# POWERING A GREEN NOVA SCOTIA, TOGETHER.

## 2020 Integrated Resource Plan Summary

Nova Scotia POWER
An Emera Company

November 27, 2020

# 1 IRP SUMMARY

## 1.1 Introduction

In the 2020 Integrated Resource Plan (IRP), Nova Scotia Power puts forward a long-term strategy for delivering safe, reliable, affordable and clean electricity to customers across Nova Scotia. At its core, the plan illustrates Nova Scotia Power's commitment to supporting provincial decarbonization as outlined in the Nova Scotia *Sustainable Development Goals Act* (SDGA), both by transitioning to a cleaner electricity grid and by enabling electrification of other sectors, such as transportation and heating. Given the unprecedented nature of these initiatives, as well as the increasingly dynamic and complex resource planning environment, Nova Scotia Power incorporated extensive stakeholder engagement into the process, including input from nine public workshops, six rounds of formal submissions from stakeholders, independent expert analyses, and ongoing consultation with participants. This engagement generated critical insights at each stage of the IRP process. Supported by this collaborative effort, Nova Scotia Power produced a set of resource plans to explore a broad range of potential futures and provide insights on trade-offs between these approaches. As detailed in the Action Plan, Nova Scotia Power has identified common themes and no-regrets actions that can be employed in the near term to benefit customers and the Province. These actions will rely on the continued support and involvement of the participants in this IRP process as Nova Scotia Power works together to implement this electricity strategy and transition to a deeply decarbonized electricity system. The title of the 2020 IRP Report appropriately outlines and captures this theme – Powering a Green Nova Scotia, Together.

## 1.2 Nova Scotia Power's System Transformation

This IRP represents a blueprint for a significant transformation in the way Nova Scotia Power generates and purchases electricity to serve its customers across the province. The scenarios considered in this report dramatically accelerate reductions in greenhouse gas emissions to align with customers' expectations and with the global scientific consensus that achieving deep decarbonization economy-wide is critical to mitigating the impacts of climate change.

This IRP also reflects Nova Scotia Power's long history of embracing technological innovation to meet customer needs reliably while providing customer rate stability. The Nova Scotia Power system today includes a diverse set of generation assets. It reflects the transformation that Nova Scotia Power has been making, together with customers and the Province, to respond to the needs of the province, including its economic and environmental goals. Nova Scotia Power operates hydro facilities, some commissioned almost 100 years ago, which have provided clean, renewable electricity since that time. The development of these assets culminated in the commissioning of the Wreck Cove facility in 1978. This facility is the largest hydroelectric resource in Nova Scotia, providing 200 MW of capacity as well as significant volumes of clean energy and ancillary grid services. Originally designed as a peaking power plant to serve the morning and evening peak energy demand periods, this flexible plant is now vital to the integration of variable renewable generation.

**This IRP reflects Nova Scotia Power's long history of embracing technological innovation to meet customer needs reliably while providing customer rate stability**

For decades, Nova Scotia Power has relied on coal-fired power plants to provide firm dispatchable generation that delivered a reliable electricity supply as electrical demand grew. Throughout the twentieth century, this coal was largely mined within the province, supporting the domestic economy. The current coal fleet was largely built in the 1970s-1980s. The addition of coal-fired power plants also helped transition Nova Scotia Power's generation mix away from imported oil, which by the 1970s had become prohibitively expensive and volatile in pricing. Nova Scotia Power's dedicated team of employees has operated and maintained these facilities so that they continue to perform reliably today, and the utility has added environmental controls to reduce their environmental impacts, including investments in mercury abatement, low-nitrogen oxide ($NO_x$) control technologies, and advanced coal blending practices. As one significant example, Point Aconi Generating Station was constructed with a circulating fluidized bed (CFB) boiler, which significantly reduces sulphur dioxide emissions and, at the time of the plant's commissioning, was the largest boiler of this type.

Following the global acknowledgement of the risks of climate change and the need to achieve deep decarbonization, Nova Scotia Power has re-examined how it provides electricity to customers, shifting investments toward lower carbon sources of generation and capacity, while ensuring reliability and rate stability. This is not new thinking for the utility. When natural gas first became available in Nova Scotia in 1999, Nova Scotia Power converted the three units at the Tufts Cove

Generating Station to utilize this newly available fuel rather than more expensive and carbon-intensive heavy fuel oil. Nova Scotia Power also constructed an efficient combined-cycle generating facility at the Tufts Cove site, which reduced emissions relative to coal or oil. As wind generation technology has developed, Nova Scotia Power has also added this resource to its portfolio. Nova Scotia Power added its first wind turbine at Wreck Cove in 1981, which was one of the first commercially operating wind turbines in Canada. Nova Scotia is now a wind energy leader with approximately 600 MW of wind generation installed across the province, supplying 18 percent of annual energy demand. These wind resources have contributed to meaningful reductions in greenhouse gas emissions.

Nova Scotia is directly connected to the rest of the North America electricity system via an interconnection with New Brunswick through one 345 kV tie and two 138 kV tie lines. In addition, the recent completion of the Maritime Link, a 500 MW high-voltage direct current subsea cable and 230 kV high-voltage alternating current transmission line between the provinces of Nova Scotia and Newfoundland and Labrador, now enables access to zero-carbon electricity and dispatchable firm capacity while supporting longer term rate stability, marking another transformation of the Nova Scotia system with the first HVDC converter station and interconnection with a second neighbouring province.

**The IRP shows that economy-wide deep decarbonization, in line with the SDGA, can be supported by Nova Scotia Power through investment in a diverse, low-carbon resource portfolio**

The innovative spirit that is driving Nova Scotia Power's efforts to decarbonize its generation mix will also enable the utility to meet greater heating and transportation energy demand driven by electrification. The SDGA is designed to attain sustainable provincial prosperity through decarbonization of at least 53 percent (relative to 2005) by 2030 and attainment of "net-zero" carbon emissions by 2050. The analysis in this IRP shows that economy-wide deep decarbonization, in line with the SDGA, can be supported by Nova Scotia Power through investment in a diverse, low-carbon resource portfolio. This transformation will also require the utility to optimize the utilization of its existing assets to manage costs and ensure reliability. Nova Scotia Power has shown repeatedly over time that it is able to harness the energy of the company and the province to transform its generation mix, and the utility is ready to do it again. The results of this IRP will guide Nova Scotia Power in completing this important work.

## 1.3 Evolving Planning Landscape

Electric utilities today must navigate a rapidly changing and uncertain resource planning environment, driven by decarbonization goals, regulatory and policy developments, new technologies with uncertain future price trajectories, and changing customer expectations. Nova Scotia Power has considered these factors across a wide range of planning assumptions and scenarios to ensure that this IRP considers the many ways that the future could unfold.

**The resource planning environment is uncertain, driven by decarbonization goals, regulatory and policy developments, new technologies with uncertain future price trajectories, and changing customer expectations**

- **Decarbonization:** The need for deep greenhouse gas emission reductions is recognized across the globe. On October 30, 2019 the Lieutenant Governor of the Province of Nova Scotia granted Royal Assent for the SDGA[1], which established provincial greenhouse gas emission reduction goals of at least 10 percent below 1990 levels by 2020; at least 53 percent below 2005 levels by 2030; and "net-zero" by 2050 by balancing greenhouse gas emissions with greenhouse gas removals and other offsetting measures. Similar decarbonization targets are being discussed at the Federal level. Nova Scotia Power has already reduced its own greenhouse gas emissions meaningfully below 2005 levels, achieving a 38 percent reduction by 2019. Nova Scotia Power will continue this trend through its commitments to coal unit retirements and increasingly stringent decarbonization targets. In this IRP, Nova Scotia Power has evaluated resource plans that integrate more renewable energy and achieve deep decarbonization targets by mid-century, and in some cases much earlier. The scenario plans under evaluation in this IRP achieve between 87 and 95 percent reductions in greenhouse gas emissions from the Nova Scotia Power electricity system by 2045.

**The SDGA established provincial greenhouse gas emission reduction goals of at least 10 percent below 1990 levels by 2020; at least 53 percent below 2005 levels by 2030; and "net zero" by 2050**

- **Electrification:** Deep Decarbonization in Nova Scotia: Phase 1 Report[2] (Deep Decarbonization Pathways), consistent with similar studies across North America, shows that electrification of vehicles and buildings is key to achieving economy-wide decarbonization. As the greenhouse gas content of electricity continues to decrease, the greenhouse gas savings from electrifying end uses such as transportation and heating increase. Thus, Nova Scotia Power is proactively planning the system so that it can accommodate electrified loads as they materialize.

**Electrification of vehicles and buildings is key to achieving economy-wide decarbonization**

[1] *Sustainable Development Goals Act*, 2019, c. 26 – not proclaimed in force. (The SDGA will be proclaimed in force by order of the Governor in Council following public consultations and the making of regulations establishing goals to achieve sustainable prosperity consistent with the principles and focus areas set out in the act. (ss. 14 and 16).

[2] Appendix A, Energy + Environmental Economics (E3), Deep Decarbonization in Nova Scotia: Phase 1 Report, February 2020.

- **Technology:** The cost and characteristics of generation technologies are changing rapidly. The array of new and evolving technologies available to Nova Scotia Power – including wind turbines, efficient natural gas plants, battery or other energy storage, solar panels, potential new low emitting fuels and others – has advanced significantly in the last decade, and continued cost declines are expected. Moreover, new transmission projects can provide access to low- or zero-carbon energy and firm capacity[3] from other regions and help integrate Nova Scotian renewable energy. This changing landscape makes deep decarbonization more achievable than at any time before. Nova Scotia Power has evaluated a wide range of technologies that can contribute to Nova Scotia's needs, and Nova Scotia Power remains committed to evaluating new resource options as they become available. While specific resource selection in the IRP is indicative of the preferential resource category, detailed study will be required to confirm and optimize specific unit retirements and resource additions. The IRP Action Plan recommends appropriate steps to continue this work.

Technologies including wind turbines, efficient natural gas plants, battery or other energy storage, solar panels, potential new low emitting fuels, and others have advanced significantly in the last decade, and continued cost declines are expected

- **Customer Choice:** Customers are increasingly investing in onsite energy solutions that can help manage energy usage, including energy efficiency and distributed generation technologies. In this IRP, Nova Scotia Power has forecast continued adoption of customer-sited solutions and has considered a range of resource strategies that expand energy efficiency and/or distributed generation. These technologies have the potential to provide benefits to the electricity system but can also have impacts that must be carefully understood and incorporated into system planning to ensure that value is received by all customers.

New transmission projects can provide access to low- or zero-carbon energy and firm capacity from other regions and help integrate Nova Scotian renewable energy

[3] Firm capacity refers to owned or contracted generation capacity that can turn on and dispatch up to maximum output on command, barring any forced outages.

## 1.4 Planning Objectives

Through the IRP process, Nova Scotia Power undertakes long-term system planning to understand how the electricity system will continue to meet the needs of customers and respond to changes in the electricity planning landscape. This process informs ongoing investment, retirement, and operating decisions that are in the best interests of customers over a 25-year planning horizon. Nova Scotia Power plans the system to be safe, reliable, affordable, clean, and robust under many potential future outcomes. In the near-term, Nova Scotia Power plans to undertake "no-regrets" actions that further these planning objectives and that are shown to be robust, or common, under many potential futures. Figure 1 further describes these objectives.

***Figure 1. System Planning Objectives***

**SAFE**
- Provide safe electric service throughout the province
- Promote an injury-free workplace where everybody goes home safe every day

**RELIABLE**
- Meet reliability requirements for supply adequacy
- Procure essential grid services for system stability and reliability

**AFFORDABLE**
- Minimize the present value of the long term costs of the power system
- Manage the magnitude and timing of electricity rate impacts

**CLEAN**
- Reduce greenhouse gas and other emissions
- Support economy-wide decarbonization through long-term planning

**ROBUST**
- Develop a plan that can withstand realistic potential changes to key assumptions
- Build in flexibility so that future decisions aren't overly constrained

## 1.5 The IRP Planning Process

Nova Scotia Power's 2020 IRP reflects a detailed effort over more than a year to create an electricity strategy for the future. In consultation with stakeholders, Nova Scotia Power has produced several interim documents: Pre-IRP Deliverables, IRP Terms of Reference, Assumptions and Analysis Plan, Scenarios and Modeling Plan, Initial Modeling Results, Final Modeling Results, and the Draft Findings, Action Plan and Roadmap. Throughout the process, Nova Scotia Power has incorporated input from a large group of stakeholders to utilize the best available information and include alternate views for

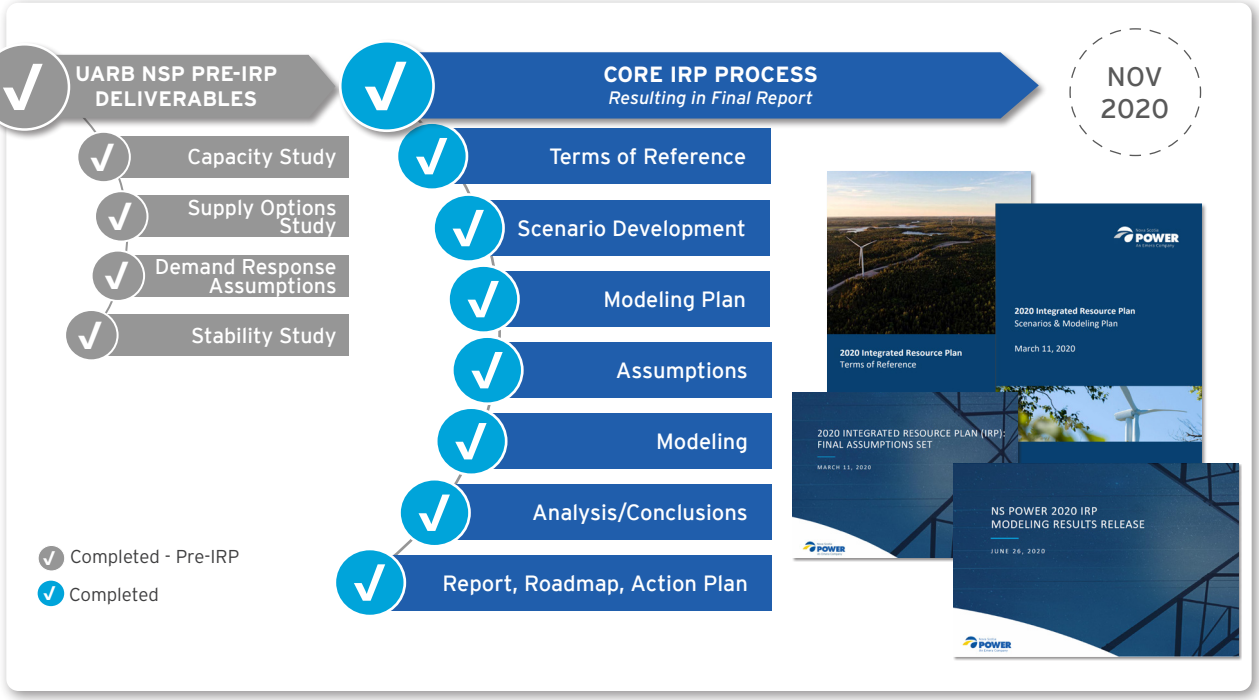
how the system could evolve. This process ensures the IRP is transparent, inclusive of stakeholder comments, and effective at meeting Nova Scotia Power's long-term planning objectives.

To build on the findings of the IRP, Nova Scotia Power has developed an Action Plan and Roadmap to advance next steps. The Action Plan serves as a near-term guide for changes to the system and informs the planning initiatives that Nova Scotia Power will undertake. The Roadmap details a strategy for monitoring signposts that confirm or indicate a need to alter the near-term strategy.

The publication of the IRP report does not mark the end of planning efforts. As highlighted in the Action Plan, Nova Scotia Power will continue to perform planning analyses on a regular basis to ensure that it continues to identify resource options and strategies that are beneficial to customers. As is the case for utilities across North America, the IRP serves as a directional roadmap to guide future decision making but does not prescriptively predetermine actions over the coming years and decades. The IRP identifies several resource plans that could meet long-term goals and requirements, which vary in the type, quantity, and timing of resource changes. As Nova Scotia Power continues to study resource options and obtain new information, including costs for specific project options, it will use these resource plans as a guide but will adapt as necessary to best serve customers. The IRP Findings, Action Plan and Road Map are based on common insights across the scenarios studied, to ensure a "no-regrets" approach is taken in the follow-up next steps.

Figure 2. shows the key milestones within the pre-IRP study process and the core IRP process that have been undertaken in consultation with stakeholders to lead up to the delivery of this Final Report.

***Figure 2. Pre-IRP Study Process and the Core IRP Process***



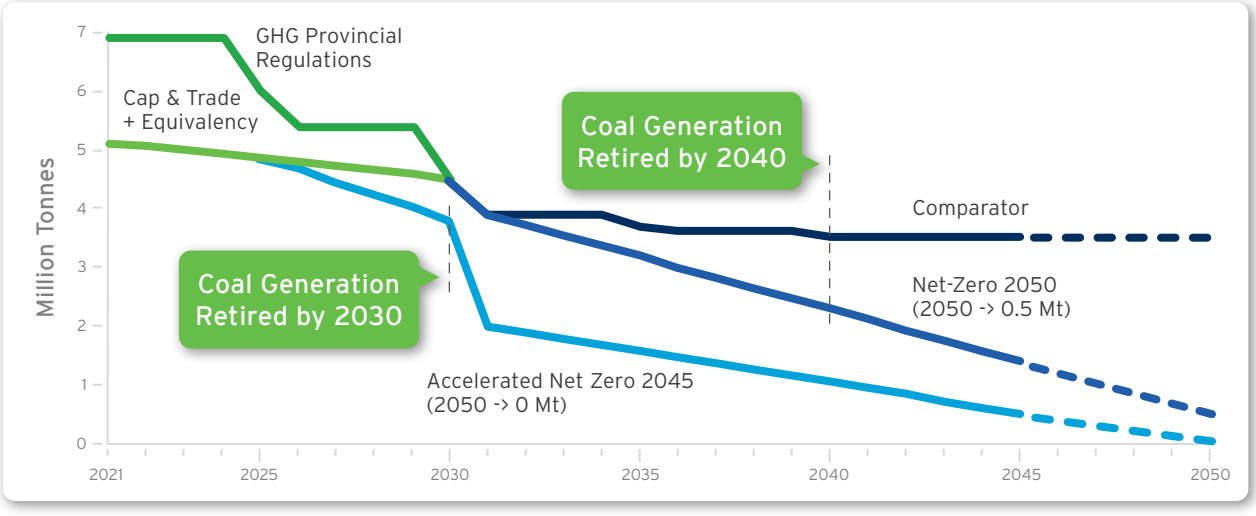
## 1.6 Exploring a Diverse Set of Scenarios

Nova Scotia Power undertook an initial scenario development exercise with stakeholders to solicit input on an appropriate range of scenarios to be considered through the IRP exercise. From there, using this stakeholder input, Nova Scotia Power constructed a diverse set of scenarios to explore policy options, resource strategies, and potential future worlds. By exploring a range of approaches under different conditions and circumstances, Nova Scotia Power has assessed the trade-offs in following different pathways to attain its long-term objectives. In addition, with a scenarios-based approach, Nova Scotia Power has ensured that its planning strategy is robust under a range of possible future conditions.

Scenarios following the accelerated net-zero by 2045 trajectory retire all coal power plants no later than 2030, while the other scenarios retire all coal plants by 2040

Figure 3 depicts Environmental Policy Scenarios (Greenhouse Gas Scenarios and Coal Retirement Scenarios) that were identified for evaluation through the IRP exercise. The Environmental Policy Scenarios utilize one of three trajectories for greenhouse gas emissions, which govern the maximum amount of greenhouse gas emissions from generated or imported energy during a given year. The trajectories for GHG emissions include one based on the equivalency agreement between the Province of Nova Scotia and the Government of Canada,[4] one that is consistent with a path to reaching provincial net-zero carbon emissions by 2050, and one that reaches provincial absolute zero electricity sector carbon emissions by 2050. These last two trajectories broadly align with the targets set in the SDGA, which does not set an electricity sector-specific target. Scenarios following the accelerated net-zero by 2045 trajectory retire all coal power plants no later than 2030, while the other scenarios retire all coal plants by 2040. Coal units can be retired earlier if determined to be economic by the optimization model.

***Figure 3. Greenhouse Gas Emissions Trajectories and Coal Retirements***

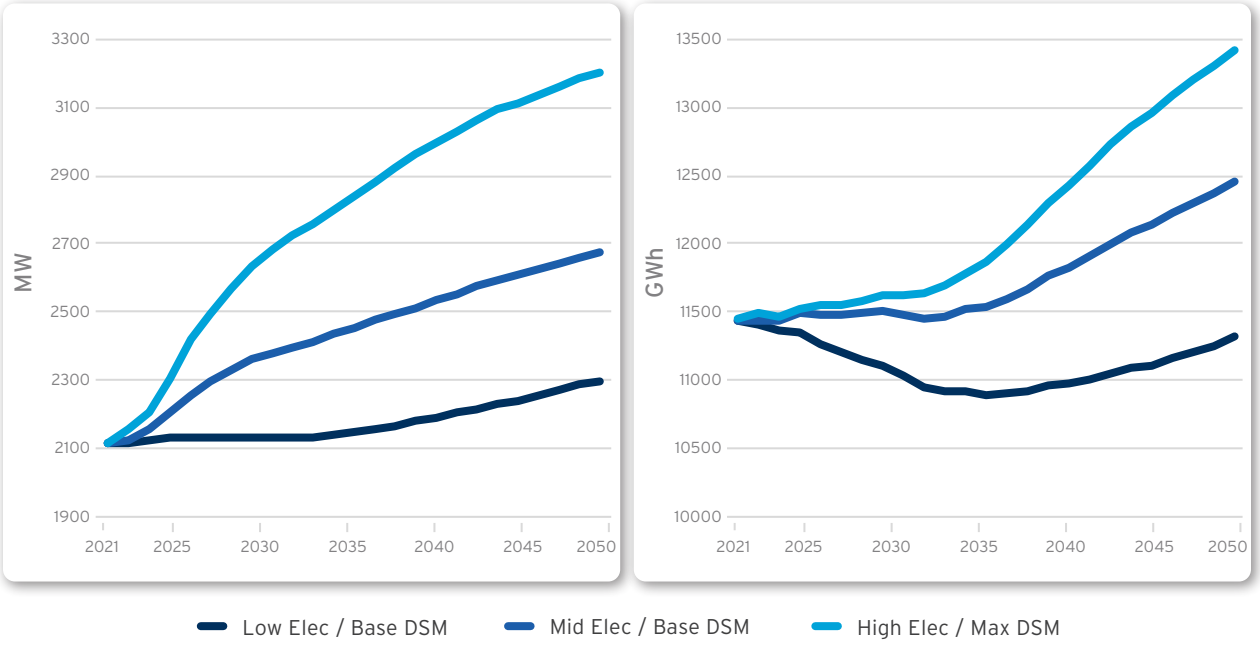



[4] The Province of Nova Scotia has an agreement-in-principle with the Government of Canada to develop a new equivalency agreement providing Nova Scotia with the ability to continue to achieve meaningful GHG reductions through moving directly from fossil fuel generation to clean energy sources while enabling Nova Scotia's coal-fired plants to operate at some capacity from 2030 to 2040.

The load trajectories developed for the IRP, shown in Figure 4, reflect three possible levels of electrification and varying levels of energy efficiency in the province. Depending on the pace of adoption for end use electrification, there could be a wide range of impacts on system load over the coming decades. The electrification trajectories impact the amount of energy that must be supplied both throughout the year and during periods of peak energy demand. The High Electrification level envisions near-complete electrification of heating demands by 2050 and 100 percent sales of electric vehicles for light duty vehicles by 2040. The Mid Electrification level envisions half of this deployment level. The Low Electrification Level envisions continuation of the current pace of growth in building and transportation electrification. These electrification assumptions are coupled with assumptions regarding energy efficiency deployment developed by EfficiencyOne (E1) for modeling. These assumptions were informed by a detailed analysis of deep decarbonization in Nova Scotia (Deep Decarbonization Pathways), completed as an input to the IRP process and provided as Appendix A.

**The High-Electrification level envisions near-complete electrification of heating demands by 2050 and 100 percent sales of electric vehicles for light duty vehicles by 2040**

***Figure 4. Firm Peak Load and Annual Energy Forecasts***



Nova Scotia Power also tested three alternative resource strategies for the planning of its system: Current Landscape, Distributed Resources, and Regional Integration. These strategies represent different approaches to planning the system. The Distributed Resources strategy contemplates a high uptake of small-scale resources (e.g. rooftop solar), while the Regional Integration strategy allows for new interconnections to other regions and corresponding access to out-of-province resources for firm energy and capacity, in addition to in-province resources. The Current Landscape strategy reflects a smaller deployment of distributed resources and does not allow for new transmission solutions to access new markets.

The various options developed for GHG emissions trajectory, load/electrification forecast, and resource strategy are summarized in Figure 5 below; this summary aligns with the naming convention Nova Scotia Power developed for various scenarios.

***Figure 5. Key Drivers for Scenarios***

### DECARBONIZATION

- **Equivalency:** Coal plants retired no later than 2040. GHG reduction trajectory consistent with the Province of Nova Scotia agreement-in-principle with the Government of Canada to develop a new equivalency agreement
- **Net Zero:** Coal plants retired no later than 2040. GHG reduction trajectory consistent with reaching net-zero carbon emissions by 2050
- **Accelerated Net Zero:** Coal plants retired no later than 2030. GHG reduction trajectory consistent with reaching net-zero carbon emissions by 2045

### ELECTRIFICATION

- **Low Electrification:** Current pace of growth in building and transportation electrification, which may be inconsistent with the targets outlined in the SDGA
- **Mid Electrification:** Half of the building and transportation electrification achieved in the High Electrification scenario
- **High Electrification:** Near-complete electrification of space and water heating demands by 2050 and 100% sales of electric vehicles for light duty vehicles by 2040

### RESOURCE STRATEGY

- **Current Landscape:** Current pace of deployment of distributed resources and no new interconnections to other regions
- **Distributed Resources:** Adds distributed resources, modeled as solar PV, in larger quantities relative to the current trajectory
- **Regional Integration:** Allows for new interconnections to other regions and corresponding access to out-of-province resources for energy and capacity

In addition to the core set of scenarios, Nova Scotia Power evaluated numerous sensitivities, many of which were requested through or informed by stakeholder feedback, to ensure the findings are robust.

## 1.7 Developing Optimal Resource Plans

Nova Scotia Power assessed each scenario by optimizing its resource portfolio and operations using a suite of analytical planning models. Through consultation with stakeholders, and input from the Energy and Environmental Economics (E3) Supply Options Study, prepared as part of the Pre-IRP deliverables and through the Assumptions stage of the IRP, Nova Scotia Power worked with stakeholders to characterize the capabilities and costs of various technologies that can contribute to the long-term objectives. Detailed inputs include capital costs, operating costs, operating characteristics, and contributions to system reliability. These details, along with the characteristics of Nova Scotia Power's existing system and the details of a particular scenario, are inputs to the optimization models. The models then identify the lowest-cost solution – including investment, retirement, and operating decisions – while maintaining reliability and satisfying the environmental targets for the scenario.

The optimal resource plan for each scenario includes a different long-term mix of resource technologies, based on the given system conditions and constraints modeled. The long-term capacity expansion model used by Nova Scotia Power, PLEXOS LT, is able to choose among available resource technologies that offer a range of capabilities, as seen in Figure 6. The model allows each resource technology to be assessed on a level playing field when choosing a solution that meets reliability and greenhouse gas reductions requirements at the lowest cost. The result is a unique resource portfolio for each scenario.

***Figure 6. Resource Options***

| Resource Technology | Low-Carbon Energy | On-Demand Capacity & Grid Services |
|---|---|---|
| Wind Turbines | ● | ● |
| Solar PV Projects | ● | ○ |
| Hydro Plants | ● | ● |
| Imports (Firm) | ● | ● |
| Imports (Non-Firm) | ● | ○ |
| Battery Storage | ○ | ● |
| Demand Response | ○ | ● |
| Energy Efficiency | ● | ○ |
| Distributed Generation | ● | ○ |
| Thermal Plants | ○ | ● |

● Provides service(s) ● Provides service(s) on a limited basis ○ Mostly not applicable

Nova Scotia Power considered a wide range of technologies, including renewable resources, imports via new transmission lines, battery storage, compressed air energy storage, customer-sited solutions such as demand response and distributed resources, and natural gas power plants. Nova Scotia Power is planning its system to increase the share of generation from low- and zero-carbon resources and decrease the share of generation from greenhouse gas-emitting resources.

Hydroelectric resources in Nova Scotia have the benefit of providing zero-carbon energy, ancillary grid services,[5] and on-demand capacity, helping to reduce greenhouse gas emissions and maintain reliability. Incremental firm imports are another resource option that can provide zero-carbon energy and ancillary grid services. Firm imports are considered firm because Nova Scotia Power can rely on them to be available at any point during the year, barring any forced outages. Incremental firm imports are available in the "Regional Integration" and "Distributed Resources" scenarios.

Wind and solar PV resources provide zero-carbon energy but provide only limited ancillary grid services and do not provide on-demand capacity in the same way that hydroelectric resources, thermal plants, and firm imports do. Nevertheless, these resources do contribute to ensuring reliability, as demonstrated in the effective load carrying capability (ELCC) in the PRM and Capacity Value Study completed by E3 as part of the pre-IRP deliverables. However, this same study showed that the contribution to reliability for these resources – especially solar PV – is relatively low and declines with increased penetration. Battery storage and demand response can provide on-demand capacity for limited durations, while "fossil" based generators – generators that produce power by burning fossil fuels including coal, oil or natural gas – can provide on-demand capacity for unlimited durations, barring any forced outages.

Nova Scotia Power has significantly reduced its greenhouse gas emissions from fossil power plants as other energy resources have become available and plans to continue that trend. Fossil fuel-based power plants will increasingly play a "back-up" role for clean energy resources. Even in deep decarbonization scenarios, these resources may continue to play a valuable role in providing ancillary grid services and on-demand capacity, even if they generate very rarely. The resource plan optimization model considers the cost of low utilization at fossil power plants and compares it to the cost of other solutions; the model considers all potential resource combinations and ultimately identifies a lowest-cost resource portfolio that maintains reliability and reduces greenhouse gas emissions according to the modeled emissions levels.

[5] "Ancillary Grid Services" is used in this IRP to encompass a variety of services that are essential for maintaining reliability of the power system, including provision of operating reserves, inertia, frequency response, reactive power / voltage control, and black start capabilities.

## 1.8 Overview of Key Findings

Nova Scotia Power evaluated a broad range of potential future scenarios that reflect key uncertainties over the coming decades. While each scenario has a unique optimal resource plan, Nova Scotia Power has identified common themes from across the modeling results and developed these into the Key Findings presented here. These Key Findings are the basis of the IRP Action Plan and Roadmap.

1. **Steeply reducing carbon emissions in line with Nova Scotia's Sustainable Development Goals Act will require significant efforts from each sector of the economy, with the electricity sector playing a major role.** Nova Scotia Power has analyzed provincial economy-wide decarbonization efforts in line with the targets of the SDGA. The Deep Decarbonization Pathways report confirmed that electrification of energy end uses in other sectors is an important tool to achieve deep decarbonization affordably. As more end uses electrify, Nova Scotia Power will incorporate these new loads into its planning efforts to continue providing electricity service that remains reliable and affordable. Nova Scotia Power modeled three levels of electrification as part of this IRP in order to capture these impacts.

   Electrifying heating and transportation already reduces greenhouse gas emissions today. For example, switching to a heat pump today reduces greenhouse gas emissions by 35 percent when compared to oil heat on today's system. As Nova Scotia Power decarbonizes its electricity mix with the addition of the Maritime Link energy blocks and other low- and zero-carbon energy resources identified in this IRP, incremental greenhouse gas savings will grow. Across the scenarios, the greenhouse gas reduction achieved by switching to a heat pump increases to 87-95 percent by 2045.

   The trend for electric vehicles is similar. Today, switching to an electric vehicle can reduce greenhouse gas emissions by approximately 60 percent when compared to driving an internal combustion engine vehicle. Across the scenarios, the greenhouse gas reduction from switching to an electric vehicle increases to 91-96 percent by 2045. The electric sector will serve as a key enabler in the pursuit of economy-wide decarbonization.

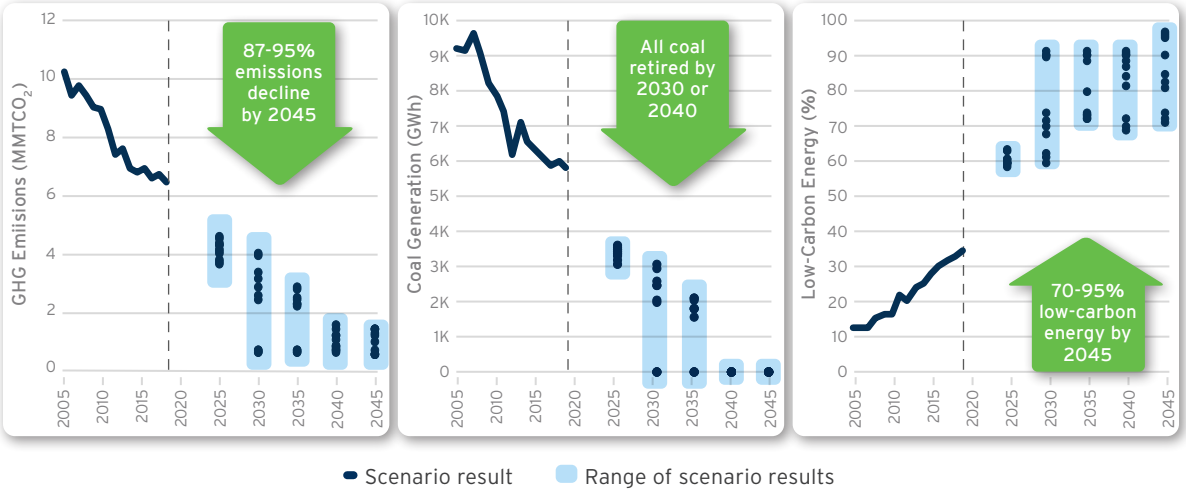
   Nova Scotia Power considered two primary greenhouse gas reduction trajectories.[6] Under both trajectories, Nova Scotia Power significantly reduces greenhouse gas emissions by 2045, achieving reductions of 87-95 percent relative to 2005 emissions levels. This represents a significant contribution to achieving the SDGA targets of a net-zero economy by 2050, province-wide.

[6] Nova Scotia Power also evaluated Comparator scenarios that follow the Equivalency trajectory for greenhouse gas reductions. However, these scenarios are not aligned with the SDGA goals and thus are not considered to be compliant plans.

As part of this IRP, Nova Scotia Power has also considered the relative customer rate impact of various scenarios over time. The directional level analysis work has shown that increased electricity sales due to electrification can reduce upward pressure on electricity rates while facilitating carbon reductions in other sectors; this is a consequential finding which supports the electricity sector's role in economic decarbonization of the provincial economy.

2. **Decarbonizing Nova Scotia Power's electricity supply will require investment in a diverse portfolio of non- and low-emitting resources.** Nova Scotia Power will implement two strategies to transform its generation portfolio over the planning horizon. First, Nova Scotia Power will eliminate coal generation, which is a significant source of greenhouse gas emissions, from its generation portfolio. Nova Scotia Power has modeled the retirement of coal generation by 2030 in some scenarios, and by no later than 2040 in any scenario. Second, Nova Scotia Power will increase the share of low- and zero-carbon generation by increasing domestic renewable energy production in Nova Scotia and importing low- and zero-carbon power via new transmission. Increasing zero-carbon energy from close to 30 percent today to as much as 70 percent by 2045 is a significant undertaking and will enable critical emissions reductions. This transition must be affordable for customers and will also require that sufficient firm capacity resources be available to maintain reliability with the system's transformation and growing capacity needs. Figure 7 shows the change in greenhouse gas emissions, coal generation, and low-carbon generation over time across scenarios.

***Figure 7. Transformation of Generation Mix Across Scenarios***



The IRP analysis demonstrates that wind is the lowest-cost domestic source of renewable energy and is selected preferentially over solar in all resource plans. Additional wind capacity of at least 500 MW by 2045 is selected by the optimization model. The timing of new wind generation often correlates with the retirement of coal units to provide replacement emissions-free energy; firm capacity to pair with the wind energy replacing fossil fuel-based generation is also added. Solar resources are selected in limited quantities late in the planning horizon (2043+) under scenarios following the Accelerated Net-Zero 2045 trajectory; solar generation provides an emissions-free energy resource under these very low emission scenarios but is less well suited than wind to Nova Scotia's system needs due to lower annual capacity factors (resulting in a higher energy cost) and a solar generation profile that is highest in the summer months (while Nova Scotia's load is winter peaking).

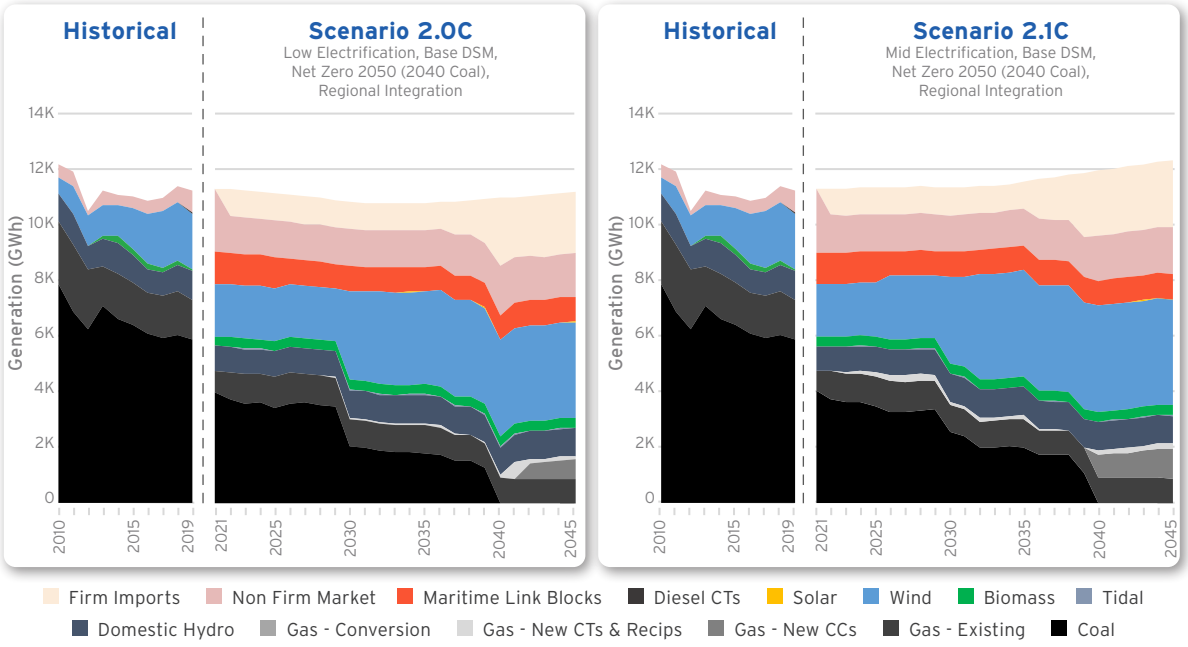
Regional Integration (i.e. investment in stronger interconnections to other jurisdictions) is an economic component of the lowest-cost plans under each load scenario. Both the Reliability Tie, which strengthens Nova Scotia's connection to the North American electrical grid, and a Regional Interconnection, which enables access to firm capacity and energy imports, are shown to have value. This finding is robust across a wide range of assumptions and sensitivities. Replacement of reliable, firm capacity, as can be provided via Regional Integration, is critical to the next phase of system transformation under evaluation in this IRP.

Other key elements of the plan include Nova Scotia Power's existing domestic hydro resources; these are shown to provide economic benefit to customers and are economically sustained through the planning horizon with appropriate reinvestment requirements. In addition, energy efficiency and Demand Side Management (DSM) programs and costs in the range of the "Base" profile, per the EfficiencyOne 2019 DSM Potential Study[7] are shown to be most economic relative to other options evaluated under the primary IRP metric; effects on other metrics are mixed and these findings will inform future DSM program development. Scenarios analyzed with high Distributed Resources penetrations are shown to have higher cost NPV values than Regional Integration scenarios once a low-range estimate of DER cost is incorporated; these scenarios are also shown to have a significantly higher relative rate impact and as a result are not selected for incorporation into the IRP Action Plan.

[7] https://nsuarb.novascotia.ca/ Matter M08929, Exhibit N-1, EfficiencyOne (E1), 2019 DSM Potential Study Report, August 14, 2019.

Figure 8 shows how the generation mix evolves in two low-cost key scenarios, 2.0C and 2.1C. These scenarios are representative of many of the resource plans considered. In these scenarios, greenhouse gas emissions are on the Net-Zero 2050 trajectory, electrification is following the Low (2.0C) or Mid (2.1C) Electrification forecast, and Nova Scotia Power has the option of accessing firm capacity and energy through transmission expansion to other jurisdictions. With the delivery of Nova Scotia Power's contracted hydro blocks and energy imports via the Maritime Link, clean imports increase and displace coal generation, resulting in a significant decline in coal generation early in the planning horizon. The decline in coal generation continues through 2040, by which time all coal-fired power plants are retired. Wind generation and low carbon imports grow to replace retiring coal, making up a larger share of the generation mix.

***Figure 8. Historical and Future Generation Mix Under Scenarios 2.0C and 2.1C***



3. **Firm capacity resources will be a key requirement of the developing Nova Scotia Power system in both the near and long term.** Today, Nova Scotia Power's coal plants provide firm capacity, energy, and essential grid services to the system, all of which are components of reliable system operation. The scenarios examined in this IRP have shown that Nova Scotia Power can retire these units and still operate the system reliably, but new resources are needed to provide these services. Nova Scotia Power will need additional firm generating capacity to ensure that the system is reliable with sufficient supply available to meet expected demand, especially during periods of low renewable generation and peak loads. The need for additional firm generating capacity may also grow with increasing energy demand. Depending on the pace of electrification, energy demand will increase over the next few decades as more vehicles and heating systems plug into the grid. This will further increase the need for additional firm generating capacity that can ensure reliability.

Figure 9 shows retirement of existing capacity and the change in energy demand for a 2040 coal phase-out schedule and both the Low (2.0C) and Mid (2.1C) Electrification trajectories. Nova Scotia Power has been managing a small capacity deficit in the near-term, but this shortfall will grow significantly over the next ten years. Coal plant retirements, as well as economic retirements of other existing thermal power plants, reduce the amount of available firm capacity.

***Figure 9. Existing Effective Capacity and Capacity Needs under Scenario 2.0C and Scenario 2.1C***

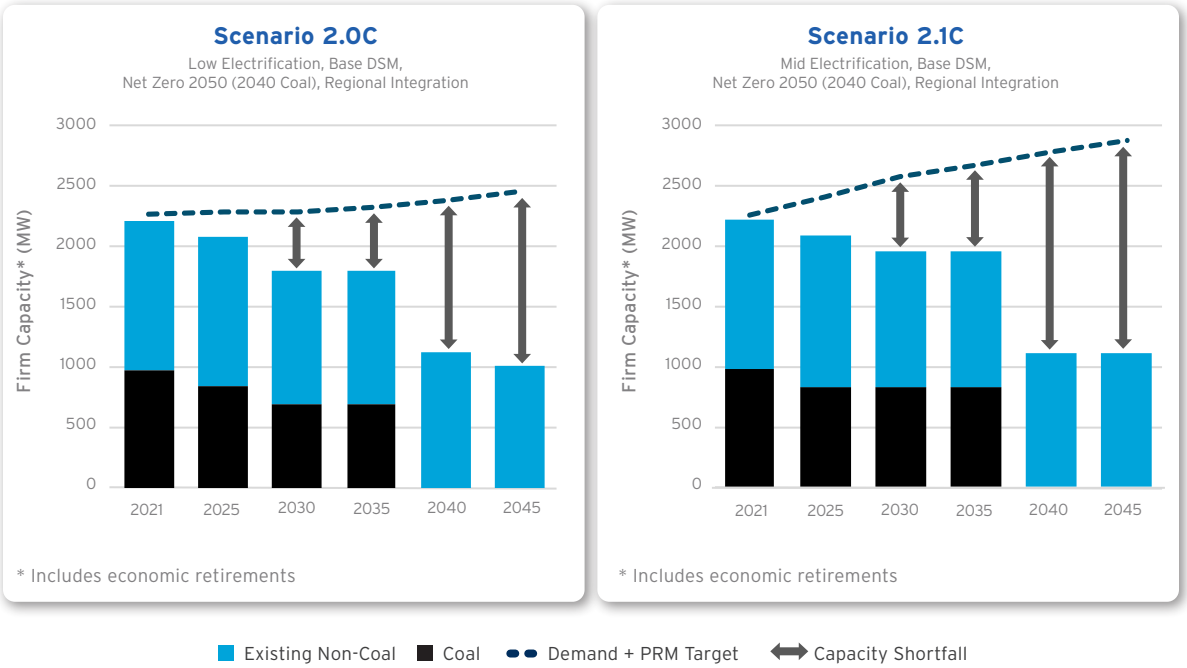
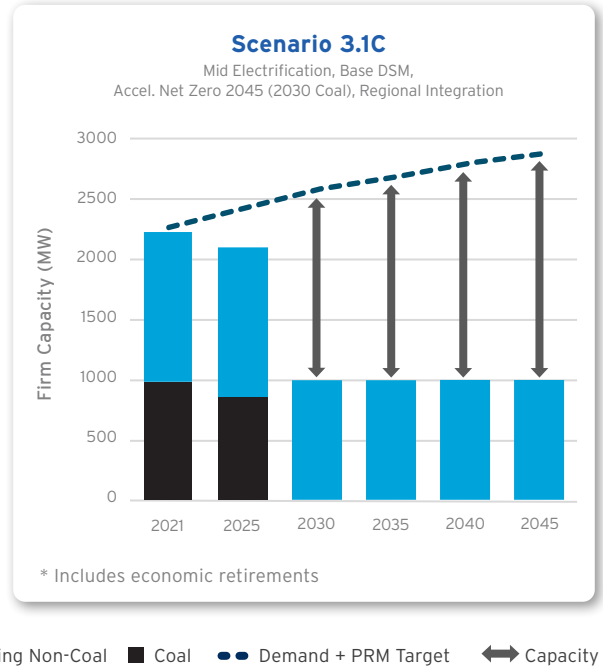


Figure 10 shows the same information, but for a scenario with a 2030 coal phase-out schedule. Because the coal retirements are accelerated and load growth is the same, a large capacity shortfall occurs earlier in the planning horizon.

***Figure 10. Existing Effective Capacity and Capacity Needs Under Scenario 3.1C***




There are several resource technologies that can help fill this firm capacity shortfall, and each has a particular set of capabilities which help to contribute to this reliability need. Nova Scotia Power has drawn from the set of IRP optimized resource plans from low-cost scenarios to identify common elements; these common elements are understood to be robust to a wide range of potential futures and can be incorporated into a no regrets Action Plan and Roadmap.

The IRP analysis has shown that combustion turbines are the lowest-cost domestic source of new firm capacity; they replace retiring thermal capacity in all resource plans. These units are also fast-acting, meaning they can quickly respond to changes in wind and non-firm imported energy. They operate at low capacity factors, meaning that they facilitate integration of non-emitting resources and do not significantly contribute to GHG emissions. In addition, Nova Scotia Power's existing combustion turbine resources provide similar services and economic benefit to customers and are sustained through the planning horizon with appropriate reinvestment requirements. Low-cost, low emitting generating capacity may also be provided economically through redevelopment of existing natural gas-powered steam turbines or coal unit conversions. Fuel flexibility, including low/zero carbon alternative fuels, may also be an option for new and redeveloped resources and will be considered in the IRP Action Plan and Roadmap.

The aggregated Demand Response (DR) programs modeled in the IRP have also been shown to have economic value, offsetting firm generation capacity requirements. A DR program with a target program capacity of approximately 75 MW is shown to have value and is incorporated into the IRP Action Plan. Battery storage also provides firm capacity and can support the integration of variable renewable generation, however its ability to substitute for firm capacity resources is limited by its relatively short duration. Up to 120 MW of storage by 2045 is selected in the portfolios with deployments of 30-60 MW by 2025 in many plans.

For each scenario modeled, the IRP identifies the lowest-cost solution that addresses the firm capacity and energy requirements, meets the greenhouse gas trajectory, and satisfies all other operating requirements. Figure 11 shows the near-term change in capacity for a subset of the scenarios modeled. In all scenarios, fossil capacity is retired within the near-term horizon, and a diverse set of resources is added. Gas capacity is added across all scenarios to ensure reliability, but this new gas capacity is operated relatively infrequently.

***Figure 11. Cumulative Capacity Additions and Retirements in the Near Term (2026)***

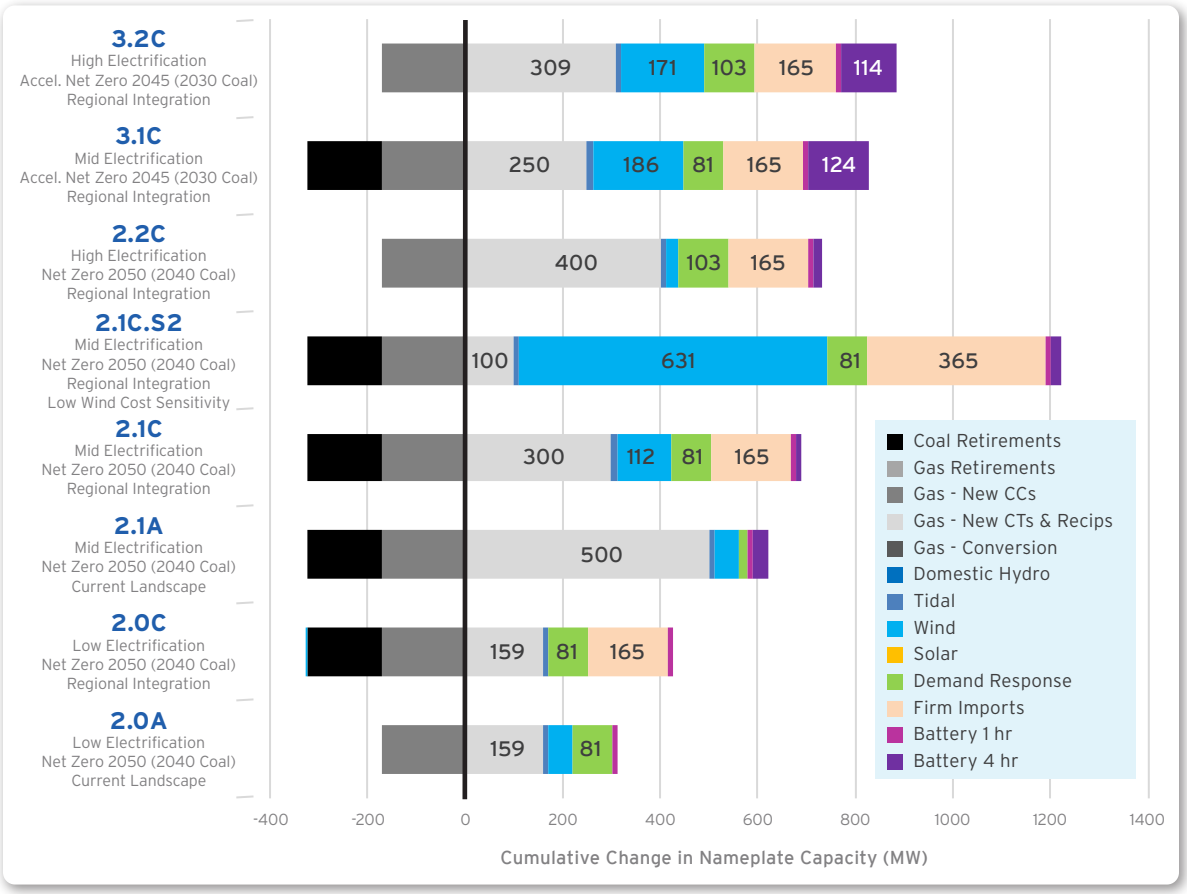
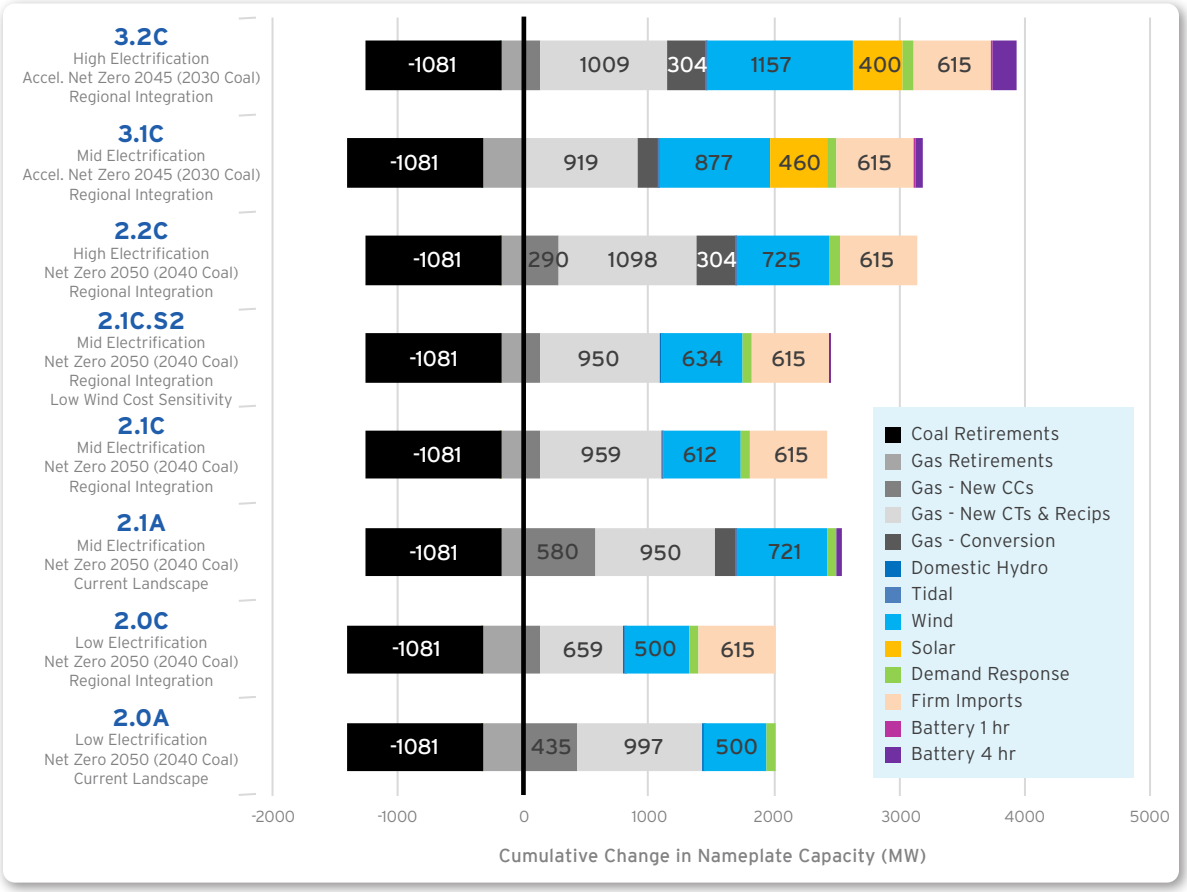


Figure 12 shows the change in nameplate capacity in the long term for the same subset of key scenarios. By this time, all the coal units are retired. A diverse set of resources is added to reduce greenhouse gas emissions and ensure reliability.

***Figure 12. Cumulative Capacity Additions and Retirements in the Long Term (2045)***




4. **The SDGA-compliant key scenario which minimizes the cumulative present value of the annual revenue requirement of the 25-year planning horizon (adjusted for end effects) is 2.0C (Low Electrification / Base DSM / Net-Zero 2050 / Regional Integration).**
The model considered coal retirements in 2030 and in 2040. When coal retirements are required by 2030 in combination with accelerated GHG reduction targets, the replacement firm capacity and energy resource requirements create higher costs leading up to that year as generating resources are replaced. This contributes to a higher net present value (NPV) over the entire IRP planning horizon. Shifting the coal retirements to 2040 lowers costs on an NPV basis, however, the replacement resource mix is similar and so is the cumulative relative rate impact by 2045. This finding indicates that Nova Scotia Power should continue to monitor the planning environment for opportunities to advance the coal transition economically and affordably.

## 1.9 Overview of Action Plan and Roadmap

The Action Plan is a key output of the 2020 IRP. As described in the 2020 IRP Terms of Reference, the Action Plan identifies the critical undertakings required over the near term to implement the long-term electricity strategy. Nova Scotia Power has identified near-term investment and operational strategies that ensure it will satisfy its planning objectives while not closing off opportunities that may later prove to be advantageous.

### 1.9.1 Action Plan

The Action Plan includes insights and ranges informed by the model outputs and findings, as analyzed across the scenarios. These will continue to be reviewed and updated, and should be understood in terms of their orders of magnitude or directional time frames.


1

Develop a **Regional Integration Strategy** to provide access to firm capacity and low carbon energy while increasing the reliability of Nova Scotia's interconnection with North America. This strategy will include:

a. Identifying opportunities for near-term firm imports over existing transmission infrastructure

b. Immediately commencing the development of a Reliability Tie and Regional Interconnection via an appropriate regulatory process with target in-service dates as follows:

   i. Reliability Tie: 2025-2029 (or earlier if practical and feasible)

   ii. Regional Interconnection: 2027-2035

c. In parallel with Regional Interconnection development, and working with neighbouring jurisdictions, conducting detailed engineering and economic studies for firm import options requiring new transmission investment and strengthened regional interconnections, including evaluations of availability and security of supply, emissions intensity, and dispatch flexibility.

2

**Electrification** is a key variable in this IRP and results indicate that under economic resource plans it can support provincial decarbonization while reducing upward pressure on electricity rates for customers. Nova Scotia Power proposes several Action Plan items from this IRP related to electrification:

a. Initiate an Electrification strategy to develop options for encouraging beneficial electrification with the goals of maintaining rate stability while decarbonizing the Nova Scotia economy consistent with the Sustainable Development Goals Act. The Electrification Strategy will:

   i. Incorporate industry best practices such as those identified by the Regulatory Assistance Project[8] as well as other relevant work, for example electrification programs in other jurisdictions and the details already contained in the Deep Decarbonization Pathways report.

   ii. Develop and propose pilots and/or programs that focus initially on the transportation and building electrification sectors identified in the Deep Decarbonization Pathways report as key sectors for early electrification adoption. These pilots and programs will be subject to NSUARB oversight.

b. Initiate a program to collect detailed data, including data on the quantity, flexibility and hourly load shape of incremental electrification demand, to assist with further system planning work.

c. Address electrification impacts on the Transmission & Distribution system as additional experience and data become available. This will include an analysis of available and projected T&D capacity at varying levels of electrification as well as identification of potential mitigation options and cost estimates. This analysis will leverage data from the AMI implementation as it becomes available.

3

Initiate a **Thermal Plant Retirement, Redevelopment, and Replacement Plan**, including:

a. Develop a plan for the retirement and replacement of Trenton 5, targeting 2023, while identifying required replacement capacity and energy in parallel. Begin decommissioning studies for Nova Scotia Power's other coal assets and develop and execute a coal retirement plan including associated regulatory approval process; this coal retirement plan will include significant engagement with affected employees and communities.

[8] Farnsworth, D., Shipley, J., Lazar, J., and Seidman, N. (2018, June). Beneficial electrification: Ensuring electrification in the public interest. Montpelier, VT: Regulatory Assistance Project. (raponline.org)

b. Complete a thermal plant Depreciation Study to update depreciation rates and a recovery strategy to better align depreciation with updated useful lives for generation assets. Invest sustaining capital into individual thermal units appropriate to their retirement categorization.

c. Develop a plan for the redevelopment or replacement of existing natural gas-powered steam turbines to provide low-cost, fast-acting generating capacity to the Nova Scotia system. Fuel flexibility is a component of this work, including consideration for low/zero carbon alternative fuels.

d. Initiate a wind procurement strategy, targeting 50-100 MW new installed capacity by 2025 and up to 350 MW by 2030. This strategy will solicit Nova Scotia-based market pricing information which will inform the selected wind capacity profile and timing, informed by the IRP wind sensitivities.

   In parallel with other elements of the wind procurement strategy, complete system stability studies to determine whether additional dynamic system inertia constraints, operating limits, and/or provision of alternate services like Fast Frequency Response (FFR), are required to enable higher levels of wind integration on the Nova Scotia system, particularly in advance of the commissioning of integration measures such as the Reliability Tie.

**4**

Create a **Demand Response Strategy** targeting 75 MW of capacity, for deployment by 2025. Available resource cost, flexibility, and reliability may inform pursuit of additional Demand Response capability.

a. The strategy will be closely linked to the Electrification Strategy being developed in parallel. The strategy will build on learnings from Nova Scotia Power's Smart Grid Project, Nova Scotia Power's Time Varying Pricing application, the DR Joint Working Group between Nova Scotia Power and Efficiency One, the Extra-Large Industrial Active Demand Control (ELIADC) tariff, and the Large Industrial Interruptible Rider.

**5**

Nova Scotia Power will calculate **Avoided Costs of DSM** (capacity and energy) for scenarios 2.0C and 2.1C. 2.0C will be used as the Reference Plan and 2.1C will be available for additional reference.

### 1.9.2 Roadmap

As conditions change – either through changes to policy, technology, or economics – Nova Scotia Power will adapt its resource plan to best serve customers. The Roadmap sets out a series of signposts that, if observed, may indicate a need to alter the system planning strategy.

1

Advance engineering study work on coal to gas conversions at Trenton and Point Tupper Generating Stations. Monitor cost outputs of this work relative to IRP assumptions and update the balance of new and converted capacity resources accordingly.

2

Complete detailed system stability studies under various current and future system conditions, reflective of both stressed system states and normal operating conditions, while considering higher quantities of installed wind capacity as seen in the IRP modeling results. This work will also consider the impacts of grid service provision from inverter-based generators (such as wind turbines) and how the introduction of new ancillary grid services like Fast Frequency Response might affect existing services such as Synchronized Inertia. Monitor results for significant divergence from wind integration assumptions modeled in the IRP and trigger an update as needed.

3

Pursue economic reinvestment in existing hydro and combustion turbines with individual capital applications as applicable; economic justification as part of a capital application will be required to confirm decision to pursue Mersey hydro redevelopment. Continue sustaining capital investment in thermal units, aligned with their projected retirement classification. Monitor required levels of sustaining capital investment for significant changes from IRP assumptions and, if observed, trigger a unit-specific analysis of alternatives. Monitor unit reliability for significant changes from IRP assumptions and, if observed, trigger an ELCC calculation and/or PRM study as required.

4

Monitor the development of low/zero carbon fuels that could replace natural gas in powering generating units to provide firm, in-province capacity.

5

Continue to track the installed costs of wind, solar, and energy storage to look for variations from the trajectories established in the IRP (in particular, monitoring for divergence from the "Base" to the "Low" pricing scenarios as defined in the IRP Assumptions). Nova Scotia Power will solicit Nova Scotia-based market information which will inform this as needed. Work with E1 to monitor ongoing operational unit costs of DSM in Nova Scotia.

6

Track the ongoing development of the Nova Scotia Cap-and-Trade Program, including auction results and developing regulations. In particular, monitor GHG market size for indications that value from incremental allowance sales (beyond the projected economic emissions reductions shown in the IRP results) can be incorporated into long-term resource planning decisions with greater certainty. Significant changes in the value of incremental GHG reductions could influence resource plan components including non-emitting generation procurement, DSM levels, and coal retirement trajectories.

7

Monitor electrification growth in Nova Scotia to understand at what point the provincial load profile starts to move from Low, to Mid, to High levels of electrification as defined in the IRP Assumptions for firm peak and/or annual energy requirements. An observed transition will, among other impacts, inform the use of DSM avoided costs in related proceedings and trigger a PRM study using actual peak, energy, and load shape data.

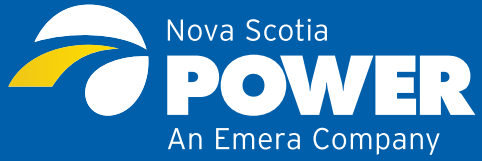
8

Continuously refine the Action Plan and Roadmap items via an evergreen IRP process. This process should facilitate annual updates as conditions change and technology or market options develop, and as Action Plan items are completed or significantly advanced. Nova Scotia Power will include a summary of updates as part of IRP Action Plan reporting and will incorporate the opportunity for stakeholder comment and feedback as part of the update process.

## 1.10 Going Forward

Nova Scotia Power's 2020 IRP reflects global themes of transformation, economy-wide decarbonization, adoption of green technologies, and collaboration with a broad range of stakeholders. Interest in these themes has been intensified as a result of the ongoing COVID-19 pandemic, and the associated focus on economic recovery. Nova Scotia Power is pleased to present this IRP Report as a result of the collective efforts of interested parties to understand and plan for the potential long-term clean energy future of Nova Scotia and to identify a roadmap for system planning based on scenarios that will ensure the utility continues to deliver safe and reliable electricity while accelerating an affordable transition to clean energy in this context.

Nova Scotia Power is appreciative of the input of stakeholders throughout this IRP process, which is among the most significant stakeholder engagement work Nova Scotia Power has undertaken. The 2020 IRP expanded the focus of the traditional utility planning exercise to understand the role of the electric utility within Nova Scotia's broader transition to a clean energy future. Nova Scotia Power will continue to update and advance this work as part of an evergreen IRP process going forward. Building on this foundation of collaboration will be a key element of Nova Scotia reaching its sustainability goals — Powering a Green Nova Scotia, Together.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