Integrated Resource Plan Action Plan Update

FEBRUARY 2023

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Introduction

Nova Scotia Power is pleased to provide this update to its IRP Action Plan.

On November 30, 2020, Nova Scotia Power submitted **Powering A Green Nova Scotia, Together: 2020 Integrated Resource Plan (IRP)** to the Nova Scotia Utility and Review Board.

The IRP Final Report provided the findings and recommendations following an intensive, collaborative project. It set out both an Action Plan and a Roadmap to advance the findings of the IRP.

This IRP Action Plan Update, the second annual Action Plan Update in the 2020 IRP Planning Period, provides the following:

- An update on the Action Plan and Roadmap items for 2022
- An update on electricity planning environment changes
- For ongoing items, a description of planned work for 2023

IRP Action Plan Overview

Action Plan Items

Nova Scotia Power's 2020 IRP Action Plan consists of 5 Action Plan Items, some of which include multiple elements:

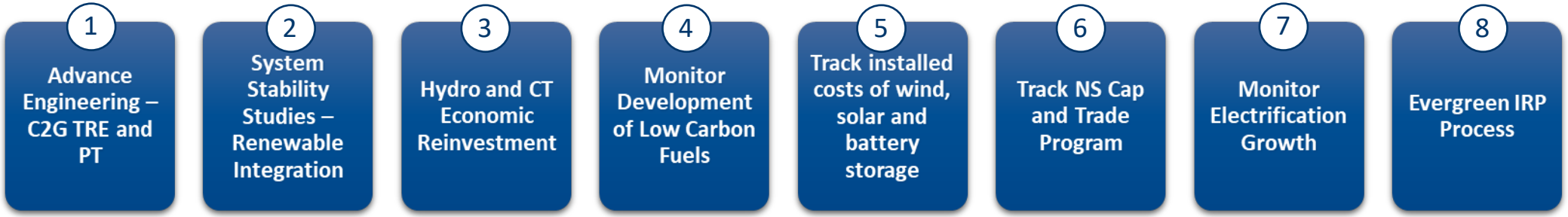
This Annual Report provides an update on each of these Action Plan Items.

Descriptions of the Action Plan Items can be found in the Final IRP Report Summary (Section 1.9.1).

IRP Action Plan Overview

Roadmap Items

NS Power also monitors the following 8 Roadmap Items for potential impact on Action Plan execution:



Descriptions of the Action Plan Items can be found in the Final IRP Report Summary (Section 1.9.2).

In this report, Roadmap item updates have been integrated with the Action Plan Item they are most directly related to.

The evergreen IRP process, which is ongoing, will reflect the most significant changes identified in the planning environment since the 2020 IRP.

Planning Environment Updates

Planning Environment Changes

Clean Electricity Regulation (CER)

Environment and Climate Change Canada (ECCC) has announced their intention to develop a Clean Electricity Regulation (CER) designed to achieve Net Zero GHG emissions for the electricity sector by 2035.

ECCC released their initial discussion paper proposing a clean electricity standard in the Spring of 2022 and NS Power engaged in discussions with ECCC as part of their stakeholder engagement process over the spring of 2022.

NS Power has identified the following key parameters to enable a net zero 2035 electricity system under a future CER:

- Consideration for Reliability and Affordability as key values on the path to both a Net Zero electricity system and economy
- The ability for low-capacity factor, fast-acting generation (both natural gas and liquid fueled) beyond 2035 to support system reliability and the integration of variable renewable generation (as supported by the outcomes of the 2020 IRP) until emerging technologies for firm and dispatchable non-emitting generation are commercially available and affordable for customers
- Development of a GHG credit framework that supports NS Power's role in the electrification of other sectors

ECCC released a follow-up to the discussion paper in the form of a Proposed Frame for a Clean Electricity Regulation under the Canadian Environmental Protection Act (CEPA) in July 2022, which will establish the performance standards and operating parameters for emitting generation in 2035 and beyond.

NSP continued discussions with ECCC in 2022. ECCC has now ended this phase of consultation in preparation for Canada Gazette 1 publication, however NS Power anticipates continued external stakeholder engagement on the modeling outcomes ahead of Canada Gazette 2 and will continue to be engaged.

Planning Environment Changes

Rate Legislation

- NS Power has been engaged in a General Rate Application (GRA) throughout 2022. Prior to a decision from the UARB, the Provincial Government introduced legislation on October 19, 2022 which, among other things, limits non-fuel rate increases to a total of 1.8 per cent between the effective date of the UARB's decision and the end of 2024.
- The recent approval of this legislation (Bill 212) has created uncertainty regarding future NS Power projects.
- The current impacts on those planned investments include:
  - The planned investments in the Eastern Clean Energy Initiative (ECEI) are paused
  - NS Power investment in the Atlantic Loop was paused

Planning Environment Changes

Maritime Link (ML) Base Block and Reliability

- Nalcor filed their "Reliability and Resource Adequacy Study – 2022 Update" on October 3, 2022 which points to both:
  - On-Island capacity constraints in meeting Newfoundland & Labrador (NL) growing load requirements and the need for more on-island firm generation capacity
  - A range of reliability levels of the Labrador Island Link (LIL) were considered in the Study. NLH has, in the context of this study, indicated that the actual realized reliability will be determined as the asset is fully commissioned and operations progress. This creates near-term uncertainty as to potential capacity availability – both in terms of NL capacity needs and the amount available for export.
- These findings indicate additional near-term firm imports via the Maritime Link (up to ~85MW), identified in the 2020 IRP as a potential new firm capacity resource, will not be available

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Regional Integration Strategy

Near Term Firm Imports

Action Item 1a

Throughout 2022, NS Power continued discussions with both New Brunswick and Newfoundland to explore opportunities for incremental near-term firm capacity imports from both New Brunswick and Newfoundland.

Update on potential Firm Imports from New Brunswick:

- Firm import capacity from NB Power continues to be unavailable due to transmission system limits and committed firm exports to Prince Edward Island.
- NS Power received confirmation from NB Power that the Reliability Tie, without additional transmission investment further into New Brunswick, is not anticipated to provide additional firm import capacity to NS. This is consistent with modeling assumptions in the 2020 IRP.

Update on potential Firm Imports from Newfoundland:

- The 2022 10 Year System Outlook included an 85MW firm import from NL, commencing Winter 2023/24, based on the 2020 IRP findings and subsequent discussions with Nalcor.
- The Nalcor Reliability and Resource Adequacy report, published October 3, 2022, indicates that Nalcor will be capacity deficient in the near term and that the LIL reliability will be lower than previously anticipated.

This combination of findings indicates that the likelihood of obtaining near-term firm import capacity from NB Power and/or Nalcor has materially decreased. As a result, NS Power will not include these resources in near-term planning analyses and they have been removed as resource options from the ongoing evergreen IRP update.

NS Power will be responsive to any future changes in the availability of firm imports over existing transmission.

Reliability Tie

Action Item 1b

The Reliability Tie is a second 345kV AC transmission line from Onslow, NS to Salisbury, NB. For internal planning purposes, the Nova Scotia portion of this new transmission line has been designated as L-8005.

This enhanced transmission interconnection is anticipated to provide the following system benefits:

- Increased integration opportunity / reduced curtailment of domestic wind (or other variable inverter-based) generation
- Reductions to minimum online generation constraints in order to meet system synchronous inertia requirements
- Allow for expansion to access additional energy and capacity markets via additional transmission infrastructure beyond Salisbury, NB

The reliability tie work plan for 2022 focused on progressing the permitting and design aspects required to advance the project.

Reliability Tie

Significant progress was made in 2022 on progressing the scope of work, including the following:

- Continued Class III design work for L-8005
- Commencement of a Facility Study (associated with TSR 411)
- Negotiations with the Canada Infrastructure Bank (CIB) to develop low-cost debt financing options
- Progress toward a potential NBP-NSP Intertie Development agreement
- Development of an easement acquisition plan
- Initiation of discussions with NS Environment staff regarding a Class 1 EA Process; additional environmental work includes:
  - Most of the biophysical field work has been completed
  - Archaeology and other work with First Nations has commenced
  - Preliminary results indicate no serious issues from an environmental perspective
- Engagement of Millbrook and Sipekne'katik Indigenous communities continues
- Government Stakeholder engagement with respect to landowner outreach is ongoing

Due to the recent legislated electricity rate cap (Bill 212), the future timing of this project is under review.

Atlantic Loop

Since October of 2022, NS Power investment in the Atlantic Loop has been paused as a result of the legislated electricity rate cap (Bill 212).

Despite these constraints, NS Power is continuing to progress the following:

- Discussions with Hydro Quebec to understand a potential model for imports/exports that serves both NS Power's need for dispatchable renewable energy and opportunities to export variable renewable generation from Nova Scotia, which will continue in 2023.
- Discussions at the Federal level seeking opportunities to secure funding given the regional importance of the Atlantic Loop

TSR 411

- NS Power completed a transmission planning study (TSR 411) to study the system impact associated with a 550MW import to Nova Scotia from New Brunswick, consistent with the Regional Integration Strategy evaluated in the 2020 IRP and subsequent discussions on the Atlantic Loop project.
- The study was completed in 2022 and included the following assumed resource changes:
  - Coal units retired or converted to gas by 2030
  - 200MW battery available on the system (consistent with the 2022 ACE Plan)
  - New synchronous condensers available at Point Aconi and Point Tupper
  - Additional wind generation and combustion turbines (in alignment with the Rate Base Procurement Program and ECEI projects)
- The results of the study demonstrate that the NS Power system remains stable and within transmission design criteria under both load flow and dynamic modeling cases.
- TSR 411 progressed to the Facilities Study stage in 2022.

2
Electrification Strategy

Electrification Strategy

Action Plan Item 2

The focus in 2022 for the Electrification Strategy involved working with E3 to evaluate and identify impacts of, and strategies to enable, beneficial electrification in Nova Scotia.

The electrification strategy components include the following:

- Task 1: Objectives and Analysis Plan
- Task 2: Jurisdictional Scan and Electrification Load Shapes
- Task 3: Revenue Requirement Model and Customer Affordability Calculator
- Task 4: Beneficial Electrification Modeling Tool and Program Option Modeling Results
- Task 5: Electrification Roadmap

Key components of this work completed in 2022 included the following:

- Complete a jurisdictional scan to fully understand the role electrification is playing across North America in supporting the path to Net Zero (Task 1 and 2)
- Develop electrification load shapes based on various heat pump usage profiles/building shell upgrades and levels of EV adoption/charging strategies to understand the impacts of electrification on peak load requirements (Task 2)
- Develop a cost benefit analysis tool to analyze electrification scenarios, which will ultimately inform programming to support economy-wide electrification (Task 3 and 4)
- Complete a roadmap outlining the electrification strategy and key findings/proposed next steps/recommendations for programming to support the electrification strategy (Task 5)

Electrification Strategy

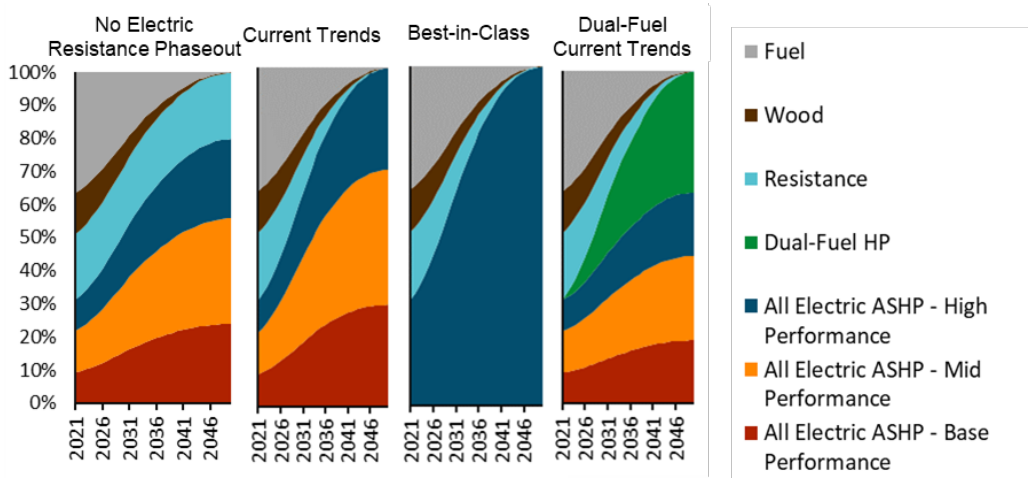
Jurisdictional Scan/Load Shapes

- E3 completed a jurisdictional scan of North America, which confirmed the following areas of focus for electrification in Nova Scotia:
  - Transportation – electric vehicle (EV) charging infrastructure and managed charging programs, as well as EV standards
  - Buildings – new build electric mandates (shell improvements and heat pump adoption/usage)
- To assess the impact on peak load requirements, load shapes were developed based on heat pump adoption/building shell improvement scenarios as well as EV managed charging scenarios
- The building electrification load shapes have been incorporated into the evergreen IRP work this year to assess the impact of the most likely electrification scenarios:
  - Current Policy and Trends: peak load profile impact based on heat pump adoption and usage reflective of current policy and heat pump adoption/building code trends
  - Hybrid Peak/Dual-Fuel: peak load profile based on a dual-fuel approach - heat pump adoption combined with retaining fossil fuel back up heat sources for use during peak load periods (coldest nights of the year), resulting in reduced peak load requirements

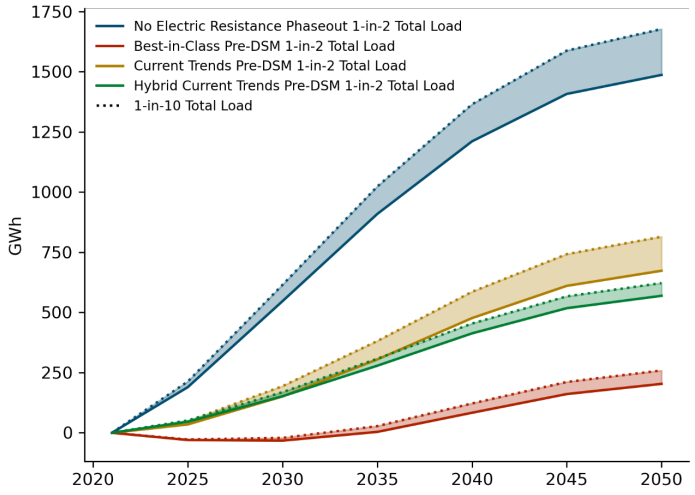
Load Shape Development

Building Electrification

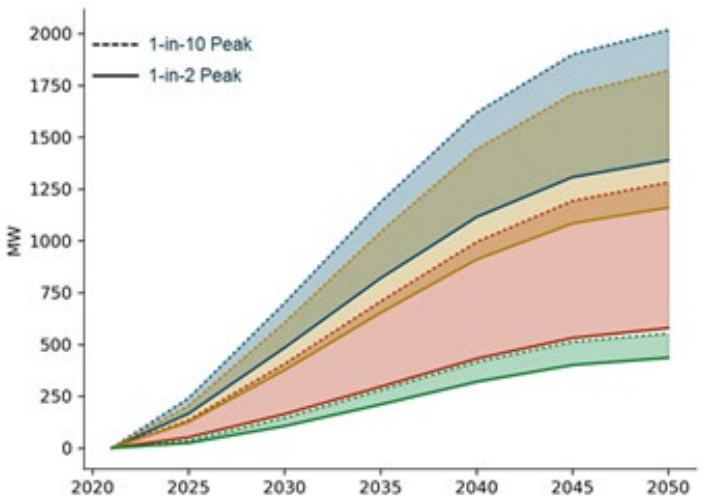
Residential Building Stock Rollover by Scenario



Incremental Annual Load Growth from Building Electrification



Incremental Non-Coincident Building Peak Demand Forecast



The Stock Rollover charts at left demonstrate the breakdown of heating sources by building electrification scenario.

The load growth charts below demonstrate the impact on the annual load and peak load for the different building electrification scenarios considered

- The lower load growth profile for the best-in-class scenario can be attributed to the universal uptake of high-performance heat pumps
- The peak load impacts are a result of the declining efficiency of heat pumps in colder weather. The dual-fuel scenario incorporates peak load reductions when fuel back up sources are used for the coldest periods of the year.

Load Shape Development

EV Load Impacts with Managed Charging

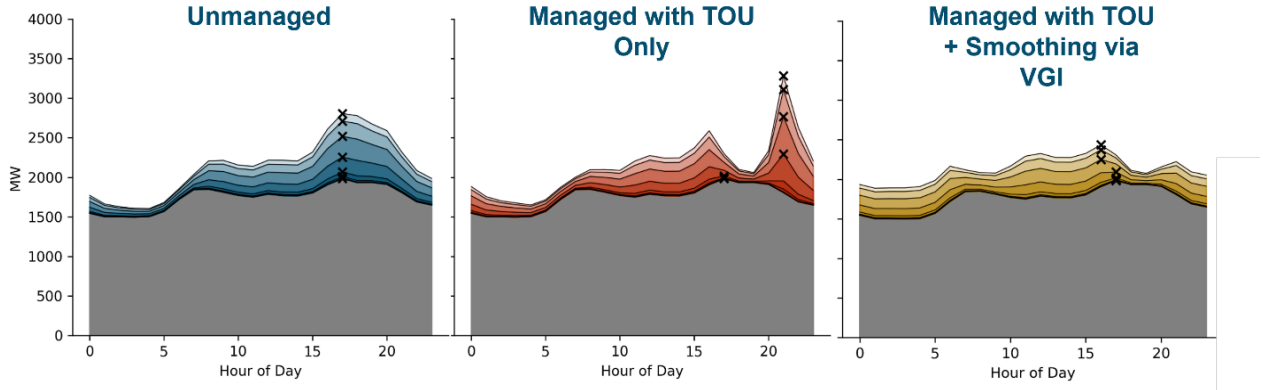
E3 developed a model that simulates driving and charging of thousands of EV drivers

- The driving patterns provide an indication of the load impacts as a result of charging patterns
- It also provides insight into the impacts and benefits provided by managed charging programs

The following charts provide an example of the peak load impacts for light duty vehicles by charging scenario:

- Time of Use (TOU) alone reduces the typical peak but creates an incidental peak at the beginning of the off-peak charging period
- Smoothing via vehicle grid integration (VGI) is required to reduce peak impacts from increased electrification due to EV charging patterns

Peak winter weekday loads from 2025-2050 with increasing light-duty vehicle loads



Cost Benefit Analysis

E3 and NS Power developed a cost benefit analysis tool to enable the analysis of building and transportation electrification solutions and the impacts of various programs.

The metrics produced as part of the cost benefit model include:

- Participant Cost Test: costs and benefits to the fleet owner, vehicle driver or building owner
- Ratepayer Impact Measure: the costs and benefits to all rate payers
- Societal Cost Test (from the perspective of the Province of Nova Scotia): the costs and benefits to the Province

The cost and benefit analysis includes consideration for the following:

- Transportation: incremental upfront purchase costs of EVs, tax credits, operating and maintenance (O&M) savings, vehicle fuel savings, electricity bills and electricity supply costs for EV charging, charging infrastructure costs, and emissions savings
- Buildings: upfront incremental cost of the appliance, incremental electricity bills, avoided fuel oil or natural gas bills, incremental electricity supply costs, avoided fuel supply costs, utility incentives, and emissions savings.

Electrification Strategy Roadmap

Key Findings

E3 and NS Power developed an Electrification Strategy Roadmap to summarize key findings and recommendations on programming to support beneficial electrification in both the transportation and building sectors.

Based on the results of both the jurisdictional scan, the report identifies the following key findings:

- Electrification of end uses reduces total, economy-wide emissions in Nova Scotia
- Most transportation electrification investments produce benefits that exceed costs for drivers, ratepayers and society
- Policy changes may be required to encourage adoption of the most efficient equipment to support building electrification and avoid potential adverse impacts to ratepayers
- Utility actions through time of use rates and programs to avoid “rebound peaks” at the beginning of off-peak hours to manage transportation loads will be crucial to minimizing costs and achieving ratepayer benefits
- Encouraging adoption of advanced building technology (high performance heat pumps and hybrid heat pumps as well as building shell energy efficiency measures) will be essential to mitigate peak load impacts

NS Power is currently finalizing the Electrification Strategy Roadmap and will issue it in 2023 for stakeholder comment and feedback.

Monitor Electrification Growth

Roadmap Item 7

The 2022 load forecast includes consideration for electrification growth from increased heat pump adoption and the shift to electrification in the commercial and industrial sectors, supported by federal and provincial electrification programs designed to lower carbon emissions.

As part of the evergreen IRP process, NS Power has developed load assumptions that were shared with stakeholders. The evergreen IRP load forecast is based on the 2022 Load Forecast Report, extended to 2050, with the following parameters:

- Parallels the 2020 IRP Mid Electrification scenario through 2030 and then shifts toward 2020 IRP High Electrification
- Includes Base DSM assumptions for peak and energy reductions
- Incorporates electrification policies available prior to publication (such as EV sales targets and economy-wide net zero commitments)

Additional electrification policy introduced since the filing of the 2022 Load Forecast Report (e.g. federal 2026 EV sales target, provincial restriction on new oil heat installations in 2025) support, and potentially accelerate, the electrification impacts modeled.

Electrification will continue to be a key driver considered in the 2023 Load Forecast Report.

3

Thermal Plant Retirement, Redevelopment, and Replacement Plan

Trenton 5 Retirement Plan

Action Plan Item 3a

As discussed in the last IRP Action Plan Update (January 2022), the target retirement date for Trenton 5 was updated from 2023 to 2024.

In order to continue to maintain resource adequacy while minimizing capital investment in the unit, operating restrictions were put in place that limit the number of operating hours of the unit.

With the updates in this Action Plan Update related to near-term firm import and fast acting generation availability (see updates on IRP Action Items 1a and 3c), the retirement of Trenton 5 is anticipated to be impacted. Any unit retirement requires replacement firm capacity, which was previously planning to be provided via the addition of firm imports from Newfoundland as well as the ECEI BESS project.

NS Power will provide a further update on Trenton 5's targeted retirement date as part of the 2023 10-Year System Outlook Report.

Trenton 5 Retirement Plan

Action Plan Item 3a

During 2022, NS Power completed a transmission planning study to assess the impacts on the transmission system of the retirement of Trenton 5. The study provides recommendations for system reinforcements to mitigate impacts to the system upon retirement of Trenton 5.

The study results provided the following key findings:

- The limits of the Cape Breton Export (CBX) interface and the arming limits of existing Remedial Action Schemes (RAS) will be reduced as generation from Trenton (with the retirement of Trenton 5) is reduced under peak conditions:
  - In many cases the limiting factor for CBX flows are the thermal ratings for 138kV lines between 2C Port Hastings and 50N Trenton. Line upgrades to increase flow limits are one potential reinforcement to mitigate unit retirement impacts.
  - A potential alternative to uprating the lines was identified in the form of Flexible AC Transmission System (FACTS) devices which could increase the CBX transfer limits and raise the associated RAS arming limits. NS Power will continue investigating the potential for this technology to support Trenton 5 retirement.
- Voltage support is required with the reduction in generation from Trenton 5 under some system conditions:
  - Installation of capacitor banks at 50N-Trenton 69kV buses can mitigate the issue
- Onslow South interface limits will be reduced for the equivalent value of available dynamic reactive power reserve in Metro

The findings of this study will guide NS Power in planning for the retirement of Trenton 5.

Depreciation Study

Action Plan Item 3b

NS Power's Thermal Depreciation study was paused during the GRA regulatory process with the intention of initiating the depreciation study following a decision from the UARB.

The GRA Settlement Agreement submitted to the UARB recommends a Decarbonization Deferral Account (DDA) to recover undepreciated thermal asset net book values (NBV) and unrecovered decommissioning costs.

As an outcome of the UARB approval of the GRA Settlement Agreement, the Board has directed NS Power to prepare a depreciation study before the next GRA. This will inform the creation of the DDA, which was approved by the Board.

Fast Acting Generation - BESS

IRP Action Plan Item 3c

A Battery Energy Storage Project (200MW) was included in the 2022 ACE plan for subsequent submittal. Progress on the Battery Storage (200MW) project included:

- RFP for equipment supply was issued and proposals were received and reviewed by the ECEI project team
- Sites were selected and Interconnection Feasibility Studies were completed
- Development of an alternatives analysis and economic analysis model was completed
- Development of a draft capital application was progressed

With the passing of the rate cap legislation (Bill 212) the ECEI BESS project has been paused.

*Note: BESS now considered a transmission asset (was categorized as Fast Acting Generation for the 2020 IRP).

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Fast Acting Generation – CT

IRP Action Plan Item 3c

The 2020 IRP identified that new fast acting generation is required to support coal phase out and thermal unit retirements, integration of variable renewable generation, and load growth driven by electrification while lowering system GHG emissions.

In 2022, NS Power worked with partners to gather data on new fast acting generation options from vendors in the form of a Fast Acting Generation Survey. The results of the report provide a directional analysis of the properties, benefits, and costs of various potential unit and configuration options.

Fast Acting Generation Survey

NS Power engaged Advisian-Worley (Advisian) to survey the available fast acting generation technology options to provide peaking power, ancillary services and net load following to support system reliability with the addition of variable renewable energy resources. Consideration for the current and future hydrogen compatibility of various fast-acting generation technology options was evaluated as part of the survey.

The purpose of the study was to provide an indication or a short list of potential turbine and/or reciprocating engine generator configurations that can be further evaluated by NS Power to determine the best approach for future fast-acting generation projects.

The scope of the study includes the following:

- Identification of technology and configuration options
- Development of performance, Capital Cost, Operating Cost and Levelized Cost of Energy (LCOE) analyses based on the range of operating profiles
- Operating profiles included both peaking and standby

Fast Acting Generation Survey

To provide the basis of the study, the NS Power team established a technical scope for plant design guidelines and performance targets:

- Purpose of the unit: fast acting peaking power delivery service to address power supply gaps/maintain grid reliability/stability during periods of low output from variable renewable energy
- Capable of providing ancillary services including load following, VAR support and voltage control
- Capable of fast start response time (10min start with at least 50 MW delivery) and ramp rate (min: 10% per min)
- Potential synchronous condenser capability
- Existing and future hydrogen firing capability
- Unit size range between 10MW and 150MW
- Unit types include aero/industrial/frame Gas Turbines (GTs) and Reciprocating Internal Combustion Engines (RICE)
- Primary and secondary fuel types specified as gas and light fuel oil
- Emissions capabilities within allowable limits

Fast Acting Generation Survey

Advisian performed an industry survey of the fast-acting generation options, which included an OEM and generation technology matrix.

Configuration and technology screening was conducted on the matrix using the NS Power specifications to create a short list of potential candidate options:

- Potential options were comprised of CTs and RICE engines that could be used to make up a 150 MW Fast Acting Power Centre; 24 CT and RICE models were considered
- Detailed attributes were obtained from OEMs for 11 models

Six Fast Acting Power Centre configurations ~150 MW capacity were selected for detailed analysis:

	Units	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Installed Net Capacity (MW)	***MW***	145	167	147	157	156	146
Number of RICE engines installed	**#**	8	0	2	0	4	2
Number of GTs installed	**#**	0	3	2	7	1	2

Fast Acting Generation Survey

The results of the LCOE and NPV RR analysis indicate the following:

- Although Frame/Industrial GTs have a relative capital cost advantage to aeroderivative and RICE, disadvantages include higher heat rates and relatively lower flexibility. Longer start times and higher minimum load points were also disadvantages identified for frame units.
- In addition, for Industrial GTs, there is less technology maturity with respect to synchronous condenser and hydrogen firing capabilities, which are important performance metrics for NS Power.
- As the forecast unit capacity factor (CF) increases, inclusion of RICE units in a combination configuration becomes more beneficial due to relatively superior and constant heat rates and high turndown ratios (i.e. greater range of capacity).
- A combination of Aero GTs + RICE comes at a small CAPEX premium to Industrial CTs + RICE but offers the most operating flexibility.

The results of the Fast Acting Generation Survey will inform NS Power's evaluation of potential new firm capacity options.

Wind Procurement Strategy

Action Plan Item 3d

The 2022 focus for the Wind Procurement Strategy included the following components:

- Support of the Provincial Rate Base Procurement (RBP) program including the completion of Interconnection Feasibility Studies
- Progress NS Power ECEI wind projects

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Nova Scotia Rate Base Procurement

On July 9, 2021, the Province of Nova Scotia announced the 'Rate Base Procurement' program to acquire low-cost renewable generation to serve Nova Scotia Power customers. Procurement parameters include the following:

- A target of 1100 GWh of renewable energy from renewable assets, with a maximum project size of 100 MW
- Projects must be in-service by December 31, 2025
- Projects will be required to provide ancillary services to the Nova Scotia Power system

NS Power completed approximately 35 Interconnection Feasibility Studies as requested by proponents via the Generation Interconnection Procedure (GIP) process within the timeline requested by the Procurement Administrator.

On August 17th, 2022, the RBP portfolio was announced which included 5 projects totaling 372 MW of installed capacity of new wind generation. The average energy rate of the project is $53.17 CAD/MWh.

NS Power is currently completing Interconnection System Impact Studies as requested by proponents and this work will continue in 2023.

Nova Scotia Power Wind Projects

NS Power included an ECEI Wind Project as an item for subsequent submittal in the 2022 ACE Plan.

This project includes the development of new wind assets in Nova Scotia under the ECEI project.

Over the course of 2022, the ECEI team has progressed both scope development and project benefit analysis.

With the recent electricity rate cap legislation (Bill 212), the ECEI wind project has been paused.

Wind Integration Studies

Roadmap Item 2

In parallel with the Wind Procurement Strategy, a series of comprehensive transmission planning studies are ongoing to determine required changes to system or operational support in order to maximize levels of wind integration.

With the support of a consultant with global expertise in the study of Inverter Based Resources (IBRs), the following scope of work was advanced in 2022:

- Simulation Model Updates:
    - PSSE simulation model updates
    - Development of Nova Scotia system PSCAD simulation base cases
- Detailed System Studies:
    - System Inertia
    - System Strength
    - Maximum Wind

Wind Integration Studies – Initial Results

System Inertia

Studies to date find no unusual or unexpected results. Loss of inertia from the retirement of thermal generating units can be replaced with a mix of Synchronous Inertial Response from remaining thermal plants and synchronous condensers as well as Fast Frequency Response from the Maritime Link, grid scale batteries, and technology-enabled response from new Inverter Based Resources (IBRs). Study documentation will provide recommendations.

System Strength

Analysis and study of the reduction in system strength following the retirement of thermal generating units has highlighted the potential for adverse impact to the grid and the solutions are not as straightforward as for the reduction in inertia. Study and analysis for the following are underway:

- Adequate Short Circuit Ratio (SCR) for generating units to stay online during a disturbance
- Adequate fault current for the grid protection devices to operate properly following a disturbance
- System strength sufficient to deliver support over all areas of the province and avoid large step changes when switching reactive devices

The above have the potential to result in a slow recovery of the system following an event. There is an increased potential for harmonics, transients, IBR control system interactions and sub-synchronous interactions with remaining online synchronous units.

Unlike support for inertia, IBRs are less able to support system strength during an event. While support for inertia can travel a long distance and can therefore be provided at several key locations in the region, system strength must be provided close to where a system event occurs. At this time, synchronous machines are the only demonstrated resource with strong and reliable support for System Strength. Analysis, review and study of evolving technologies ongoing.

Wind Integration Studies

2023 Work Plan

The 2023 work plan will incorporate findings from the Inertia and System Strength studies to refine maximum wind study scenarios:

- Continue to develop simulation models for study of additional scenarios and new technologies
- Complete Maximum Wind study and document technically viable options for economic analysis

Continue the revision and development of documentation and guidelines:

- Continue to review and update Transmission System Interconnection Requirements to enable new resources to better support a grid with high penetration of Inverter Based Resources
- Add System Strength assessment requirements and methodology to Planning studies process
- Incorporate study findings into Planning and Operations processes and guidelines

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Coal Unit Conversions

Roadmap Item 1

The 2020 IRP resource plans selected coal to gas conversions in roughly half of the key scenarios examined, indicating that converted units are a cost-effective source of dispatchable firm capacity at relatively low-capacity factors (generally <10%).

2022 progress on the ECEI Coal to Gas conversion project included:

- Progressing Class III engineering design package
- Advancement of Project economic analysis

In addition, work continued to evaluate options for supply of natural gas:

- NS Power engaged with pipeline operator to provide preliminary engineered proposal for future natural gas delivery
- Natural gas supply is being assessed due to local pipeline constraints

With the recent electricity rate cap legislation (Bill 212), the coal to gas conversion project has been paused.

Thermal Investment - Utilization Factor

Roadmap Item 3

For the purposes of the 2020 IRP, sustaining capital estimates for the existing thermal assets were based on a High Utilization Factor approach (HUF), which reflects investment required to address wear on components driven by the HUF (example: high-capacity factor, cycling, operating hours). This was a conservative assumption intended to ensure that the modeling results were not influenced by low sustaining capital assumptions.

For the purposes of the evergreen IRP, the model is subjected to carbon pricing through the Output Based Pricing System (OBPS), which leads to lower HUF utilization factors. This was demonstrated as an outcome of the Early Insights model that was shared with stakeholders in the spring of 2022.

To more accurately reflect the utilization of thermal resources with consideration for the impacts of carbon pricing and environmental constraints, the updated sustaining capital forecast for thermal resources is based on the forecast utilization from the Early Insights model.

The following updates on thermal, combustion turbine and hydro system sustaining capital investments will provide a comparison to the fixed portion of the sustaining capital as compared to the 2020 IRP assumptions.

Thermal and CT Investment

Roadmap Item 3

Updated sustaining capital profiles are included as an assumption in the ongoing evergreen IRP update and corresponding modeling work (please refer to the evergreen IRP assumptions material).

Thermal Investment

The sustaining capital profiles for the thermal units have been updated based on the evergreen IRP utilization factor approach and the 2030 coal phase out requirements.

As referenced in the 2022 ACE Plan (Section 11.1.2), the NS Power thermal generation investment is less than the IRP capital forecast for 2022

- This is a result of the updated utilization factor approach and the resultant sustaining capital values as compared to the 2020 IRP assumptions; the ACE investment values are aligned with projected utilization factors and reliability/risk tolerances
- This will result in differences in the investment profiles in future years (timing of major refurbishments would shift).

CT Investment

The sustaining capital values for the diesel CTs has decreased as compared to the 2020 IRP assumptions for 2021/2022. This supports the 2020 IRP outcome in support of continued CT operation and confirms the evergreen modeling approach to assume ongoing operation of the diesel CT fleet.

CT Financial Reporting – 2021/2022

Description	2021	2022
OM&G fixed - CT (diesel units)	$689,996	$693,186

Sustaining Capital	2021	2022
Burnside-1	$2,165,499	$565,241
Burnside-2	$248,105	$182,846
Burnside-3	$248,011	$146,739
Burnside-4	$248,731	$407,266
Victoria Junction-1	$2,209,427	$7,263,449
Victoria Junction-2	$155,639	$32,295
Tusket-4	$1,724,185	$1,552,561
Total	$6,999,597	$10,150,397

CT Performance Reporting - 2021

Unit	Net Generation (MWh)	Net Capacity Factor (%)	DAFOR (%)	Availability Factor (%)	Failed Starts	Maintenance Outage Hours	Operating Hours
Burnside-1	505	0.2%	98.2%	65.8%	2	2	46
Burnside-2	1,691	0.6%	15.9%	96.0%	2	40	111
Burnside-3	1,768	0.7%	95.0%	73.9%	11	5	105
Burnside-4	1,990	0.8%	15.7%	92.3%	0	386	123
Victoria Junction-1	510	0.2%	75.6%	93.7%	2	35	32
Victoria Junction-2	383	0.1%	74.7%	95.0%	1	6	26
Tusket-4	65	0.0%	6.1%	84.8%	2	1015	31

CT Performance Reporting - 2022

Unit	Net Generation (MWh)	Net Capacity Factor (%)	DAFOR (%)	Availability Factor (%)	Failed Starts	Maintenance Outage Hours	Operating Hours
Burnside-1	3,792	1.4%	96.2%	41.3%	6	21	202
Burnside-2	6,698	2.5%	74.4%	84.9%	1	15	317
Burnside-3	6,303	2.4%	9.2%	94.7%	8	2	316
Burnside-4	1,924	0.7%	46.7%	59.1%	2	7	119
Victoria Junction-1	1,400	0.5%	60.1%	72.8%	4	10	68
Victoria Junction-2	984	0.4%	37.4%	97.0%	2	2	68
Tusket-4	831	0.3%	71.6%	93.5%	6	18	73

Hydro Investment

Roadmap Item 3

The sustaining capital for the fixed capital cost portion of the small hydro systems for 2022 is lower than the 2020 IRP assumptions (approximately 15%).

The capital spend that was forecasted for the Mersey system in 2022 has been deferred to allow for better definition of project scope and consultation/engagement opportunities.

The sustaining capital difference in 2022 would also reflect the impacts of the previously noted deferred projects as compared to the 2020 IRP (Tusket Main Dam, Gaspereau Main Dam, Ruth Falls Dam and Marshal Falls Dam)

The sustaining capital profiles for the hydro systems have been updated and were included as key input assumptions as part of the ongoing evergreen IRP update and corresponding PLEXOS modeling work (please refer to the evergreen IRP assumptions material).

Nova Scotia POWER
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Hydrogen

Roadmap Item 4

NS Power's focus for low emitting fuels (specifically hydrogen) in 2022 has been to understand the potential future value of Hydrogen to the power system. This has occurred through engagement with prospective hydrogen production project developers and also through NS Power's participation in the Atlantic Hydrogen Alliance.

There have been significant developments in both identifying hydrogen as an emerging clean energy source and the potential for domestic hydrogen production over the course of 2022:

- The ECCC Clean Electricity Regulation frame cites hydrogen as an example of emerging technologies to enable the path to a net zero 2035 electricity system
- There has been interest in the development of domestic hydrogen production in Nova Scotia by several potential developers in the region
- The recent amendment (October 17, 2022) to the Electricity Act and other pieces of enabling legislation aim to increase the opportunities for hydrogen project developers in Nova Scotia

As part of the evergreen IRP modeling in 2022, NS Power is including both the load requirement for a representative domestic hydrogen plant as well as hydrogen-enabled combustion turbine unit costs and fuel pricing for both imported and domestic hydrogen.

This will enable an understanding of the impact the domestic load will have on the system as well as assess the benefits of a domestic hydrogen source to support future emerging clean generation in the form of hydrogen combustion turbine generation.

Atlantic Hydrogen Alliance

The current focus of the Atlantic Hydrogen Alliance is to support a pathway to enabling green hydrogen production in the region.

As a result, the AHA are supporting the development of discussion papers through the Enabling Conditions Working group, with the intent of identifying and prioritizing conditions required to increase access to hydrogen as an affordable, low carbon energy source in Atlantic Canada.

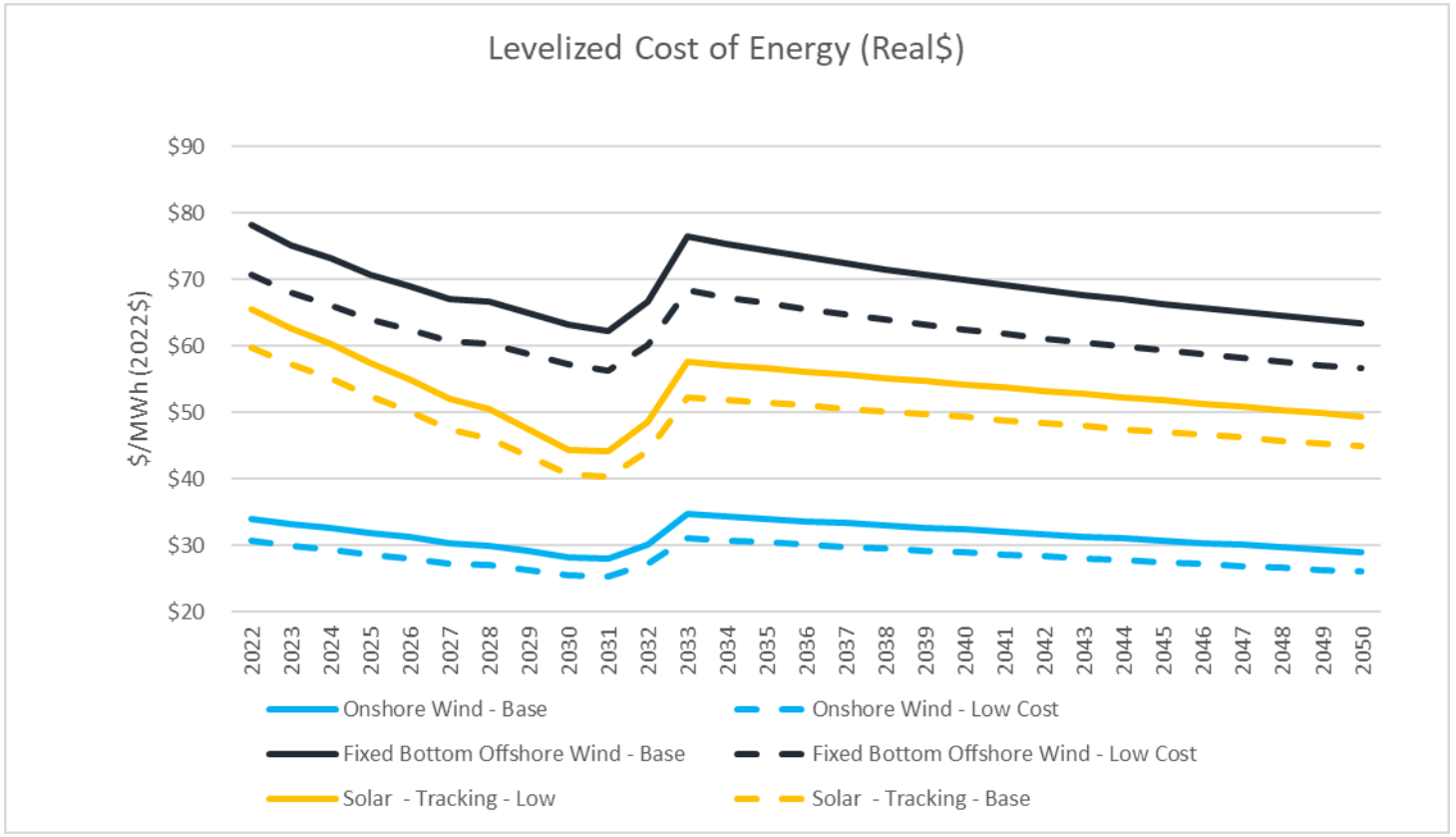
The following are the key themes that have been identified and assigned to working group members in 2022:

- Codes and Standards in Atlantic Canada – prioritize enabling codes and standards applicable to Atlantic Canada
- Access to Renewable Electricity – address barriers to accessing competitive renewable electricity for green hydrogen production
- Atlantic Canadian representation on the Federal Hydrogen Working Groups – represent Atlantic Canada's interests at the NRCan Hydrogen Working groups

The focus of the work progressed in 2023 will reflect the key themes identified in 2022.

Updated Renewables/Storage Cost Trajectories

Roadmap Item 5



This chart reflects the updated LCOE values for renewable generating resources included in the updated evergreen IRP assumptions.

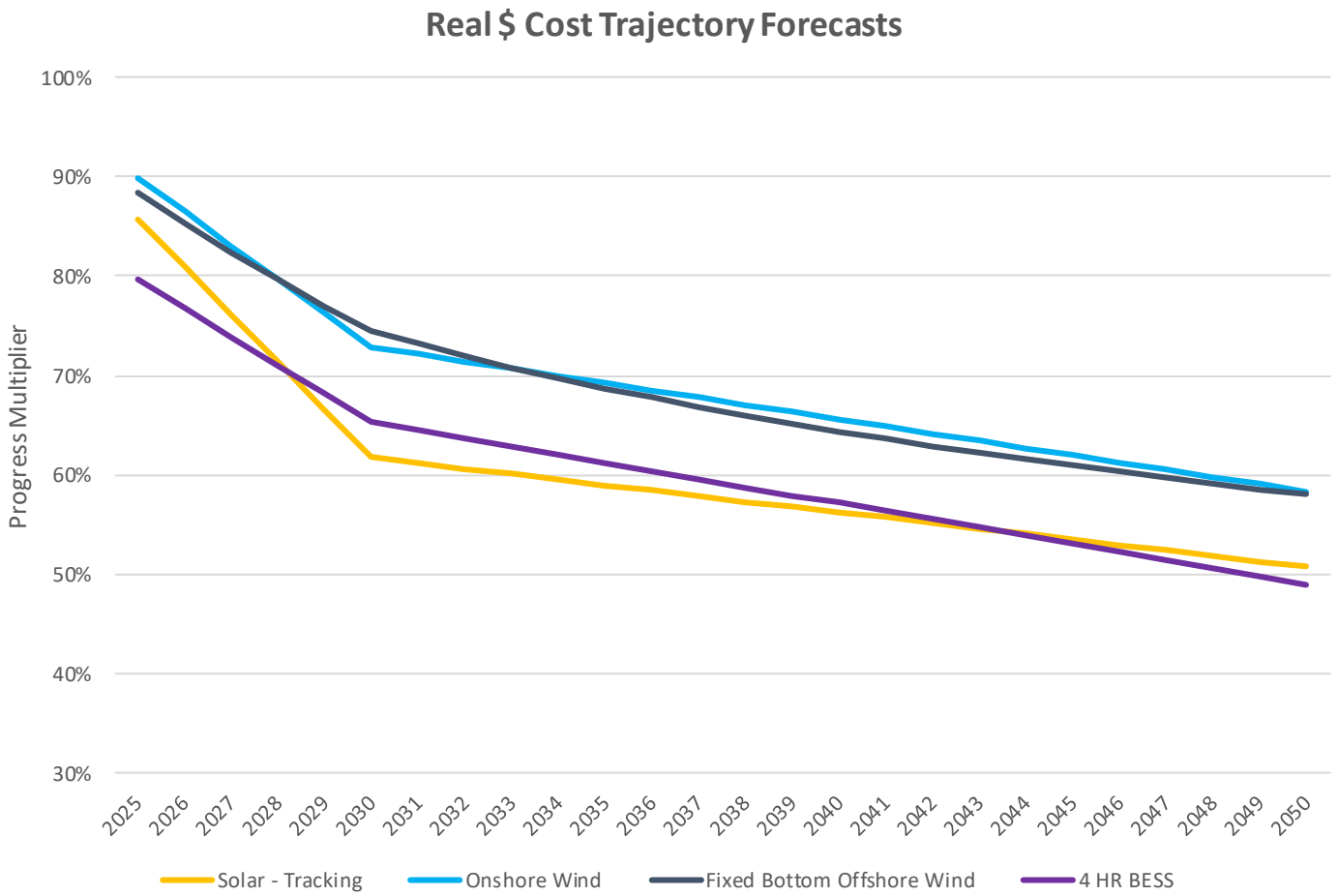
The shape of the LCOE trajectory between 2023 and 2033 is a result of the Investment Tax Credit (ITC) for qualifying renewables combined with technology cost decline forecasts.

Sub-Technology	Capacity Factor
Onshore Wind	39%
Offshore Wind	45%*
Solar	17%

**'High' capacity factor assumption for the 2020 IRP*

Updated Renewables/Storage Cost Trajectories

Roadmap Item 5



Trajectories are based on NREL ATB 'Moderate' price trajectory forecasts

This chart reflects updated renewables and storage cost trajectories included in the updated evergreen IRP assumptions.

The prices have been updated based on the NREL ATB 'Moderate' price trajectory forecasts and are forecasted out to 2050.

4

Demand Response Strategy

DR Strategy – 2022 Pilot Projects

The work completed in 2022 in support of the Demand Response (DR) Strategy includes the following:

- Progress the Residential DR Pilot:
  - Completion of water heater DR pilot for both temperature and machine learning based controllers (program is run by E1 with support from NSP)
  - Advanced work on the final report of the water heater controllers tested to date
  - Selected a vendor for the program for winter 2022/2023 based on 2022 results to date
- Progress on the Commercial & Industrial (C&I) DR Pilot:
  - Prepared for winter peak shift events for identified customers as part of the NSP Distributed Energy Resource Management System (DERMS) integrated pilot, part of the Smart Grid Nova Scotia project
  - Selected turnkey aggregator (company supporting C&I pilot from design to implementation) and support along with E1 to achieve December 2022 target of 3MW
- Evaluated the Time-Varying Pricing (TVP) Tariff Pilot for year 1 of the pilot for both the Time of Use (TOU) and the Critical Peak Pricing (CPP) tariffs

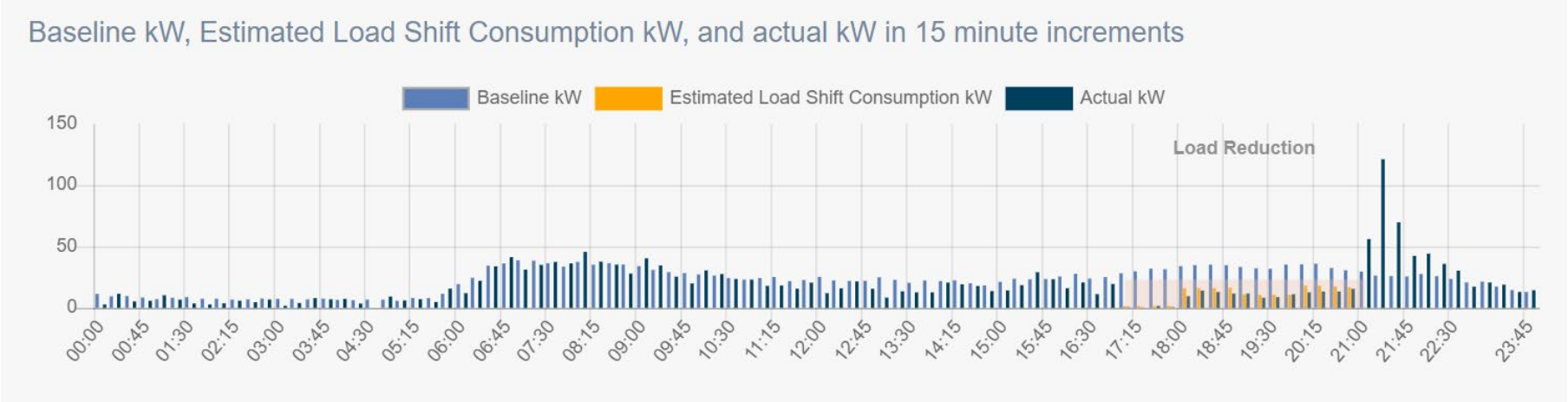
Water Heater Control Programs

Residential Water Heater DR Pilot

- The customer program pilot/live testing period was conducted between November 2021 to November 2022
  - Recruitment was completed in March of 2022; E1 managed both recruitment and installations
  - A customer survey report was completed following installation, mid-pilot and at the end of the pilot
  - A final report summarizing the results of the pilot project is planned to be completed in Q2 of 2023
- Transition to the full program occurred in November 2022
  - E1 followed up with pilot participants in support of the full program with 159 customers re-enrolling in the program
- For all new participants in the full program, the Shifted Energy device will be used, however the program will continue to test both devices for customers continuing to use the Aquanta controller during the 2023 winter period

Water Heater Control Programs

- Early Learnings and Observations:
  - The Shifted Energy forecasts are accurate if baseline requirements are met (3 events per week)
  - Snapback observed following events (Shifted Energy offers adjustable randomized return to load feature to mitigate this)



  - Average estimated evening event savings (during the winter period) of 0.5 kW
  - Survey results indicated the following:
    - 8 in 10 participants indicated access to hot water was unchanged compared to prior to starting pilot
    - Very few participants were aware of the occurrence of a DR event

C&I DR Pilot – Phase 1

- Customer Program:
  - Integrate the Smart Grid NS DERMS with Siemens Energy Systems platform (completed for all three sites)
  - E1 providing incentive of $125/kW for confirmed savings averaged across all events (based on E1 Operational DSM Program)
  - Pilot live period: Feb 2022 to Mar 2023
- Recruitment:
  - Recruited 3 customers to participate in the C&I DR pilot (for the upcoming winter season) – joint effort between Siemens, NSP and E1
- Function testing at all sites now complete and use case testing is in progress
  - Priority – CPP scheduling approach* to enable system peak reduction
  - Potential – generation contingency (pre-charge, customer notification requirements) and load levelling (intra-day, day-ahead, modified time of use as per Smart Grid NS)

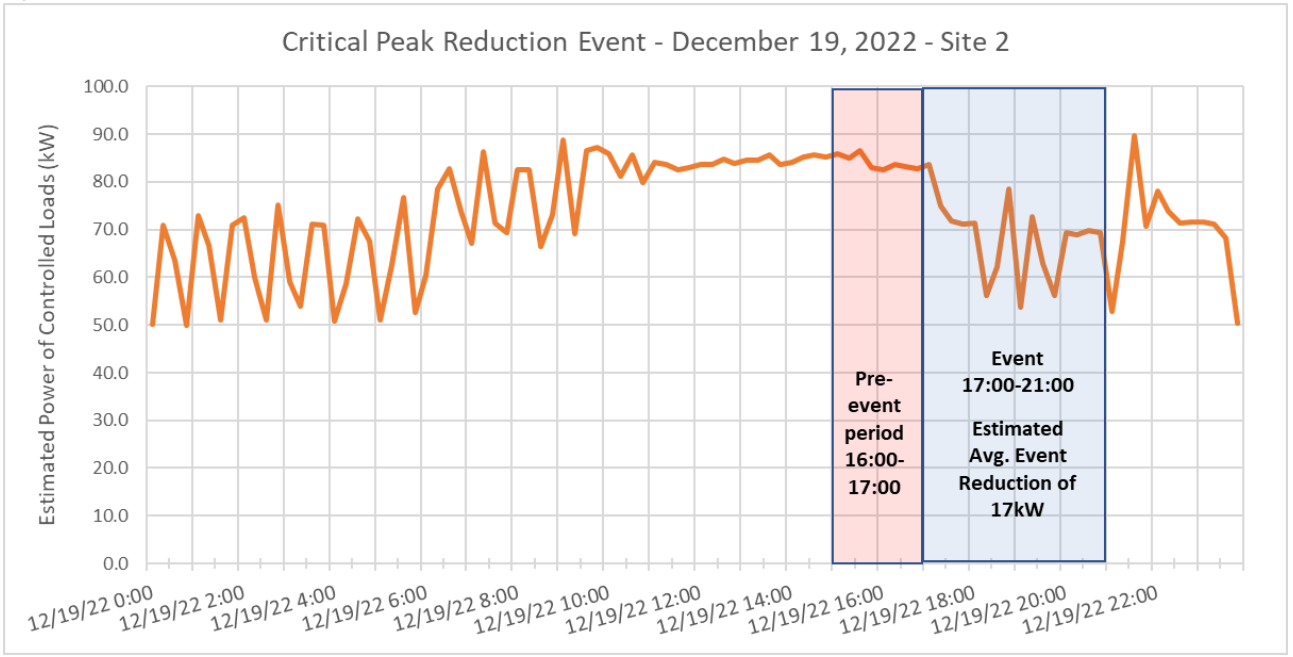
**Based on day ahead system margin, max 12 events per season, max 1 event per day, max 4-hour duration, M-F 7-11am or 5-9pm*

C&I DR Pilot: Phase 1 Testing

The chart below is an example of a Critical Peak Reduction Event for a C&I site:

- The results demonstrate the outcome of a pre-event period (indicated by the red area in the chart below) to increase energy usage followed by the Critical Peak Reduction Event (reflected by the blue area)
- The purpose of the pre-event is to allow the equipment load to increase, which reduces the impact to customers when the equipment is shut down during the reduction event

Note: the graph below shows aggregated estimated power of the controlled equipment, which is calculated partly based on equipment name plates and trends



C&I DR Pilot – Phase 2

- Customer Program
  - Providing support to IPKeys (selected turnkey aggregator) along with E1 as they progress the pilot project
  - Pilot live period:
    - Season 1: Dec 2022 to Feb 2023
    - Season 2: Dec 2023 to Feb 2024
- Recruitment target of 3MW – recruitment is still ongoing
  - Will only include scheduling of CPP events*

**Day ahead system margin, max 12 events per season, max 1 event per day, max 4-hour duration, M-F 7-11am or 5-9pm; customers receive email notification one day before event*

TVP Pilot - Framework

NS Power launched the TVP Tariff Pilot on November 1, 2021 with the goal of incentivizing customers to use electricity during off-peak periods to help reduce operation costs and defer the capital costs of future infrastructure while providing lower cost electricity to customers.

Customers who opted to be a part of the two-year pilot were offered the choice of either Time of Use (TOU) or Critical Peak Pricing (CPP)

- TOU: customers pay a higher price for electricity consumed between 7am and 11am and 5pm and 9pm on all non-holiday weekdays, November through March; customers then pay a lower price for electricity during winter off-peak hours and the remainder of the year, April through October
- CPP: customers pay a lower price for electricity at all times except during critical peak pricing events from November through March; participating customers pay substantially higher price for electricity consumed during CPP events
  - NS Power may call CPP events between 7am to 11am or 5pm and 9pm
  - NS Power called eight CPP events between December 1, 2021 and February 28, 2022

TVP Pilot – Evaluation Findings

The evaluation of the TVP Pilot for year 1 included a detailed load impact evaluation for participants of both the CPP and TOU tariffs, which produced the following findings:

- 960 households and 30 businesses participated in the TVP pilot
- Participants in both tariffs consistently reduced their electricity demand during peak periods:
  - TOU participants reduced their electricity demand by 12.6% and 10.8% (morning and evening peaks, respectively); electrically heated homes saw a reduction in demand of more than 350W on average during the morning peak periods
  - CPP participants saw a reduction of 18.3% of the average reference load (average load reduction of 564W)
- The following was observed for pilot participants:
  - Reduction in electricity demand during the highest Adjusted Net Load (ANL) hours
  - Nearly all reported taking one or more actions (deferring timing for electricity needs such as laundry, dishwasher, heating) to reduce electricity demand during peak periods
  - Participant satisfaction with the TVP pilot is high overall

NS Power will continue to collect data (including additional data not collected as part of year 1) and will complete an evaluation of the complete, 2 year pilot in 2023.

5

Avoided Costs of DSM

Avoided Costs of DSM

Action Plan Item 5

NS Power will have the models available to calculate avoided costs of DSM for specific use cases if requested in the future.

Similar to the 2020 IRP, the avoided costs will be calculated by NS Power. Since this is not part of the evergreen IRP scope, NS Power can provide this information following the conclusion of the evergreen IRP work if requested.

2023-25 DSM Resource Plan

Action Plan Item 4

- E1 has completed its analysis for the 2023 – 2025 Demand Side Management (DSM) Resource Plan
- E1 and NSP supported a resource plan that includes:
  - Incremental cumulative net energy savings of 412.7 GWh
  - Cumulative peak demand savings of 96.7 MW
  - Total investment level of $173 M over the three-year period
- The matter was filed with the UARB and approved
- For the purposes of the evergreen IRP modeling, E1 provided updated DSM forecasts that included the settlement plan values for 2023 to 2025 (inclusive) and forecasted values beyond 2025 (includes a ramping up of values from 2025 to meet the DSM forecasts)

Evergreen IRP

Roadmap Item 8

Roadmap Item 8 stated that NS Power would initiate evergreen IRP updates when significant changes to the planning environment are observed. This approach is intended to reflect the increasing pace of change in the planning environment.

Significant changes to the planning environment since the 2020 IRP have been observed which indicate that an evergreen IRP update is warranted.

NS Power initiated an evergreen IRP update in 2022, which is currently underway. An update on evergreen IRP process, schedule, and draft modeling results were released on January 13, 2023. Following this update, NS Power released updated assumptions on January 26, 2023 for stakeholder review/feedback.

Please see the January 13, 2023 update for the anticipated schedule to conclude the evergreen IRP.