to the residential and commercial sectors grows considerably; together these sectors represent 75% and 92% respectively, of the scenario 1 and scenario 2 energy demand reduction. This pattern is driven by the fuel substitution effects that occur as we move into an advanced, more complex policy mix. It also reflects differences in how the policies are targetted towards different sectors (for instance, the standards in scenario 2 are primarily directed at the residential and commercial sectors).

Exhibit 3.10: National Achievable Potential by Sector Share of Energy Reduction in 2025: Scenarios 1 and 2





3.3.4 Savings by Fuel: Achievable Potential

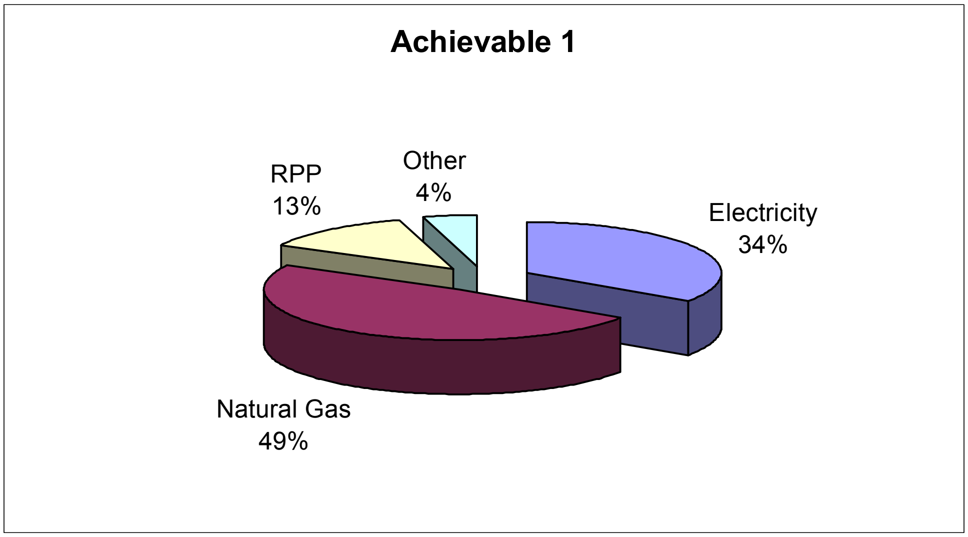
Exhibit 3.11 presents the distribution of the total achievable potential energy demand reduction in 2025 according to the types of fuel. The results show how different policy mixes can affect the energy demand reduction by fuel as the results are markedly different between the two achievable potential scenarios. For scenario 1 the largest energy demand reduction impact in 2025 is achieved in secondary natural gas end-uses, representing 49% of the total savings, followed by electricity energy demand reduction , at 34% of the total. The results are largely reversed under scenario 2 where the largest energy demand reduction impact in 2025 is achieved in electricity reduction, representing 55% of the total energy demand reduction. The main driver contributing to this result is the considerable increase in cogeneration in the DSM Aggressive scenario. About 30% of the electricity reduction impact is due to added cogeneration supply.

Exhibit 3.12 summarizes the amount of additional electricity that is induced by the policies simulated in the two scenarios. As shown, the incremental cogeneration output ranges from 9.2 PJ to 61.7 PJ (2.6 TWh to 17.1 TWh). The upper value is equivalent to nearly 40% of the installed cogeneration capacity in Canada in 2003.[18] It is also about 40% of the economic cogeneration potential.

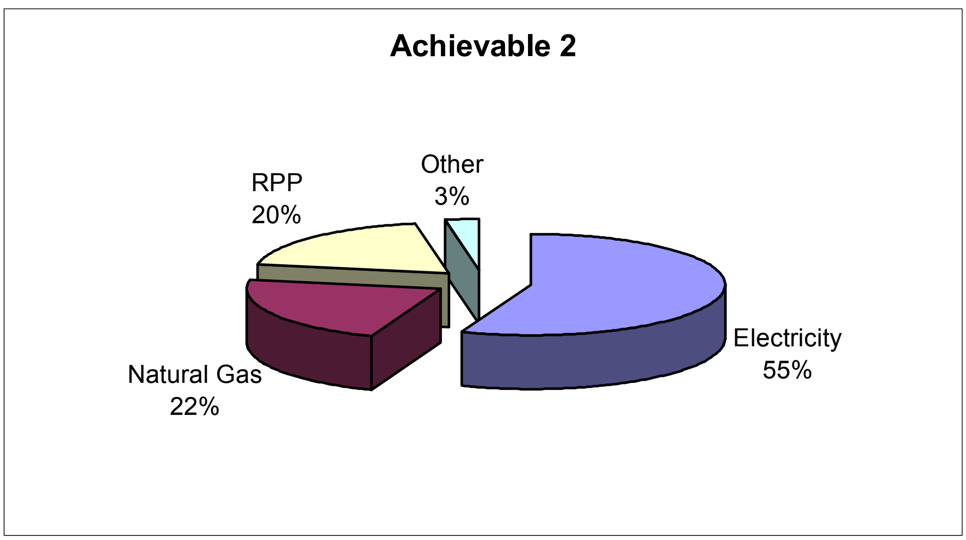
While more than 95% of the current installed cogeneration capacity is in the industrial sector, the commercial sector offers the highest potential for incremental cogeneration, in the range of 31% to 40% of the total for the two scenarios.

[18] Mark Jaccard and Associates, *Strategic Options for Combined Heat and Power in Canada, For Natural Resources Canada*, August 2004, p.40. The installed capacity in 2003 was 6.8 TWe. Assuming an average capacity factor of 70% and an average heat-to-power ratio of 2.5, the amount of electricity currently produced is approximately 40 TWh and the amount of thermal energy produced is approximately 100 TWh per year. This amounts to approximately 6% of total electricity generation in Canada in 2003.

Exhibit 3.11: All Sector Savings According to Fuel



Note:
-'Other' includes: Coal, Petroleum Coke, Waste Fuels, Off gases, Wood Waste and Spent Pulping Liquor
-'RPP' is Refined Petroleum Products



Note:
-'Other' includes: Coal, Petroleum Coke, Waste Fuels, Off gases, Wood Waste and Spent Pulping Liquor
-'RPP' is Refined Petroleum Products

Exhibit 3.12: Added Cogeneration Generation by Sector

	Achievable Potential		Economic Potential
	scenario 1	scenario 2	
Additional Electricity Generated (TWh/year)			
Total	2.56	17.14	54.58
Residential	1.35	6.89	26.14
Commercial	0.42	3.43	6.17
Industrial	0.79	6.83	22.27
Additional Electricity Generated (PJ/year)			
Total	9.23	61.71	196.50
Residential	4.86	24.80	94.12
Commercial	1.52	12.33	22.20
Industrial	2.85	24.59	80.18

4. DISCUSSION

As noted, the results identify an achievable potential of between 2.9% to 10.1% range in DSM potential relative to the reference case forecast. The following discussion examines some of the dynamics affecting the outcomes and attempts to place the results in the context of findings from other studies.

Impact on Industry

In 2003 the industrial sector represented the largest percentage of Canada's secondary energy consumption, 38% of the total (including transportation). Nevertheless, the achievable potential analysis reduction in energy demand for industry is considerably less than that of the residential and commercial sectors. On the surface, it would appear that the energy efficiency performance gains in the residential and commercial sector are not attainable in industry. That would be a misleading conclusion because, as shown in the last part of this section, other studies that focus solely on energy efficiency have shown significant economic and achievable potential in industry. Rather, it is important to understand that the modeling construct and dynamics of this study provide some insight into how a particular mix of policy instruments might affect industry, but in a more dynamic, less linear fashion than shown in some of the other energy efficiency studies.

We have seen from the analysis that, in a dynamic- integrated modeling construct, industry could chose fuel substitution and cogeneration investments as alternative investments to energy efficiency or which could offset some of the energy efficiency gains. The key factors influencing the outcomes of the industry achievable potential results are:

- Scenario 1 was largely driven by subsidies. It appears that, relative to the dynamics of the residential and commercial sectors, the reduced paybacks induced by the subsidies do not have the same effect for industry in addressing the gap between the social and private discount rates. This may be due to the typically higher hurdle rates that industry demands for energy efficiency investments.

- In scenario 2, the application of standards in industry was limited and did not play the same role as building and end-use equipment standards do in the commercial/institutional and residential sectors. In addition, the renewable energy subsidies and the changes in building types (to mimic urban land use policies) had a far less application to industry than the other sectors.

- In scenario 2, the marginal cost pricing instrument has a considerable effect on industry energy use dynamics as electricity prices increase relative to other fuels. This drives additional fuel switching for end-uses where these fuels can be substitutes, particularly combustion. The end-use efficiency of electric heating is always higher than for direct combustion of fuels, resulting in additional secondary energy demand for the affected end-uses. This drop in performance is particularly evident where there is a considerable switch to the utilization of wood waste in industry; wood waste use increases fairly significantly in scenario 2.

Finally, it is also important to note that the study did not examine the energy management potential in the upstream oil and gas sector, which is an energy intensive and growing sector of the economy.

Why the DSM Aggressive Scenario Has a Large Fuel Substitution/Cogeneration Effect

CIMS simulates the competition of DSM technologies of different levels of efficiency and fuel type to meet a given energy service demand. The choice pathway has four options: i) choose a more efficient upgrade within the same fuel type, ii) choose a more efficient upgrade using a different fuel, iii) choose a base technology with a different fuel, iv) make no upgrade or change in fuel choice. The DSM technology competition is largely driven in the policies, but not exclusively so, by two main factors: changes in capital costs or changes to energy prices. Consequently, as the mix of policies assessed in CIMS varies, so does the impact weighted between energy efficiency and fuel substitution.

Therefore, we see that the policy mix in the DSM Aggressive scenario results in significant fuel switching and cogeneration. In particular, marginal cost electricity pricing and the carbon liability in scenario 2 affect different fuels unevenly. In response to the carbon liability, there is fuel switching to less carbon intense fuels (away from coal and oil), while marginal cost pricing encourages fuel switching away from electricity. Together, these two policy instruments contribute to a greater take-up of wood waste ('hog fuels') in the pulp and paper and wood and allied products sectors.

Similarly, the policies simulated in the DSM Aggressive scenario bolster the economic conditions for cogeneration, which has significant impact on the results. Marginal cost pricing for electricity, in particular, increases the differential between gas prices and electricity prices – which is critical to cogeneration development.

It's important not to let the current pricing conditions cast a shadow over the projected outcome in 2025. At the present time, high natural gas prices are making natural gas driven cogeneration less economic because they are reducing the "spark spread", i.e. the cost differential between natural gas and electricity, so that self-generation becomes less cost effective. However, the simulation of the achievable potential includes policies that favourably influence the economics of cogeneration – marginal cost pricing for electricity in particular increases the differential between gas prices and electricity prices – which is critical to cogeneration development

Why the Sectoral Contribution Changes

We have seen an enormous shift in the allocation of the total savings between the DSM Status Quo and DSM Aggressive scenarios. While the magnitude of the overall savings increased, the share of energy savings that is attributed to industry is significantly smaller. This has occurred because the mix of policies simulated in the DSM Aggressive scenario: i) induce a greater degree of fuel substitution and cogeneration as noted above, and ii) in terms of end-use efficiency, are more conducive to performance improvements in the buildings sectors.

In scenario 2, the application of standards in industry has limited application and cannot play the same role as building and appliance standards do in the commercial/institutional and residential sectors. The effect of the renewable subsidies are similar less pronounced in industry.

What CIMS Did Not Model

The achievable and economic potential scenarios were not run utilizing the CIMS' energy price and macro-economic feedback systems. This level of analysis was beyond the scope of the study. If CIMS had been allowed to iterate between the energy demand and supply sectors, we would have seen the impacts of reduced consumption of electricity on its cost of production, and hence its price. In turn, if the price change had been significant, the energy-demanding residential, commercial and industrial models would have been re-run until a new energy supply and demand equilibrium was achieved. We speculate that if these macro-economic feedbacks had been run, increased production costs in industry might have caused increased final prices and lower production demands, particularly for the scenario 2 policy mix. Ultimately, these dynamics would lead to additional secondary effects in the residential and commercial sectors.

Transportation Benefits: Location Efficiency

In scenario 2, we touched briefly on the possible energy reduction effect of advanced urban land use policies. This was modeled by changing dwelling shares running into the future, to reflect increased urban densities. There is a possible transportation dividend to be reaped from such policies. Numerous studies have been completed in the past 15 years on the energy and lifestyle cost savings of dense urban areas relative to sprawling urban areas – thus termed "location efficiency".

Research has consistently shown savings of 20%-40% in urban transportation energy as urban density doubles. For instance, if policy makers targeted a density of 10 people/hectare in 2030 Canadian urban areas, which would be a 43% increase in urban density compared with current patterns, this could result in a 10%-20% annual reduction in urban transportation energy consumption. To put this into perspective, a 10%-20% annual savings applied in 2003 in Canada's urban areas would save roughly 100PJ-200 PJ annually in *passenger* transportation alone.

System savings

The projected savings in electricity demand have been calculated at the customer level. However, these savings have a significant impact on capacity requirements to meet the demand. A unit of electric demand reduction is worth more (12% to 30% more depending on the generation mix) than a unit of additional supply in terms of generation capacity.[19]

[19] To meet electricity demand, you need to have a generation capacity that exceeds your demand by a minimum of around 12% for hydro generators to around 30% for coal-fired generators to handle routine maintenance and down time of equipment.

Comparison to other studies

There have been many North American studies in the past five years investigating the achievable potential for energy efficiency in various sectors. Comparisons of study outputs from one study to another are always difficult because of often different analytical constructs, modelling approaches, data sets and assumptions. Nevertheless, the comparisons provide another source of estimates to consider, and an indication of how the current study relates to other efficiency potential studies that have been undertaken.

The two achievable potential scenarios generate energy demand reduction reductions ranging from 2.9% to 10.3% in 2025, relative to the reference case forecast. These results are of the same order of magnitude generated by a 2005 U.S. study investigating energy efficiency potential in all sectors which produced a energy demand reduction range of 4% to 9%, also for two scenarios running to 2025.[20] The U.S. study used the National Energy Modelling System (NEMS) and considered a wide range of policy instruments, and like the current study, assessed the potential by directly representing policies in an energy-economy model.

Exhibit 3.13 compares the range of achievable potential energy demand reduction from some recent demand-side management (DSM) studies conducted in Canada, distinguished according to sector and fuel.

The comparison shows that, with the exception of the industrial results, the upper bound (the scenario 2 results) exceeds the upper bound of these recent DSM studies. Indeed, it is clear that the CIMS industrial results act to offset the performance from the other sectors when the overall reduction in demand is considered.

In interpreting this difference, it is important to bear in mind that scenario 2 as defined in this project includes price and regulatory instruments that extend beyond the scope of current utility programs. The analysis also incorporates land-use measures, cogeneration and renewables, and includes the interactive effects of the policies, including their impact on fuel switching.

Industry shows a lower potential for several reasons. First, the regulatory, land use and renewable subsidy policies are largely targetted to the residential and commercial sectors. Second, fuel switching to gas and the additional natural gas required to cogenerate (the cogeneration effect) simply outweighs the gains in energy efficiency gains in industry. Although there is fuel substitution and cogeneration in the other sectors, the other elements in the scenario induce significantly more efficiency over the long run.

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[20] Energy Information Administration, Office of Integrated Analysis and Forecasting, *Assessment of Selected Energy Efficiency Policies*, May 2005 U.S. Department of Energy Washington, DC 20585.

Exhibit 3.13: Achievable Potential Performance Range From Recent DSM Studies

Sector and Fuel	Savings Range			
	Lower %		Upper %	
	Other studies	CIMS analysis	Other studies	CIMS analysis
Residential				
Electricity	3	4.4	7.5-14	27
Natural Gas	2	5.6	3-7	11.8
Commercial				
Electricity	3	4.4	3-5	22.8
Natural Gas	3	3.5	6-10	11.5
Industrial				
Electricity	2	2.9	15-25	14.3
Natural Gas	3	3.3	7-10	-2.7