EfficiencyOne

2050: Net-Zero Carbon Nova Scotia White Paper

September 2021

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FOREWORD

Nova Scotia's story is not yet written when it comes to achieving net-zero emissions. There are both challenges and opportunities.

While the province has achieved significant reductions in greenhouse gas emissions since 2005, and is a leader in Canada, there is no single action that will get us to net-zero by 2050. Planning and collaboration are essential. Together we can achieve this goal.

And there is still much to be done.

Among the work that lies ahead: reducing the use of fossil fuels in power generation; fuel switching in homes and businesses to cleaner and more efficient sources of energy; increasing levels of renewable generation on a small and large scale; using electric vehicles to support the electric grid and help transform the way we use our energy; and implementing higher levels of energy efficiency to support homes and businesses in their efforts to reduce consumption.

We also need to build the capacity necessary to achieve our goals ensuring that skills and trades are developed as new technologies become more widely adopted. Capital investments and innovative finance are central to achieving net-zero. And energy poverty must be significantly reduced; no one can be left behind as we transform the economy. Finally, the expertise for implementing low-carbon solutions must be shared and advanced throughout Atlantic Canada.

Context is also critical. The world economy was built on the use of fossil fuels, although some economies were built on the strength of available resources such as large-scale hydro-power generation. What is clear today is that there are existing technologies that can be deployed and adopted. The scale of the change needed is extraordinary, but the immediacy and the pace of change must be considered. Mobilizing the needed training, financing mechanisms, institutional support, and business-delivery capability is an unprecedented challenge.

Investment in energy efficiency, electrification, and decarbonization are important opportunities and they need to be addressed to achieve provincial net-zero. Taken together, these strategic options encompass 65% of Nova Scotia's GHG emissions that can be addressed through buildings and transportation.

EfficiencyOne, in collaboration with Ralph Torrie of Torrie Smith Associates, has authored this White Paper to promote discussion of the strategies and solutions available to the province and stakeholders in responding to the climate emergency. There will be ongoing opportunities to expand and analyze in greater detail many of these possible strategies and solutions, and to that end, EfficiencyOne will be authoring a series of technical papers following this White Paper.

EXECUTIVE SUMMARY

Greenhouse gas (GHG) emissions in Nova Scotia are 30% lower in 2019 compared to 2005 due to a combination of economic structural change, energy-efficiency, and growth in the renewable energy supply.

EfficiencyOne's energy-efficiency programs and further reductions in coal use by Nova Scotia Power Inc., are expected to result in further emission reductions by 2030, but a challenging path lies ahead if GHG emissions are to be all but eliminated by 2050. As illustrated in Figure ES-1, while emissions from heavy industry and electricity generation have been declining, emissions from buildings and transportation has declined only slightly over the past 15 years. Achieving net-zero emissions in Nova Scotia will require completing the phase-out of coal generation while at the same time adopting electric vehicles and switching fossil-based heating systems to electricity.

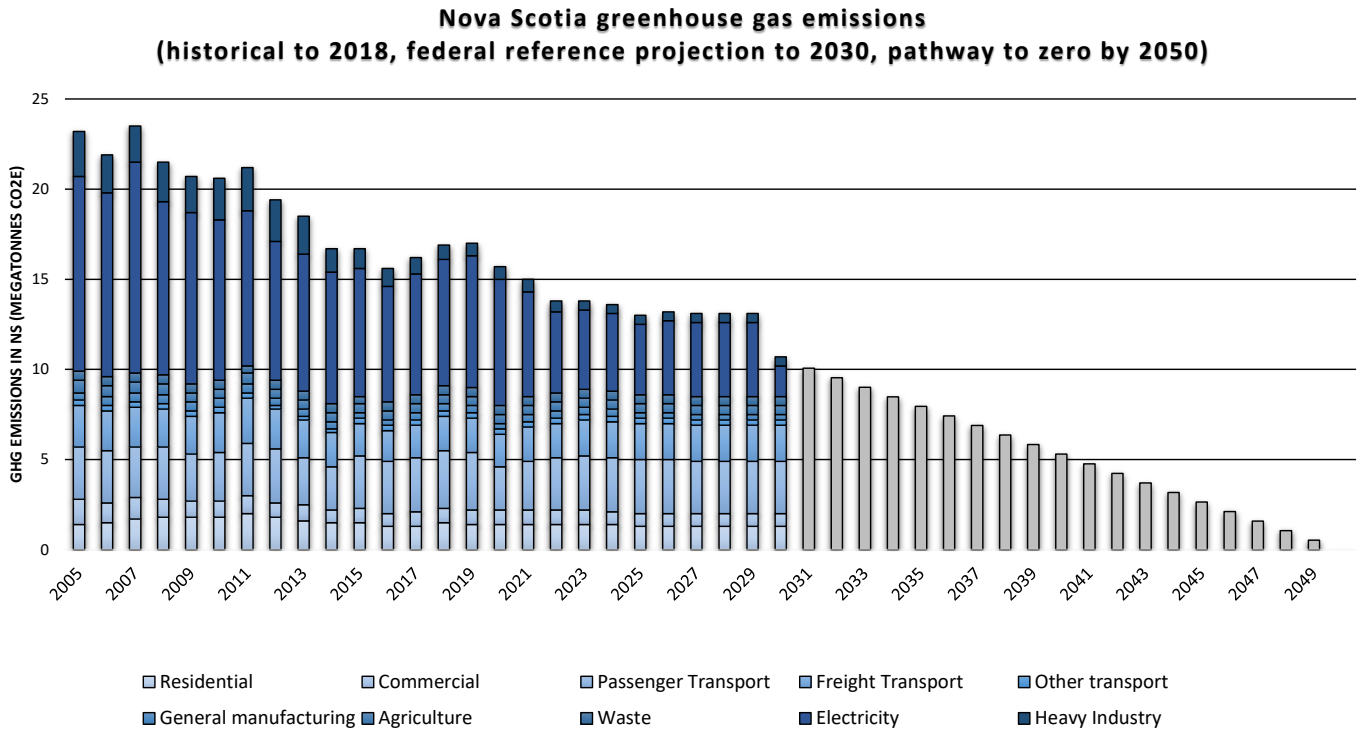


Figure ES-1

While not all the technological options for meeting the emissions challenge are equally developed and ready to be applied at scale, there are number of commercially available options that can be deployed now.

The key electrification technologies – the electric vehicle and the cold-climate heat pump – are far more efficient than the fossil fuel technologies they replace, underscoring the interdependence of efficiency gains and electrification in the drive toward net-zero emissions. Building retrofits with ongoing efficiency improvements in all energy end uses creates the possibility for the simultaneous achievement of electrification and grid decarbonization.

The transition to net-zero and a post-fossil fuel future offers both opportunities and challenges for Nova Scotia to build back better in the post-COVID-19 economic recovery. Nova Scotia can meet the challenges of scaling up the implementation rate of safe-bet technologies – technologies that

are commercially available now – to cut GHG emissions from the fuel and electricity use by buildings and support the electrification of light vehicles. EfficiencyOne has built up considerable capacity for addressing the barriers to and challenges of implementing demand-side management (DSM) and energy-efficiency measures and has earned a reputation as a trusted and honest broker with a wide network of public and private sector partners. These are attributes that are well suited to addressing a broader range of decarbonization options for households and firms, and doing so with client-focused, integrated program delivery.

The levels of energy efficiency, electrification, and decarbonization that are needed for a net-zero pathway in Nova Scotia need to be delivered cost effectively, in a timely manner, and with cohesive supporting policies. The current institutional and regulatory framework in Nova Scotia predates the climate emergency and is not aligned with achievement of provincial net-zero. Achieving net-zero requires an integrated strategy that prioritizes energy efficiency and supports the simultaneous decarbonization of the electricity supply and electrification of buildings and vehicles.

To be viable, the path to net-zero needs to work for everybody — and that means including everybody. Energy-efficiency and electrification programs must include services for low-income homeowners and renters, seniors and youth, Mi'kmaw communities, small business, institutions, and commercial and industrial business. Designing and delivering tailored programs will help ensure that everyone has access to and can participate in a green, sustainable recovery.

STRATEGIC ACTIONS

There is no single action that will get us to net-zero by 2050. Now is the time for everyone – government, institutions, industry, organizations, not for profits, and individual citizens – to get to work advancing innovative approaches to decrease GHG emissions and to develop a collaborative model that builds on existing successes. Collectively we must:

- Continue advanced and aggressive programs for traditional and non-traditional demand side management.

- Increase focus on the thermal efficiency of new and existing residential and commercial/institutional buildings.

- Accelerate deployment of heat pump advanced technology for space and water heating (advanced three-stage heaters).

- Accelerate deployment of electric vehicle (EV) chargers in residential and commercial buildings along with acceleration of EV purchases.

- Facilitate growth in building-related distributed renewable energy (wind & solar) and storage.

INTRODUCTION AND CONTEXT

The response to the COVID-19 pandemic has caused an unprecedented level of social and economic disruption but it has also provided an opportunity for a reset, to build back better. The pandemic recovery coincides with the heightened sense of urgency that has emerged around the need to cut GHG emissions deeply and quickly in an effort to stop average global temperatures from continuing to rise. This paper explores how Nova Scotia can contribute to an effective emergency response to climate change as the post-COVID-19 pandemic recovery proceeds in the years ahead.

Urgent action is needed to mitigate the effects of climate change. To limit the average rise of temperatures globally by no more than 1.5 degrees Celsius, GHG emissions of all types need to be reduced from 2010 levels by 45% within 20 years. Then emissions must be further reduced to achieve net-zero emissions by 2050.[1]

Canada has made significant commitments to reduce GHG levels; however, the reality is that GHG emissions in Canada were 4% higher in 2019 than in 2010. Over the same period, emissions in Nova Scotia declined nearly 21%, the largest drop among all the provinces, but progress has slowed in the last few years and meeting any emission reduction target presents a formidable challenge that will require a step change in the rate of emission reductions. Federal actions can only get us part way to achieving net-zero. There is a great responsibility on behalf of each province and territory to do their part to reduce emissions so that Canada can achieve its GHG-reduction goals.

In Nova Scotia, over 90% of GHG emissions consist of the carbon dioxide emitted from the tailpipes of vehicles, the smokestacks of power plants, and the chimneys and vents of furnaces, boilers, and water heaters in homes, commercial buildings, and industrial establishments. There is no practical pathway to net-zero for Nova Scotia that does not include eliminating or reducing fossil fuel combustion from all these sources to extremely low levels. This paper considers the technological and related challenges and opportunities inherent in achieving a steep decline in greenhouse gas emissions over the next 10 years and beyond. This paper also identifies strategic pathways to achieving that goal.

PROGRESS TO DATE

The approach that the province has taken to date has been working: hard caps on carbon dioxide emissions in the power sector, energy-efficiency programs that have reduced CO2e emissions by one

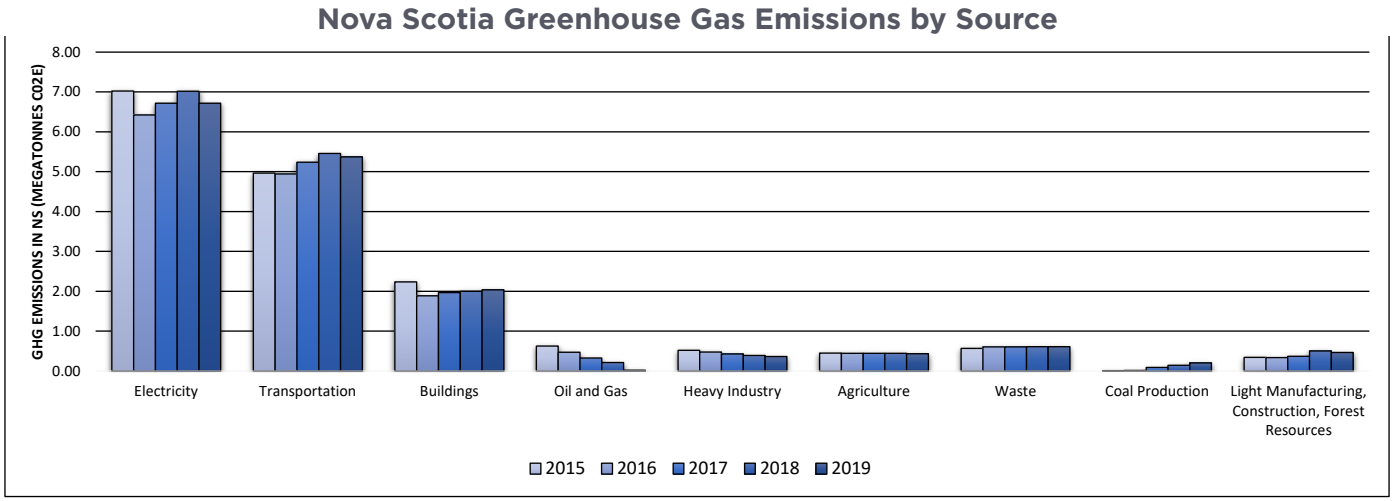


Figure 1. Nova Scotia greenhouse gas emissions by source (Canada's Official Greenhouse Gas Inventory, open data set)

1. Net-zero does not mean 100% of all GHG emissions will be eliminated. To achieve net-zero, a balance is needed between emissions that are still being created in the economy and offsets that are emission free such that on a net basis the pluses and minuses of all sources of emissions add to zero.

million tonnes annually, targets to achieve 80% of renewables on the grid by 2030, and significant provincial and federal funding to decrease the use of carbon-based fuels and reduce energy costs for homes, businesses, institutions, and non-profit organizations. Combined with the shift in the province's economy to lower-emitting industries, these policies and initiatives have resulted in GHG- emission reductions, but progress has varied by sector (as shown in Figure 1) and has levelled off in recent years. Electricity, transportation, and buildings generate the most emissions in Nova Scotia and are, thus, the focus of this paper.

In the past, industry has been an important contributor to the overall decline of emissions in Nova Scotia, but heavy industry emissions (excluding power generation) now represent a relatively small share of the province's GHG footprint. The provincial economy is largely post-industrial and additional structural change has limited the potential to contribute to future emission reductions.

Accelerating progress toward net-zero will require a holistic approach in which energy efficiency, the shift to electricity derived from non fossil based systems, and the growth of the renewable energy supply are achieved together.

This integrated approach, encompassing whole systems, presents challenges to traditional policy, regulatory, and business practices. There are challenges that will require new partnerships, innovative financing, and changes in the policy and regulatory frameworks around which energy systems are built and operated.

NET-ZERO AND THE INTEGRATED RESOURCE PLAN

Creating a net-zero electricity system is necessary to achieving the long-term goal of net-zero emissions for the entire economy, and in that regard, Nova Scotia Power's recently completed integrated resource plan (IRP)[2] is particularly relevant. The IRP includes analysis of multiple options across a wide spectrum that can decarbonize the electricity supply by 2050. Several scenarios were explored that included the use of much higher levels of electrification combined with options for the future power supply, and the use of much higher levels of demand-side management to offset the additional need for electricity arising from the switch to electric vehicles and away from fossil fuel-based heating.

The IRP makes it clear that the business-as-usual electrification case identified as the most likely outcome over the next 25 years for taking the electricity grid to net-zero is incompatible with the transformation that needs to occur to achieve the larger goal of net-zero emissions across the provincial economy. The regulatory framework in which Nova Scotia Power does its planning is not conducive to a fully decarbonized electricity system in conjunction with a fully decarbonized economy. ***The current IRP objective is to identify and plan for the lowest-cost solution over the next 25 years that is partially constrained by emission limits, but that does not achieve provincial economy-wide net-zero requirements.***

Although the IRP was completed in 2020, much has changed in recent months, including a federal cost of carbon escalating to $170/tonne by 2030, the requirement to have 80% renewable energy in Nova Scotia by 2030, and potential for coal retirement[3] by 2030. One issue that cannot be underestimated is the ability and timing for Nova Scotia Power to develop its plans for regional integration that must be in place (i.e., electricity infrastructure in the ground) before coal can be permanently retired. Expanding interprovincial trade in electricity via high-voltage transmission infrastructure involves significant risk and potential for delay due to the complexity and intergovernmental nature of the regulatory and planning requirements. Engagement with Indigenous communities before any lands can be accessed is also a necessity part of the planning process for interprovincial infrastructure, and additional time and planning is needed for this complex and important activity.

2. *Powering a Green Nova Scotia, Together. 2020 Integrated Resource Plan*. Nova Scotia Power, November 27, 2020. https://irp.nspower.ca/.
3. https://irp.nspower.ca/files/supporting-documents/IRP-Modeling-Results-2020-06-26.pdf

Higher levels of demand-side management, including demand-response programs, are needed to hedge against the risks of delays and regulatory bottlenecks in the expansion of clean-electricity energy imports and against the possibility that electrification will increase demand beyond expected levels. As shown in Figure 2, Nova Scotia occupies a leadership position in Canada in the delivery of energy efficiency programs and GHG reductions, and this will need to be expanded to meet the challenges that lie ahead. Where feasible, the replacement of resistance heating with heat pump technology and the acceleration of distributed-energy installations such as solar and battery storage offer additional hedging strategies against the possibility that clean-electricity imports fall short of what is required to achieve the coal phase-out target.

The levels of energy efficiency, electrification, and decarbonization that are needed for a net-zero pathway in Nova Scotia need to be delivered cost effectively, in a timely manner, and with cohesive, supporting policies. The current institutional and regulatory framework in Nova Scotia predates the climate emergency and is not aligned with emissions reductions to get to net-zero. Achieving that goal requires an integrated strategy that prioritizes energy efficiency and that supports the simultaneous decarbonization of the electricity supply and electrification of buildings and vehicles.

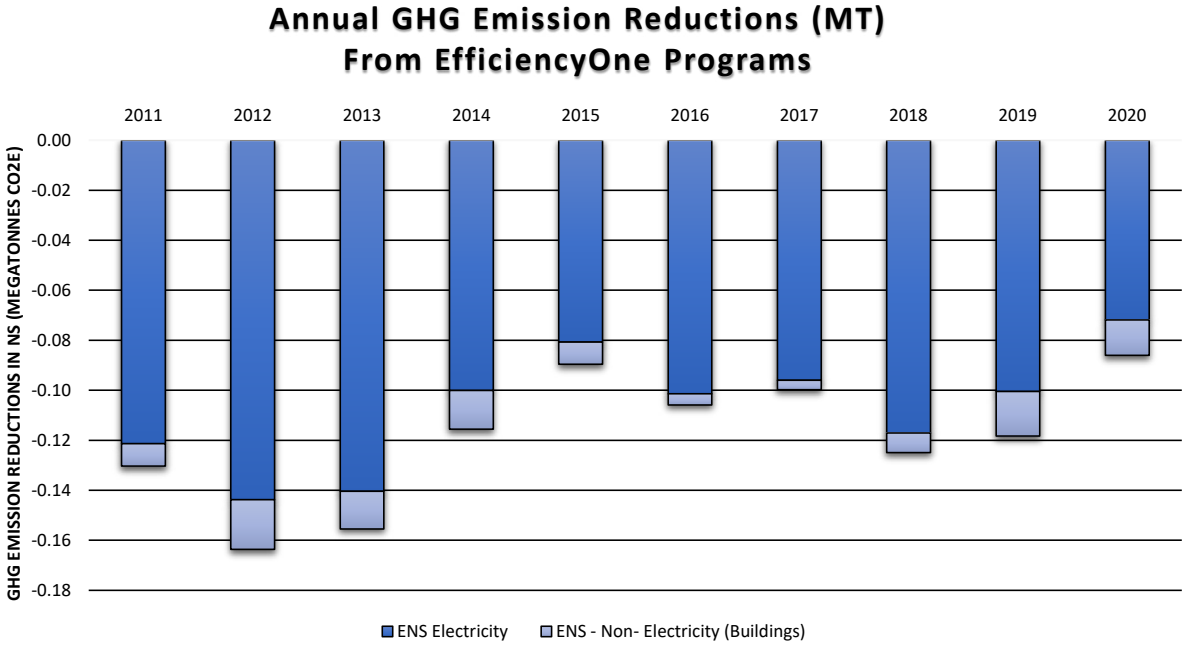


Figure 2 Annual GHG Emissions Reductions from EfficiencyOne Programs, 2011-2020

PATHWAYS TO NET-ZERO

Picking up on themes from the EfficiencyOne Green Paper [4], this White Paper focuses on the following pathways to achieving net-zero that together define the possibility for the economic recovery following the COVID-19 pandemic to be a green economic recovery that drives investment, job creation and economic renewal.

1. Energy Efficiency and Decarbonization

Whole-building strategies and implementation pathways must emphasize the first principle of energy efficiency. In a net-zero future, building stock will transform from its current state, and electric vehicles will form part of the new grid that includes greater roles for distributed energy resources, vehicle-to-grid technology, and micro-generation opportunities. Electrification is itself a powerful efficiency measure, but to achieve the overarching goal of net-zero, it must be part of an integrated strategy ensuring a continuing decline in the share of Nova Scotia's electricity that comes from coal or other fossil fuel generation.

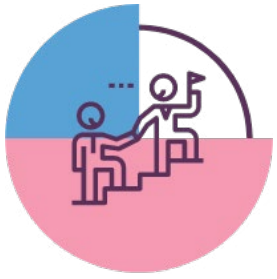
2. Partnerships, Collaboration, and Training

These are all components of creating an environment for success in achieving net-zero. The effort required to achieve net-zero carbon requires cooperation among a diverse group of stakeholders – homeowners, building owners and occupants, contractors, utilities, local governments, Indigenous communities, neighbourhood associations, not-for-profit organizations, and others. Many solutions to achieving net-zero are local in nature and will require coordination and collaboration between provincial and municipal governments that understand local circumstances, needs, and opportunities. Training should be integrated appropriately in all occupational training programs at Nova Scotia Community College and other training facilities.

3. Innovative Financing and Private Investment

The transition to net-zero is characterized by significant capital investments that will pay for themselves over time yet are not currently supported by well-established financial infrastructure. As the price for carbon increases over time, it will improve the business case for emission reduction investments and will stimulate innovation in financing options that provide flexibility for homeowners and businesses.

4. Equity



Energy poverty is a significant issue in Nova Scotia. Strategies for transformation must be done in a way that eliminates energy poverty while ensuring equal access to healthy, comfortable indoor environments and affordable access to energy efficiency goods and services in the community.

5. Regional Capacity Building

The technologies for decarbonization and the expertise for financing and delivering on these will be major drivers of the global economy for the next several decades. The leadership position Nova Scotia has established for energy-efficiency gains and decarbonization is the result of the capacity that has been developed for financing and delivering cost-effective and equitable programs with a wide range of partners. At the regional level, Atlantic Canada has also shown how interprovincial trade in electricity can advance the low-carbon transition. This demonstrated success and experience constitute a foundation for further collaboration on energy efficiency, electrification, and renewable electricity growth that can contribute to regional economic development. The growth of energy efficiency and zero carbon energy within the region will displace the current financial outflow for fossil fuel purchases and can also lead to the region becoming an exporter of low-carbon technologies and implementation capability.

4. *Getting to Net-Zero: Accelerating a Green Economic Recovery.* Efficiency One, November 2020. https://www.efficiencyone.com/2020/11/15/getting-to-net-zero-accelerating-a-green-economic-recovery/.

NOVA SCOTIA GHG EMISSIONS – RECENT TRENDS AND CHALLENGES AHEAD

RECENT TRENDS IN GHG EMISSIONS

Figure 3 compares the energy (left) and corresponding emissions (right) of primary energy consumption in Nova Scotia from 2005 through 2019[5] and reflects relevant trends. GHG emissions from energy use declined by 7.5 Mt CO2e or 30% over this period with most of this decline occurring in the decade prior to 2015. These have been the major contributing factors to GHG reductions in Nova Scotia:

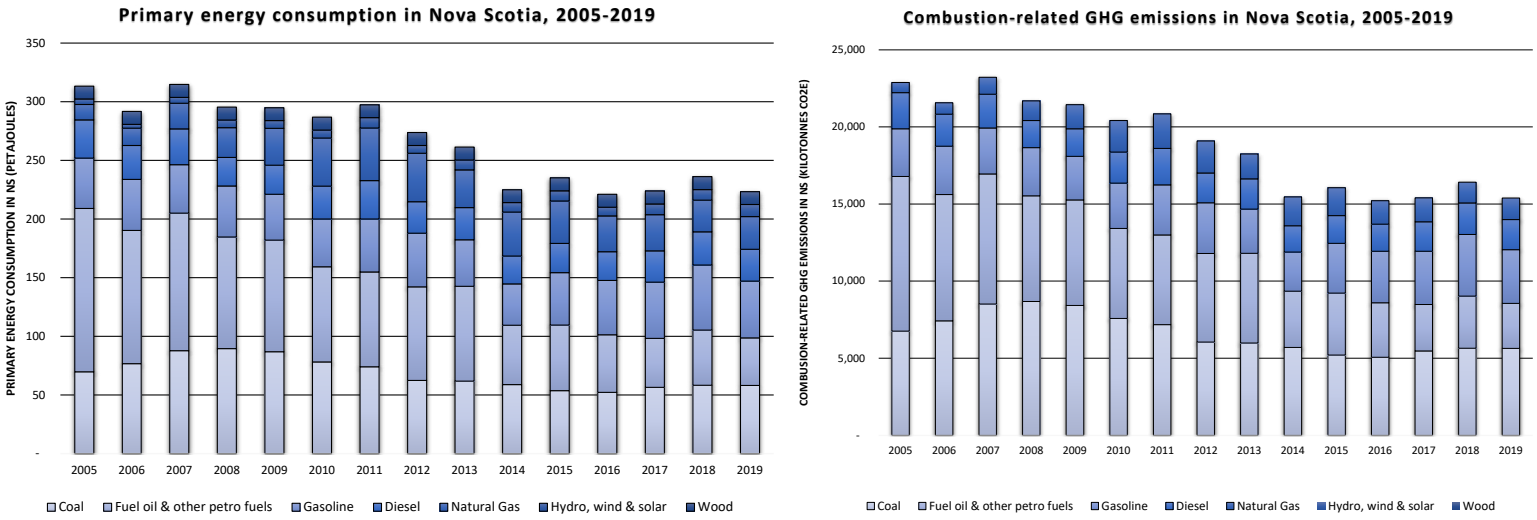


Figure 3

• Overall, primary energy consumption decreased 30% indicating that the emissions decline was driven mostly by the reduction in energy consumption and secondarily by the shift away from fossil fuels. It is not quite that cut and dried, however, as the replacement of electricity for fuel oil also increases efficiency. Between 2005 and 2019, fuel oil, coal, and diesel consumption fell by nearly 50% while consumption of natural gas, renewable electricity, and gasoline increased by 45%. The net effect was the overall decrease of 30% in energy consumption referred to above, with a corresponding 6.7 Mt CO2e drop in annual emissions.

• Between 2005 and 2019, the annual consumption of fuel oil and other petroleum fuels (not including gasoline and diesel, which are shown separately) dropped by 71%, with a corresponding drop in emissions of 7.1 Mt CO2e. A closer look at the sector-by-sector data shows that this decline was concentrated in the commercial building sector, where fuel oil use fell by 83%. In contrast, fuel oil use in the residential sector declined only 2.3%. Commercial building efficiency gains and the uptake of natural gas in the Halifax Regional Municipality (HRM) have driven the decline in fuel oil consumption in the commercial buildings sector. A similar decline of fuel oil use in the residential sector will be a necessary component of a low- carbon transition in Nova Scotia.

• The decline in coal consumption by Nova Scotia Power made the second largest contribution to the drop in fossil fuel combustion and emissions during the 2005-2019 period, albeit a distant second to the drop in fuel oil consumption. By 2019, coal consumption was down 17% from its 2005 levels, with corresponding emissions down by 1.1 Mt CO2e. In a low-carbon transition, these emissions must decline sharply over the next 10 years, and they are expected to as Nova Scotia Power implements its decarbonization strategy and complies with federal and provincial climate change policies and mandates that will result in a grid that is 80% or more carbon-free by 2030.

5. Energy from wood is not included in the Statistics Canada energy balances. There are no official estimates of wood energy use in Nova Scotia and what data is available is incomplete and inconsistent. We have included 11,000 TJ, representing about 600 kilotonnes per year, of which an estimated 60% is for residential space heating.

• Gasoline and diesel consumption and emissions were at about the same level in 2019 as they were in 2005. There are expectations for the electrification of vehicles (as well as possible contributions from green hydrogen and biofuels) to finally cut into these emissions in the coming years. This will clearly be necessary for a low- carbon transition.

• Natural gas has established a foothold in the HRM, particularly in apartments and commercial buildings, adding a new and growing source of GHG emissions. Natural gas use more than doubled between 2005 and 2019 adding 0.74 Mt CO2e to annual emissions, thus, partly offsetting the 8.2 Mt CO2e reduction in annual emissions from the drop in fuel oil and coal combustion described earlier. If all the growth in gas consumption is assumed to have offset what would otherwise have been fuel oil use, then the additional growth in annual emissions would have been about 0.3 Mt CO2e.

• Renewable electricity – hydro and wind power – also doubled between 2005 and 2019 bringing the renewables share of electricity to 28%, a figure that is expected to jump to 40% when Muskrat Falls is fully online. Electricity provides about 25% of all energy needs in the province, so the 28% renewables share of electricity represents approximately 7% of total provincial energy needs. When combined with the contribution from wood and biofuels, renewables make up 14% of total energy use in Nova Scotia.

THE GHG REDUCTION CHALLENGE THAT LIES AHEAD

Figure ES-1 provides a graphical representation of the emission reduction challenge facing Nova Scotia.[6] Emissions from heavy industry and electricity generation have been declining, but there is a base of emissions from buildings and transportation that has declined only slightly over the past 15 years. Achieving net-zero emissions in Nova Scotia will require completing the decarbonization of the electricity supply at the same time as electrification of transportation and building energy requirements are being pursued, creating upward pressure on the aggregate demand for electricity.
Demographic projections for Nova Scotia, including those underlying the emissions projection in

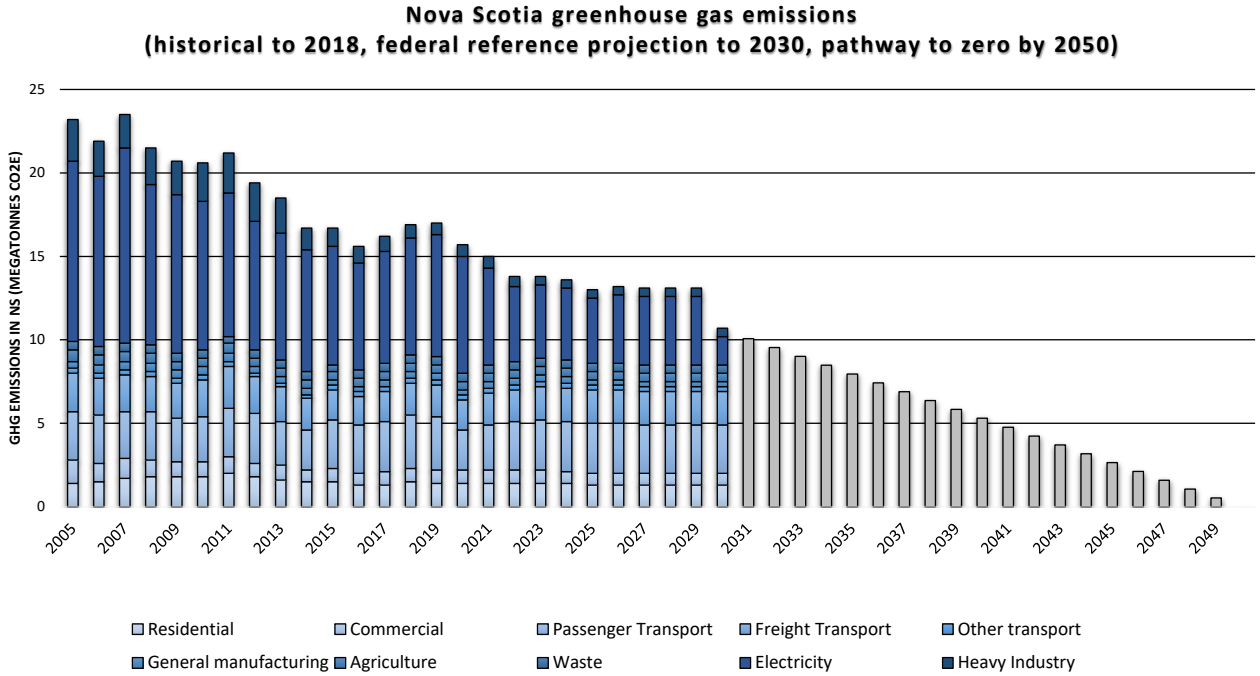


Figure ES-1

6. In Figure ES-1, emissions from electricity generation are shown as a separate sector so that the emissions for residential and commercial buildings and the other sectors represent only the emissions from their direct fuel combustion. Emissions from fossil fuel combustion comprise over 90% of all GHG emissions in Nova Scotia, but Figure ES-1 also includes emissions from agricultural, industrial, and waste management processes. Figure ES-1 combines historical data for consumption up to and including 2018, and for the period 2019-2030 reflects the federal government's reference projection for Nova Scotia from the December 2020 climate plan. The reference projection data is available on the government's Open Source data site at https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/projections.html and includes policies and measures funded, legislated, and implemented by federal and provincial governments as of September 2020. Projected GHG emissions in the reference projection for Nova Scotia in 2030 total 10.6 Mt CO2eq.

Figure ES-1, have until recently reflected relatively low population growth over the next 10 years. The recent increase in in-migration to Nova Scotia could put additional upward pressure on energy use and related emissions. The extent of this upward pressure will depend not only on the amount of in-migration but on the age profile, occupations, and lifestyles of new arrivals. The in-migration will result in energy and related emissions from additional housing and personal transportation, reinforcing the importance of the shift to electric vehicles and of ensuring new buildings are constructed to net-zero standards.

The technological pathways for achieving the emission reductions reflected in Figure ES-1 all require the simultaneous pursuit of energy efficiency, electrification, and decarbonization of the electricity supply. These three objectives are interdependent and can reinforce each other if pursued as part of an integrated and coordinated strategy. For example, the conversion from combustion to heat pumps and electric motors, and from resistance heating to heat pumps, brings a three-fold increase in efficiency that renders electrification a critically important class of efficiency measures on the pathway to net-zero carbon. However, all parts of the economy need to do their part. The transformation to a clean electricity supply is well under way, but the pace at which fossil fuels can be phased out of Nova Scotia's electricity supply is just as dependent on the pace of efficiency improvement as on growth in renewable electricity. This makes decarbonization of the economy dependent on both traditional DSM energy efficiency and the retrofitting and conversion of existing buildings to electric heat and on new buildings being constructed as well as existing buildings according to higher levels of energy efficiency from new codes and standards.

STRATEGIC ACTIONS

The level of GHG emissions 10 and 20 years from now is being determined by the choices we make today. Some technological solutions are in a more advanced state of readiness than others, and there is agreement on their necessity – these are what the Canadian Institute for Climate Choices (CCCS) Blue Ribbon Panel describes as safe bets in their recent report,[7] and which the International Energy Agency (IEA) has identified as the priority options for decarbonization over the next 10 years.[8] These are the solutions that consistently show up in all low-carbon scenarios, that rely on commercially available technologies, and that can reasonably be expected to decline in cost if they are deployed at scale. They include energy- efficiency measures and equipment such as heat pumps, renewable electricity (small and large scale), and electric vehicles, a list to which we would add greater inter-provincial trade in clean electricity. There are barriers to overcome in taking these safe bets to scale – challenges related to financing, policy, delivery capacity, and equity – but all strategies for rapid emission reductions over the next critical 10-15 years include successful deployment of these solutions.

There are other innovative technologies that could play a large role in the transition away from fossil fuels but which are not yet commercially available or for which there are still unsolved challenges in taking them to scale. These include hydrogen, carbon capture and storage, and advanced biofuel technologies. While continued research, development, and commercialization of these innovations is important, the magnitude and timing of their potential contribution to the transition off fossil fuels in Atlantic Canada remain uncertain. However, these innovations should continue to be pursued along with any other technologies that show promise for reduction of emissions and growing the local economy, such as marine battery technology (electric vessels), landfill gas conversions, and biofuel development. Together these innovations can contribute to a reduction in emissions that form 35% of overall emissions in Nova Scotia, represented by the smaller sections in Figure 5.
For the purposes of this White Paper, we focused on solutions that can make a significant contribu-

7. Jason Dion et al. *Canada's Net-zero Future: Finding Our Way in the Global Transition.* Canadian Institute for Climate Choices, February 2021. https://climatechoices.ca/reports/canadas-net-zero- future/
8. *Net-zero by 2050 - A Roadmap for the Global Energy Sector.* International Energy Agency, May 2021. https://www.iea.org/reports/net-zero-by-2050.

tion now and over the course of the coming decade. This does not imply that Nova Scotia does not have a role to play in the continued development of innovative solutions; indeed, there are initiatives underway in Nova Scotia for hydrogen development, carbon-capture technologies, biofuel development, and other advanced technologies. But in the context of what needs to be done now to bend the emissions curve, it is the safe-bet solutions that are the clear priority: energy efficiency, renewable electricity, and electrification. These solutions are particularly effective at reducing emissions where it matters most in Nova Scotia – in buildings, transportation, and electric power supply – and accelerating their deployment is the key to making progress over the next critical decade.

For Nova Scotia, a focus on technologies that are commercially available and ready to scale suggests a number of strategic actions:

• Continue advanced and aggressive programs for traditional and non-traditional demand side management.

• Increase focus on the thermal efficiency of new and existing residential and commercial/institutional buildings.

• Accelerate deployment of heat pump advanced technology for space and water heating (advanced three-stage heaters).

• Accelerate deployment of electric vehicle chargers in residential and commercial buildings along with acceleration of EV vehicle purchases.

• Facilitate growth in building-related distributed renewable energy and storage.

Taken together, these strategic options encompass 65% of Nova Scotia's GHG emissions (as shown in Figure 5); they rely exclusively on safe-bet technologies ready to scale and necessary on all pathways to a low-carbon future. They fit well with the holistic, systems approach in which energy efficiency, electrification, and distributed solar energy are developed within an integrated strategy for improved, climate-fit buildings.

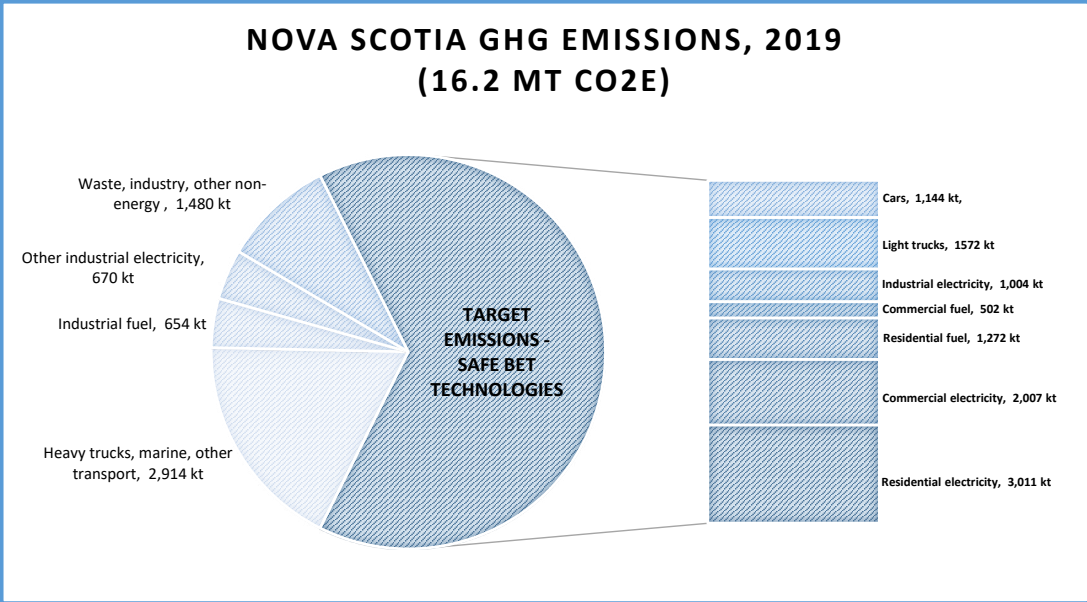


Figure 5 [9]

9. Canada's Official Greenhouse Gas Inventory. GHG_Econ_Can_Prov_Terr data set. Accessed May 17, 2021

DEMAND SIDE MANAGEMENT

The continued improvement in the efficiency of electricity-using devices and their integration into the new grid, with associated control and instrumentation technologies, will be an essential element of the low-carbon transition. Without the energy efficiency and conservation efforts to date, the province's GHG emissions would be roughly one million tonnes CO2e or 6% higher than they are today. DSM programs also account for 25% of the province's GHG reductions over the past 10 years. Increasing investment in energy efficiency and associated resources, including industry capacity, is needed.

The most recent Nova Scotia Power IRP tested a range of DSM levels in conjunction with higher levels of electrification that will occur as the adoption of more efficient space heating, hot water heating, and EVs occurs, increasing demands on the electricity grid. As the electrification necessary to achieve the province's overall net-zero target proceeds, higher levels of DSM will also be required to offset the need for additional costly and high-risk infrastructure and to maintain a continued decline in the use of fossil fuel for electricity generation.

ZERO-EMISSION BUILDINGS: CODES, STANDARDS, AND MASS RETROFITS

The fuel and electricity use of residential and commercial buildings in Nova Scotia accounts for 42% of the province's GHG emissions – all pathways to decarbonization in the province must include a transition to zero-carbon buildings. Meeting the province's GHG emission targets will require that new buildings be net-zero emitters and that existing buildings be retrofitted to higher levels of thermal-energy efficiency, that emission-free energy is substituted for fossil fuel, and that heat pump technology be widely deployed to increase the efficiency of space and water heating. Wood fuel will continue to contribute to home heating in Nova Scotia, including as a backup fuel, but electricity has the advantage of phasing out fossil fuel on a large scale: the distribution system is fully built and heat pump technology can provide heat with three times the efficiency of combustion technologies.

The relatively large share of space and water heating currently being provided with baseboard and other electric-resistance heating technologies in Nova Scotia constitutes a strategic opportunity for decarbonization in the province. When these loads are converted to heat pump technology, it reduces both energy and peak demands on the grid, thus, freeing up capacity that can help accommodate the electrification of vehicles and fossil fuel-heated buildings. The combination of building retrofits and heat pump technology offers the possibility of virtually eliminating fossil fuel combustion in Nova Scotia buildings without increasing the aggregate consumption of electricity from buildings above the current level. Further, achieving and maintaining a zero-emission electricity supply will be much less difficult if the aggregate demand for electricity can be kept in check with advanced and integrated approaches to building retrofits that include building-envelope upgrades for greater energy efficiency and improved air quality, continued pursuit of higher levels of energy efficiency and demand response, and the implementation of heat pumps wherever feasible for space and water heating.

It is important that new buildings are built to be net-zero energy ready, defined as a building that consumes as much energy as it produces if and when renewable energy generation is added.

Actions that can be taken in Nova Scotia regarding building codes and standards can help achieve net-zero energy ready construction. These include:

- Adoption of federal and provincial building codes to facilitate the transition to a net-zero ready code;
- Advancement of regulations to support and enforce new codes; and,
- Stakeholder engagement and education as well as ongoing support and training.

Other activities to support the transition to a net-zero-ready code include, but are not limited to:

Long-term Transition Schedule
• There are five tiers in the *National Building Code 2020* and four tiers in the *National Energy Code of Canada for Buildings*. Establishing a timeline for transition allows the industry to plan for important changes.

Compliance Support
• It is critical to provide ongoing support to industry partners to increase compliance and prepare for the next stepwise increase in code-minimum performance levels (e.g., training on how to interpret energy-model reports for building officials and builders).

Incentives for Top Performers
• As the code baseline increases, incremental energy savings diminish and offering incentives becomes less and less cost-effective for regulated DSM programs, but more and more necessary to transform the market.

PERSONAL ELECTRIC VEHICLES

Along with the heat pump, the electric vehicle is a foundation technology for the transition to a net-zero future. The electric vehicle is four to five times more efficient than its gasoline-powered counterpart, so even at the relative carbon-intensive levels of the current Nova Scotia power grid, conversion to EVs cuts emissions by 50%,[10] a reduction that will continue to increase as the carbon intensity of the grid declines. Cars bought today will be in use throughout the 2020's, making the early and rapid uptake of EVs a necessary condition for achieving GHG emission reductions in the current decade.

Battery technology continues to evolve, and prices continue to drop. Batteries with 75-100 kWh capacity in EVs that can travel 400 km or more on a single charge are now commonplace. While the initial cost of electric vehicles is still significantly higher than an equivalent gasoline-powered car, fueling costs are 65% lower, maintenance costs are 50% lower, and EVs are expected to last longer. As a result, the total cost of ownership of an EV in Nova Scotia is now equal to or less than that for an equivalent gasoline-powered car, even without counting the value of the carbon savings, and the costs will continue to decline. When the value of carbon is included in the calculation and as it increases as proposed by the federal government (to $170/tonne by 2030), then even with Nova Scotia's relatively carbon-intensive electricity, the total cost of ownership of EVs will be significantly lower than the gasoline-powered cars they replace.

A strategy for the transition to electric vehicles in Nova Scotia should also consider their other attributes. Most EVs will use 20% or less of their battery capacity during a typical day and will be parked and plugged into the grid for 95% of the time. They will constitute a significant amount of electrical storage capacity that could be utilized in the buildings where they are connected or fed to the grid to provide peak capacity, help alleviate distribution-system bottlenecks, provide backup power during weather events, and other grid services. Vehicle manufacturers are just getting on board with vehicle-to grid capability, and although there are less than a handful of models that can perform in this manner, the expectation is that this capability will be further developed among a broader range of EV models in the future.

While local availability is limited, there are over 30 EV models on the market in Canada, and the number is growing every year. Most personal EVs will be charged at night at home, and while they can be charged from a regular 110-volt outlet, it is faster to charge them from a 240 volt Level 2 charger. This represents an additional expense and inconvenience for the EV buyer of about $2,500. Addressing

10. For example, see https://advocacy.consumerreports.org/wp-content/uploads/2020/10/EV-Ownership-Cost-Final-Report-1.pdf.

new codes and standards can ensure this does not become a drag on the EV adoption rate by mandating EV chargers in all new homes and parking garages while government can underwrite the retrofitting of Level 2 chargers in existing homes and buildings throughout the province. A campaign to make all homes and buildings in Nova Scotia EV ready would achieve economies of scale and lower costs per installed charger. Integrating the installation of EV chargers is a logical addition to a mass building retrofit and climate-proofing program, and would reduce costs further. [11]

DISTRIBUTED ENERGY: BUILDING-RELATED SOLAR PHOTOVOLTAICS AND STORAGE

Distributed energy resources (DER) are expected to play a growing role in the provincial electricity system, and this includes roof-mounted solar photovoltaics and both building- and neighbourhood-level electricity storage. Increasing the supply of DER hedges the risk that the increased level of clean-power imports included in Nova Scotia Power's regional integration efforts will not be attained while at the same time contributing to a more self-reliant and resilient grid.

Distributed energy resources are treated as demand modification in the Nova Scotia Power IRP scenarios, with the potential generation by 2030 being in the 1,000 - 1,400 GWh range, increasing to as much as 1,900 GWh by 2050, and HalifACT – the HRM climate action plan – includes much higher levels in its low-carbon scenario. These distributed energy resources are composed mostly of rooftop solar installations, and their design and installation will need to be coordinated as well as integrated with parallel actions for building retrofits, electrification, and EV-charger installation.

INTEGRATED SOLUTIONS TO DECARBONIZATION

The options summarized previously are all building related; they involve changes to the technology inside and outside homes and commercial buildings and changes to the structures themselves. At a minimum, their deployment requires the consent and engagement of the building owners if not their active involvement in financing and execution.

The measures and technologies are interconnected, both with each other and with other improvements or alterations being undertaken by the building owner and can only realize their full potential when their design, financing, and implementation are part of an integrated strategy for the building. This does not mean they must be implemented simultaneously, (although there are usually economies and cost savings that can be realized by minimizing the number of separate interventions), but it does mean that their implementation should be coordinated and integrated with the plan for the building's improvement. For example, conversion to a heat pump in a building that has not been retrofitted increases costs, results in oversizing of equipment, and misses opportunities for increased comfort and indoor air quality.

When considering all the options and having a plan to scale up, integration of solutions provides many incremental benefits in the reduction of carbon and energy use. The current approach to delivery of energy efficiency programs has been highly effective, and now is the time to develop integrated strategies and bundling of services for even deeper energy savings.

11. EV charging for apartment buildings and condominiums presents a challenge but 75% of Nova Scotia households occupy single family dwellings that have driveways, garages, or access to on-street parking where chargers can be deployed.

CHALLENGES AND OPPORTUNITIES

PACE OF NEEDED CHANGE

The greatest challenge in addressing the climate change emergency is achieving the necessary rate at which GHG emissions must be reduced to restrict the global temperature increase to 1.5 Celsius. After more than a century of building dependence on fossil fuels, we must now transition to a net-zero energy system within a single generation. Business as usual simply will not get us to where we need to go.

There is a world of difference between the policies and initiatives for eliminating fossil fuel dependence eventually and the policies and initiatives required to achieve it by 2050. Even for the safe-bet technologies available now, accelerating deployment to the levels required presents a significant challenge. The most cost-efficient timing for decarbonizing heating systems, vehicles, and buildings involves doing it when they are scheduled for replacement anyway, but the normal replacement or capital-renewal cycles for these technologies can be 10-25 years or longer. Vehicles purchased in the next few years will still be on the road in 2030 and beyond, and new buildings constructed today will be standing for decades. The urgency of a step change in the level of investment in the energy transition is echoed in every major analysis, including most recently in a major report from the International Energy Agency. [12] ***There is simply no time left to lose in responding to the climate emergency.***

CAPACITY CONSTRAINTS

Even where technologies are available, we do not have the capacity today to design, finance, manage, and build them out at the scale required. This is both a challenge and an opportunity. As demand for technology increases, mobilizing the needed training, financing mechanisms, institutional support, and business-delivery capability comprises a challenge that is unprecedented. But this challenge also presents opportunities for full employment, economic growth, and institutional repurposing and renewal that could carry society forward for decades into the future. Mandatory courses in related energy efficiency programs in post secondary institutions that address these current constraints will motivate a new generation of students to think in different ways and be prepared to face new challenges in the evolving workforce.

FUNDING AND FINANCING

Energy efficiency, electrification, and renewable energy technologies typically have low (sometimes zero) long-run operating costs, but they require relatively large up-front capital investments. There is nothing inherently new about this; much of modern-grid technology and infrastructure is capital-intensive and has been made possible by business and financing strategies that spread the repayment of the initial capital costs over millions of consumers and over long periods of time. Indeed, the fossil fuel and electricity industries epitomize this approach, with multi-billion-dollar investments repaid over decades, one kilowatt-hour or one litre of fuel at a time. The financial challenge facing accelerated uptake of carbon-free technologies and measures – building retrofits, energy efficiency, energy-efficient equipment, renewable electricity, electric vehicles – is not that they are too expensive but that they lack the innovative financing methods and infrastructure to attract the capital required and to make the repayment convenient and manageable while maintaining or lowering the total cost of mobility and building ownership.

12. *Net-zero by 2050 - A Roadmap for the Global Energy Sector*. International Energy Agency, May 2021. https://www.iea.org/reports/net-zero-by-2050.

Many of the investments identified in this paper are investments in the upgrading of the efficiency of residential and commercial buildings, building related storage and distributed generation, building-connected distributed generation, and electric vehicle charging infrastructure, also building connected in most cases. ***To achieve a net-zero economy within a generation, these investments need to start now and proceed at an unprecedented pace.***

There are several interrelated challenges that must be met to rapidly transform the building stock to net-zero, but key among them is the need for innovative approaches that minimize the up-front capital outlay, financial risk, and inconvenience to home and building owners. There is financing infrastructure in place that is adaptable for investments in clean electricity and electric vehicle purchases, but financing the transition of building stock to net-zero requires both government and private sector leadership and innovation.

Retrofit innovation is the focus of research internationally and in Canada. The Energiesprong model first developed in the Netherlands repays lenders from energy savings under a performance contract, and project aggregation is used to minimize risk, reduce costs, and attract large investors. In Canada, the federal government will offer $40,000-interest-free loans through the Canada Mortgage and Housing Corporation while supporting on-bill financing of retrofits through a PACE (property assessed clean energy) program. Commercial building retrofits have been added to the mandate of the Canada Infrastructure Bank (CIB) and its Commercial Building Retrofits Initiative encourages project aggregation ($25 million minimum) and relatively deep retrofits (30% GHG reduction target).

The pricing of carbon and the development of carbon markets will change behaviours and business practices, and will stimulate innovations for attracting investment to the most cost-effective options for reducing emissions. However, the availability of attractive financing for efficiency and emission-reduction benefits is necessary but not by itself sufficient to ensure rapid and equitable uptake of climate mitigation in the buildings sector. The residential and commercial building markets are complex, and the motivations and capacities of homeowners and building owners to invest in emission mitigation are influenced by a wide range of factors in addition to cost, including convenience, perceived risk, and other competing priorities for time and attention. This is one more reason why success in accelerating climate mitigation in buildings will require an integrated, whole-building approach that engages all owners.

AWARENESS AND PUBLIC ENGAGEMENT

The low-carbon transition will be disruptive to business as usual. It will change the way we live and work, and it will change the way we pay for access, comfort, and other amenities. It has the potential to foster a sense of common purpose and social cohesion when it is implemented equitably and with a shared understanding of the rationale for and the benefits of the changes that it brings. This, in turn, will require public awareness, education, and engagement every step of the way, championed by local and provincial governments in a coordinated and concerted effort.

MUNICIPAL, PROVINCIAL, AND FEDERAL ACTIONS

Municipal, provincial, and federal actions to reduce carbon and address climate change have significant momentum and funding. While there are many commitments being made to reduce GHGs across the globe, it is local actions that make the difference as each jurisdiction has its own unique set of challenges. Policy changes can address broad issues at a national level, but it is the local governments that implement the change based on what issues need to be resolved.

Federal and provincial funding has been allocated to many programs in the province to address the largest three sources of emissions, and many policy drivers exist in Nova Scotia to reduce carbon including the federal-equivalency agreement to reduce carbon dioxide from the use of coal to produce electricity; the renewable electricity regulations that will drive 80% renewable electricity by 2030; and cap-and-trade regulation that creates a carbon market for large emitters (thus avoiding the federal carbon pricing backstop).

Municipalities have direct or indirect control and influence over 50% of all GHG-emission sources in Canada including homes, buildings, landfills, transportation, residential waste, and commercial buildings. The local influence of municipalities is critical in achieving GHG reductions as many solutions such as electric buses, landfill-gas management, building retrofits, street lighting, and even land-use planning affect the level and pattern of energy use and emissions in the community.

ELECTRIFICATION

The efficiency advantage of heat pumps, electric vehicles, and other electric technologies over their fossil fuel counterparts make them critical components of a net-zero future. Even with the current carbon intensity of the Nova Scotia grid, the electricity required to power electric vehicles and heat pumps is produced with lower GHG emissions than the emissions from the gasoline vehicles and oil furnaces they replace. As the carbon intensity of the grid declines, the electricity advantage will increase, as it must if the province is to stay on course for net-zero emissions by 2050.

The need for greater electrification to support the net-zero decarbonization objective comes at a time when the electricity system is undergoing a transformation. Concurrent technological and bus iness-model innovations are beginning to transform the way electricity is produced, stored, and used. Increased use of electricity for heating and transportation; falling prices for storage and renewable generation; growth of distributed generation and storage; a shift from production-centered to consumer-centered business models; multi-directional flow of information and energy; and automated and remotely-controlled optimization are all contributing to the reinvention of the electricity sector.

In the emerging system, there is a relative shift in value creation toward the retail end of the generate–transmit–customer spectrum (i.e., the distribution side of the grid transforms to allow consumers to participate in giving their own renewable energy, solar, EVs, home batteries, and more back to the grid and being compensated for that energy), and the vector itself is giving way to a highly interconnected grid that supports the two-way flow of energy and information between producers and consumers.

One result is a much higher degree of interdependence between the central utility and the actions and investments of households, firms, and prosumers in distributed generation, digital innovations, and advanced metering, storage, and hardware and software for building energy-supply-and-demand management.

STRATEGIC PATHWAYS

We have referred above to a number of strategic actions involving technologies that are commercially available and that can lead progress toward net-zero in the next critical decade if their rates of deployment can be rapidly scaled up. This is no small challenge and will require government policies and regulatory frameworks to be aligned with the net-zero goal; the coordinated mobilization of capital and financing innovations; workforce training; the institutional capacity to manage the effort;

the growth of the business and supply chain capabilities required; and the education, engagement and support of all Nova Scotians. At the same time, intensive research, development and commercialization efforts will be required to bring on the next generation of technologies needed to maintain the momentum toward net-zero and to tackle the decarbonization of sectors where technological options are still in development.

Identification of strategic actions and technologies for reducing emissions help us envisage the net-zero destination, but the strategic pathways for getting there will be defined by how we overcome the challenges and work together to realize the opportunities the transition to net-zero offers Nova Scotians in realizing their social and economic aspirations. This is uncharted territory, but we summarize here a number of important pathways that are emerging.

ENERGY EFFICIENCY FIRST REMAINS THE PRIORITY

Efficiency always tops the priority list for any effective decarbonization strategy, not only for its direct cost-savings and emission-reduction benefits but for the role it plays in facilitating electrification and in optimizing the amount of additional infrastructure required to achieve and maintain a carbon-free supply of electricity.

Integrated program delivery is a key to success in accelerating emission reductions. The inter-connectedness of energy efficiency, electrification, and decarbonization is a theme that repeats throughout the technical, financial, and logistical dimensions of the low-carbon transition.

Implementing building retrofits to avoid oversized heat pump systems and integrating the installation of rooftop solar and EV chargers with DSM and other building improvements are examples of the need for a building-based approach that works with building owners to coordinate and finance the needed transition.

PARTNERSHIPS

The transition to become net-zero involves interconnections between different technology solutions as well as interdependencies among stakeholders and a partnership approach to implementation. These partnerships provide valuable insights into customer behaviors and new and emerging trends, which, in turn, helps to refine and develop programs that better meet customer needs. A broad range of service providers enable longer-term, strategic business decisions, including investments in facilities, fleets, and jobs. Fostering strong partnerships is a best practice that can be applied to the broader net-zero effort that requires industry professionals, supporters and champions, funders, investors, and more to achieve emission-reduction targets.

INNOVATIVE FINANCING

Innovative financing is another critical component of accelerated decarbonization. This includes the aggregation and marketing of investments as well as the design and implementation of the financial infrastructure and business ideas needed to keep the total cost of home, business, and vehicle ownership from growing as the transition from fossil fuels to energy efficiency and renewables plays out. For any solution to be sustainable, it cannot rely solely on public funding; it must also tap into private sector financing such as pension funds, private equity funds, and various green funds while ensuring that the value created by carbon pricing is channeled to decarbonization investments.

EQUITY

The transition to net-zero must be just and equitable. Energy poverty is an issue in Nova Scotia, and the transition to net-zero is capital intensive. To succeed, the transition must have widespread support, and this means that everyone must be included and everyone must share in the benefits. Energy-efficiency programs must include services for low-income homeowners and renters (such as Nova Scotia's successful HomeWarming program), Mi'kmaw communities, small business, and all commercial and industrial business. Training and employment strategies must target the unemployed and disadvantaged so that the great potential to drive economic and community renewal can be realized. And the economic transition must be seen as an instrument for continued reconciliation with the Mi'kmaq and even with the land itself. To that end, Mi'kmaw band-owned homes in Nova Scotia are being retrofitted to become more energy efficient and comfortable to live in while reducing the use of fossil fuels. This initiative is based on the need for services and provided at no cost.

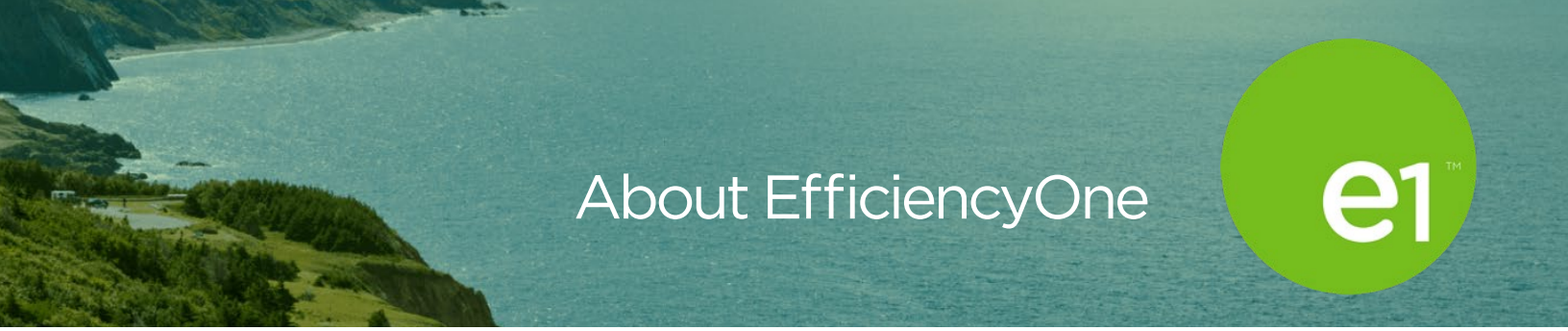
REGIONAL ECONOMIC DEVELOPMENT

Atlantic Canada's demonstrated success in regional cooperation in the energy sector constitutes a foundation for further collaboration on energy efficiency, electrification, and renewable electricity growth that can contribute to regional economic cooperation and development. The growth of efficiency and zero-carbon energy delivery within the region will displace the current financial outflow for fossil fuel purchases and can also lead to the region becoming an exporter of low-carbon technologies and implementation expertise that promises to be in high demand in the decades ahead.

CONCLUSION

The adverse social, economic, and public health effects of climate change will increase in the coming years, a consequence of past GHG emissions on the atmosphere. As the ecosphere adjusts to the impact of the fossil fuel-powered industrialization of the past 150 years, heat waves will become more intense. So will storms, droughts, and wildfires. Climate change has been officially recognized as an emergency by the Government of Canada, the Province of Nova Scotia, the Halifax Regional Municipality, and other Nova Scotia municipalities. Without deep cuts in GHG emissions in the next decade, the human toll and economic costs of inaction will be severe. And they will be borne by our children and future generations for decades to come.

The good news is that the actions necessary to make emission cuts can benefit citizens in every community and in every walk of life. Mobilizing an effective emergency response to climate change through a transformation of our buildings, transportation, and energy systems to net-zero is not a threat to the economy; on the contrary, it is the key to continued health and prosperity. Making the investments now in the transition to net-zero as we build back from the COVID-19 pandemic offers a strong foundation for economic renewal, full employment, greater self-reliance, and sustainable prosperity throughout Nova Scotia and Atlantic Canada.



About EfficiencyOne

Helping people build a better world through efficiency.

EfficiencyOne is a non-profit organization deeply committed to climate action and helping Canada achieve its net-zero targets. Familiar to most Nova Scotians as the operator of Efficiency Nova Scotia, EfficiencyOne has received national recognition for its high electricity and heating fuel savings achievements, as well as its low-income services and innovative Indigenous programs. We operate an independent, target driven, and performance-based business model which has been cited by the International Energy Agency.

We believe passionately that Canada must move more aggressively to reduce GHG emissions by adopting higher efficiency standards for the construction of new buildings, reducing emissions from vehicles, and reducing energy poverty. Our work includes a partnership with our province's Mi'kmaq communities, with plans to retrofit 2,400 homes and use band-preferred contractors to build capacity with Indigenous businesses.

Through our work, we understand first-hand the opportunity to reduce the use of fossil fuels in existing buildings through deep energy retrofits. In fact, we believe that with access to capital and other financial products and services, combined with local market insights, Canada's residential and commercial building stock can be retrofitted to net-zero by 2040.

Achieving net-zero requires a holistic approach, with the intention of truly transforming how energy is generated and used in Nova Scotia. An increase in investments and associated resources is needed to make this achievable.

Nova Scotia has robust energy efficiency market knowledge, expertise, and industry capacity. The energy efficiency sector is a significant contributor to sustainability goals and plays a major role in reducing GHG emissions. EfficiencyOne's programs are designed to be accessible by diverse communities, to leave no one behind, and to reduce energy poverty in Nova Scotia.

EfficiencyOne is committed to climate change mitigation and works in partnership with the Government of Nova Scotia and The Government of Canada to do its part in achieving climate change and sustainability goals. Efficiency-One's team of experts connects and speaks directly with Nova Scotians to help implement successful projects, reduce energy use, and achieve climate change goals. Helping people build a better world through efficiency.

EfficiencyOne

2050: Net-Zero Carbon Nova Scotia White Paper

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