Demand Side Management Opportunities for Alberta

Prepared for:

Alberta ENERGY EFFICIENCY ALLIANCE

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Executive Summary

Demand side management (DSM) is used broadly across Canada and the US to reduce the cost of utility services. It is extremely common across all market types including those with competitive wholesale and retail markets. Guidehouse was retained by the Alberta Energy Efficiency Alliance (AEEA) to determine the potential DSM opportunities in Alberta and provide key insights based on different types of DSM programs being delivered and the cost-effectiveness of these initiatives in other jurisdictions.

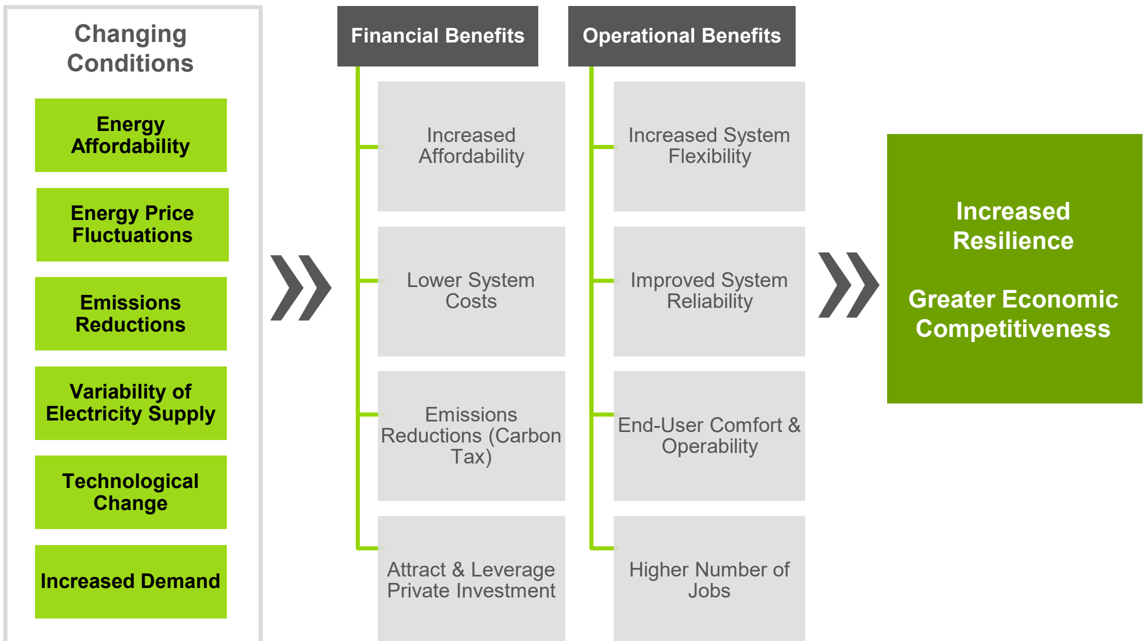
The analysis and research conducted in this report revealed the following key points:

1. There are many types of DSM programs being delivered in other jurisdictions. Programs also vary based on end-use sector, including residential, commercial, and industrial. The flexibility and scalability of DSM offers many advantages for program implementers to adapt DSM specifically for the province of Alberta.

2. DSM programs offer a wide range of benefits from a consumer, utility, and policymaker perspective. These benefits include energy savings, peak demand reductions, greenhouse gas (GHG) reductions, and increases in system flexibility and non-energy benefits such as increased comfort and reliability, investment into building stock renewal, and reduced operation and maintenance costs.

3. DSM programs are also complementary to initiatives including those focused on reducing emissions such as carbon capture, utilization, and storage (CCUS); hydrogen; renewable natural gas; and other emissions reduction technology development. Although these emissions reduction approaches tend to increase costs for consumers, DSM reduces costs and emissions at the same time. This helps to diversify and balance various emissions reduction approaches, and increases the likelihood of successful deployment of each. Figure ES 1 shows all these benefits contribute to the resiliency and economic competitiveness of businesses and households—particularly at a time of rapidly changing energy costs and technological advancement.

Figure ES 1. DSM Program Value Proposition

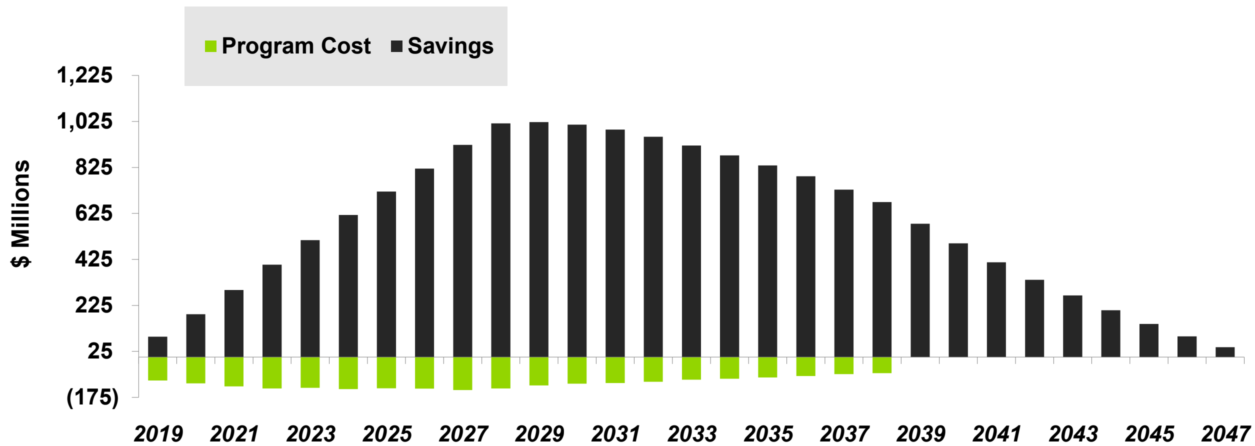


(Source: Guidehouse)

4. There is a consistent, positive ROI for DSM across a wide range of jurisdictions. Cost-effective analyses of DSM programs are almost exclusively positive, with benefit-cost ratios averaging around 2 to 1 when accounting for both program and participant investments.

5. DSM can increase resiliency by reducing customer exposure to commodity price shock or to weather-driven price spikes. From a customer bill perspective, the level of investment for DSM can be less than 1% of bills. The percentage reduction in cumulative energy savings is typically much greater (i.e., 7.5 to 1 ratio in some cases) than the percentage increase in average customer bills.

Figure ES 2. DSM Investment vs. Savings Generated[1]



(Source: Guidehouse)

6. Unlike almost all other jurisdictions in North America, Alberta does not integrate energy efficiency into its management of the electric and natural gas utility systems. As a result, Albertans pay more than they need for utilities, in both economic and environmental costs. Existing studies conducted for the province of Alberta highlight the significant savings potential that has yet to be realized.

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[1] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018

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Acronym and Abbreviation List

ACEEE .... American Council for an Energy-Efficient Economy

AEEA .... Alberta Energy Efficiency Alliance

BESS .... Battery Energy Storage System

BQDM .... Brooklyn Queens Demand Management

BTM .... Behind the Meter

CCUS .... Carbon Capture, Utilization, and Storage

CHP .... Combined Heat and Power

C&I .... Commercial and Industrial

COS .... Cost-of-Service

DER .... Distributed Energy Resources

DERMS .... Distributed Energy Resources Management System

DG .... Distributed Generation

DR .... Demand Response

DRIPE .... Demand Reduction Induced Price Effects

DRMS .... Demand Response Management System

DSM .... Demand Side Management

EE .... Energy Efficiency

EPA .... Environmental Protection Agency

EV .... Electric Vehicle

EVSE .... Electric Vehicle Supply Equipment

GHG .... Greenhouse Gas

GJ .... Gigajoule

GW .... Gigawatt

GWh .... Gigawatt-Hour

HVAC .... Heating, Ventilation, and Air Conditioning

IDSM .... Integrated Demand Side Management kW .... Kilowatt-Hour

LED ....Light-Emitting Diode

LNG .... Liquified Natural Gas

MW .... Megawatt

MWh .... Megawatt-Hour

NPA .... Non-Pipes Alternative

NREL .... National Renewable Energy Laboratory

NWA ....Non-Wires Alternative

O&G ....Oil & Gas

PBR ....Performance Based Regulation

P.V. .... Present Value

ROI ....Return on Investment

T&D .... Transmission and Distribution

TJ ....Terajoule

TOU .... Time-of-Use

TRC .... Total Resource Cost

UK .... United Kingdom

US .... United States

VPP .... Virtual Power Plant

1. Introduction and Background

As the global electricity and natural gas industries shift in response to new technologies and emissions reduction goals, demand side management (DSM) programs are evolving past commonly used tools to shave kilowatt-hours and gigajoules. Specifically, these utility programs are moving to integrate with other distributed energy resources (DER) to help ensure reliability, meet federal and state/provincial efficiency requirements, maximize the benefits from existing asset investments, and help municipalities meet their emissions reduction targets or other energy goals. The increasing integration of utility programs is creating new value stacking for utilities and their customers. The cost-effectiveness of DSM programs has been proven over the course of three decades. As Alberta charts its energy future, DSM programs offer a logical mechanism to address growing customer, utility, and government needs.

This white paper explores DSM opportunities in Alberta and aims to help inform stakeholders on the topic of DSM and its economic, environmental, and consumer benefits. This will include discussion of traditional focus areas (e.g., increasing the use of energy efficiency and demand response [DR]), as well as newer areas of opportunity (e.g., DER integration, managed charging, non-wires/pipes alternatives). This white paper explores the potential scope of DSM (e.g., range of technologies and services included) and the range of costs and benefits (e.g., value stack) through DSM for consumers, utilities, systemwide, and the province as a whole. The information presented in this paper includes existing research conducted by Guidehouse and other publicly available research from Alberta and other jurisdictions.

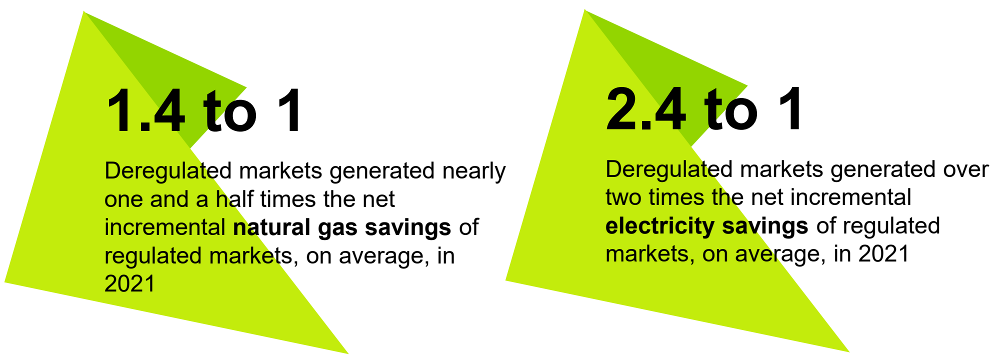
2. Defining DSM

The energy landscape is undergoing a transformation. This includes but is not limited to rapid technology changes (including to the cost and availability of renewable energy and EVs); ambitious clean energy targets for both electricity and natural gas driving investments into carbon capture, utilization and storage (CCUS); hydrogen production; and renewable natural gas; growing pressures related to energy usage and peak power demand; increasing energy affordability challenges; and increasing digitization and rising consumer expectations. These trends have highlighted the relevance and urgency for DSM.

In Alberta, several recent studies have shown DSM to be one of the most cost-effective options to address the emerging pressures brought about by energy and digital transformation. The lack of energy efficiency, DR, and DER management within Alberta to date highlights the massive savings potential that has yet to be realized in the province.

The viability and efficacy of DSM programs has been demonstrated across a wide range of regional market types. In the US, regulated utilities were largely responsible for driving early-stage DSM market growth, with states such as Vermont, Minnesota, and Arizona continuing to generate significant energy and cost savings through DSM initiatives. As more states have shifted to deregulated frameworks, deregulated utilities have aggressively capitalized on DSM potential.

Figure 2-1. Deregulated Markets Have Capitalized on DSM Potential[2]



(Source: Guidehouse, ACEEE)

DSM refers to the wide and diverse array of energy efficiency and DR technologies, services, programs, and strategies to help consumers optimize and reduce the energy use of their equipment, buildings, operations, and behavior. DSM investments help homeowners and businesses control their energy use, lower their utility costs, save water, and reduce emissions. DSM programs can be used to shape, curtail, and shift both electricity and natural gas load in an optimized manner. This section defines DSM, identifies the range of potential technologies available, and highlights the drivers of DSM for Alberta.

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[2] State Energy Efficiency Scorecard: 2021 Progress Report, ACEEE, 2021

2.1 *Energy Efficiency*

Energy efficiency refers to reducing the amount of energy required to provide products and services. More specifically, it means delivering more products or services for the same energy input or delivering the same products and services for less energy input. The goal of energy efficiency programs is to engage industrial, commercial, and residential customers in energy savings through various processes such as technology improvements (e.g., efficient pumps, motors, heating, cooling, lighting, and energy management systems) and behavior change such as managing energy consumption remotely.

2.2 *Demand Response*

DR has traditionally referred to the curtailment of demand through a few critical electric power peak events during the year. More broadly speaking, it refers to the practice of modifying (shifting or reducing) electricity usage during a particular period of time to better match electricity grid needs with available supply. Reduction in energy use is typically due to financial rewards for participation such as lower electricity rates, bill credits, or rebate programs. The prescribed change in energy can be manual (initiated by the customer after receiving notification from the utility) or automated through DR management systems (DRMSs).

Historically, DR has been less prevalent in the natural gas industry but changing market factors have increased interest in the practice over the past decade. Natural gas DR can be implemented by decreasing actual gas consumption in a building or by using smart control systems to effectively reduce gas consumption at the site during times of peak use.

2.3 *Integrated DSM and DER Management*

Integrated DSM (IDSM) combines energy efficiency and DR to deliver energy and peak demand savings to utilities through shared program delivery. IDSM can thus improve the cost-effectiveness of existing energy efficiency and DR programs. IDSM also creates new business models and allows program providers in the DR and efficiency spaces to position themselves to offer integrated programs that could spur innovation and customer engagement. As most utility customers think of DR and energy efficiency as energy savings programs, the IDSM program model might streamline customer communication further boosting satisfaction. Some utilities and program providers further broaden the program to include DER technologies beyond energy efficiency and DR. DER management programs bring in other two-way grid communicating devices into utility programs that lay outside the traditional bounds of DR or efficiency.

Figure 2-2 shows the evolution of DER management. The combination of integrated DSM and DER management can be considered as complementary components under a broader umbrella of grid modernization.

Figure 2-2. Evolution of DER Management

Application	Energy Efficiency	Demand Response	DER Management
Enabling Technologies	Lighting HVAC & Major Appliances Building Envelopes Energy Efficient Appliances	Local Control Switches Load Management Receivers Smart Thermostats Smart Meters	Distributed Generation Energy Storage EV / EVSE
Description	Delivering the same service using less energy	Voluntary reduction in consumption during tight supply periods	Bring BTM DERs into utility programs that lay outside the traditional bounds of DR or EE

Basic → **Advanced** →

(Source: Guidehouse)

3. Balancing DSM Benefits and Costs

This section summarizes the range of costs and benefits from DSM programs for utilities, customers, and states and provinces as a whole. This includes an analysis of historical and projected DSM program costs and benefits, as well as discussion of value stacking opportunities created by multiple benefits streams.

In most cases, DSM program benefits considerably outweigh the costs due to value stacking opportunities. Value stacking refers to the addition of multiple benefit streams, which can help improve the economics of DSM programming. This includes energy and cost savings, peak demand reduction, asset and capacity deferral, emissions reduction and avoided carbon tax, customer engagement, grid flexibility, and more. The valuation and aggregation of these different benefit streams through DSM is responsible for the high cost-effectiveness found throughout all program levels. This section includes discussion of each benefit stream to demonstrate the viability and proven value of DSM at any scale.

Guidehouse conducted a scan of utility DSM cost-effectiveness in other jurisdictions and found that programs are almost always cost-effective, even if the utility has excess capacity and slow load growth. In cases of low or marginal cost-effectiveness, regulators may still approve individual DSM programs to ensure equitable energy-savings opportunities among different rate classes or income levels, or because the program may include innovative technologies that promote broader energy savings.[3] Even when individual programs with lower cost-effectiveness are included, the total portfolio of programs always provides a positive ROI as higher return programs balance the returns for equity- or innovation-based programs.

Table 3-1 summarizes a dozen collected case studies and presents the results of total resource cost (TRC) cost-effectiveness tests. It also includes information pertaining to utility type (vertically integrated or unbundled) and regulatory framework (cost-of-service [COS] ratemaking or performance-based regulation [PBR]) to illustrate the positive cost-effectiveness realized across a variety of jurisdictions. A portfolio of programs is considered cost-effective when the benefit-cost/TRC ratio is one or greater.

[3] The EmPOWER Maryland Energy Efficiency Act Report OF 2020, PSC of Maryland, April 2020

Table 3-1. DSM Portfolio Cost-Effectiveness, Case Studies

Utility	Vertically Integrated	Regulatory Framework	Program Type	Program Years	TRC Ratio
Focus on Energy	No	PBR	Both	2019-2020	2.5[4]
				2015-2018	3.6[5]
				2011-2014	3.1[6]
				2010	2.3[7]
Oklahoma Gas and Electric[8]	Yes	PBR	Both	2019	1.6
FortisBC	Yes	COS / PBR	Electric	2019-2022	1.5[9]
			Gas	2020	1.2[10]
Commonwealth Edison[11]	No	PBR	Electric	2015-2016	2.6
Duquesne Light[12]	No	PBR	Electric	2016-2020	2.1
FirstEnergy (Pennsylvania)[13]	No	PBR	Electric	2016-2020	1.8
PECO[14]	No	PBR	Electric	2016-2020	1.9
PPL Electric[15]	No	PBR	Electric	2016-2020	1.8
PSO Oklahoma[16]	Yes	PBR	Electric	2019	2.6
Black Hills Colorado[17]	Yes	PBR	Electric	2019-2021	2.2
Avista—Idaho[18]	Yes	PBR	Electric	2018	2.1
Union Gas[19]	No	PBR	Gas	2016	2.8
Nicor Gas[20]	No	PBR	Gas	2018-2020	2.5
Enbridge Gas (EGD Rate Zone)[21]	No	PBR	Gas	2020	2.2
Enbridge Gas (Union Rate Zone)					2.1
Boston Gas / Colonial Gas[22]	Yes	PBR	Gas	2016-2018	1.9
PSC of Colorado[23]	Yes	PBR	Gas	2015	1.8
Average (Electricity)	**N/A**	**N/A**	**N/A**	**N/A**	**2.1**
Average (Gas)	**N/A**	**N/A**	**N/A**	**N/A**	**2.1**

(Source: Guidehouse, Footnote Sources)

[4] Focus on Energy 2019–2020 Biennium Economic Impacts, Cadmus, February 2022
[5] Focus on Energy 2015–2018 Quadrennium Economic Impact Analysis, Cadmus, July 2020
[6] Focus on Energy Economic Impacts 2011-2014, Cadmus, December 2015
[7] Focus on Energy Evaluation, Annual Report (2021), Tetra Tech, June 2011
[8] Oklahoma Comprehensive Demand Program Portfolio 2019 Annual Report, Oklahoma Gas and Electric, July 2020
[9] Application for Approval of 2019-2022 Demand Side Management Expenditures Plan, FortisBC, March 2019
[10] Natural Gas Demand-Side Management (DSM) – 2020 Annual Report, FortisBC, March 2021
[11] ComEd Review of PY8 Total Resource Cost Test Assumptions, Navigant Consulting, January 2019
[12] Energy Efficiency Study for Pennsylvania, GDS Associates, February 2015
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] 2019 Energy Efficiency and Demand Response Programs: Annual Report, ADM Associates, June 2020
[17] Advice Letter No. 786, Black Hills Energy, March 2020
[18] Order No. 35129, Idaho Public Utilities Commission, August 2021
[19] Natural Gas Conservation Program Results, Environmental Commissioner of Ontario, 2019
[20] Nicor Gas Energy Efficiency Plan January 2018-December 2021, Nicor Gas, June 2017
[21] Draft Demand Side Management Annual Report, Enbridge Gas Inc., April 2021
[22] 2016-2018 Energy Efficiency Term Report, National Grid, August 2019
[23] 2016 Report to the Colorado General Assembly on Demand Side Management (DSM), PUC of Colorado, 2016

TRC tests are by far the most common approach to assessing cost-effectiveness, as they capture the total costs and benefits of DSM programming, including for the utility, program participants, and non-participants.

These results indicate that for every dollar spent on electric or natural gas DSM measures (including both program and participant investments), more than two dollars are delivered in benefits. This collection of case studies also demonstrates the viability and efficacy of DSM programming across a wide range of utility, market, and program types.

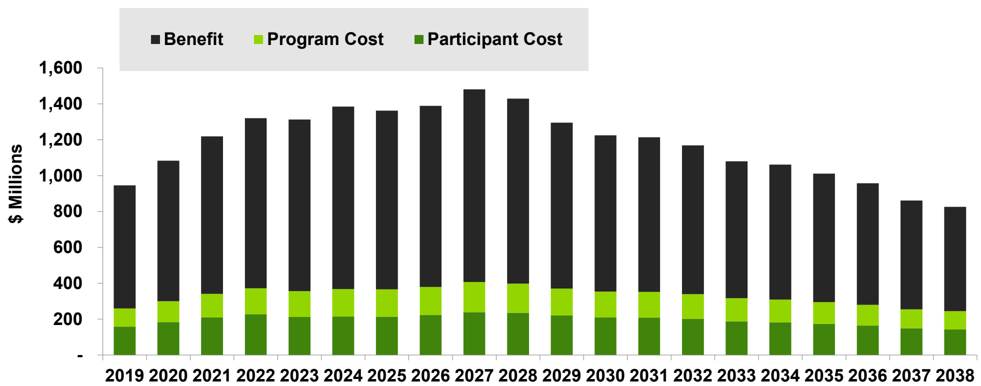
The cost-effectiveness of DSM was also demonstrated as part of the American Council for an Energy-Efficient Economy (ACEEE) *2020 Utility Energy Efficiency Scorecard*. This study published the results of cost-effectiveness tests from 52 US utilities. TRC tests were used by 32 reporting utilities, resulting in an average benefit-cost ratio of 2.4. Although different testing methods were applied, every utility reported positive test results.[24]

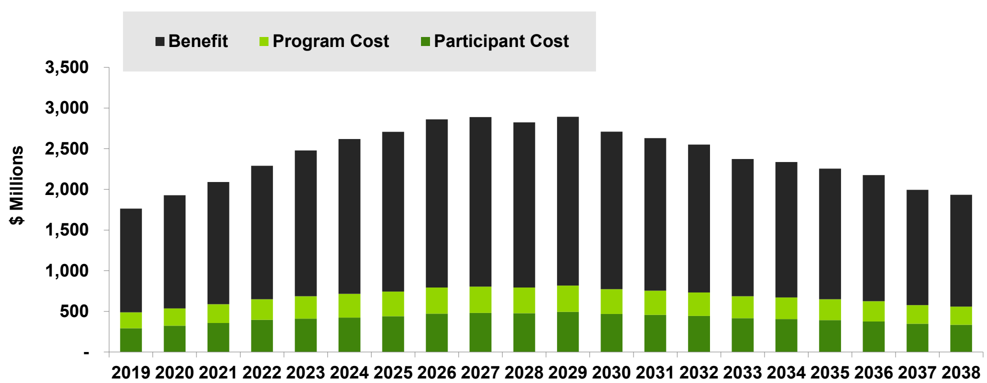
It is worth noting that energy and cost savings may be particularly robust in the early stages of DSM program implementation, given the easy opportunities. For example, a scan of 10 US natural gas programs from 2004 found impressive TRC ratios ranging from 1.6 to 5.6, with an average of 2.7.[25] The longevity of ROI for DSM, however, is due in part to the ability for utilities to continually update programming as new technologies and approaches to delivering energy savings are developed. As the amount of available funding increases in a given jurisdiction, and the value of avoided energy and emissions reductions increases, there are higher energy savings available. As Table 3-1 shows, Focus on Energy, Wisconsin utilities' statewide energy efficiency program, has produced positive benefit-cost ratios every year for over a decade, with TRC ratios ranging from 2.3 to 4.1 from 2010 to 2020. When factoring in the associated economic impacts, such as increases in employment, income, and economic activity, the range of TRC ratios from 2011 to 2020[26] grows to between 4.2 and 7.0.[27]

For Alberta specifically, DSM programs have also been shown to have high cost-effective potential. In 2019, Guidehouse conducted a potential study for Alberta to assess the energy efficiency potential for residential, commercial, and industrial customers. This study analyzed the cost-effectiveness of energy efficiency and small-scale generation as measures to reduce GHG emissions, resulting in a TRC benefit-cost ratio of 2.3 from 2019 to 2038 (excluding oil & gas [O&G]). As Figure 3-1 shows, the study results indicated a large, cost-effective, and achievable potential for Alberta, with net benefits totaling $11.1 billion ($20.0 billion including O&G) over the 20-year study period.

[24] 2020 Utility Energy Efficiency Scorecard, ACEEE, 2020
[25] Natural Gas Demand-Side Management Programs: A National Survey, 2006
[26] Focus on Energy Economic Impact Report (2010) excludes economic benefits in its cost-effectiveness analysis.
[27] Focus on Energy Economic Impact Reports, Cadmus, 2011-2020

Figure 3-1. Benefits and Costs, Energy Efficiency and Solar Measures, O&G Customer Segment Scenarios[28]



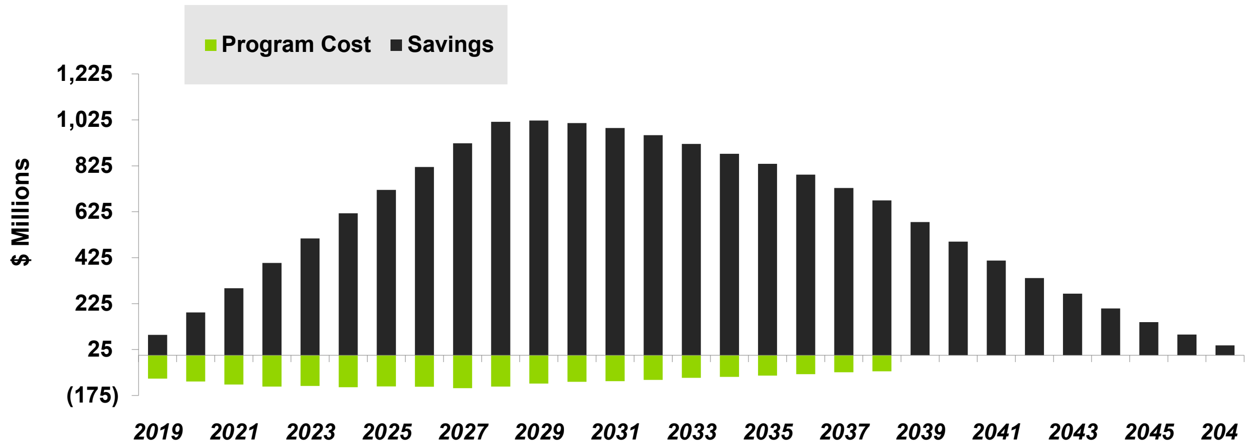


(Source: Guidehouse)

The presentation of costs and benefits in Figure 3-1 shows the benefits as they relate to a given program year (e.g., the benefit of measures installed in 2019 is displayed only in 2019) and demonstrate the greater than 2 to 1 benefit-cost ratio. Another way to view the costs and benefits is from the perspective of the utility system in the year the benefits are realized. Figure 3-2 shows the same scenario as Figure 3-1 shows (excluding O&G) with the program costs and total savings spread out over the life of the upgrades completed. Note that the decline in program spending and benefits assume that no new technologies are available and that programs are ceased after 20 years. Programs are likely to be ongoing given the continual advancement of energy efficiency technologies. This example demonstrates the significant economic benefits that can be achieved through the perspective of a program administrator over many years of programming.

[28] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018

Figure 3-2. DSM Investment vs. Savings Generated[29]



(Source: Guidehouse)

Alberta's utilities can improve the economics of energy efficiency and other DSM by generating layered benefit stacks to unlock greater value than the sum of its parts. The following sections include detailed discussion on the individual benefit streams included within these cost-effectiveness analyses.

3.1 *Energy Savings*

DSM programs present an undeniable opportunity to reduce consumer costs through a reduction in energy consumption. This is often the core objective of DSM programs, as energy savings are responsible for delivering many of the benefit streams captured throughout the following sections. For customers, cumulative energy savings contribute to lower monthly bills (Section 3.3). For utilities, energy savings contribute to lower system costs and can be used to defer, reprioritize, or eliminate expensive investments in system capacity (Section 3.2). Energy savings also contribute to lower social and monetary costs from fewer GHG emissions, such as abatement of carbon taxes (Section 3.4). These specific use cases are detailed in Sections 3.2–3.4.

As Table 3-2 and Table 3-3 show, net incremental energy savings varied widely by province in 2020. For Alberta specifically, the tangible savings realized in 2020 was a function of Energy Efficiency Alberta programs that were winding down at the time. This contributed to a small increase in electricity savings over 2019 (+0.06%), however, it remains as one of the lowest-performing provinces across both electricity and natural gas.[30]

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[29] Ibid.

[30] 2021 Canadian Provincial Energy Efficiency Scorecard, Efficiency Canada, 2021

Table 3-2. Net Incremental Electricity Savings (2020)[31]

Province	Energy Savings (GWh)	Savings % of Domestic Sales
Nova Scotia	87.3	0.86%
Prince Edward Island	10.9	0.76%
British Columbia	281.2	0.52%
Quebec	826.4	0.48%
New Brunswick	49.7	0.43%
Newfoundland and Labrador	34.2	0.37%
Ontario	343.4	0.27%
Manitoba	53.3	0.25%
Alberta	53.0	0.10%
Saskatchewan	N/R	N/R
Total	**1,739.4**	**N/A**

(Source: Guidehouse, Efficiency Canada)

Table 3-3. Net Incremental Natural Gas Savings (2020)[32]

Province	Natural Gas and Non-Regulated Fuel Savings (TJ)	Savings % of End-Use Demand
Prince Edward Island	45.2	0.87%
Quebec	2,532.1	0.81%
British Columbia	1,075.4	0.44%
Nova Scotia	160.3	0.42%
New Brunswick	83.0	0.40%
Ontario	3,697.2	0.34%
Manitoba	146.6	0.17%
Alberta	187.0	0.05%
Saskatchewan	23.4	0.03%
Newfoundland and Labrador	N/R	N/R
Total	**7,950.2**	**0.35%**

(Source: Guidehouse, Efficiency Canada)

The low net incremental energy savings for Alberta in 2020 illustrates the significant opportunity gap between realized and potential savings. As part of Guidehouse's *Energy Efficiency Alberta 2019-2038 Energy Efficiency and Small-Scale Renewables Potential Study*, it was estimated that Alberta could generate an average of 350 GWh and 1,395 TJ in incremental electricity and gas savings annually (excluding O&G) over the study period, respectively. The savings figures

[31] Ibid.
[32] Ibid.

reported in 2020 account for only 13% (natural gas) and 15% (electricity) of these projected potentials.[33]

With a high number of industrial customers in the province, Alberta has a particularly valuable opportunity for reducing energy costs. Studies have demonstrated the cost-effectiveness and impact of energy efficiency in reducing industrial energy usage specifically:

- Savings from large customers can often be acquired at a lower cost than programs targeted at other sectors, and on a national level, the industrial sector saves more energy per program dollar than other customer classes.[34]
- The California Public Utilities Commission *Energy Efficiency Portfolio Report* found that, in keeping with past trends, industrial customer segments contributed the largest share of natural gas savings throughout the 2013-2015 program cycle.[35]
- Canadian energy efficiency reports have estimated that energy management could save up to 30% of industrial energy use.[36]
- According to the International Energy Agency, by 2050, appropriate policies could decrease industrial energy intensity by 38%.[37]
- ACEEE published the results from a selection of energy efficiency programs and found that commercial and industrial (C&I) customers contribute an average of 55% of total energy efficiency program savings. In Oregon, C&I programs delivered approximately 70% of energy efficiency program savings.[38]

For total energy savings in all sectors, the US has demonstrated significantly greater net incremental savings:

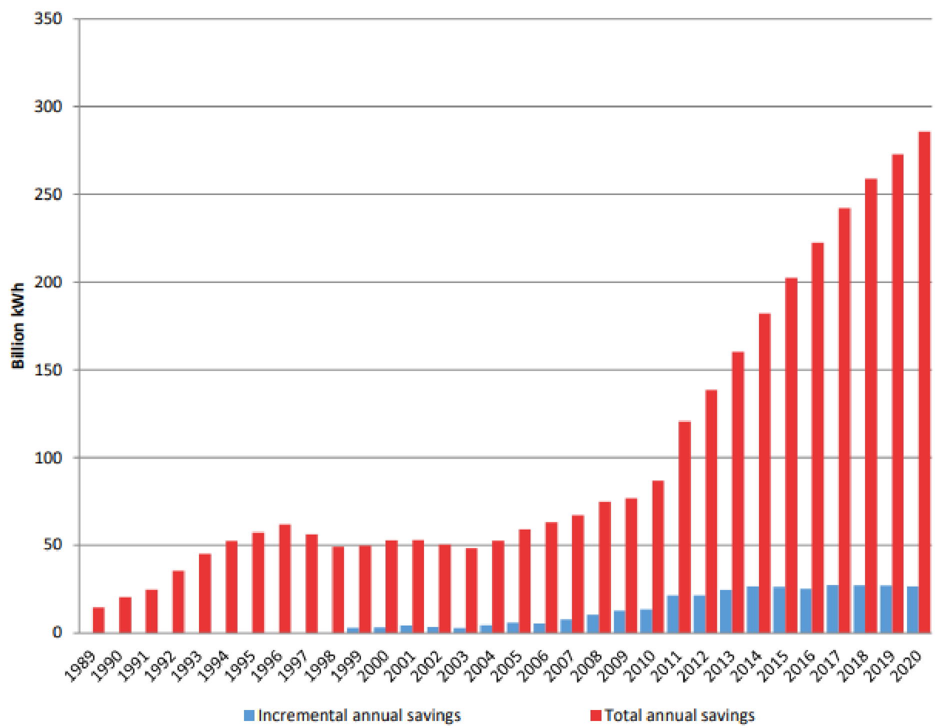
- In the US, energy efficiency programs generated particularly significant electricity savings in 2020, accounting for 26,600 GWh in net incremental savings, or approximately 0.7% of annual consumption. Cumulative savings increased dramatically over the same period, reaching 286,000 GWh in 2020, or approximately 7.7% of 2020 electricity consumption (Figure 3-3).[39]
- Consistently funded, well-designed efficiency programs are cutting electricity and natural gas load—providing annual savings for a given program year of 0.15% to 1% of energy sales; savings will typically accrue at this level for 10 to 15 years. These programs are

[33] Energy Efficiency Alberta 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018
[34] Everyone Benefits When Everyone Pays: The Importance of Keeping Large Customers in Utility Programs, ACEEE
[35] Energy Efficiency Portfolio Report, California Public Utilities Commission, May 2018
[36] Canadian Strategic Energy Management Market Study, ACEEE, 2021
[37] International Energy Agency and Natural Resources Canada, “Energy Efficiency Potential in Canada to 2050”
[38] Everyone Benefits When Everyone Pays: The Importance of Keeping Large Customers in Utility Programs, ACEEE
[39] State Energy Efficiency Scorecard: 2021 Progress Report, ACEEE, 2021

helping to offset 20% to 50% of expected cost growth in some regions without compromising end-user activity or economic well-being.[40]

These examples and Figure 3-3 illustrate an important point; energy efficiency is similar to energy capacity in that incremental additions offer only a snapshot of what is actually happening; cumulative savings offer the full picture.

Figure 3-3. Electric Savings from Utility Energy Efficiency Programs[41]

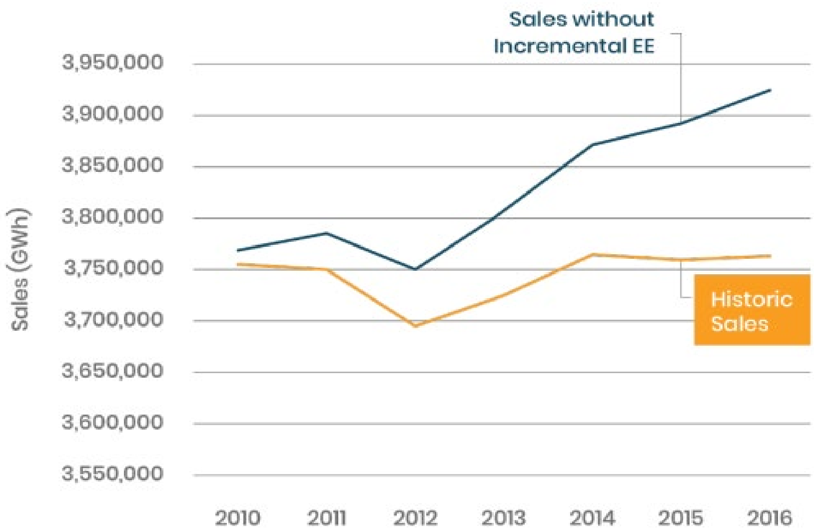


(Source: ACEEE)

The long-term impacts of energy efficiency in reducing energy usage are shown in Figure 3-4. Despite the proliferation of energy-consuming products, energy efficiency has essentially flattened historical load growth in the US. While load growth isn't likely to remain relatively flat, due to increasing electrification of transportation and heating in the US, energy consumption will grow more slowly than under a business-as-usual or no energy efficiency case.

[40] Energy Efficiency Program Best Practices, US Environmental Protection Agency, 2015
[41] State Energy Efficiency Scorecard: 2021 Progress Report, ACEEE, 2021

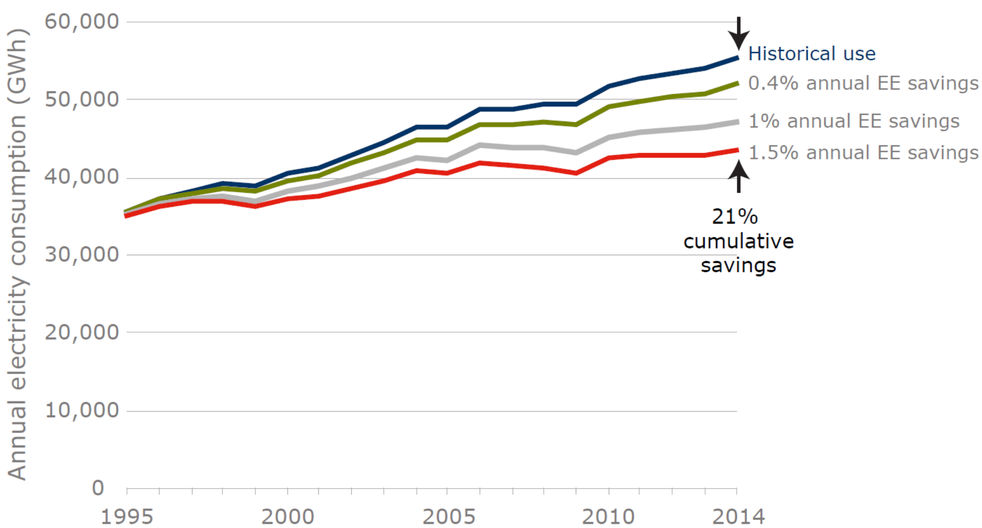
Figure 3-4. US Total Energy Sales, Energy Efficiency Scenarios[42]



(Source: VEIC)

Figure 3-5 demonstrates the difference of annual incremental electricity savings versus cumulative savings if DSM programs were actively deployed in Alberta over a 20-year historical timeframe. Depending on the aggressiveness of the approach, savings of greater than 20% over 20 years can be achieved with commensurate savings in generation and T&D expenses.

Figure 3-5. Province-Wide Electricity Consumption Under Different Efficiency Scenarios[43]



(Source: AEEA)

[42] The Value of Energy Efficiency: Past Successes and Future Strategies, 2021
[43] A Better Way to Manage Utility Costs in Alberta, Alberta Energy Efficiency Alliance, 2017

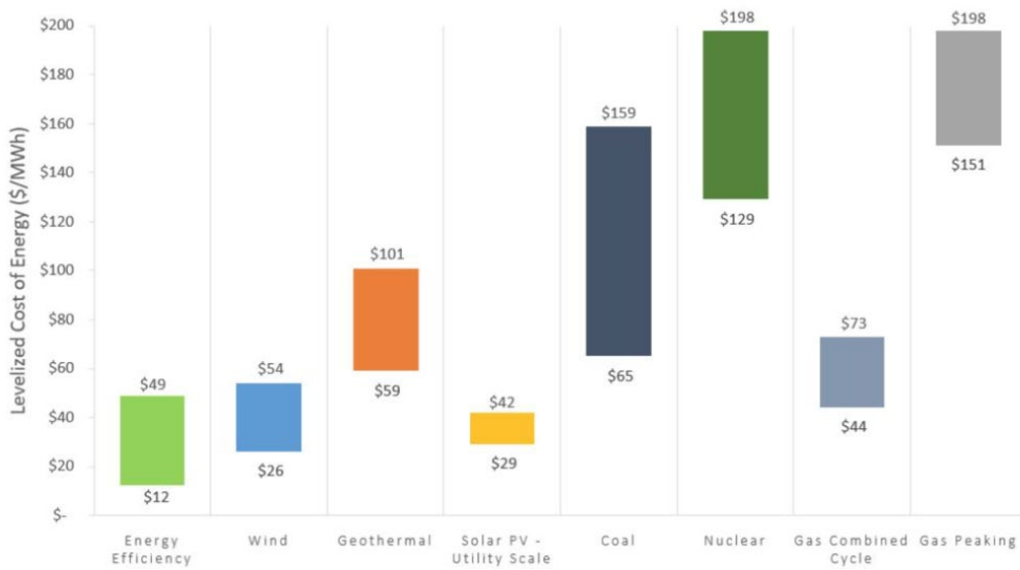
These findings were also demonstrated as part of Guidehouse's *2019-2038 Energy Efficiency and Small-Scale Renewables Potential Study*, which estimates that Alberta could generate 7,008 GWh in cumulative electricity savings and 27,892 TJ in cumulative gas savings by 2038 (excluding O&G). These scenarios result in average electricity savings (as a percentage of forecast consumption) of approximately 13% and natural gas savings of 6%.[44] In jurisdictions like Alberta, realized natural gas savings are increasingly critical as they enable utilities to reduce or avoid carbon taxation costs.

The underlying conclusion behind these findings is that energy efficiency and other DSM, when levelized, cost less than electricity supply options. In other words, reducing consumption is less expensive than increasing capacity. According to *The Value of Energy Efficiency* study, the average utility cost of delivered saved energy from DSM is approximately 2.5 cents per kWh on a levelized (lifetime) basis.[45] This aligns with ACEEE's *National Review of the Cost of Energy Saved* estimate of 2.5 cents per kWh of delivered saved energy, with state-level estimates ranging from 1.6 cents per kWh to 3.3 cents per kWh. The same study estimated an average cost of saved energy from natural gas programs of $0.37 per therm ($3.51 per GJ), with state-level estimates ranging from $0.27 per therm ($2.56 per GJ) to $0.55 per therm ($5.21 per GJ).[46] Note that these savings are from jurisdictions with natural gas prices significantly higher than Alberta. An Alberta-based natural gas DSM program would likely target measures with greater cost-effectiveness given the lower price of gas typically available in the province.

In Figure 3-6, the net utility costs of electrical efficiency are shown relative to conventional and renewable electricity supply alternatives (note that T&D costs to deliver the energy are not included in the figure).

[44] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018
[45] The Value of Energy Efficiency: Past Successes and Future Strategies, Synapse Energy, 2021
[46] Saving Energy Cost Effectively: A National Review of the Cost of Energy Saved Through Utility-Sector Energy Efficiency Programs, ACEEE, September 2009

Figure 3-6. Levelized Cost of Electrical Energy Efficiency and Supply[47]



(Source: ACEEE)

The omittance of T&D costs from levelized cost analyses can mask the true value of energy efficiency relative to supply-side resources. For example, the T&D costs (i.e., upgrades) associated with Alberta's energy system were approximately $59 per MWh in 2018.[48] When applied to even the low end of the renewable energy options presented in Figure 3-6, the cost justification of energy efficiency becomes astutely clear. Energy efficiency not only presents the lowest cost energy supply resource but also offers benefits around local economic development, load balancing capabilities, improvements in building stock quality, productivity, and public health.[49] Figure 3-7 summarizes the key findings from this section.

Figure 3-7. Key Findings Summary

Key Findings
1. Alberta ranks as one of the lowest provinces in realized energy savings to date for both electricity and natural gas.
2. Cumulative energy savings, rather than incremental savings, is the more appropriate indicator of overall efficacies and impacts surrounding energy efficiency and other DSM programs.

[47] The Cost of Saving Electricity for the Largest U.S. Utilities: Ratepayer-Funded Efficiency Programs in 2018, ACEEE, June 2021

[48] The Price of Power: Comparative Electricity Costs across Provinces, C.D. Howe Institute, October 2020

[49] Energy Efficiency and Electric Vehicles, Rocky Mountain Institute, 2018

3. When levelized, the cost of delivering energy efficiency and other DSM is often lower than capacity or infrastructure alternatives.

(Source: Guidehouse)

3.2 *Peak Demand Reductions*

In addition to the electricity and natural gas savings potential discussed earlier, DSM programs can deliver capacity savings through reductions in maximum (peak) demand for energy. Canada's electricity usage rose by about 3% in 2021[50] and, according to the *AESO 2021 Long-Term Outlook*, peak load in Alberta is projected to grow from 11,771 MW in 2021 at an average annual rate of 0.5% (reference case) or 2.0% (cleantech case) through 2041, aided in part by incremental load from EV charging. This equates to peak demand of over 13,000 MW under the reference case, and nearly 17,500 MW under the cleantech case, by 2041.[51]

The macrotrends underlying these growth projections are:

- Alberta's EV market and associated infrastructure has been growing, supported by strong federal funding and vibrant community engagement.[52] Guidehouse experts project that EV sales in Alberta are expected to increase by a factor of 15 over the next decade, increasing from ~2% of light duty vehicles sales in 2021 to ~27% by 2030.[53] AESO is projecting a similar uptick in provincial EV adoption, with impacts on peak power demand ranging from 400 MW to 3,900 MW.[54]

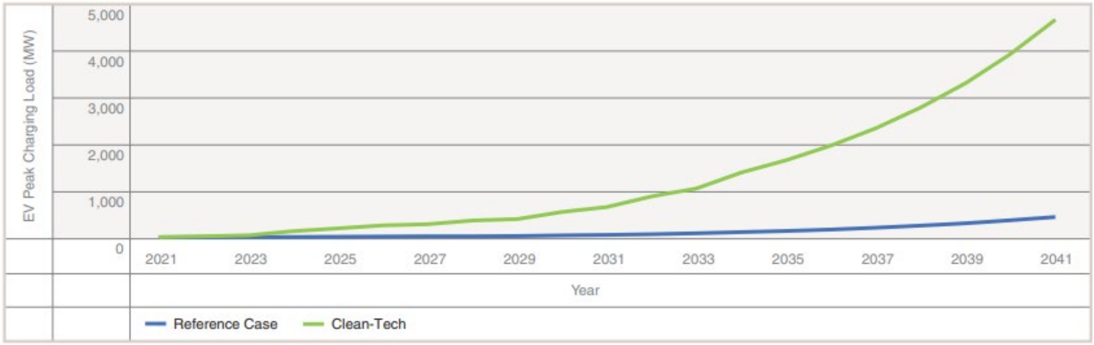
- In January 2022, Alberta set a record for electricity usage during a bitterly cold stretch of weather.[55] This follows an unprecedented heatwave in the summer of 2021, where energy usage surged to surpass previously recorded peak demand.[56] Weather-related drivers were also responsible for the Texas power crisis of February 2021; in that instance, more proactive planning around extreme weather events and reducing energy demand (rather than adding capacity) were cited as future mitigation solutions.

These emerging trends are leading to imbalances in traditional peak demand profiles due to increasing congestion in power systems and peak load brought about by EVs, and new peak demand periods (e.g., summer and winter peaks) created by extreme weather events. This creates operational pressures for grid operators from potentially overloaded equipment and financial pressures for customers from higher demand charges and wholesale market prices. For example, the addition of a single EV on a residential transformer is comparable to two

[50] Electricity Market Report, International Energy Agency, 2022
[51] AESO 2021 Long-term Outlook, AESO, 2021
[52] Alberta Energy Transition, DELPHI.ca, 2021
[53] Market Data: EV Geographic Forecast – North America, Guidehouse Insights
[54] AESO 2021 Long-term Outlook, AESO, 2021
[55] Cold Snap Sees Alberta Hit Electricity Use Record, CBC News, 2022
[56] ENMAX 2023 Cost of Service Application

households from a load management perspective.[57] Figure 3-8 shows the anticipated growth in incremental peak demand attributed to EVs in Alberta.

Figure 3-8. Incremental Peak Load Attributed to EVs[58]



(Source: AESO)

While other jurisdictions are also concerned about the potential distribution impacts of increased demand from EVs and other factors, some are concluding that these peak demand pressures can be managed through energy efficiency programs, DR, managed charging, and time-of-use (TOU) rates.[59] Many regional studies have found that pursuing untapped DSM could yield significant reductions in peak demand:

- Berkeley Labs published results from DSM programs from nine US states, representing 43% to 49% of national energy efficiency spending during the 2014-2016 period. According to this study, the average first-year cost of saving peak demand was $1,483 per kW if peak demand reductions were the only goal of the programs.[60] As energy efficiency programs are primarily used for reducing total consumption, the peak demand savings are a shared benefit from these programs.

- In the Southeastern US, annual incremental energy efficiency increases of only 0.75% above business-as-usual will be more than capable of offsetting the high energy demand scenario's added EV 2040 summer and winter peak load.[61]

- According to the National Renewable Energy Laboratory (NREL), the use of integrated, smart EV charging could eliminate peak period EV charging and reduce the daily peak demand from EVs by 23%.[62] This is supplemented by other studies that show energy

[57] Non-Wires Alternatives Study, Guidehouse, 2020
[58] AESO 2021 Long-Term Outlook, AESO, 2021
[59] Submission to the Alberta Utilities Commission, Energy Efficiency Alberta, 2020
[60] Using Energy Efficiency to Meet Peak Electricity Demand, NARUC, 2019
[61] Submission to the Alberta Utilities Commission, Energy Efficiency Alberta, 2020
[62] Incorporating Residential Smart Electric Vehicle Charging in Home Energy Management Systems, NREL, 2021

efficiency and DR to be more cost-effective solutions than smart charging.[63] This highlights the potential value in integrated DSM leveraging multiple programs.

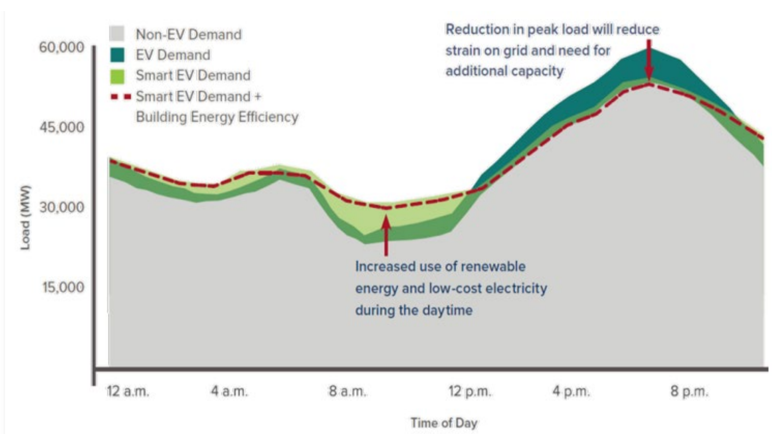
- According to the U.S. Environmental Protection Agency (EPA), many state and regional studies have found that pursuing economically attractive but as yet untapped energy efficiency could deliver more than 20% savings in total US electricity demand from 2015-2025. These savings could help cut load growth by half or more. Savings in direct use of natural gas could similarly provide a 50% or greater reduction in natural gas demand growth.[64]

- SoCalGas's Seasonal Savings program for residential customers with a smart thermostat resulted in 8% gas heating savings during the winter of 2016-2017. The MA DOER Nest Seasonal Savings programs resulted in a 3.5% heating savings in the winter of 2014-2015 (73% of participants had gas fueled heating furnaces)—including significant results on the 10 peak days.[65]

- Fort Collins Utilities, in Colorado, estimates annual savings of 2,023 MWh of electricity with significant winter peak demand savings of 1,850 kW at a TRC of $1.8 cents per kWh.[66]

Figure 3-9 illustrates the impact of widespread deployment of smart EV charging and building energy efficiency on peak electric growth in California. These measures have a payback of less than 4 years and achieve about a 7% reduction in statewide hourly electricity use. Paired with smart EV charging to control charging times, the peak evening load can be reduced to entirely offset EV electricity use.

Figure 3-9. Energy Efficiency and Smart Charging for Peak Demand Management[67]



(Source: Rocky Mountain Institute)

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[63] Non-Wires Alternatives Study, Guidehouse, 2020
[64] Energy Efficiency Program Best Practices, US Environmental Protection Agency, 2015
[65] Demand Response for Natural Gas Distribution, The Brattle Group, June 2018
[66] Energy Efficiency Program Best Practices, US Environmental Protection Agency, 2015
[67] Energy Efficiency and Electric Vehicles, Rocky Mountain Institute, 2018

These findings demonstrate the clear capacity benefits that energy efficiency, in conjunction with DR and smart charging, can provide. Table 3-4 lists the net incremental capacity savings generated by energy efficiency and DR resources for each Canadian province in 2020, averaging 0.5% and 1.8%, respectively. This demonstrates the peak demand reductions that can be added in a single year from energy efficiency and DR.

Table 3-4. Net Incremental Electricity Capacity Savings by Province, Canada 2020[68]

Province	Energy Efficiency Savings (% of Peak Demand)	DR Savings (% of Peak Demand)	Total Savings (% of Peak Demand)
Manitoba	0.3%	3.6%	3.9%
Ontario	0.2%	3.3%	3.5%
Saskatchewan	N/R	1.8%	1.8%
Newfoundland and Labrador	0.6%	0.9%	1.5%
Nova Scotia	1.2%	N/R	1.2%
Quebec	0.2%	0.9%	1.1%
Prince Edward Island	0.9%	N/R	0.9%
New Brunswick	0.2%	0.3%	0.5%
British Columbia	0.3%	N/R	0.3%
Alberta	N/R	N/R	N/R
Average	**0.5%**	**1.8%**	**1.6%**

(Source: Guidehouse, Efficiency Canada)

Although Alberta did not report net incremental capacity savings as part of Efficiency Canada's *2021 Canadian Provincial Energy Efficiency Scorecard*, Guidehouse has performed multiple studies to explore the potential impacts of energy efficiency and other DSM programming in reducing provincial peak demand. According to these studies, Alberta has an opportunity to generate significant demand savings through DSM while alleviating anticipated grid pressures over the next 10 to 20 years:

- In a study completed for Alberta, Guidehouse determined that energy efficiency, residential DR, and smart charging could cost-effectively avoid peak demand increases due to EV adoption for the study period (2020-2030). Under the base scenario, a combination of several DR and energy efficiency measures would be sufficient to cover incremental transformer peak requirements modeled in the study, without implementing smart charging.[69]

[68] 2021 Canadian Provincial Energy Efficiency Scorecard, Efficiency Canada
[69] Non-Wires Alternatives Study, Guidehouse, 2020

- In an alternative study, Guidehouse estimated that Alberta could generate cumulative peak (winter) demand savings of approximately 919 MW by 2038 (excluding O&G).[70] Based on the *AESO 2021 Long-Term Outlook,* these savings would equate to approximately 7% of peak demand in 2038 under the reference case, and 6% under the cleantech scenario. [71]

Energy efficiency and other DSM tools that can incentivize off-peak charging to reduce system demand are logical solutions given the alternative of high-cost peak electricity prices and increased investment in transmission and distribution (T&D) capacity. More utilities are looking for mechanisms beyond traditional upgrades to defer costly grid investments. These findings have given rise to the emerging non-wires and non-pipes alternatives (NPAs) use cases that are profiled within the next section. Figure 3-10 shows a summary of the key findings from this section.

Figure 3-10. Summary of Key Findings

Key Findings
1. Both Canada are Alberta are expected to see continuous growth in peak demand over the next decade due to an increase in EV adoption and more frequent extreme weather events, among other drivers.
2. The increasing frequency and volatility of peak demand is placing new pressures on system operators, utilities, and consumers.
3. Studies have shown the efficacy of using low-cost approaches, such as energy efficiency, DR, and other DSM, to address the growing pressures of peak demand.

(Source: Guidehouse)

3.2.1 Capital Asset Investment Deferral

The definition of an NWA varies across Canada, the US, and globally. There are also slight variations in names for NWAs throughout the industry, including non-transmission alternatives, non-wires solutions, and more recently, NPAs, as applicable fuel sources expand from electricity to include natural gas. An inclusive definition, and the one used in this white paper, combines a variety of assets that can be used to defer or replace the need for more traditional upgrades. More specifically, this paper defines an NWA as:

[70] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018
[71] 2021 Long-Term Outlook Data File, AESO, 2021

A grid investment or project that uses non-traditional T&D solutions, such as distributed generation (DG), energy storage, energy efficiency, DR, and grid software and controls, to defer or replace the need for specific equipment upgrades, such as T&D lines, pipes, or transformers, by reducing system demand.

More than 100 NWA projects are in various stages of planning and implementation throughout the US.[72] The first NWA projects consisted mainly of targeted DSM to reduce distribution constraints. In 2022, the best-known distribution-side projects rely on targeted DSM, including the Brooklyn Queens Demand Management (BQDM) program, which has deferred $1.2 billion in traditional upgrades.[73] The results from several NWA programs are presented in Table 3-5.

Table 3-5. Summary Findings for NWA Case Studies[74]

Utility	Type	Description
Arizona Public Service	DER	The Punkin Center battery energy storage system (BESS) is an innovative example of using DER for NWA. This 2 MW, 8 MWh BESS provided Arizona Public Service a more cost-effective alternative to stringing 17 miles of wire over rough terrain. In addition to feeder-level wires capacity deferment, the storage system also counts for avoided generation capacity.[75]
Bonneville Power Administration	DR	Bonneville Power also found substantial savings through NWA. The utility canceled a $1 billion transmission line and is instead using DR to manage line congestion rather than overbuilding for a few peak hours of demand each year.
Central Maine Power	EE, DR, DER	Costs for the project were estimated at around $6 million. Maine ratepayers saved over $12 million compared with a stranded transmission asset that turned out was not needed.
Central Hudson Gas and Electric	EE, DR	Central Hudson achieved more than 30% participation of eligible customers within the targeted zone (Fishkill) with the most capacity need. The utility exceeded the total first-year megawatt target for all three zones, achieving 5.9 MW of load reduction compared with the target of 5.3 MW.
Consolidated Edison	EE, DR	The BQDM program helped to meet objectives by implementing both traditional and non-traditional customer-side and utility-side solutions. Savings have successfully delayed the buildout of a new substation as the New York Public Service Commission approved a $200 million budget beyond the initial load relief projections.
National Grid	EE, DR	In conjunction with other projects, the Tiverton NWA Pilot deferred a $2.9 million feeder project over 5 years. The effort has remained cost-effective over its life, with a benefit-cost ratio of 1.40.

[72] Non-Wires Alternatives Tracker, Guidehouse Insights, 2019
[73] Non-Wires Alternatives: Case Studies from Leading U.S. Projects, E4 The Future, November 2018
[74] Ibid.
[75] Arizona Public Service Punkin Center Energy Storage Project, AEIC, 2019

Xcel Energy	EE, DR	In Minnesota, a small-scale NWA pilot successfully saved 576 kW of peak electricity across two small communities, higher than the pilot goal of 500 kW. The pilot cost came to $163,000, within the estimated range of a 1-year deferral.[76]

(Source: Guidehouse, E4 The Future)

In a handful of cases in the US, NWAs also substantially reduced the potential stranded costs that would have resulted from investing in unnecessary infrastructure upgrades and then finding that forecast load growth did not materialize.[77]

The valuation of benefits from energy efficiency and other DSM programs in the context of NWA and NPA will vary depending on location, systemwide impacts, and time of day or year.[78] One common metric used in determining the fiscal impact of DSM on T&D infrastructure investment is avoided T&D costs.

Table 3-6 presents several estimates of the avoided T&D costs delivered through utility DSM programming.

Table 3-6. Avoided T&D Costs from DSM, Jurisdiction Scan

Utility	Avoided Distribution Costs ($ per kW-Year)	Avoided Transmission Costs ($ per kW-Year)	Avoided T&D Costs ($ per kW-Year)
Massachusetts Electric[79]	$102.48	$94.00	$196.48
Narragansett Electric[80]	$80.24	$94.00	$174.24
PSC of New Hampshire[81]	$79.98	$94.00	$173.98
Connecticut Light and Power[82]	$14.05	$94.00	$108.05
Focus on Energy[83]	N/A	N/A	$66.47
Pacific Gas and Electric[84]	$23.70	$14.70	$38.40
Portland General Electric[85]	$22.40	$10.80	$33.20

(Source: Guidehouse, Footnote Sources)

[76] Non-Wires Alternatives as a Path to Local Clean Energy: Results of a Minnesota Pilot, Center for Energy and Environment, 2021

[77] Ibid.

[78] Everyone Benefits: Practices and Recommendations for Utility System Benefits of Energy Efficiency, ACEEE, June 2015

[79] Avoided Energy Supply Components in New England: 2021 Report, Synapse Energy, March 2021

[80] Ibid.

[81] Ibid.

[82] Ibid.

[83] Ibid.

[84] Best Practices in Energy Efficiency Program Screening, Synapse Energy, July 2012

[85] Ibid.

The development of NPA has been slower, with New York accounting for the majority of NPA projects to date. While only a handful of utilities have undertaken NPA projects to date, multiple programs and studies have been initiated to analyze the savings potential of DSM programming for NPA[86]:

- In response to National Grid's *FY 2022 Gas Infrastructure, Safety and Reliability Plan*, it was determined that weatherization and electrification would cost significantly less than any of the energy facilities National Grid had proposed to resolve its current peak gas constraint.[87]

- In 2018, Enbridge and Union Gas commissioned a study on the potential impact of targeted DSM on natural gas infrastructure investment. On average, the maximum achievable potential for peak demand savings from aggressive DSM implementation ranged from about 1.05% of peak demand per year in the Enbridge service territory to 1.24% of peak demand per year in the Union Gas service territory.

- According to The Brattle Group, the deferral of a theoretical $100-$500 million gas pipeline or liquified natural gas (LNG) peak-shaving investment in New England would be expected to save between $10 million and $70 million per year (assuming 5% to 10% cost-of-capital and 30-year depreciation).[88]

- Central Hudson commissioned a study on the avoided cost of its distribution system. Based on this study, the Vassar Road (PN) System was identified as highly relevant for an NPA project. The utility conducted a simplified cost-benefit analysis to compare the incremental costs of higher incentives and the benefits associated with targeted load reductions in the PN line and determined smart thermostats to be the most cost-effective measure.

Although Table 3-5 and Table 3-6 provide a snapshot into the landscape of NWA and NPA, Guidehouse Insight's *Non-Wires Alternatives* tracker can provide more granular visibility. Among tracked projects, energy efficiency was found to be the most commonly used solution for NWA, followed closely by DR.[89] At the aggregate level, several studies also show an increasing use and cost-effectiveness of DSM programming as NWA:

- In the US, energy efficiency programs created nationwide net savings of more than $4.1 billion from reduced spending on electricity generation and T&D infrastructure.[90]

[86] Integrated Resource Planning Proposal – Additional Evidence, Enbridge Gas Inc., October 2020

[87] Re: Docket No. 5099 – National Grid 's FY 2022 Gas Infrastructure, Safety and Reliability Plan, Acadia Center, March 2021

[88] Demand Response for Natural Gas Distribution, The Brattle Group, June 2018

[89] Non-Wires Alternatives Tracker, Guidehouse Insights, 2019

[90] The Value of Energy Efficiency: Past Successes and Future Strategies, VEIC, 2021

- According to the Rocky Mountain Institute, non-wires solutions can improve the system benefits of DER deployments and help realize over $17 billion in additional net present value from DER through 2030 across the US.[91]

- Increasing the current global energy efficiency retrofit rate in buildings from approximately 1% per year to just over 5% per year can achieve at least 30% energy savings and can accommodate global baseline adoption of 550 million EVs on the road through 2040 without increasing generation capacity dramatically.[92]

- Several jurisdictions are now requiring that utilities consider non-wires solutions in their plans to meet energy needs, including British Columbia, New York, California, and Rhode Island. Maine and Vermont also have been working to encourage or require consideration of non-wires alternatives.[93]

These positive indications of the benefits of NWA have also been found for Alberta. In 2020, Guidehouse conducted a study that assessed the value of energy efficiency in reducing EV costs imposed on Alberta's electric distribution system. This study demonstrated the potential impact of managed charging programs in supporting NWA projects. In both the base and aggressive EV adoption scenarios, the portfolio of NWA was found to be significantly less expensive than the traditional wires investment. Table 3-7 shows the benefit-cost ratios for both the base and aggressive scenarios of EV adoption in Alberta.

Table 3-7. Non-Wires Alternatives vs. Traditional Wires Investment[94]

Scenario	P.V.[95] of Traditional Wires Investment Cost	P.V. of NWA Cost	Benefit-Cost Ratio
Base	$10,524	$442	**23.8**
Aggressive	$12,792	$5,178	**2.5**

(Source: Guidehouse)

The study included a number of supplemental findings[96], including:

- For the Base scenario in 2030, energy efficiency and DR alone can mitigate the constraints of slightly overloaded transformers.

- Due to the conservative nature of this study, the portfolio of non-wires alternatives is likely more cost-effective than stated. This study assumed aggressive EV adoption,

[91] The Non-Wires Solutions Implementation Playbook, Rocky Mountain Institute, 2018
[92] Energy Efficiency and Electric Vehicles, Rocky Mountain Institute, 2018
[93] Modernizing the Electric Grid: State Role and Policy Options, NCSL, 2019
[94] Non-Wires Alternatives Study, Guidehouse, 2020
[95] Present Value (P.V.) refers to the value of future dollars in present day terms
[96] Non-Wires Alternatives Study, Guidehouse, 2020

presented a conservative valuation of DR, and considered only distribution costs for the traditional wire's investment—all factors that contribute to a lower cost-benefit ratio.

- The scalability of NWA can allow for flexible, cost-effective mitigation of transformer loading. This study has shown the relationship between overloading and cost-effectiveness is non-linear - costs escalate as the overloading on the transformer increases. The scalability of NWA allows for precise control of what is acquired.

However, even with managed charging, system upgrades may still be needed, particularly for substations and transformers. Instead of traditional investments, utilities could work hand-in-hand with their customers to implement NWA. Some possibilities here might include DER solutions such as onsite energy storage—either in front of or behind the meter (BTM)—more intelligent, grid-edge software, or the use of an onboard vehicle battery with vehicle-to-grid technology. Such strategies could help avoid significant grid investments that could become stranded assets if a significant number of EVs move out of an area (e.g., a fleet relocation), another vehicle technology emerges, or another charging preference evolves within a community.[97]

Using energy efficiency and other DSM as NWAs and NPAs is impactful as it can deliver cost savings to participants and non-participants through lower rates and reduced supply-side costs and risks. These rate and bill impact considerations are discussed in the following section.

Figure 3-11 shows a summary of the key findings from this section.

Figure 3-11. Summary of Key Findings

Key Findings
1. The use of DSM as an approach to NWAs is becoming increasingly popular, with several jurisdictions now requiring that utilities consider non-wires solutions in their plans to meet energy needs.
2. The use of DSM as an approach to NPAs is growing in interest where customers rely on gas to heat their homes and water.
3. DSM as an NWA is expected to grow in importance with an increased uptake in EVs.

(Source: Guidehouse)

[97] Ibid.

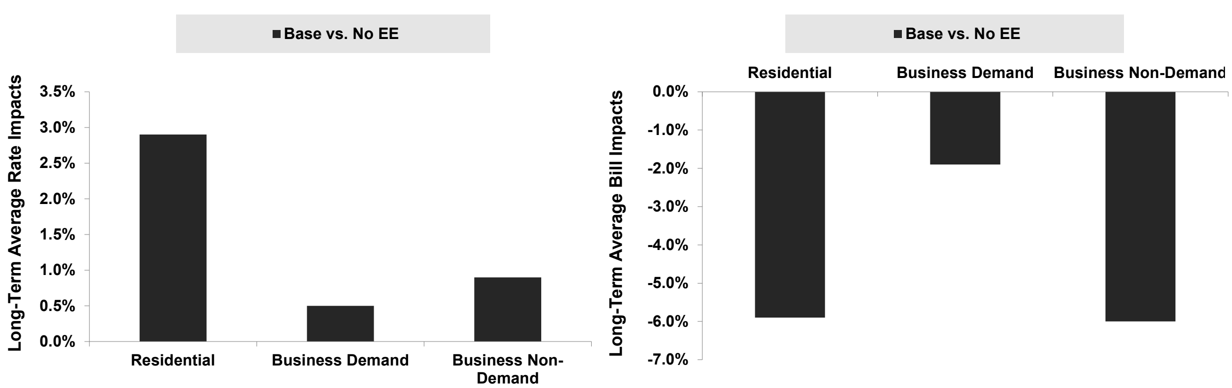
3.3 *Rate Changes and Bill Impacts*

Energy prices have been on the rise throughout Canada. In Alberta, energy prices increased by 34% between November 2020 and 2021.[98] This is due to a combination of factors, including relatively high wholesale market prices, a colder-than-normal winter, and energy providers' variable-based (i.e., floating) pricing models. With future markets for both electricity and natural gas listing high, Alberta's energy rates could remain high through the first quarter of 2023.[99] These short-term impacts are susceptible to becoming long-term trends due to accelerating pressures on system demand, discussed in Section 3.2, including the adoption of EVs, frequency of extreme weather events, etc.

Before analyzing the financial impacts of DSM on utility ratepayers, it is important to differentiate rate changes and bill impacts associated with energy efficiency and other DSM programs. Rates refer to average energy and T&D charges (e.g., $/kWh or $/GJ), whereas bills refer to the actual dollar amount paid (e.g., kWh or GJ usage multiplied by the rate plus fixed charges). Thus, energy affordability can be improved by offering lower rates and supporting lower consumption.

Figure 3-12 shows the long-term rate impacts and average bill impacts by sector for a base energy efficiency versus a no energy efficiency scenario. In this scenario, rates across customer classes increase between 0.5% and 3% while the average bill savings are 2 to 6 times greater than the rate increases.[100] These figures illustrate the disproportionate impact that DSM programs can have on lowering customer bills relative to associated rate increases.[101]

Figure 3-12. Efficiency Vermont (EVT) Long-Term Rate and Bill Impacts by Sector: Scenario Comparison[102]



(Source: Guidehouse, Synapse Energy)

[98] Electricity Bills on the Rise in Calgary after 'Significant' Increase in Demand, Global News, 2022

[99] Alberta Utility Bills Expected to Remain High Throughout 2023, Global News, 2022

[100] Rate and Bill Impacts of Vermont Energy Efficiency Programs, Synapse Energy, April 2014

[101] As Vermont utilities are vertically integrated, the electricity charge is a bundled rate that includes all rate components. The rate components include a generation charge, a transmission charge, a distribution charge, and a charge for other taxes and fees.

[102] Rate and Bill Impacts of Vermont Energy Efficiency Programs, Synapse Energy, April 2014

DSM program costs may add a few dollars to the monthly distribution rate, however, the cumulative energy savings delivered from these programs have been shown to have a greater impact in reducing total customer bills. In terms of customer perception, DSM program surcharges may be listed as a specific line item on monthly bills, or can be bundled as a component of a larger cost category (e.g., distribution).

A review of the bill impacts from several DSM programs provided the following results:

- The 2018-2020 EmPOWER Maryland program is among the most aggressive in the US with an incremental annual energy savings target of 2% per year. This approach costs an average of $4.53 for energy efficiency and $2.37 for DR per monthly residential bill, respectively, but results in significant cumulative energy savings (approximately 29% reduction in electricity consumption for five utilities from 2008 to 2019).[103]
- With a less aggressive approach, South Carolina Electric and Gas is projecting average long-term net bill impacts of -1% and -2% through 2037, depending on the scenario, relative to no energy efficiency.[104] This indicates a reduction in overall bills even when program costs are taken into account.

Table 3-8. EmPOWER Maryland 2019 Bill Impacts and Energy Savings[105]

Utility	Energy Efficiency	DR	EE and DR Charge (% of Monthly Bill)	Cumulative Savings (% Reduction in Energy Charges from 2008 to 2019 due to EE and DR)
Baltimore Gas and Electric	$3.91	$3.22	6.7%	33.7%
Delmarva Power and Light	$3.71	$1.21	2.9%	17.6%
Potomac Edison	$5.82	N/A	4.9%	15.3%
Potomac Electric	$4.29	$2.96	5.7%	37.6%
Southern Maryland Electric Cooperative	$4.90	$2.08	4.7%	12.1%
Total	**$4.53**[106]	**$2.37**[107]	**4.9%**	**28.5%**

(Source: Guidehouse, PSC of Maryland)

At an aggregate level, studies have shown similar results.

- *The Value of Energy Efficiency* study, published by Synapse Energy, found that every US state is expected to experience lower bills as a function of energy efficiency in 2030,

[103] The EmPOWER Maryland Energy Efficiency Act Report OF 2020, PSC of Maryland, April 2020
[104] Reinvigorating SCE&G's Energy Efficiency Programs, Synapse Energy, 2016
[105] The EmPOWER Maryland Energy Efficiency Act Report OF 2020, PSC of Maryland, April 2020
[106] This refers to 'average' values
[107] Ibid.

with average net residential bill savings ranging between $64 and $147 between 2016 and 2030, depending on the scenario.[108]

- The U.S. EPA issued results on lifetime customer bill reductions from multiple utility energy efficiency programs. Based on four profiled case studies, average spending on energy efficiency was approximately $86.5 million, and estimated bill savings were approximately $270 million.[109]
- In Wisconsin, Focus on Energy has delivered $100 million and $21 million in first-year electricity and natural gas bill savings[110] for program participants, respectively. Lifecycle bill savings are expected to reach $1.45 billion for electric customers and $335 million for natural gas customers through 2044.[111]
- In Massachusetts, natural gas DSM programs are delivering bill savings between 2% and 30% for residential program participants, depending on the measures installed.[112]
- As part of the Clean Energy Jobs Act, Illinois estimated potential natural gas bill savings in excess of $700 million in 2020 as part of new gas efficiency programs, when accounting for utility program costs. This is expected to grow to approximately $800 million (even in inflation-adjusted terms) within 5 years. The new programs will produce nearly four dollars in reduced natural gas bills for every efficiency program dollar spent. [113]

For Alberta specifically, investment in DSM programs may begin on the lower end of the spectrum. This should not be considered a barrier to DSM program development. Considering a conservative energy efficiency budget scenario of $50 million annually, it is estimated that the average residential bills would increase by approximately $0.38 per month. Expanding this province-wide budget scope to $150 million annually would result in bill increase of approximately $1.42 for a monthly residential bill.[114] While these costs are less than 1% of monthly bills (with a similar impact on nonresidential customers), the benefits of a $150 million per year program over 20 years are greater than $1 billion of direct savings for every year of programming.[115]

Indirect savings also occur for all consumers as reduced demand generally results in lower wholesale market prices:[116]

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[108] The Value of Energy Efficiency: Past Successes and Future Strategies, VEIC, 2021
[109] Energy Efficiency Program Best Practices, US Environmental Protection Agency, 2015
[110] Reported as biennium (2019-2020) first-year electricity and natural gas savings
[111] Focus on Energy 2019–2020 Biennium Economic Impacts, Cadmus, February 2022
[112] Natural Gas Energy Efficiency in Massachusetts, Department of Public Utilities
[113] Gas Efficiency Saves money and Builds a Stronger Illinois: Fact Sheet, NRSC, April 2019
[114] Submission to the Alberta Utilities Commission, Energy Efficiency Alberta, 2020
[115] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018
[116] Submission to the Alberta Utilities Commission, Energy Efficiency Alberta, 2020

- ComEd and Pennsylvania-New Jersey-Maryland Interconnection long-term market prices show a 1% decrease in load causing a 2% price reduction. Similarly, a 1% Illinois load reduction caused a price reduction of 0.5% to 1% in Midcontinent Independent System Operator's territory.
- Evidence from an Ohio price mitigation analysis shows all customers, irrespective of their participation, save approximately $2 per month on their residential electricity bill due to energy efficiency programming.
- In July 2001, California achieved a peak demand reduction of 14% as compared with 2000—the year of prolonged electricity supply shortages—helping avoid a repeat event and prevent price spikes.
- According to a 2015 study conducted on behalf of ATCO Gas, gas energy efficiency programs could lead to demand reduction induced price effects[117] (DRIPE) of $0.54 per GJ.[118]

Rate changes and bill impacts affect customer classes differently based on the level of program participation. Program participants experience bill reductions through direct energy savings. For non-participants, rate changes affect monthly bills in a linear fashion whereas bill impacts are determined both by rate increases and systemwide savings such as reduced wholesale market prices and reduced T&D costs. A review of multiple case studies illustrates the difference in benefits allocation:

- Nova Scotia Power calculated long-term average bill and rate impacts as part of the EfficiencyOne 2016-2018 DSM Plan. For non-participants, monthly bills are expected to decrease by ~1% or less, while program participants could see their bills decline by 20% or more, based on customer class.[119]
- Narragansett Electric's *2021-2023 Annual Energy Efficiency Plan* estimated average monthly bill decreases for electric DSM program participants, ranging from 5.5% for residential participants to between 2.6% and 8.6% for C&I customers. Non-participants, meanwhile, are projected to experience minor bill increases estimated at 0.3% for residential customers and between 0.2% and 0.6% for C&I customers.[120]

Unlike almost all other jurisdictions in North America, Alberta does not integrate energy efficiency into its management of the electricity and natural gas utility systems. As a result,

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117 Demand Reduction Induced Price Effects (DRIPE) is a measurement of the value of demand reductions in terms of the decrease in wholesale energy prices, resulting in lower total expenditures on electricity or natural gas within a given jurisdiction.

118 Alberta's Energy Efficiency Potential, Dunsky Energy Consulting, December 2015

119 Direct Testimony of Tim Woolf, 2015

120 Direct Testimony of Joel Munoz and Jennifer Kalay, 2021

Albertans pay more than they need to for utilities, in both economic and environmental costs.[121] Figure 3-13 shows a summary of the key findings from this section.

Figure 3-13. Summary of Key Findings

Key Findings
1. Alberta's electricity and natural gas prices are rising and have been in a recent state of fluctuation, leading to increasing customer dissatisfaction around energy affordability.
2. The combination of DSM-enabled (cumulative) energy savings and reductions to wholesale market prices and T&D costs fully or partially offset the impact of rate increases for participants and non-participants.
3. Program participants experience lower monthly bills with DSM, while non-participants' bills can increase by less than 1%.

(Source: Guidehouse)

3.4 *Environmental Impacts*

Net-zero GHG emissions targets are increasingly being pursued by companies as investors, governments, and the public demand greater action on climate change. This is increasing interest in DSM as a way to deliver not only cost savings but also environmental benefits at the same time. In Alberta specifically, GHG emissions are emerging as an additional primary driver behind DSM. DSM programs are complementary to an array of emissions-based initiatives, including carbon capture, utilization, and storage (CCUS); hydrogen; renewable natural gas; and other emissions reduction technology development. While most of these other approaches tend to increase costs, DSM reduces costs and assists with managing the overall cost of reducing emissions.

The efficacy of energy efficiency and other DSM programs as a mechanism to reduce emissions is well established:

- The ACEEE's *2020 Utility Energy Efficiency Scorecard* found that energy efficiency has the potential to cut US GHG emissions by 50% by 2050.[122]
- The Natural Resources Defense Council has indicated that energy efficiency could make an even larger contribution to emissions reductions than renewable energy.[123]

[121] 2021 Canadian Provincial Energy Efficiency Scorecard, Efficiency Canada
[122] 2020 Utility Energy Efficiency Scorecard, ACEEE
[123] The Value of Energy Efficiency: Past Successes and Future Strategies, VEIC, 2021

- In the US, enabling distribution system revenue via non-wires solutions could avoid approximately 300 million tons of carbon emissions over an assumed 20-year lifetime of DER assets—equivalent to the total lifetime emissions from a new-build 1,000 MW combined cycle gas turbine.[124]

Reducing energy consumption results in fewer emissions, however, not all energy savings are equal. For example, Alberta has particularly high electricity emissions factors due to its carbon-intensive fuel mix relative to other provinces. As Table 3-9 presents, Alberta has among the highest provincial emissions factors for electricity generation. This illustrates the differentiated potential of Alberta in particular to lower its emissions through reductions in electricity consumption.

Table 3-9. Emissions Factors for Electricity Generation by Province (CO2e Emissions) (t/MWh)[125]

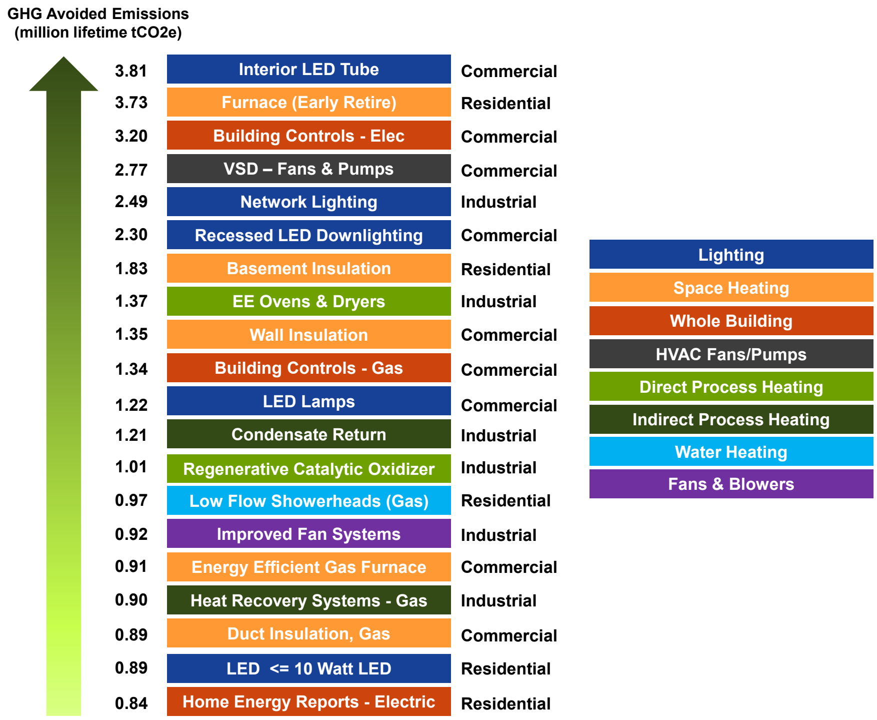
Province	CO2 Intensity
Nova Scotia	0.67
Alberta	0.59
Saskatchewan	0.58
New Brunswick	0.29
Ontario	0.03
Newfoundland and Labrador	0.02
British Columbia	0.01
Manitoba	0.00
Quebec	0.00
Prince Edward Island	0.00

(Source: Guidehouse, Government of Canada)

As Figure 3-14 shows, Guidehouse identified and ranked the top 20 measures for reducing Alberta's GHG emissions through energy efficiency across all sectors (excluding O&G). The study results conclude that Alberta has the potential to reduce GHG emissions by 8.6% (7.1% including O&G) below the business-as-usual or no-programs case within buildings and industrial facilities through a relatively conservative approach to programming while delivering a positive economic ROI.

[124] State Utility Incentives for Non-Wire Alternatives, Wharton University
[125] Electricity Generation and GHG Emission Details for Canada, Government of Canada, 2020

Figure 3-14. Top 20 Measures for Reducing GHG Avoided Emissions, 2028[126]



(Source: Guidehouse)

Utilities across North America are increasingly deploying energy efficiency as DER to meet policy goals such as reduced emissions.[127] However, the ambitious targets set forth by governments and corporations will likely require a mix of non-emitting energy resources to supplement energy efficiency and DR programs. Furthermore, gaseous distribution pathways such as hydrogen and renewable natural gas will cost more than conventional natural gas, and DSM is an opportunity to use less energy and thus offset, to a degree, the upward pressure on costs from these pathways.

DER programs can support clean energy goals by remediating backlogged interconnection queues and facilitating a higher number, and variety, of DER devices to be added and managed BTM. This also has the added benefit of futureproofing Alberta given the increasing value of load flexibility and growing enablement of flexibility markets.

DSM programs reduce costs and emissions at the same time. This helps to diversify and balance various emissions reduction approaches and increase the likelihood of successful deployment of each. All these benefits contribute to the resiliency and economic competitiveness of businesses and households—particularly at a time of rapidly changing energy costs and technological advancement. Figure 3-15 shows a summary of the key findings from this section.

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[126] 2019-2038 Energy Efficiency and Small-Scale Renewable Energy Potential Study, Navigant Consulting Inc., 2018
[127] 2020 Utility Energy Efficiency Scorecard, ACEEE

Figure 3-15. Summary of Key Findings

Key Findings
1. Companies, investors, consumers, and governments are increasingly interested in deep emissions reductions.
2. A combination of energy efficiency, DR, DER, and zero emissions energy sources will be required to reach net-zero emissions targets.

(Source: Guidehouse)

3.5 *Valuing Load Flexibility*

The rising penetration of variable renewable resources and electrification of transportation and heating makes the load flexibility provided by DSM technologies increasingly valuable. Alberta has significant renewable energy potential, with one of the best solar resources in Canada, ample wind energy potential, as well as large, untapped opportunities for biogas production (which can be upgraded for renewable natural gas)[128] and low carbon hydrogen production (with carbon capture).[129]

As Alberta's energy needs continue to transition, market structures and approaches need to be updated so that non-traditional resources, such as load flexibility, are accurately valued. Accurately valuing load flexibility affords it the opportunity to fairly compete alongside traditional resources in regional electricity markets.

The cost impacts of operating inflexible grids, combined with the potential benefits highlighted in recent studies, demonstrate the value in exploring forward-looking solutions:

- According to Piclo's *Modelling the GB Flexibility Market* study, flexibility in the UK could reduce whole-system costs by $6.2 billion per annum through 2050, as compared with a passive approach.[130]
- The International Energy Agency suggests that by unlocking energy flexibility globally, local grid operators stand to save more than $270 billion in avoided investment for new electricity infrastructure. Similarly, the smart charging of EVs could also save between $100-$280 billion to 2040.[131]

[128] Alberta Energy Transition, DELPHI.ca, 2021
[129] Alberta Hydrogen Roadmap, Alberta.ca, 2021
[130] Modelling the GB Flexibility Market, Local Energy Oxfordshire
[131] Local Grid Operators: Smart Collaboration for a Flexible Future, Kiwi Power

Energy suppliers and service providers in other deregulated markets see the increasing wave of decarbonization and grid decentralization as a challenge to traditional grid management. These suppliers see flexibility markets as a potential way to reduce costs in delivering reliable, affordable energy to customers while simultaneously supporting grid modernization and decarbonization. Deploying a wider range of connected equipment and DER that enables load flexibility can help balance the grid while delivering multiple value streams. Figure 3-16 shows a summary of the key findings from this section.

Figure 3-16. Summary of Key Findings

Key Findings
1. Several studies have identified significant future value in enabling flexibility markets and mechanisms.
2. Flexibility markets and mechanisms enable new revenue streams for utilities, which can act as a hedge against growing risks to traditional business models (e.g., decarbonization).
3. Flexibility markets and mechanisms can dramatically reduce overall system costs and enable NWA applications.

(Source: Guidehouse)

4. Conclusion

Guidehouse believes that Alberta is well placed to realize the benefits of DSM. Utility companies in Alberta should place increasing attention on DSM as one option for meeting customer needs and responding to changing societal expectations. This white paper reveals the numerous DSM offerings that can be implemented by Alberta utilities as well as the multitude of benefits that can be realized. To summarize, the key takeaways are:

- There are a variety of benefits from DSM that can be added up to create a value stack depending on the measures deployed. These benefits can include energy savings, peak demand reductions, capital investment deferral, GHG reductions, and increases in system flexibility as well as non-energy benefits such as increased comfort and reliability, investment into building stock renewal, and reduced operation and maintenance costs. Table 4-1 presents a subset of these benefit streams to illustrate the concept of value stacking; while the components and their magnitude will vary by jurisdiction, the value stacking concept is universal.

Table 4-1. Avoided On-Peak Electricity Cost Components, Energy Efficiency, and Other DSM[132]

Avoided Costs	Avoided Cost (cents per kWh)	% of Total Avoided Cost
Retail Capacity Costs[133]	1.16	8%
Retail Energy Costs	3.63	25%
RPS Compliance	0.98	7%
Subtotal: Capacity and Energy	**5.77**	**40%**
GHG Emissions (non-embedded)	5.08	35%
NOx (non-embedded)	0.08	1%
T&D	2.02	14%
Value of Reliability	0.01	0%
Electric Capacity DRIPE[134]	0.39	3%
Electric Energy and Cross-DRIPE[135]	1.08	7%
Total	**14.43**	**100%**

(Source: Guidehouse, Synapse Energy)

[132] Avoided Energy Supply Components in New England: 2021 Report, Synapse Energy, May 2021

[133] While capacity costs are not applicable to Alberta, the associated benefits would contribute to energy costs in non-capacity market jurisdictions.

[134] While capacity DRIPE are not applicable to Alberta, the associated benefits would contribute to energy DRIPE in non-capacity market jurisdictions.

[135]Cross-DRIPE: reduction in the quantity of electricity reduces gas consumption, which reduces electric prices.

- There is a consistent, positive ROI for DSM across a wide range of jurisdictions. The level of investment can be less than 1% of bills, but the benefits scale accordingly. Typically, the percentage reduction in energy and total bill costs is much greater than the associated cost of DSM programs.

- DSM programs are also complementary to initiatives including those focused on reducing emissions such as CCUS, hydrogen, renewable natural gas, and other emissions reduction technology development. While these emissions reduction approaches tend to increase costs for consumers, DSM reduces costs and emissions at the same time. This helps to diversify and balance various emissions reduction approaches, and increase the likelihood of successful deployment of each.

- The lack of energy efficiency, DR, and DER program development within Alberta to date in stark contrast with other US and Canadian jurisdictions highlights the massive energy, cost, and emissions savings potential that has yet to be realized by provincial utilities.

Given the demonstrated savings potential of DSM from both a cost and energy perspective, Alberta should be more aggressive with their pursuit of DSM programs. As shown in this paper, the cumulative long-term benefits of DSM support objectives across all players—customer, utility, and government. The sooner stakeholders recognize the benefits of DSM, the faster and more considerable cumulative benefits can be achieved.

5. Appendix

This appendix includes supplementary information on DSM. The following subsections provide information on the examples of offerings available for energy efficiency, DR, and IDSM. The drivers of each, especially in the context Alberta, are also discussed.

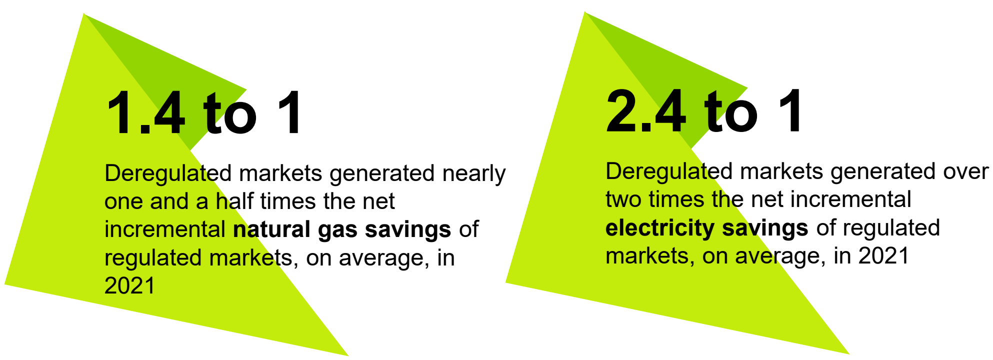
5.1 *Defining DSM*

Canada's energy landscape is undergoing a transformation. This includes but is not limited to rapid technology changes (including to the cost and availability of renewable energy and EVs); ambitious clean energy targets for both electricity and natural gas driving investments into CCUS, hydrogen production, and renewable natural gas; growing pressures related to energy usage and peak power demand; increasing energy affordability challenges; increasing digitization; and rising consumer expectations. These trends have highlighted the relevance and urgency for DSM.

In Alberta, several recent studies have shown DSM to be one of the most cost-effective options to address the emerging pressures brought about by energy and digital transformation. The lack of energy efficiency, DR, and DER management within Alberta to date highlights the massive savings potential that has yet to be realized in the province.

The viability and efficacy of DSM programs has been demonstrated across a wide range of regional market types. In the US, regulated utilities were largely responsible for driving early-stage DSM market growth, with states such as Vermont, Minnesota, and Arizona continuing to generate significant energy and cost savings through their DSM initiatives. As more states have shifted to deregulated frameworks, deregulated utilities have aggressively capitalized on DSM potential.

Figure 5-1. Deregulated Markets Have Capitalized on DSM Potential[136]



(Source: Guidehouse, ACEEE)

[136] State Energy Efficiency Scorecard: 2021 Progress Report, ACEEE, 2021

DSM refers to the wide and diverse array of energy efficiency and DR technologies, services, programs, and strategies to help consumers optimize and reduce the energy use of their equipment, buildings, operations, and behavior. DSM investments help homeowners and businesses control their energy use, lower their utility costs, save water, and reduce emissions. DSM programs can be used to shape, curtail, and shift both electricity and natural gas load in an optimized manner. This section defines DSM, identifies the range of potential technologies available, and highlights the drivers of DSM for Alberta.

5.2 *Energy Efficiency*

Energy efficiency refers to reducing the amount of energy required to provide products and services. The goal of energy efficiency programs is to engage industrial, commercial, and residential customers in energy savings through various processes such as technology improvements (e.g., efficient pumps, motors, heating, cooling, lighting, and energy management systems) and behavior change such as managing energy consumption remotely.

5.2.1 Examples of Offerings

Energy efficiency projects provide relatively low cost or no cost, easy to implement energy solutions for businesses and homeowners. Common energy efficiency examples include the use of high efficiency equipment, recovering and reusing energy, using DG such as solar panels or CHP, efficient designs of buildings, and lifestyle and behavioral changes. As energy efficiency projects are often incentivized with rebates, financing mechanisms, and upstream or midstream buydowns, they become an affordable way to reduce variable electricity and natural gas costs. As natural gas and electricity prices continue to increase in Alberta, energy efficiency is a logical solution to decrease pressure on customer bills.

Energy efficient technologies such as high efficiency pumps, motors, heating and cooling equipment, LED lighting, smart control systems, ENERGY STAR appliances and electronics, insulation, and air sealing are becoming more diversified in their capabilities and price. Given such diversification, the adoption of energy efficiency can be made through targeted programs accessible to a range of customer types including those on low and fixed incomes.

Energy efficiency programs have simultaneously become more reliant on software solutions. The growing prevalence of more precise and real-time data brought about by advanced metering systems has increased implementers' ability to forecast the savings generated from a program. The development of second-generation smart electricity and gas meters, which feature real-time sensing and analytics capabilities (e.g., waveform, integrated flow measurement), are enabling new DSM analytics use cases to be developed around active DR, voltage optimization, home energy management, safety, and more.

Guidehouse conducted a jurisdiction scan across North America and found that while every jurisdiction offers a portfolio of energy efficiency programs, there are varying levels of investment and many different types of programs being offered. Table 5-1 shows a subset of program types. Programs vary based on end-use sector, funding, and local policy objectives. The flexibility and scalability of energy efficiency offers many advantages for program implementers in Alberta to adapt their programs as required.

Table 5-1. Sample of Energy Efficiency Program Types[137]

Energy Efficiency Program Type	Example
Financial Incentive	ComEd and Nicor Gas collaborate to better accommodate and align with the statewide Illinois Home Performance with ENERGY STAR program, including offering an expanded list of rebates for air sealing, attic and wall insulation and duct sealing.
Large C&I New Construction Programs	National Grid launched its Performance Based Procurement initiative to encourage building owners and developers to include performance targets within project RFPs. Design and construction teams are then selected based on their ability to meet energy performance targets.
Lead by Example/Nonresidential Programs	The Association of Bay Area Governments' Energy Watch program, a partnership among local governments in the San Francisco area, and the Pacific Gas and Electric utility, provided implementation assistance for retro-commissioning[138] projects in government buildings and other community buildings.
Technical Assistance and Knowledge Sharing	Industries of the Future West Virginia helps manufacturers create financial savings through energy efficiency. The program provides technical assistance, conducts energy assessments, and runs best practice workshops on systemwide and component-specific topics to teach employees how to operate plants more efficiently.[139]

(Source: Guidehouse, EPA, Footnote Sources)

[137] Local Utilities and Other Energy Efficiency Program Sponsors, EPA

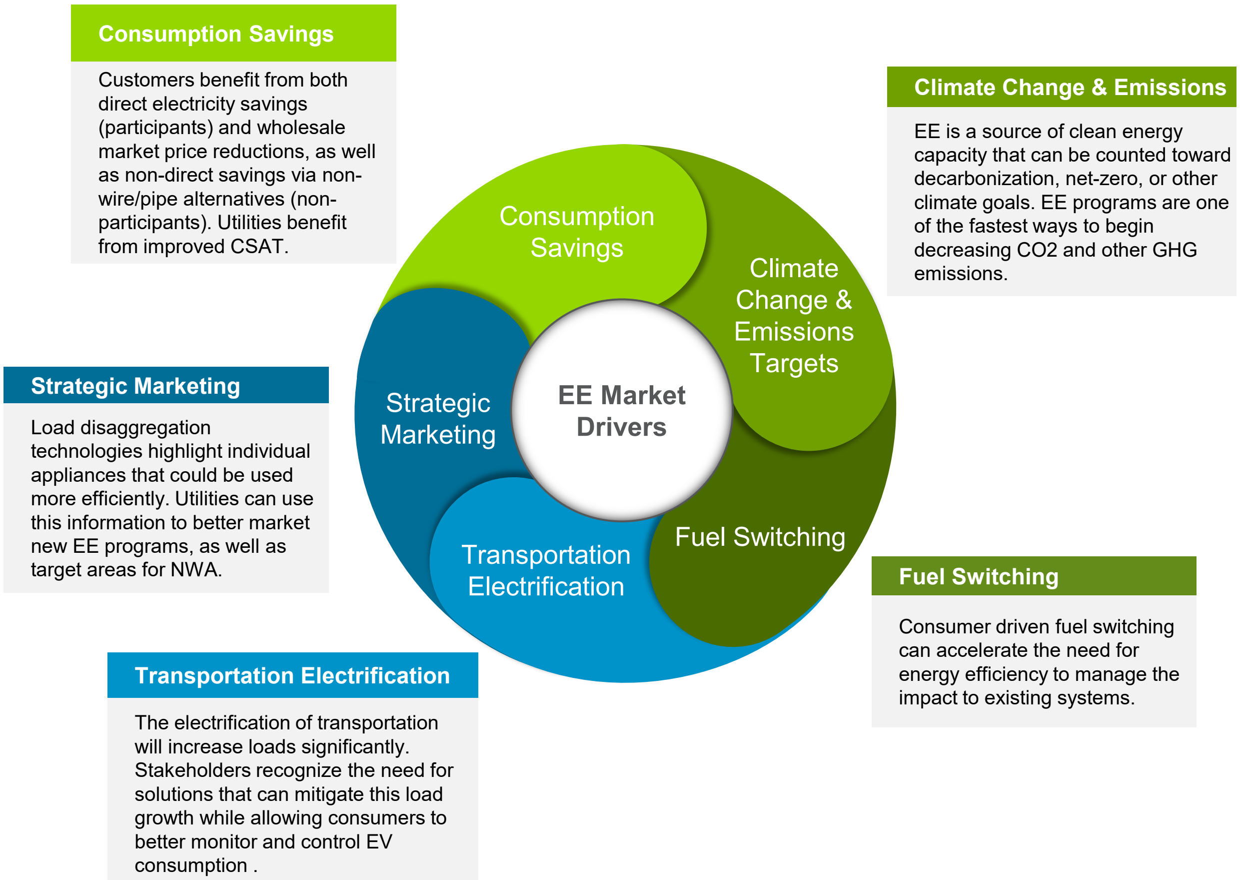
[138] Retro Commissioning is the process of fine-tuning building systems to ensure a building is running at its optimal performance.

[139] Industrial Energy Efficiency: Designing Effective State Programs for the Industrial Sector, SEE Action, March 2014

5.2.2 Drivers of Energy Efficiency

Several factors are driving the development of energy efficiency programs. Figure 5-2 highlights five key market drivers.

Figure 5-2. Energy Efficiency Market Drivers[140]



(Source: Guidehouse, ICF)

These broad market drivers suggest that Alberta is well placed to use energy efficiency to respond to their provincial drivers specifically related to the need for cost reductions and GHG emissions reductions. Energy efficiency can also be used to respond to the emerging impacts from electrification on distribution systems. While not a significant driver in Alberta currently, new approaches to strategic marketing related to energy efficiency present opportunities to leap-frog historic approaches to energy efficiency and utilize best practices to maximize ROI.

[140] Fuel Switching, ICF

5.3 *Demand Response*

DR has traditionally referred to the curtailment of demand through a few critical electric power peak events during the year. More broadly speaking, it refers to the practice of modifying (shifting or reducing) electricity usage during a particular period of time in order to better match electricity grid needs with available supply. Reduction in energy use is typically due to financial rewards for participation such as lower electricity rates, bill credits, or rebate programs. The prescribed change in energy can be manual (initiated by the customer after receiving notification from the utility) or automated through DRMSs. Examples include direct load control programs which enable a utility company to adjust the temperature setting of a smart thermostat remotely or modulate the air conditioner of a participating ratepayer during periods of peak demand in exchange for a financial incentive.

In the electricity sector, DR has been a common practice for decades. Historically, DR has been less prevalent in the natural gas industry, but changing market factors have increased interest in the practice over the past decade. Natural gas DR can be implemented by decreasing actual gas consumption in a building or by using smart control systems to effectively reduce gas consumption at the site during times of peak use. US regions like New England that experience natural gas constraints during the cold winter months have begun to pilot and launch full-scale natural gas DR programs. These programs help to reduce HVAC natural gas load during the winter months and are also compatible with technologies such as gas-powered water heater storage tanks, which are the second largest load in the home.

5.3.1 Examples of Offerings

Guidehouse's jurisdiction scan revealed that DR is a popular choice for DSM programs in regions with PBR. In at least 13 US states,[141] performance incentive mechanisms are being used to reward performance on desired metrics, such as peak load reduction, load reduction to avoid targeted infrastructure investment, displacing energy purchases during high price periods, operational load management, emergency load reductions, and ancillary services.[142]

In general, utilities are exploring or have integrated technologies such as HVAC, water heaters, energy storage, EVs and EV supply equipment (EVSE), and smart appliances into their DR portfolios. Table 5-2 shows a range of examples:

[141] Leading States Have Designed New Ways to Help Utilities Fight Climate Change, ACEEE, February 2020
[142] Report on the Study of Performance-Based Regulation, LARA, 2018

Table 5-2. Potential DR Technologies

Technology	Description
Smart thermostats	Smart thermostats allow the customer to set schedules and temperature setpoints at the BTM level, or remotely control their Wi-Fi-enabled thermostat while out of the house using the vendor's mobile app. Thermostat DR can reduce peak loads in both winter (from furnaces, furnace fans, boilers and heat pumps) and summer (from air conditioning) seasons.
Smart appliances	Smart appliances cover the spectrum of Wi-Fi-enabled communicating technologies designed to streamline comfort and efficiency within the home or commercial space. Smart appliances include but are not limited to light switches, refrigerators, dishwashers, washers, and dryers. By integrating devices that use large quantities of energy with DR and energy efficiency programs, smart appliances can help to balance grid load in times of peak demand.
Energy storage	When customers enroll their energy storage devices in DR programs, they authorize the utility to move energy back to the grid or reduce required energy from the grid at the battery's site during periods of high demand. Additionally, these devices can be called on to supplement the electricity needs of a household or business during a peak demand, thus serving as a load curtailment or rate arbitrage tool where TOU rates apply.
EVs and EV supply equipment	The use of communicating EVSE chargers can stagger vehicle charging and reduce overall demand in balance with vehicle operators' schedules and mobility needs. Connected EVs also provide the electricity grid with additional energy storage, becoming potential assets during DR and load shifting events.
Solar arrays and smart inverters	Bidirectional communications-enabled smart inverters can receive signals from the utility allowing them to serve as participating assets in DR events and help maintain grid stability.
Water heaters	By directly receiving signals from the grid, communicating water heaters can serve as an asset in load DR programs by turning off to reduce grid strain during periods of peak demand, all without inconveniencing the utility customer – although electric/heat pump water heating is not currently common in Alberta.
Cogeneration	During times of high electricity demand, cogeneration resources can provide extra electricity with CHP systems and backup generators to supplement generation at power plants and to relieve grid congestion.[143] Natural gas generators offer a logical solution for use in DR.

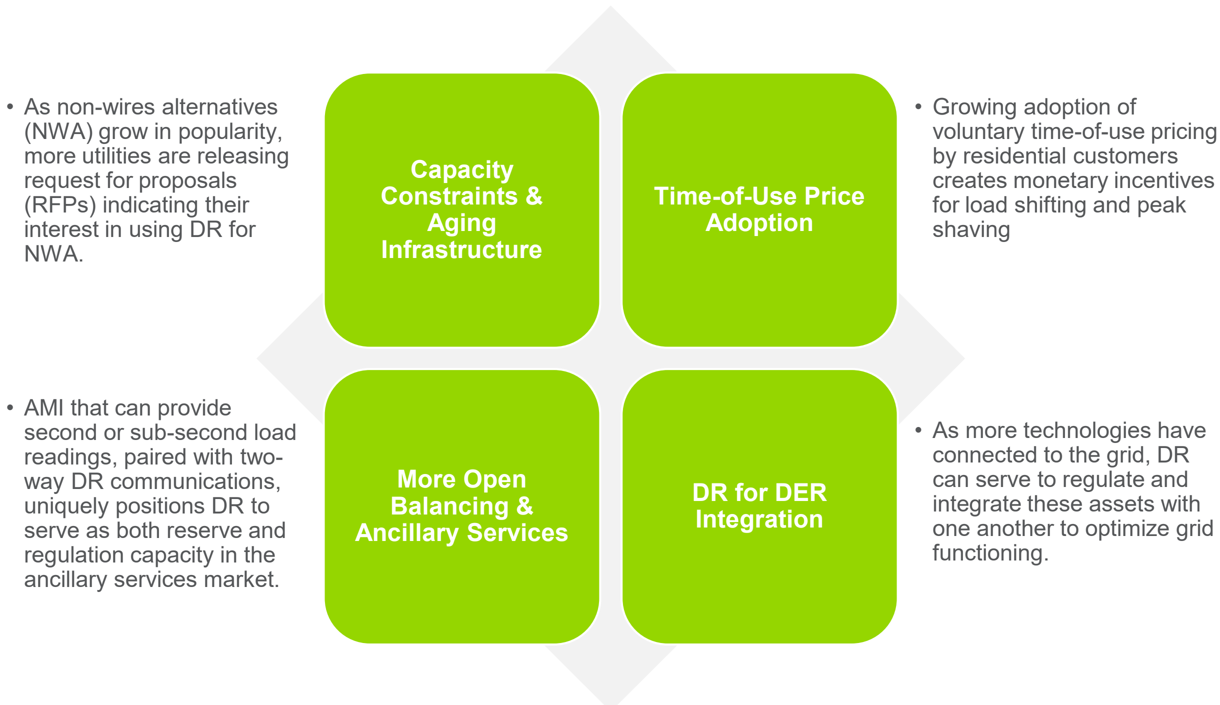
(Source: Guidehouse)

[143] Flexible Combined Heat and Power (CHP) Systems, U.S. Department of Energy

5.3.2 Drivers of DR

Figure 5-3 highlights four of the primary market drivers of DR programs. This includes growing interest in the use of DR for NWA, cost incentives provided by TOU price adoption, grid balancing to support DER integration, and the opening of ancillary services markets.

Figure 5-3. DR Market Drivers



(Source: Guidehouse)

5.4 *IDSM and DER Management*

IDSM combines energy efficiency and DR to deliver energy and peak demand savings to utilities through shared program delivery. IDSM can thus improve the cost-effectiveness of existing energy efficiency and DR programs. IDSM also creates new business models and allows program providers in the DR and efficiency spaces to position themselves to offer integrated programs which could spur innovation and customer engagement. As most utility customers think of DR and energy efficiency as energy savings programs, the IDSM program model can streamline customer communication further boosting satisfaction. Some utilities and program providers are broadening DSM to include DER technologies beyond energy efficiency and DR. DER management programs bring in other two-way grid communicating devices into utility programs that lay outside the traditional bounds of DR or efficiency.

Figure 5-4 shows the evolution of DER management. The combination of integrated DSM and DER management can be considered as complementary components under a broader umbrella of grid modernization.

Figure 5-4. Evolution of DER Management

Application	Energy Efficiency	Demand Response	DER Management
Enabling Technologies	Lighting HVAC & Major Appliances Building Envelopes Energy Efficient Appliances	Local Control Switches Load Management Receivers Smart Thermostats Smart Meters	Distributed Generation Energy Storage EV / EVSE
Description	Delivering the same service using less energy	Voluntary reduction in consumption during tight supply periods	Bring BTM DERs into utility programs that lay outside the traditional bounds of DR or EE

Basic → **Advanced** →

(Source: Guidehouse)

5.4.1 Examples of Offerings

As more DG is added to electricity systems, it will be important to evolve the systems that help to manage their interactions on the system. DER management systems can, at a site level or aggregate level, identify and prioritize the resources best suited to provide a given service. This includes, but is not limited to, DER management systems (DERMSs), demand response management systems (DRMSs), and virtual power plant (VPP) platforms.

Integrating DER can combine resources' capacity to provide meaningful grid service potential that individual DER are too small to provide in markets. The evolution of DERMS has created new opportunities to aggregate and dispatch rapid-response capacity across a variety of markets, resulting in higher levels of DER investment.

DRMS have traditionally focused on BTM applications around DR program enrollment, device tracking, forecasting, dispatch, data communications, and settlement capabilities. DERMS, meanwhile, are responsible for DER modeling and forecasting, proactively optimizing control of the grid, including voltage and power flow optimization, and coordinating utility-scale renewables (i.e., front-of-the-meter) dispatch to support operational needs.[144]

New DERMS iterations, driven by strategic partnerships, are blending grid and customer applications to allow utilities to not only model, manage, and dispatch DER, but also facilitate

[144] Guidehouse Insights, Guidehouse Insights Leaderboard: DERMS Vendors, 1Q 2019

program enrollment and DR engagement. Enterprise DERMS should be able to immediately replace the functionality of a DRMS, monetizing DER in markets or alleviating coincident system peaks and price spikes, as well as providing value for the asset owner.

The core technology for VPPs is the software platform that combines and coordinates DER to act as a single supply-side resource. The primary goals of a VPP are to achieve the greatest possible profit for DER asset owners and to maintain the proper balance of the electricity grid at the lowest possible economic and environmental cost. Together, DR and VPPs create opportunities for engaging customers whose participation in grid flexibility has become necessary following events such as the COVID-19 pandemic, intensifying wildfire seasons, and polar vortex-induced shutdowns.

5.4.2 Drivers of IDSM and DER Management

DER management technologies have been driven at the national, state/province, and local level in the US and Canada, with the most proactive campaigns for DER integration taking place in California and New York. The drivers shown in Figure 5-5 can be expected to expand the number of DER management programs.

Figure 5-5. Integrated DSM and DER Market Drivers

Growth in DERs	If DER can be orchestrated by market participants at scale, these assets can enhance the value of energy and power infrastructure across the value chain.
Deregulated Markets	DER investments offer a way to de-risk utilities against the increasing wave of decarbonization and grid decentralization. Utilities gain a competitive advantage by reducing commodity price risks, reducing company costs and customer costs (such as demand charges), and improving customer satisfaction.
Customer Satisfaction	Utilities are adopting an increasingly customer-centric approach. Some utilities are attempting to provide innovative energy solutions to attract and retain customers.
Reduce Costs	Third-party aggregators or utilities use DER to produce a sufficient collective capacity to provide grid services and defer grid and capacity upgrade costs.

(Source: Guidehouse)