GOVERNOR'S Energy Office

Dan Burgess, Director

Agenda

- Welcome
- Background and overview of Maine Energy Plan
- Overview of technical work
  - Q&A
- Break
- Overview of initial draft demand analysis
  - Q&A
- Wrap-up and next steps

The Maine Governor's Energy Office (GEO) is the state's designated energy office charged with carrying out responsibilities of the state relating to energy resources, planning and development.

www.maine.gov/energy

GOVERNOR'S
Energy Office

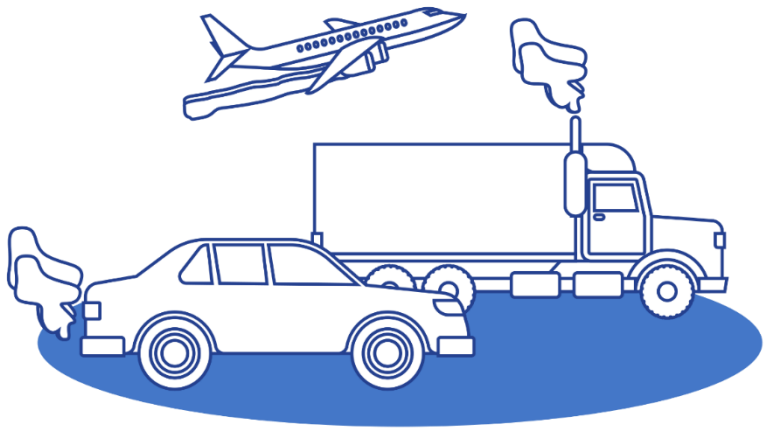
"The time has come to be bolder: I am announcing tonight that I am directing my Energy Office to draft legislation requiring that **100 percent of our electricity come from clean energy by 2040.** By accelerating our pace toward 100 percent clean energy, we will reduce costs for Maine people, create new jobs and career opportunities that strengthen our economy, and protect us from the ravages of climate change."

Governor Mills, State of the Budget Address, February 2023

GOVERNOR'S
Energy Office

Maine's Climate and Clean Energy Targets:

REDUCE GREENHOUSE GAS EMISSIONS	TRANSITION TO CLEAN ENERGY	ACHIEVE CARBON NEUTRALITY	CREATE CLEAN ENERGY JOBS
45% BELOW 1990 LEVELS **BY 2030**	**80%** **RENEWABLE BY 2030**	**2045**	**30,000** **BY 2030**
80% BELOW 1990 LEVELS **BY 2050**	**100%** **CLEAN BY 2040**		



49%

21%

12%

12%

5%

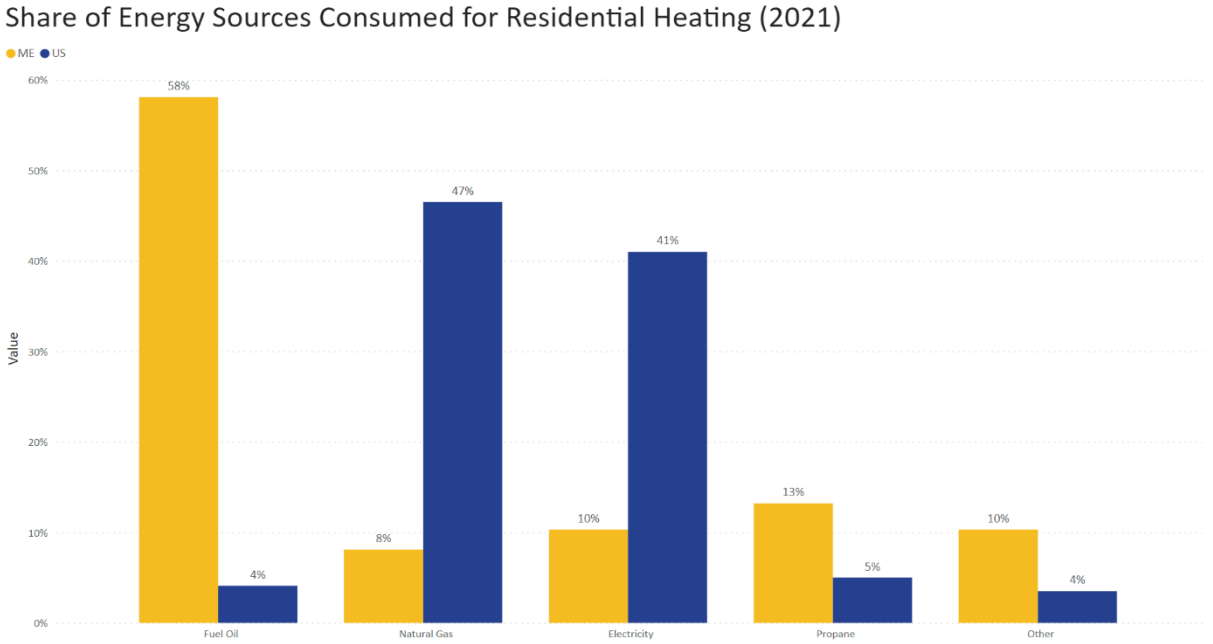
TRANSPORTATION • RESIDENTIAL • COMMERCIAL • INDUSTRIAL • ELECTRIC POWER

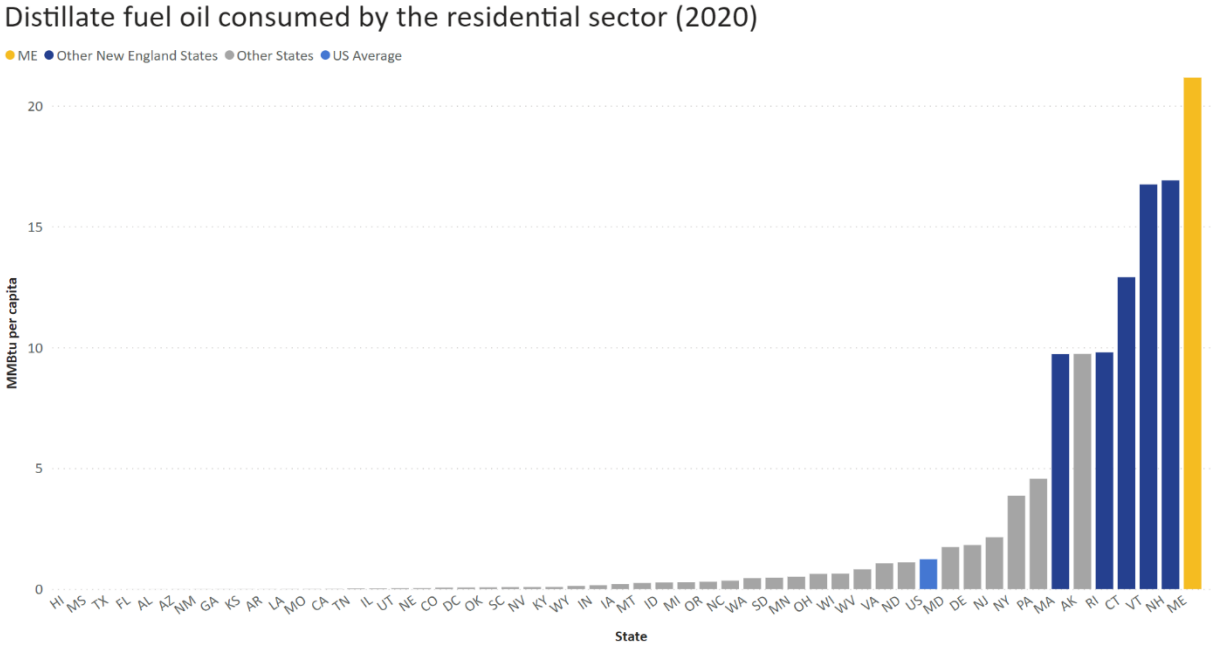
Data source: Maine Department of Environmental Protection 9th Biennial Greenhouse Gas Emissions Report

MaineWontWait.org

Maine is the most heating oil-dependent state in the country

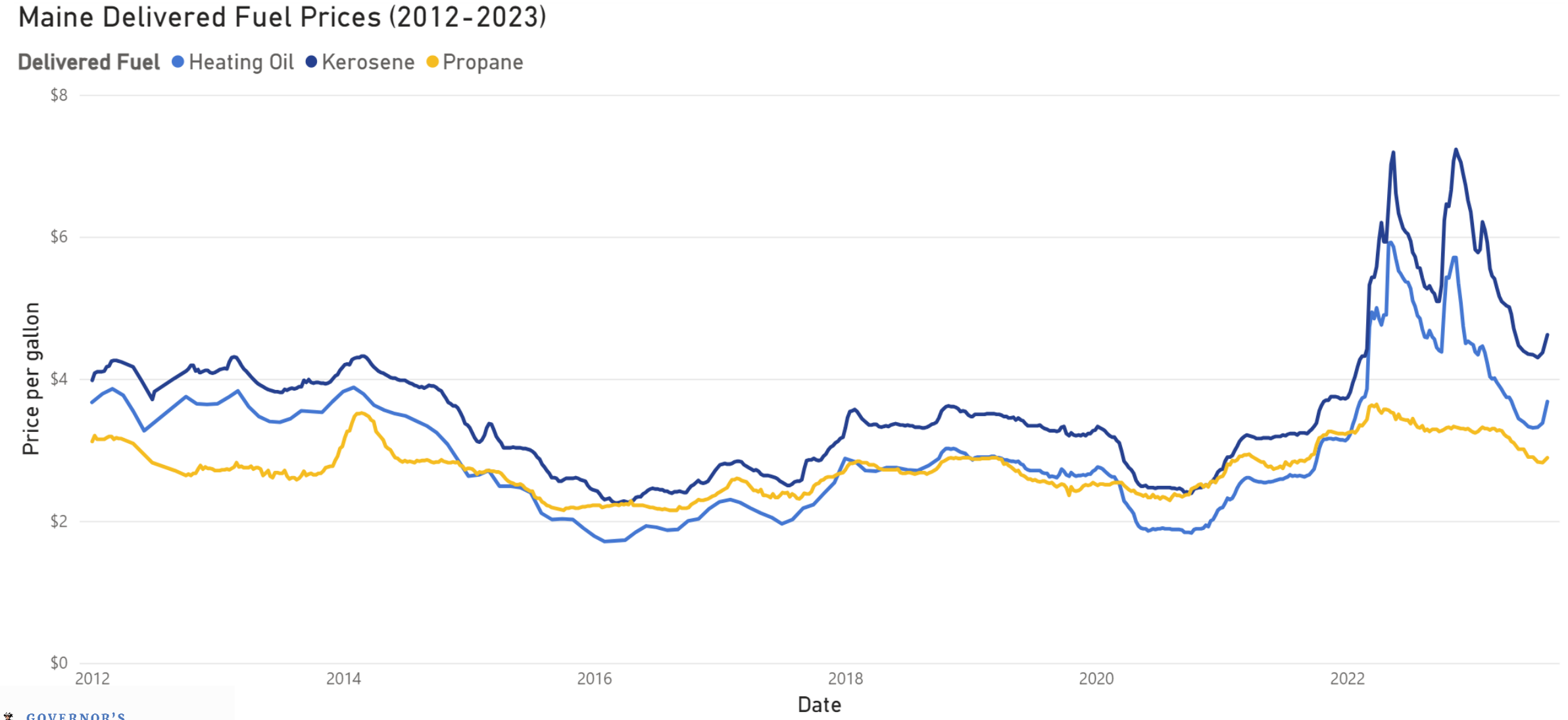
- Recent progress including energy efficiency and heat pump deployment have helped enable achievement of Maine's statutory goal of 30% reduction in heating oil consumption below 2007 levels.
- Still, 79% of Maine households heat primarily with fossil fuels, including 58% relying on heating oil.
- Maine households have the highest per-capita residential fuel oil consumption in the country.





GOVERNOR'S
Energy Office

Fossil fuel prices are volatile and have reached record highs in the wake of global disruptions



GOVERNOR'S
Energy Office

Maine Energy Policy Requirements

- **Renewable Portfolio Standard**
  - 80% of electricity delivered in Maine to be renewable by 2030
  - Supports hydroelectric, biomass, tidal, waste-to-energy, wind, and solar
  - Targeted support for new and existing resources including solar, wind, biomass, hydro, and wood-fired CHP
- **Offshore Wind**
  - Goal of 3,000 megawatts from the Gulf of Maine by 2040
  - GEO to establish procurement schedule and process with stakeholder input
- **Energy Storage**
  - Goal of 400 megawatts by 2030
  - GEO to develop procurement program for up to 200 megawatts
- **Solar**
  - Goal of 750 megawatts of distributed generation
  - GEO to implement distributed solar and storage program
  - Targeted procurement for solar on contaminated lands
- **Electrification**
  - Oil dependence reduction
  - Electrification of heating and transportation to achieve emissions reduction requirements

New, updated considerations for Maine's Energy Plan

The GEO is the state's designated energy office charged with carrying out responsibilities of the state relating to energy resources, planning and development.

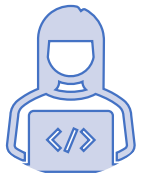
- Under Maine law, the GEO updates the State Energy Plan for delivery to the Governor and Legislature.
- The "Pathway to 2040" study will build off previous studies and bring together multiple components to supplement Maine's Energy Plan.

The process will build upon existing work to provide a comprehensive basis to inform Maine's best pathway to 100% clean electricity and enable greenhouse gas emissions reductions.

GOVERNOR'S
Energy Office

"Pathway to 2040" Study Outcomes

3-5 modeling scenarios, informed by public input and ongoing aligned processes



Concise, accessible digital summary of findings and comparison of different scenarios

Policy considerations based on the scenario comparison and interpretation

Incorporation into Maine Energy Plan

The "Pathway to 2040" study will be included as a technical volume within Maine's Energy Plan, delivered to the Governor and the Legislature in early 2024.

Maine Energy Plan

Maine is developing a comprehensive Energy Plan to meet the state's 2040 and 2050 requirements

The plan will be finalized in early 2024

Energy Plan Goals

- Identify policies to ensure Maine households and businesses have access to clean, affordable, and reliable energy in the coming decades.
- Support historically disadvantaged and low-income communities in this clean energy transition.

Informed by:

- *Detailed "Pathway to 2040" technical analysis and data*
- *Engagement with interested parties and communities*

Our Conversation Today

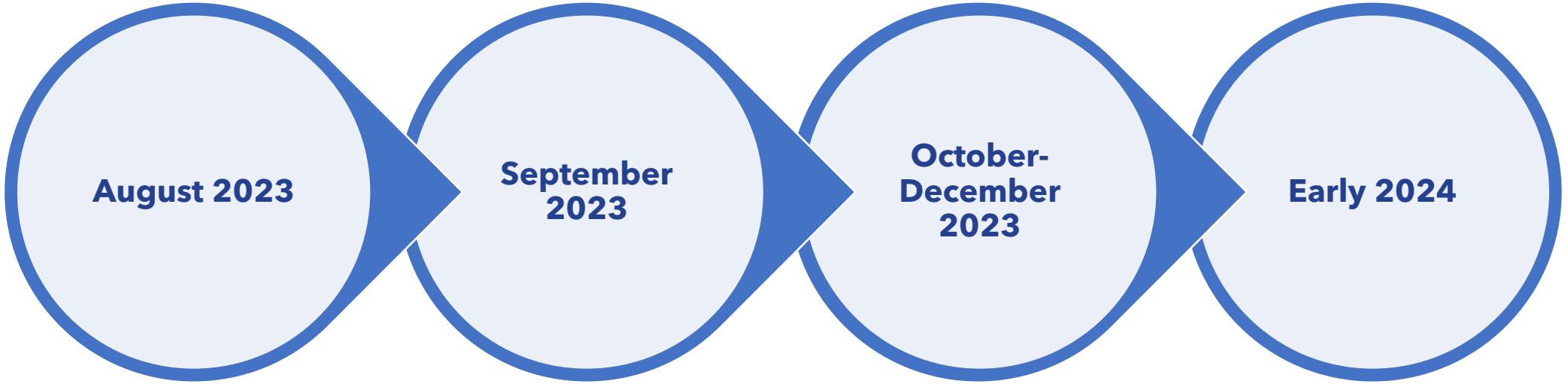
Provide information about:

- The planning process
- The technical analysis underway
- Initial results from the energy demand analysis

Receive your feedback on:

- How best to incorporate stakeholder views into this planning exercise
- The orientation of the technical work (i.e., are we asking the right questions?)
- Opportunities to improve the demand analysis

Public Engagement Timeline



- Public Kickoff; review demand-side results
- Review supply-side modeling results
- Discuss policy implications of technical work
- Publish Maine Energy Plan

Multiple opportunities for public engagement and input over the coming months

For more information and to sign up for email notifications, see:
https://www.maine.gov/energy/studies-reports-working-groups/current-studies-working-groups/energyplan2040

Maine Energy Plan

PATHWAY TO 2040 – TECHNICAL VOLUME

STAKEHOLDER KICKOFF MEETING

MODELING OVERVIEW AND INITIAL DRAFT DEMAND PROJECTIONS

THE BRATTLE GROUP
EVOLVED ENERGY RESEARCH

ON BEHALF OF THE
MAINE GOVERNOR'S ENERGY OFFICE

AUGUST 22, 2023

Brattle

EVOLVED ENERGY RESEARCH

GOVERNOR'S Energy Office

Study Overview

Energy Decarbonization Pathways – Study Goals

This study will develop and compare alternative pathways to decarbonize Maine's economy, to provide support for future policy decisions and guidance for implementation

Technologies: EVs, heat pumps, efficiency, onshore/offshore wind, solar, biofuels, etc.

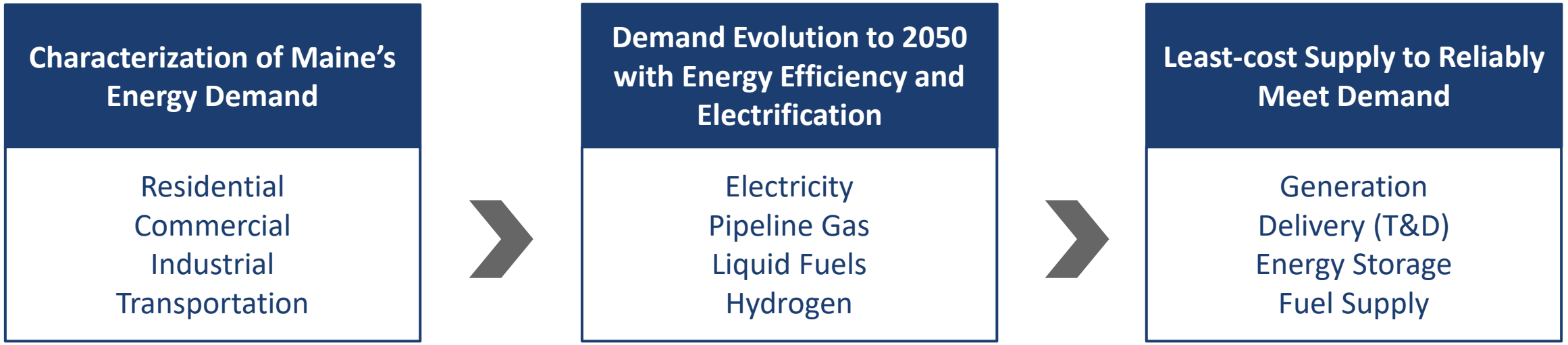
- A Pathway specifies how much of each, when and how, to meet decarbonization requirements
  - Using detailed modeling of energy supply and demand interrelationships, across all sectors of the economy

- Modeled in regional context – not just Maine
  - Surrounding states are also decarbonizing
    - Particularly the New England electricity system (and neighboring systems) – Maine is part of the regional ISO-NE grid
      Though Northern Maine is not connected to ISO-NE; NMISA connects only to New Brunswick
    - Considers electric transmission needs – both to integrate new renewables, and accommodate increased electric demand
  - Energy markets are (and will continue to be) regional/global

High-level approach

For each Pathway, study projects evolution of energy demand for Maine

- Then determines the least-cost way to supply that energy, given engineering and policy constraints



All New England is assumed to pursue similar demand strategies

- E.g., degree of all-electric vs hybrid heating, transport electrification, etc.

Supply is determined jointly across the region to provide the Pathway's energy needs at the lowest cost

Limitations – What This Study Cannot Do

Cannot predict the future:

- Technologies and fuels – uses reasonable assumptions for progress on technology cost and performance
  - Not assuming breakthroughs or unproven technologies for electric generation, EVs, heat pumps, etc.
  - Similarly for fuels (esp. clean fuels) – cost and availability projections are reasonable, though may differ from future outcomes

Cannot identify/evaluate specific generation or transmission projects or their costs

- Will identify "generic" project types, using best available estimates of cost, performance, etc. for Maine
  - But cannot specify particular generation projects or transmission paths, nor precise costs of those projects
- Results of this study can be used to identify promising pathways, which can be developed in further detail

Cannot address detailed and granular implementation issues

- Though can identify some types of issues that will likely be encountered, and perhaps approaches to address them

Models and Approach

Paired modeling framework

Demand-side: EnergyPATHWAYS model

Inputs

Existing energy infrastructure
(vehicles, furnaces, water heaters)

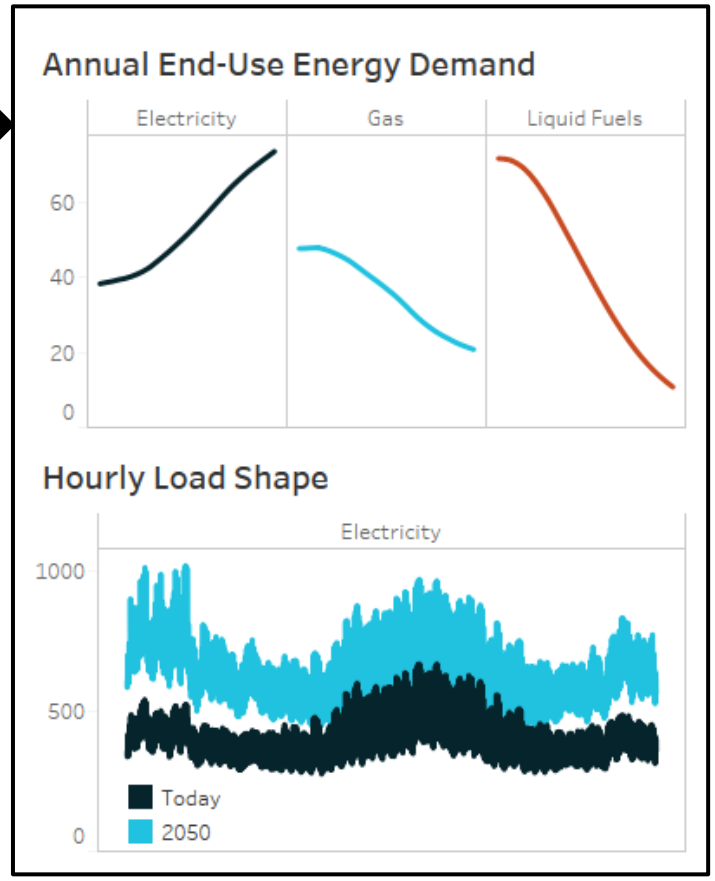
Load shapes by end-use

End-use technology cost and performance

Electrification rates
(electric vehicles, heat pumps)

Energy efficiency measures

Intemediate Outputs



Supply-side: RIO model

Inputs

End-use Energy Demand
- Annual fuel demand
- Hourly electric load

Resources
- Existing and planned additions/retirements
- New resource cost, performance, potential

Zonal topology

Fossil fuel costs

Constraints
- Emissions budget
- Energy balance
- RPS/CES
- Resource operations
- Transmission

Outputs

Capacity Expansion
- Resource additions, retirements, extensions, & retrofits
- Biofuels, e-fuels and hydrogen production
- Transmission and pipeline expansion

Operations
- Hourly generation, storage and flexible load dispatch
- Hourly inter-zonal transmission flows

Additional Outputs
- CO_2 emissions by fuel and source
- Energy system costs

Demand-side modeling

ENERGY PATHWAYS

Detailed representation of end-uses in residential and commercial buildings, transportation and industry, including hourly electric demand

Major energy consuming end-uses include:

Residential Sector

- Air conditioning
- Space heating
- Water heating
- Lighting
- Cooking
- Dishwashing
- Freezing
- Refrigeration
- Clothes washing
- Clothes drying

Commercial Sector

- Air conditioning
- Space heating
- Water heating
- Cooking
- Ventilation
- Lighting
- Refrigeration

Industrial Sector

- Boilers
- Process heat
- Space heating
- Curing
- Drying
- Machine drives

Transportation Sector

- Light-duty vehicles
- Medium-duty vehicles
- Heavy-duty vehicles
- Buses
- Aviation
- Shipping

Supply-side modeling

Capacity expansion tool produces cost-optimized resource portfolios across the electric and fuels sectors to meet identified energy demand for each Pathway

- Least-cost supply to achieve emission targets, meet energy demand and reliability needs
- Demand pathways influence power system requirements – e.g., energy and capacity needs

Electricity: Modeling identifies Operations (matching hourly supply to demand) and Investment (generation buildout), with detailed technology representations

- Offshore wind, onshore wind and solar supply curves, with their hourly generation profiles
- Thermal and hydro resources
- Diurnal and long-duration electric storage
- Inter-zonal electric transmission, including expansion needs
- EV charging flexibility can moderate electric operating costs and investment requirements
- Hydrogen production, storage and transmission

(Supply-side modeling for this project is just beginning, and will not be discussed in detail today)

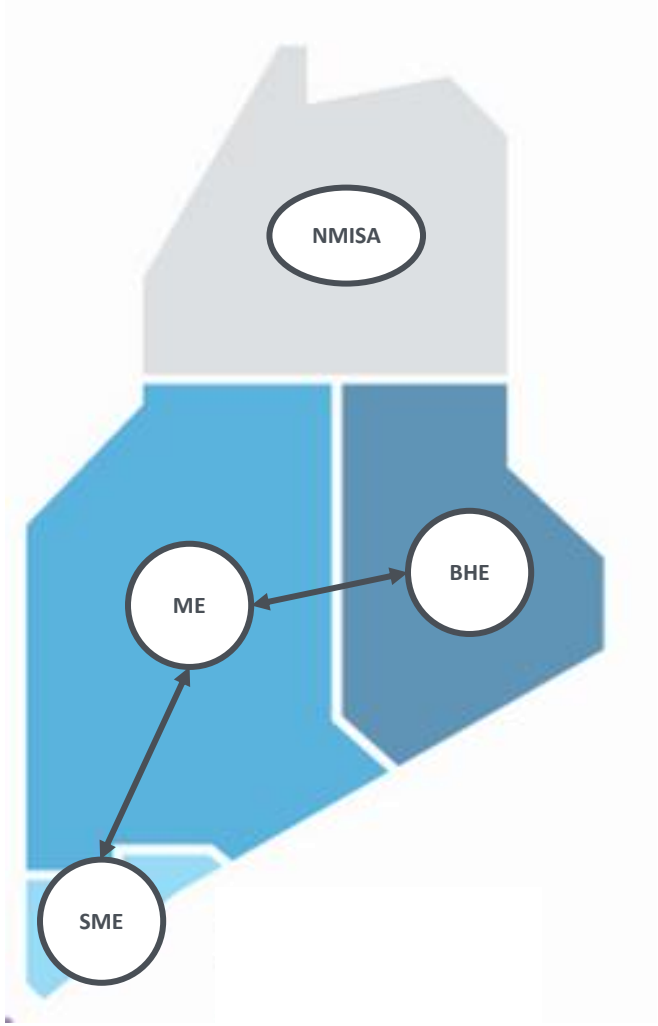
Electricity System Topology

Maine is represented with four zones

- Three zones consistent with ISO-NE system planning: SME, ME, BHE
- One zone in northern Maine (NMISA) connected to NB (not to ISO-NE)

Additional modeled zones (not illustrated here):

- Other ISO-NE states: NH, VT, MA, RI, CT
- New York
- New Brunswick
- Hydro Quebec
- Rest of Eastern Interconnection
- Rest of U.S.



Transmission Needs to Achieve Decarbonization Goals

Upgrades to the Maine and New England transmission system will be a key enabler for a decarbonized grid, and thus long-term decarbonization goals. Transmission needs are driven by:

- Increased peak electricity demand due to electrification
- The need to access and integrate renewable resources (onshore/offshore wind, solar, hydro, etc.)

Our study will incorporate the best available information about existing transmission capacity, and costs for expanding key interfaces, interconnecting renewables, and adding capacity to serve peak load

- One study objective is to identify the lowest-cost portfolio of generation resources (including transmission costs) to achieve Maine's decarbonization goals
- The results of this Maine pathways study can be used to inform specific near-term and longer-term upgrade needs

Based on our transmission planning experience across the country, we will provide recommendations for how Maine can proactively and cost effectively work with other New England states and ISO-NE to identify necessary upgrades

Questions to Stakeholders

Q & A – First Round

Questions to Stakeholders – First Round

- What questions do you have about this process?

- Which technical outcomes from the study do you think will be most helpful for energy planning in Maine?

Initial Results:

Demand-Side Pathways

Draft demand-side pathways

Two broad frameworks to decarbonize building heat (based on experience elsewhere):

(1) High Electrification – Rapid adoption of whole-home heat pumps results in transition away from fuel-based heating systems in most homes

(2) Hybrid Heat – Heat is primarily met by fuel-electric hybrid heat pumps; boilers/furnaces provide back-up heat on coldest days (eventually burning clean fuels)

- Outside of differences in decarbonizing heating, demand-side pathways share key assumptions, such as significant transportation electrification

All scenarios will be calibrated to achieve existing Maine targets; preliminary drafts are presented here for stakeholder feedback

End-use consumption: high electrification pathway

Final energy demand: energy used to deliver services: heating or transportation (excludes energy consumed in converting to other energy forms)

Overall energy consumption falls ~40%

- Battery electric vehicles and heat pumps are more efficient than their combustion counterparts

Electricity consumption more than doubles

H2-based fuels used for long distance transport and industry (in modest amounts)

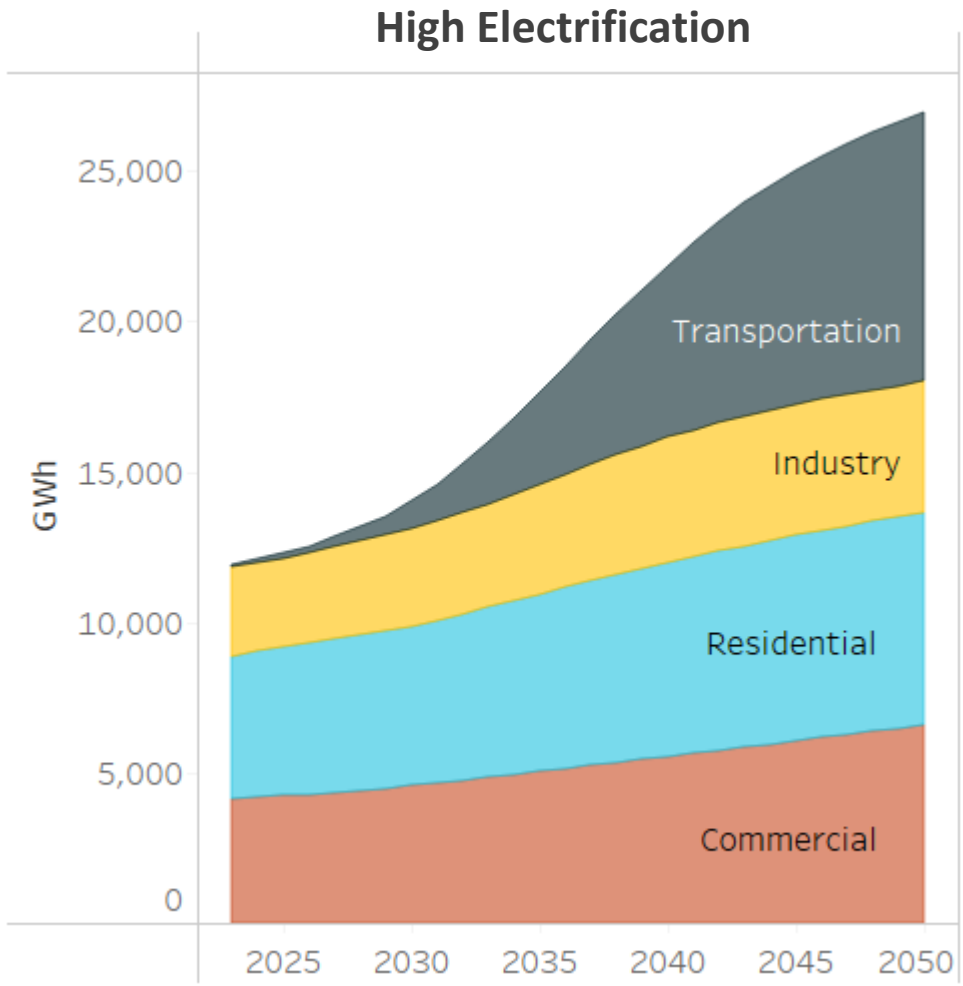
Retail electricity sales: high electrification pathway

Significant end-use electrification causes power consumption to grow ~3% annually through 2050

- Overall consumption more than doubles
- Directionally consistent with previous Maine Climate Council analysis

Electric growth is driven by:

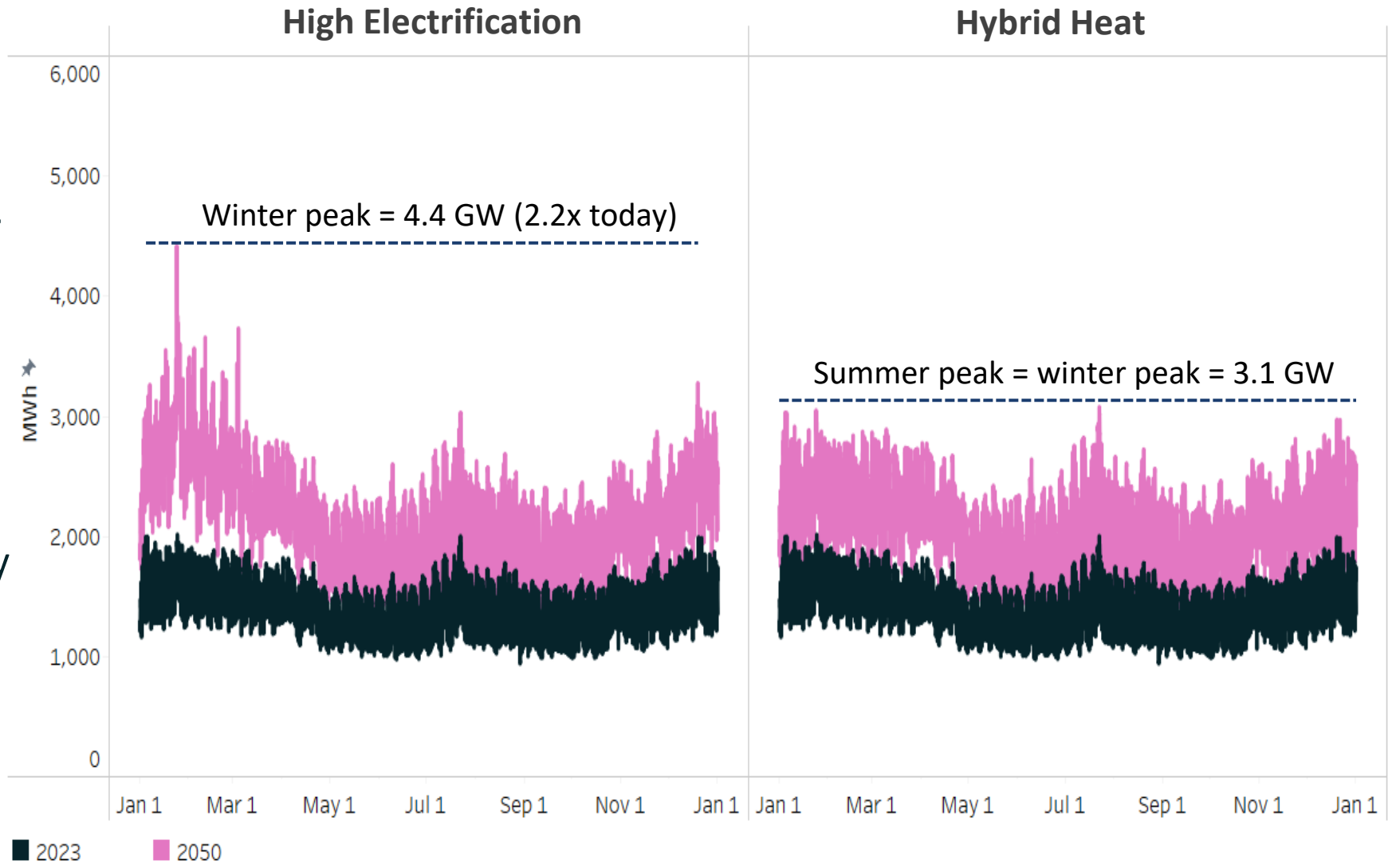
60% Transportation
30% Residential/Commercial Buildings
10% Industry



Hourly Maine load profile: excludes transport load

New England is summer-peaking now (air-conditioning load); Maine itself has similar summer/winter peaks

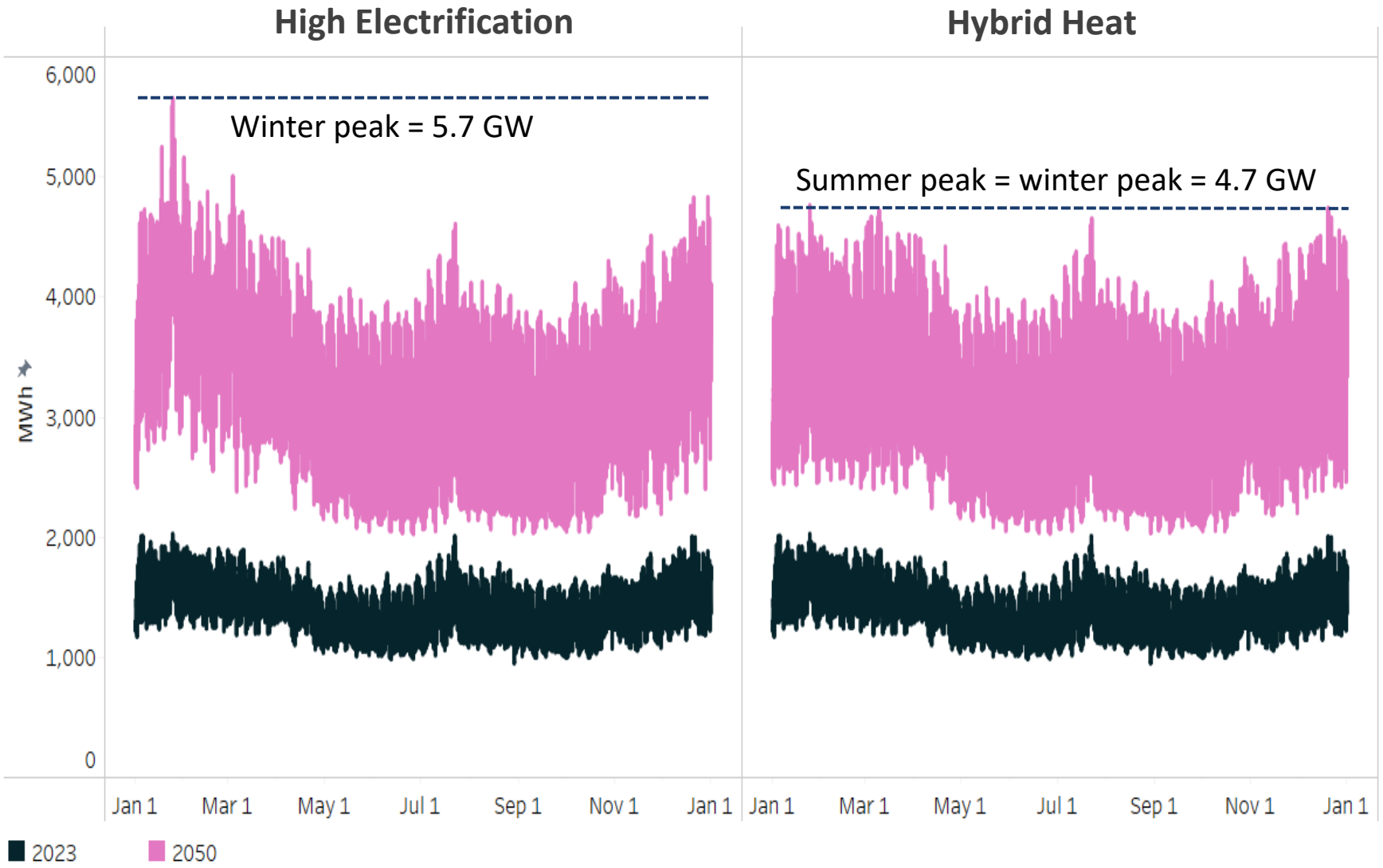
- With High Electrification, heat pumps create a big new winter demand; Maine (and New England overall) becomes strongly winter-peaking by 2050
- Hybrid Heat can help mitigate the winter peak, though also raises other issues



Hourly Maine load profile: includes transport load

Transport electrification, on top of electrified heat, increases load further

- BEV charging is flexible; this will be reflected in the supply-side optimization (not yet implemented), lowering realized peaks



Questions to Stakeholders

Q & A – Second Round

Q & A

Questions to Stakeholders – Second Round

- What questions do you have about this initial demand side analysis?
- What information do you have that could help refine and improve the analysis?

Public Engagement Timeline

- Public Kickoff; review demand-side results
- Review supply-side modeling results
- Discuss policy implications of technical work
- Publish Maine Energy Plan

Next public engagement webinar: Thursday, September 28, 2-4 p.m.

We are eager to engage stakeholders in this work. To share feedback or suggestions, please email geo@maine.gov with subject line "Pathway to 2040"

For more information, meeting registration, and to sign up for email notifications, see:
https://www.maine.gov/energy/studies-reports-working-groups/current-studies-working-groups/energyplan2040