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Deep Decarbonization in Nova Scotia: Phase 1 Report

Nova Scotia Power, Inc.

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Agenda

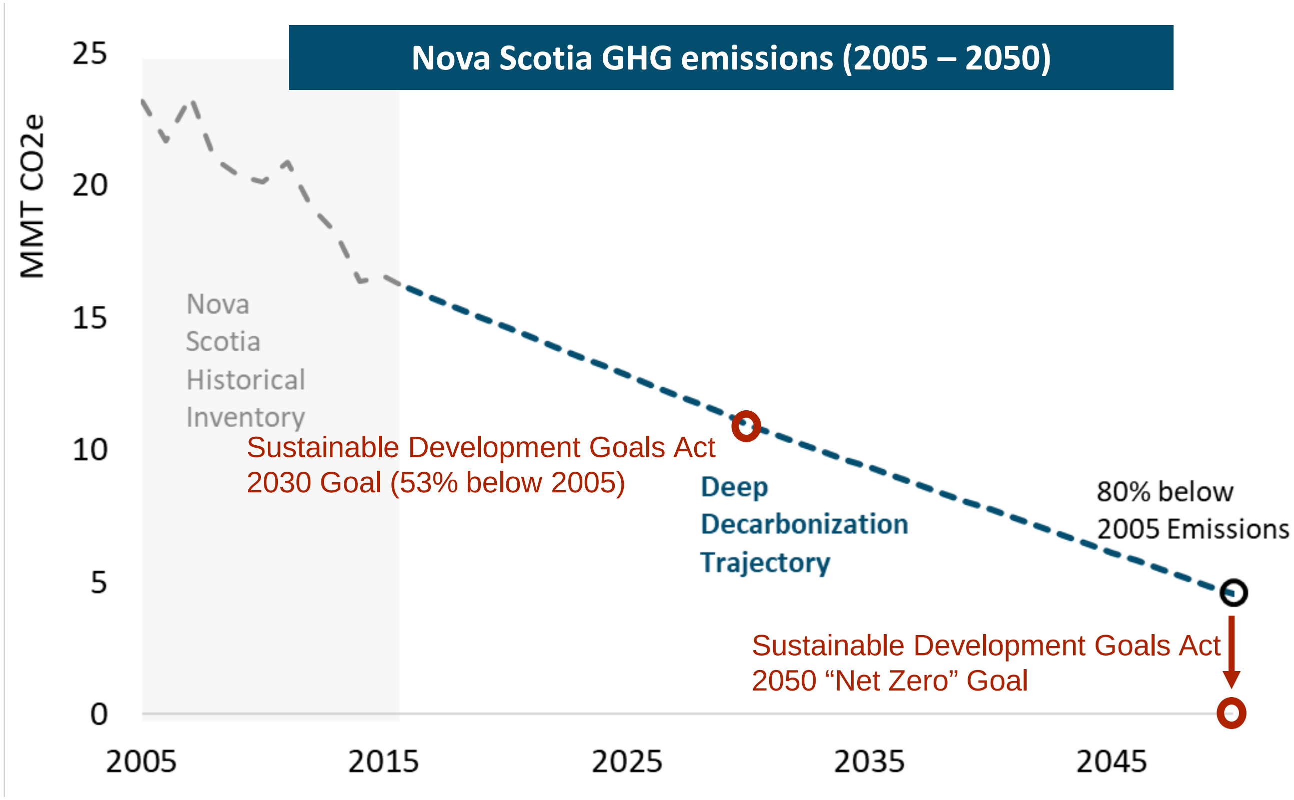
+ Background
+ Modeling Approach
+ Phase 1 Deep Decarbonization Results
+ Recommendations

Background

+ **NS Power hired E3 to evaluate pathways to achieving deep decarbonization of the Nova Scotia economy, with a specific focus on electricity decarbonization and its interplay with other sectors**
  - Study evaluated 80% economy-wide decarbonization relative to 2005 levels, by 2050
+ **Nova Scotia Sustainable Development Goal Act (SDGA) adopted in 2019, established provincial economy-wide greenhouse gas (GHG) reduction goals:**
  - 2030 target of 53% reduction in GHGs below 2005 levels
  - 2050 target of net zero, with emissions offset with removals and offsetting measures
+ **Key questions include:**
  - What are viable pathways to achieve deep decarbonization in Nova Scotia?
  - What level of electricity sector carbon reductions might be required as part of an economy-wide deep decarbonization strategy for Nova Scotia?
  - What role might be played by electrification of vehicles and appliances, and how might that impact electric load served by Nova Scotia Power?

Nova Scotia GHG Reduction Target

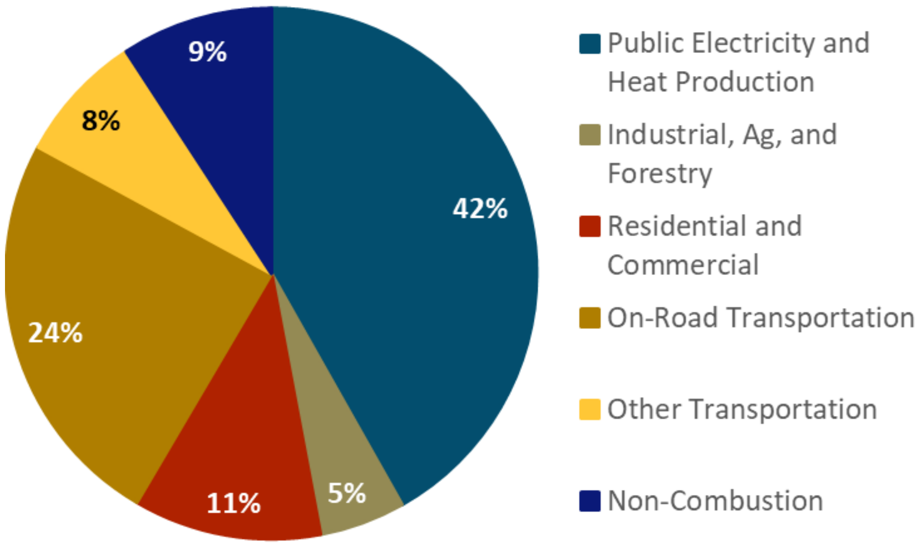
- **This study, initiated before passage of SDGA, analyzed emissions reductions of 80% below 2005 levels by 2050**
  - Further emissions reductions to achieving SDGA would require more direct emissions reductions, or offsetting measures such as carbon capture and storage



Current Emissions in Nova Scotia

- **This analysis focuses on the sectors where NS Power can support direct decarbonization:**
  - Heat for buildings
  - On-road transportation
  - Electricity generation
- **These sectors represent around three-quarters of emissions, or about 77% of current emissions in Nova Scotia**

Nova Scotia GHG emissions by sector, 2016



Source: E3 calculations based on greenhouse gas emissions inventory data and categories for Nova Scotia from Environmental and Climate Change Canada

Modeling Approach

E3 has evaluated decarbonization scenarios in many regions of U.S.

- **Scenarios evaluate 80% reductions in greenhouse gases by 2050, broadly consistent with reductions that may be needed to keep global warming below 2°C by 2050.**
- **Deeper reductions are needed to keep global warming below 1.5°C by 2050. California, New York and Nova Scotia have all set carbon neutral goal by mid-century.**

U.S. Deep Decarbonization Pathways

Evaluated scenarios to meet 80% reduction in GHGs in the U.S. by 2050,
part of the deep decarbonization pathways project (DDPP)

U.S. PATHWAYS for DDPP evaluated 4 scenarios with different electricity mixes:

1. Mixed (renewables, nuclear & CCS)
2. High Renewables
3. High Nuclear
4. High CCS

New York Deep Decarbonization

Currently evaluating options to meet a variety of economywide decarbonization goals in New York

Pacific Northwest PATHWAYS

Evaluated role of building decarbonization and renewable natural gas for NW Natural; and Cap and trade analysis for OR DEQ

California PATHWAYS

Strategies to meet 2030 & 2050 GHG targets (Air Resources Board, CPUC, Energy Commission, SMUD, SCAG, SoCalGas)

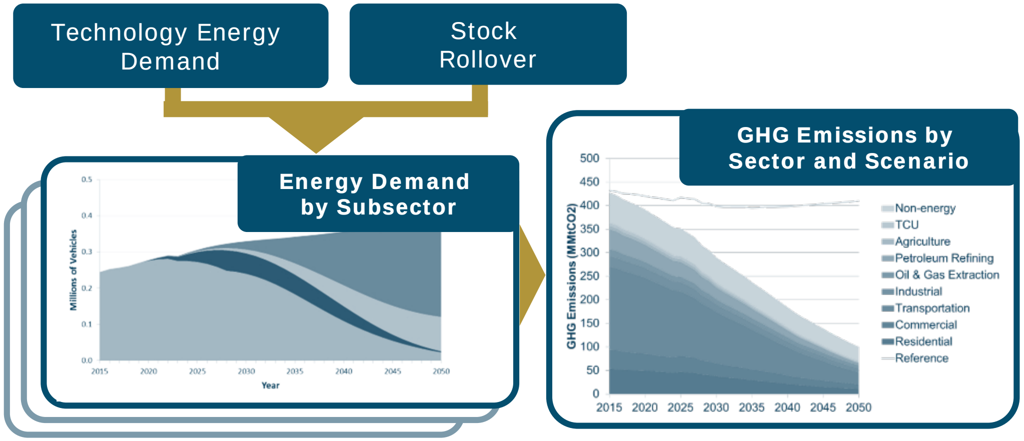
Minnesota & Maryland PATHWAYS

Scenarios for Xcel Energy's MW Integrated Resource Plan;

GHG scenarios for the state of Maryland

PATHWAYS Framework Used for this Study

- **This model quantifies economy-wide energy demand and emissions and accounts for complementary policies targeting future emissions reductions**
  - Buildings
  - Industry
  - Transportation
  - Non-Combustion
  - Electricity



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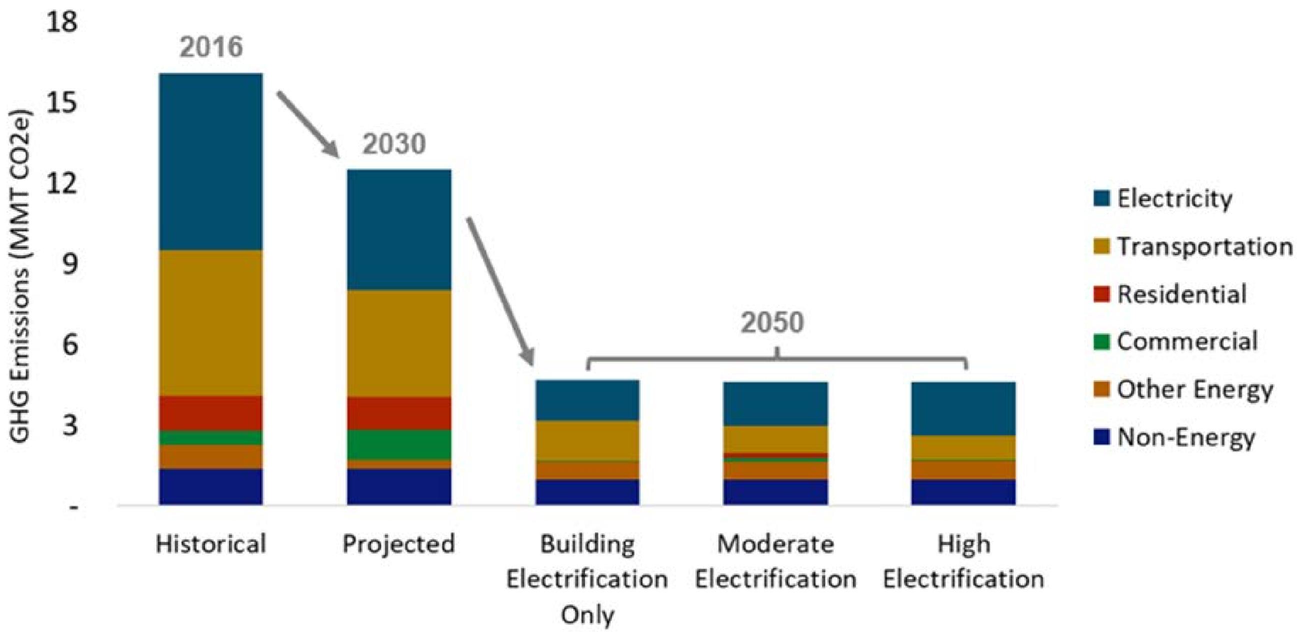
Results of Phase 1 Deep Decarbonization Analysis

Core Scenarios Modeled in this Study

+ **Reference Scenario ("Current Policies" pre-SDGA):**
  - Achieves electricity emissions level of 3.5 MMT in 2050
  - Improved appliance and vehicle efficiency standards
+ **Mitigation Scenarios (Designed to meet 2050 80% GHG reduction goal):**
  - Scenarios meet 2050 GHG goal with increasing levels of electrification, reflecting trade-off between increasing electrification vs using zero-carbon fuels to reduce emissions
  - All scenarios include significant efficiency, including building weatherization to reduce space heating demands
  - **High Electrification:** Near-complete electrification of space and water heating demands by 2050, and complete electrification of light duty vehicles by 2050, with significant electrification of other transportation sectors.
  - **Building Electrification Only:** Near-complete electrification of space and water heating by 2050, with additional emissions reductions from zero-carbon fuel (advanced biofuel)
  - **Moderate Electrification:** Achieves about half of the electrification achieved in the High Electrification Scenario, with additional emissions reductions come from zero-carbon fuel (advanced biofuels)

2050 Emissions Budget by Scenario

Nova Scotia 2016 and 2030 GHGs, 2050 Mitigation Scenario Carbon Budgets

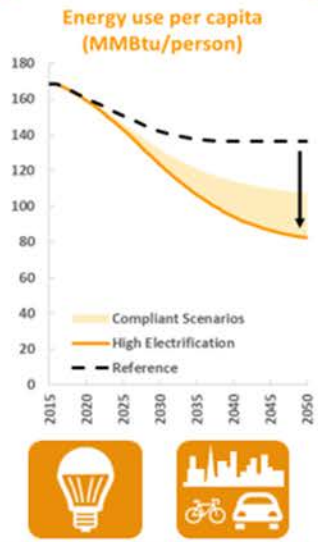


- **Scenarios vary in their reliance on electrification, with the carbon budget allocated to the electric sector increasing as the level of electrification increases**
- **After electric sector, remaining emissions dominated by transportation, industry, and non-energy**
- **Non-energy emissions include agriculture, waste, and industrial processes; to keep scenario design focused on energy, we assume all mitigation scenarios achieve 30% reduction in non-energy emissions relative to 2016**

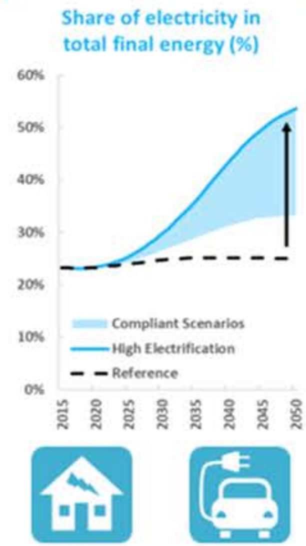
Four "Pillars" of Deep Decarbonization

Demand Side

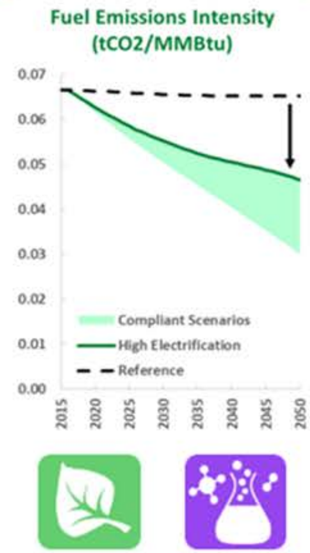
Supply Side



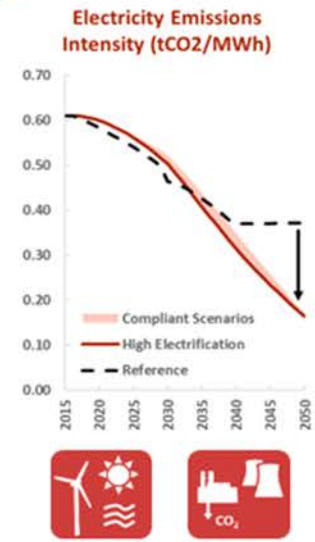
Energy efficiency & conservation



Electrification



Low carbon fuels



Low carbon electricity

Conventional Efficiency:
- Codes and standards
- Switching to efficient devices
- Building shell improvements
- Fleet vehicle standards

Buildings:
- Space heating
- Water heating

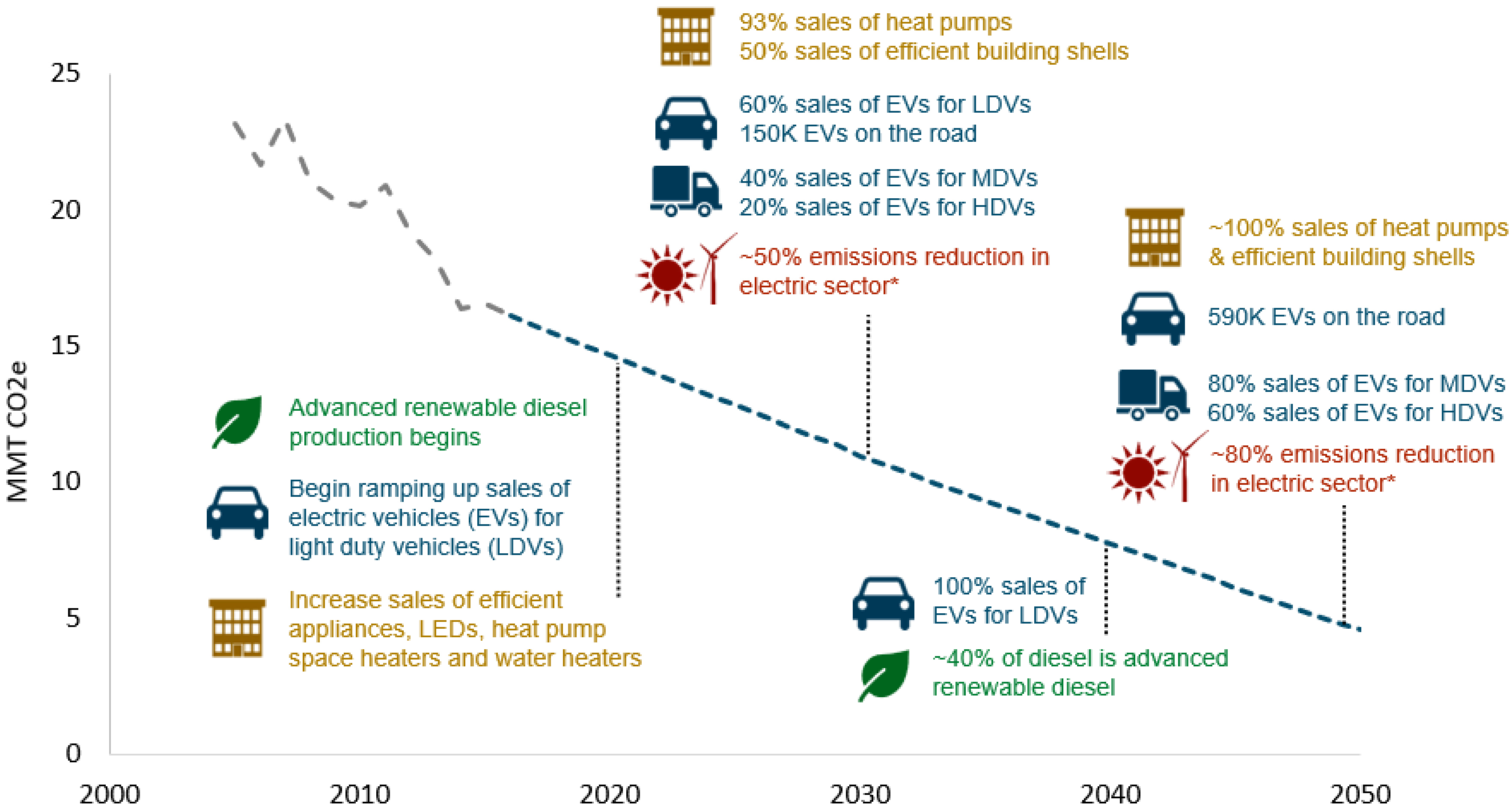
Transportation:
- Passenger vehicles
- Buses
- Medium and heavy-duty trucks

Biofuels:
- Conventional ethanol
- Renewable oil products (diesel, gasoline, jet kerosene)

Renewables:
- Solar (utility-scale and distributed)
- Wind (off- & onshore)
- Hydro

Carbon Capture

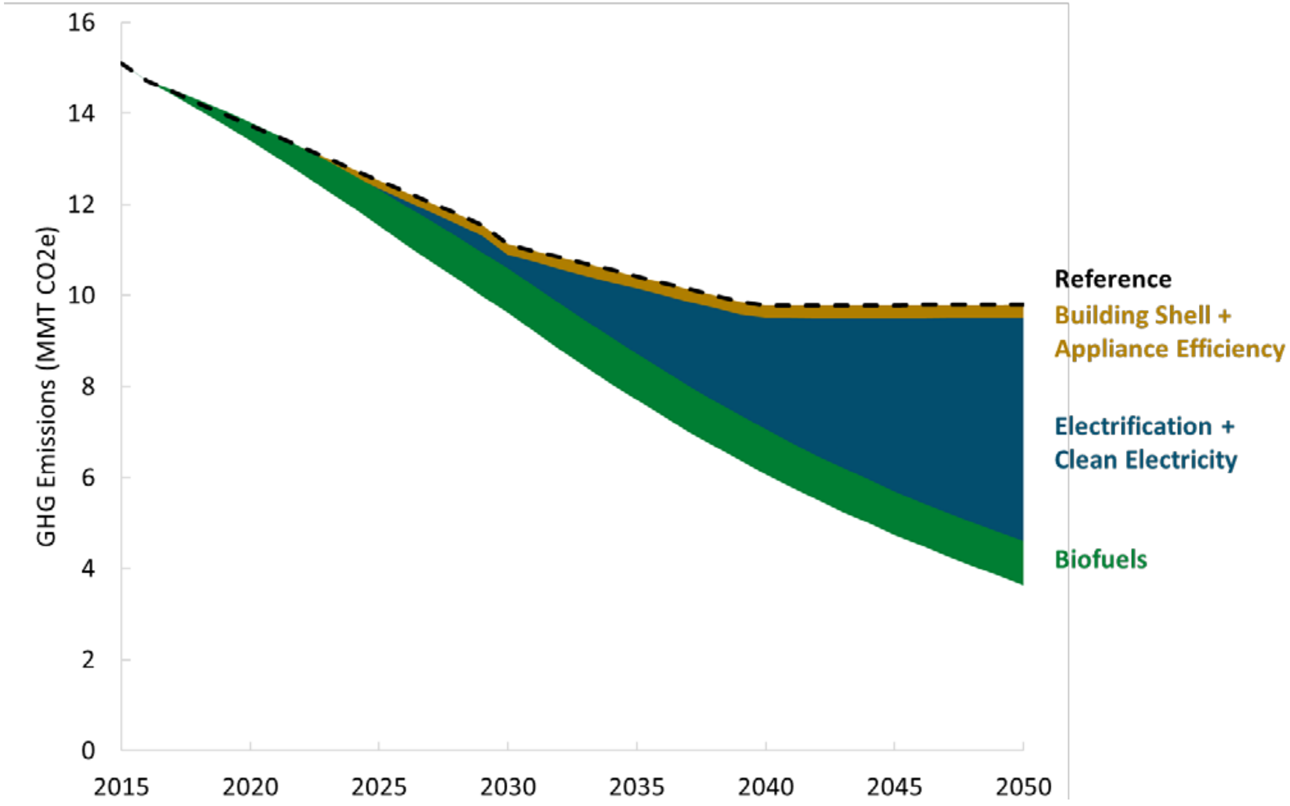
Grid Integration:
- Batteries
- Flexible loads



*Electric sector emissions reductions relative to 2005 (10.7 MMT)

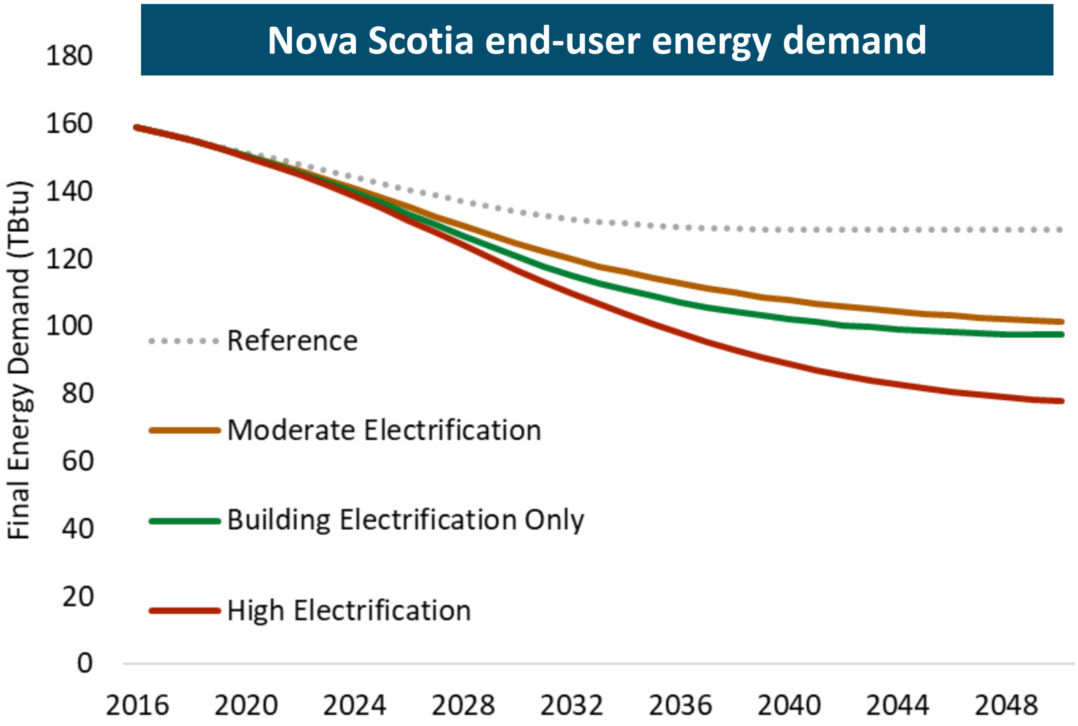
Emissions Reductions by Strategy in the "High Electrification" Scenario

- Energy efficiency plays a key role in the Reference scenario emissions reductions through 2030
- Achieving deep decarbonization levels beyond 2030 is possible with significant electrification of transportation and buildings, when paired with reliable, decarbonized electricity supply



Final Energy Demand by Scenario

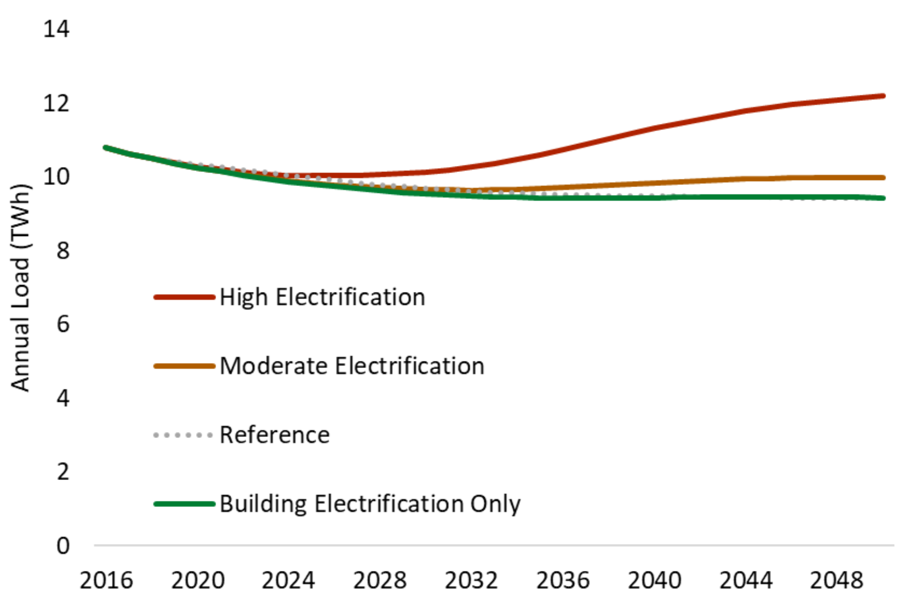
+ **All scenarios see significant efficiency improvements over the Reference case**
+ **Electrification is efficiency: energy demands of electrified end-uses are lower than their conventional alternatives**



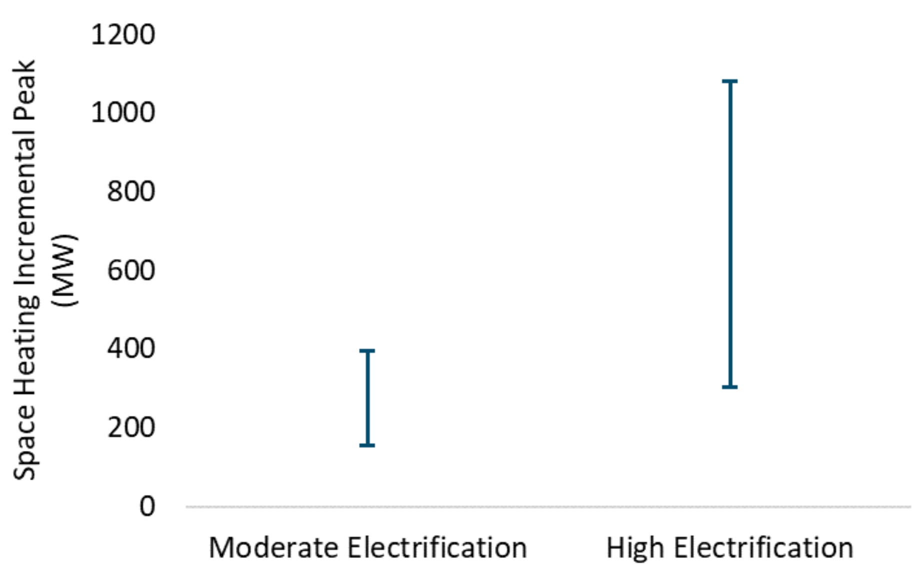
Electric Load by Scenario

- Building Electrification Only scenario has similar annual load as Reference scenario because increased heat pump load is offset by reduced load from switching resistance heat to heat pumps, and from the increased efficiency of building shells
- Moderate and High Electrification include increasing amounts of transportation and buildings electrification
- The estimated space heating peak assumes heat pumps operate as electric resistance heaters during cold hours: a variety of factors could affect this peak, and there are many mitigation options to reduce this peak

Nova Scotia annual load



Estimated space heating incremental peak in 2050



In a high building electrification scenario, winter peak demands sensitive to numerous factors

Winter peak could be higher with:

- Lower rate of building shell efficiency retrofits & improvements (assumed in all scenarios)
- Winter temperatures below average weather year planning
- Less diversity in building heating loads at cold temperatures
- Greater reliance on supplemental “strip” heat to meet winter space heating needs, e.g. due to:
  - HVAC installation practices and heat pump sizing that don’t minimize winter peak space heating needs
  - Customer override of heat pump or poor maintenance
- Higher coincidence of space heating, water heating and electric vehicle charging

Winter peak could be lower with:

- Market transformation of ground source heat pumps
- Technology improvement in cold-climate heat pumps
- More diversity in building heating loads at cold temperatures
- Demand response & flexible loads in industry, electric transportation, other non-weather sensitive end-uses
- Heat storage in buildings
- Dual-fuel heating systems: electric + oil or propane
- New electric transmission could also help to address winter peaks
- Climate change increasing winter temperatures above average weather year planning criteria

Key Conclusions for NS Power

- **Synergistic action is needed across all sectors to achieve deep decarbonization**
  - Reaching 80% GHG reductions, let alone net zero, by 2050 is challenging and not a given
  - The initial stages of that transformation have begun, but need to be accelerated
- **Low-carbon electricity is essential to achieving decarbonization by enabling emissions reductions in electricity sector as well as complementary reductions in vehicles and buildings**
  - Electricity sector has already reduced emissions by more than 30% relative to 2005 levels
  - Maintaining this momentum requires continuing to integrate low-carbon resources, ensuring reliability and affordability, and allow NS Power to meet existing load and new load growth without emitting more carbon
- **Low-carbon electricity is not enough to achieve 80% economy-wide reductions**
  - All mitigation scenarios modeled, while leveraging electrification and low-carbon electricity, require additional measures and actions such as energy efficiency and zero-carbon fuels
- **Long lifetimes require early action**
  - Meeting 2050 goals may require measures to increase early adoption of electric or low-emissions infrastructure, such as public charging infrastructure to enable electric vehicle adoption
- **Building electrification is dependent on reducing costs and enhancing incentives, which may be facilitated by the utility and the province**
  - Consider rates, incentives, and infrastructure buildout to allow for consumer adoption
- **Getting to “net zero” will be an even greater challenge, requiring more direct reductions, and/or carbon removal technologies or carbon offsets**

Recommendations for Additional Analysis

- **Electric sector modeling: This study did not perform detailed dispatch or capacity expansion modeling**
  - More completely characterize potential electricity system impacts, including effects of increased load and low-carbon electricity constraints on operations, reliability
  - Perform more detailed evaluation of peak impacts and potential mitigation strategies
- **Consumer adoption modeling: This modeling assumes the rapid adoption of several low and no carbon technologies**
  - Valuable future work would be to evaluate consumer economics and choices that may drive the adoption of these technologies (such as heat pumps and electric vehicles)
- **Estimate costs of scenarios to fully assess trade-offs among different decarbonization pathways**
  - Recommend undertaking a more detailed review of, at minimum, direct costs of energy infrastructure, associated operations and maintenance costs, and fuel costs
- **Technical feasibility of heat pumps**
  - Research to understand heat pump technology feasibility and costs specifically within Nova Scotia, particularly to assess potential for performance degradation in cold temperatures

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Thank You!

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