MAINE GOVERNOR'S
Energy Office

Pathway to 2040: Draft Study Results & Implications

November 8, 2024

Dan Burgess, Director

Meeting Agenda

This is the first in a series of webinars hosted by GEO throughout the fall on the Maine Energy Plan.

- Introduction and overview of 2040 planning process (5 min)
- Pathway to 2040 report overview, key results, and implications (25 min)
- Audience Q&A (25 min)
    - Raise hands to request to be unmuted
- Next steps (5 min)

Energy Plan Progress Update

- Since kicking off the process in 2023, we've been:
  - Gathering feedback, refining the model, and working to deliver the Energy Plan in mid-January, per statutory requirement
  - Participating in the Maine Climate Council process to deliver the 2024 update to *Maine Won't Wait*
  - Securing hundreds of millions in federal funding for grid resilience, energy efficiency, storage, and solar for Maine.

10-Year Economic Plan (DECD)

Highlights the importance of an affordable energy supply to grow Maine's economy.

Climate Plan (GOPIF / DEP)

Transitioning to clean energy is core to achieving Maine's climate and emission reduction goals.

Energy Plan (GEO)

Pathway to 2040 modeling is grounded in the 2020 *Maine Won't Wait* climate plan.

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Maine's Energy Plan

In 2023, Governor Mills directed GEO to develop a comprehensive energy plan to achieve 100 percent clean energy in Maine by 2040.

Energy Plan Outcomes

- Comprehensive plan to meet state energy goals and support climate goals
  - Informed by a detailed technical analysis and public engagement

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.

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Pathway to 2040 Study Outcomes

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 2025

- **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**

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Public Engagement has Contributed Valuable Feedback during Development of the Energy Plan

Informed by the public:

GEO hosted several public meetings and received feedback on the Pathway to 2040 study and modeling pathways in 2023 and 2024.

Reviewed by the public:

The draft technical report and Energy Plan content will be presented to the public this fall.

The Energy Plan will reflect the needs of Maine people to create a clean, affordable, and reliable energy future. The Plan will take into consideration input and feedback from partners, stakeholders, and members of the public.

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Key Takeaways

- 100% clean energy by 2040 is **achievable, beneficial**, and results in **reduced energy costs** across the economy
  - Electrification; diversity of supply are key to ensuring more affordable, reliable, clean energy for Maine
- Key considerations:
  - Innovation; emerging technologies and applications for load flexibility

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Next Steps

Public Comments

Public comments are now being accepted on this draft report.

Email **geo@maine.gov** with you written comments **before November 18, 2024.**

The full draft report is available at maine.gov/energy

Future Engagement

Stay tuned for the release of additional Energy Plan content, opportunities for comment, and webinars to engage stakeholders and the public.

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Now, we’ll turn to the Brattle Group to summarize the technical report

- Please hold Q&A for the end, there will be plenty of time for questions
- After Q&A, we’ll wrap up with next steps including upcoming webinars and public comment instructions

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Maine Energy Plan

PATHWAY TO 2040: DRAFT STUDY RESULTS AND IMPLICATIONS

THE BRATTLE GROUP
EVOLVED ENERGY RESEARCH

ON BEHALF OF THE
MAINE GOVERNOR'S ENERGY OFFICE

NOVEMBER 8, 2024

Brattle

EVOLVED ENERGY RESEARCH

GOVERNOR'S Energy Office

Agenda

- Introduction
- Key Results and Policy Implications
  - Core Pathway
  - Alternative Pathways
- Key Policy Priorities
- Q&A

Study Background

- The Governor's Energy Office (GEO) commissioned The Brattle Group and Evolved Energy Research to develop this report through the *Maine Energy Plan: Pathway to 2040* initiative to inform the development of the updated State Energy Plan and meet the Governor's directive to plan for 100% clean energy by 2040
- This report builds on previous initiatives and studies conducted by the GEO and other state agencies, including the state's climate action plan, *Maine Won't Wait*, and incorporates input from a wide range of stakeholders
- It develops several **alternative pathways** for Maine's energy sectors through the coming decades to inform the development of strategies that ensure affordable, reliable, clean energy, support the growth of Maine's economy, and achieve statutory greenhouse gas emissions requirements
  - Pathways are not intended to represent discrete choices, but rather to illustrate key issues and tradeoffs
  - Pathways were formulated to address key questions identified by stakeholders during the initial meetings
  - All pathways meet reliability requirements and minimize costs, given the pathway definition

What is a Pathway? All pathways achieve Maine's clean energy goals

- **"Core" is a high-renewables, high-electrification pathway.**
  Alternative pathways are designed to illustrate **key issues and trade-offs** that will arise in decarbonizing Maine's energy sectors, including when those issues will likely emerge and when they must be addressed
- Performance of these pathways are **compared across several dimensions**, including cost, emissions, and energy use, to identify the factors that may make some pathways more achievable and affordable
- Pathways were formulated to address key questions identified by stakeholders during the initial meetings

PATHWAYS

1. Core Pathway
2. 100% Renewable (No Thermal)
3. Hybrid Heat
4. High Flexible Load
5. No Flexible Load
6. High DER + High Flex

INSIGHTS

Pathways compare:

- Role of dispatchable thermal electricity generation
- Value of retaining furnaces and boilers to provide backup for heat pumps
- Value of load flexibility
- Effect of additional distributed rooftop solar and batteries

POLICY RECOMMENDATIONS

Incorporate insights from pathways:

- Maine's energy transition will feature elements from *multiple* pathways
- Identify the key issues and trade-offs to inform policies that facilitate Maine's energy transition

All pathways incorporate key Maine policies and targets through 2050

Economy-wide GHG reductions:

- 45% reduction by 2030; 80% by 2050 (vs 1990 levels);
- Carbon neutrality by 2045

80% renewable portfolio standard by 2030, with supporting procurements

100% clean electricity by 2040

3,000 MW of offshore wind by 2040

400 MW of energy storage by 2030

100,000 new heat pumps by 2025 (already achieved), plus an additional 175,000 by 2027

Planned resource and transmission projects

Key Results and Policy Implications

Widespread Electrification of Transportation and Heating

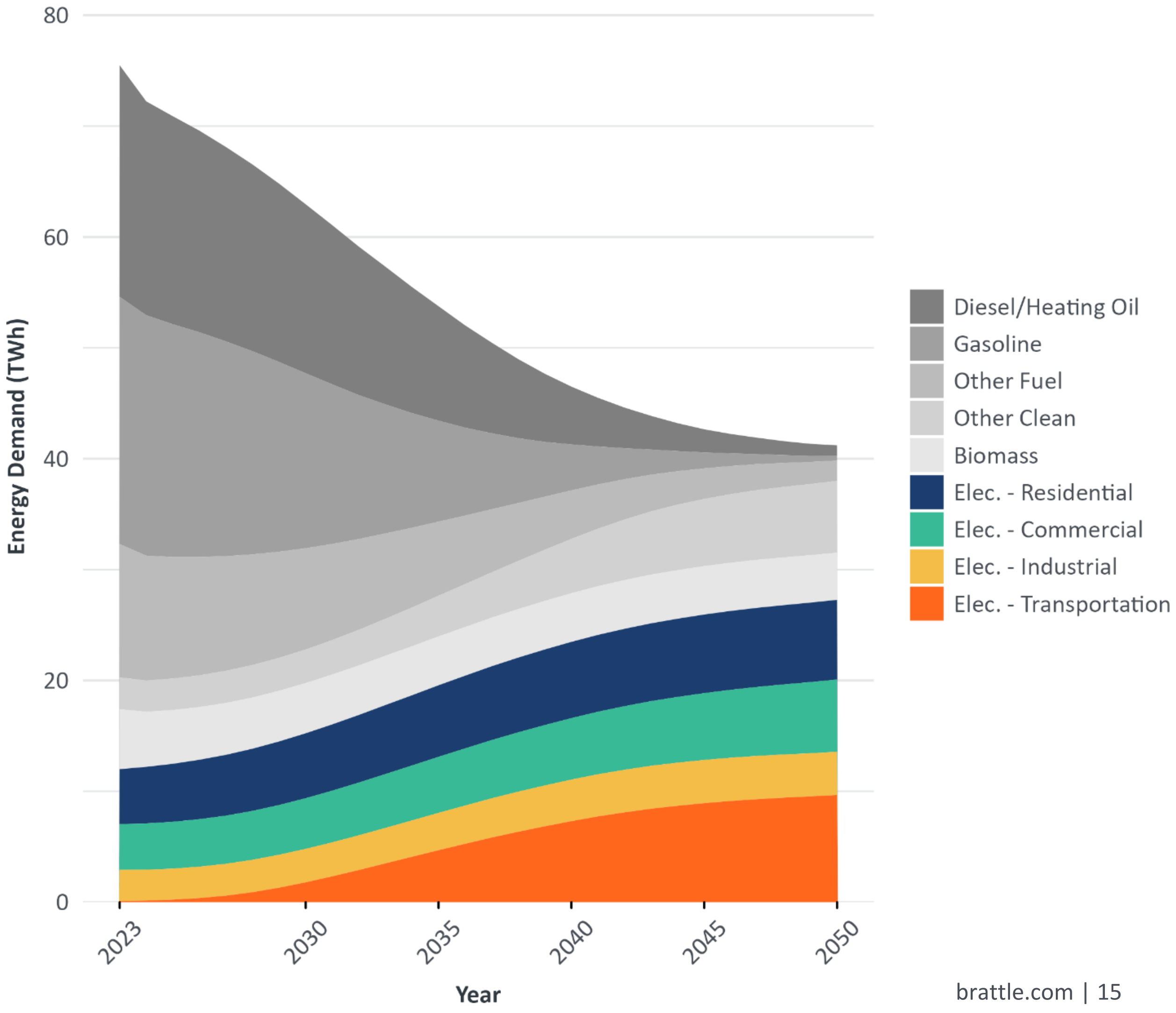
Electrification of transportation, space heating, and industry produce significant electric load growth, as electricity displaces fossil fuels

- Maine's annual total electricity consumption is projected to more than double—from 12 TWh in 2023 to 23 TWh in 2040—as fossil use declines
- About 60% of the **new electric energy** demand is for transportation, 30% space and water heating, 10% industrial
- **Peak electricity** demand nearly triples by 2040, driven by space heating

Declining fuel use accompanies electricity demand increase

Note: Hybrid Heat pathway relies on different modeling, with 50% less heating demand coming from electricity.

Forecasted Energy Demand in Maine

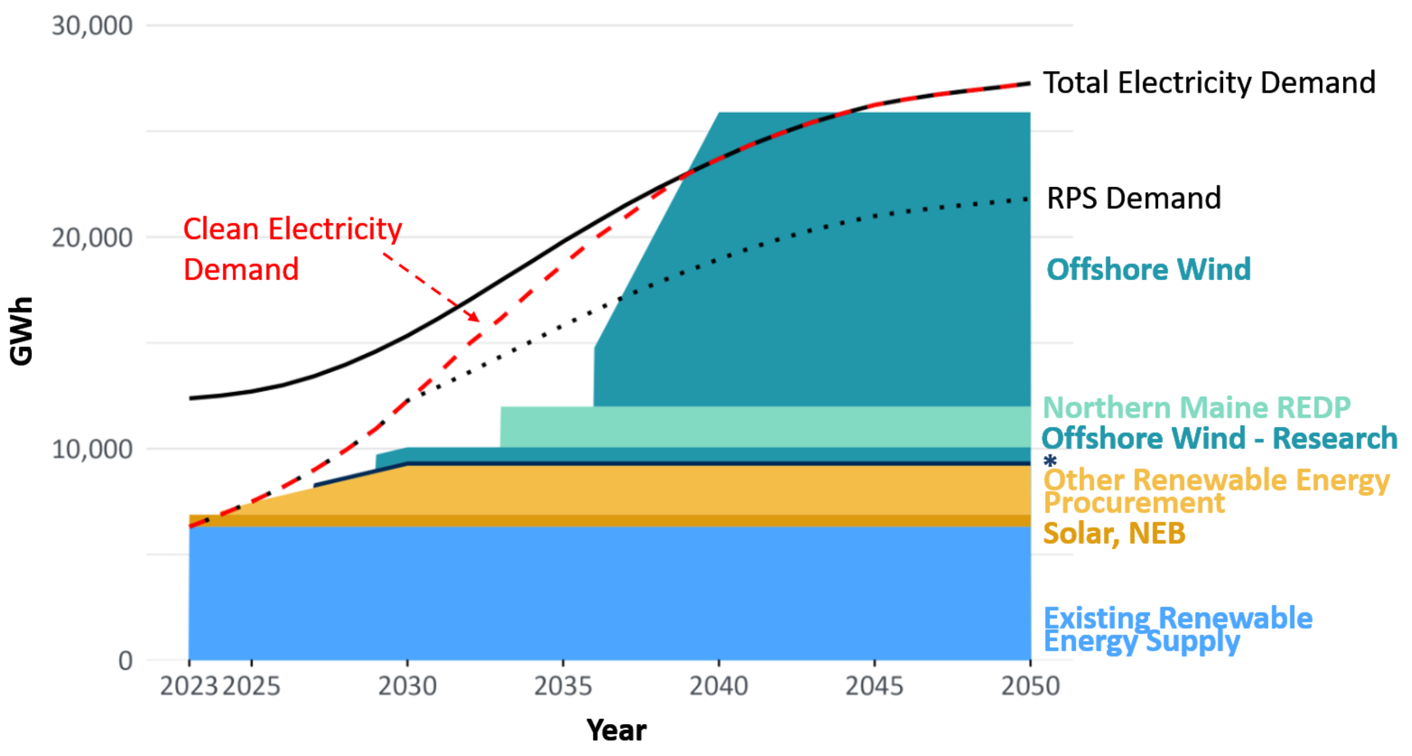


Changing Electricity Supply to Meet 100% Clean Electricity by 2040

Maine's planned renewable energy procurements will meet most of Maine's clean electricity demand by 2040

- Maine will add clean electricity resources through its commitments to offshore wind, the Northern Maine Renewable Energy Development Program, and other renewable energy procurement (see figure)
- The remaining gap can be addressed by procuring additional resources or contracts, and/or REC purchases
- Maine will need to expand its transmission system to connect these new resources, balance renewables output, and maintain reliability

Maine's Clean Electricity Demand and Planned/Contracted Resources



*Wood-fired CHP program

Key Policy Implications – Facilitate Clean Electricity Infrastructure

Maine Must Follow Through on its Commitments to Procure Clean Energy to Meet its 2040 Goals

- Maine is making strides with its commitments to renewable energy generation projects, and **must continue**
- Maine must **clearly define which energy resources qualify as clean** (beyond wind, solar, and hydro) to ensure it can plan, develop, and maintain them in an orderly way to meet the 2040 target

Policymakers Must Continue to Modernize Transmission and Distribution Planning to Facilitate Clean Energy Goals

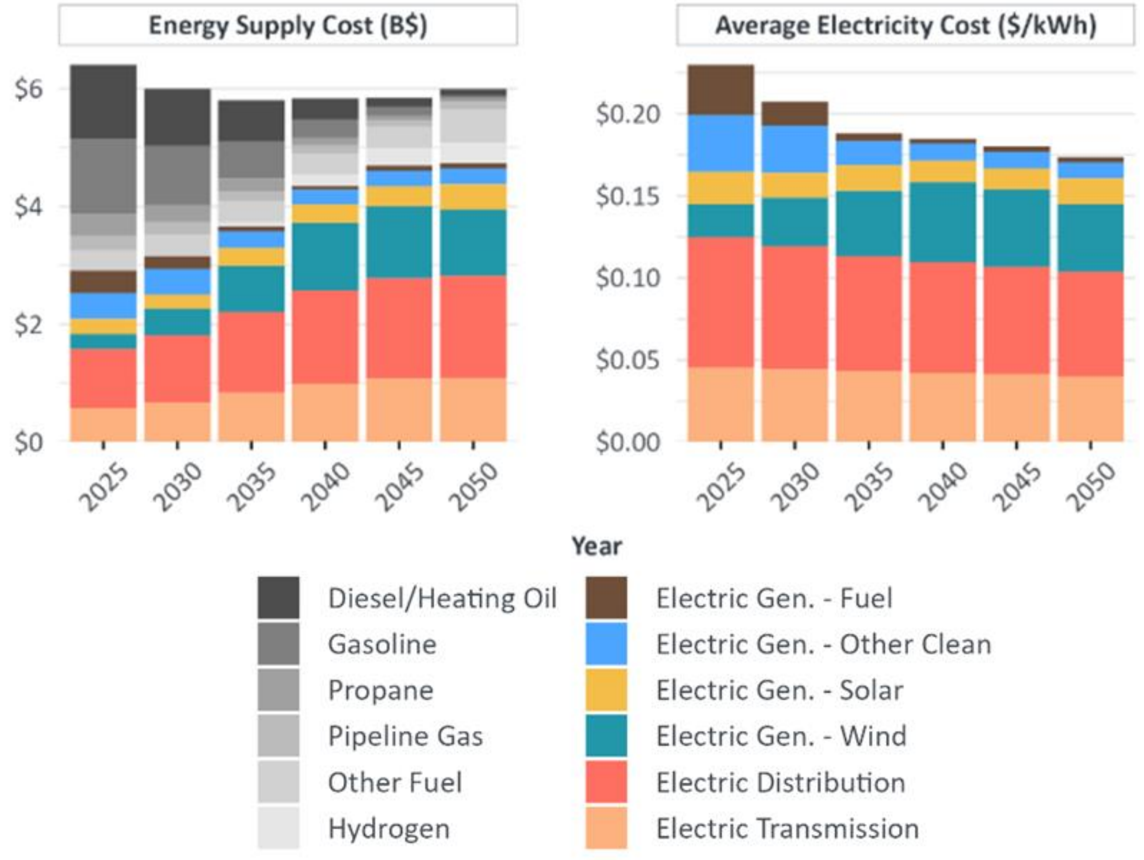
- The clean energy transition in Maine (and other NE states) will require significant **expansion of the regional electric power system**, including transmission and distribution infrastructure
- Policymakers and grid planners in Maine must **collaborate** with each other and with other entities across the region on proactive planning processes to ensure timely and cost-effective upgrades and expansion to achieve all New England states' clean electricity goals

Energy Supply Costs and Average Electricity Costs

Transition to clean energy will avoid fossil fuel cost volatility and reduce overall energy supply costs

- Electricity expenditures (for G, T, & D) rise with electricity demand—but are offset by savings from decreased fossil fuel use
  - Average unit electricity cost (delivered) will fall modestly over time, as sales volumes increase slightly faster than costs (in real $)
- Renewable costs are stable, once developed (avoiding volatile fuel prices)
  - Continued over-reliance on fossil fuels is riskier, and probably higher cost
- Household total energy costs behave similarly—declining modestly, then stable

Energy Supply Costs and Average Societal Electricity Cost For Maine (2022$)

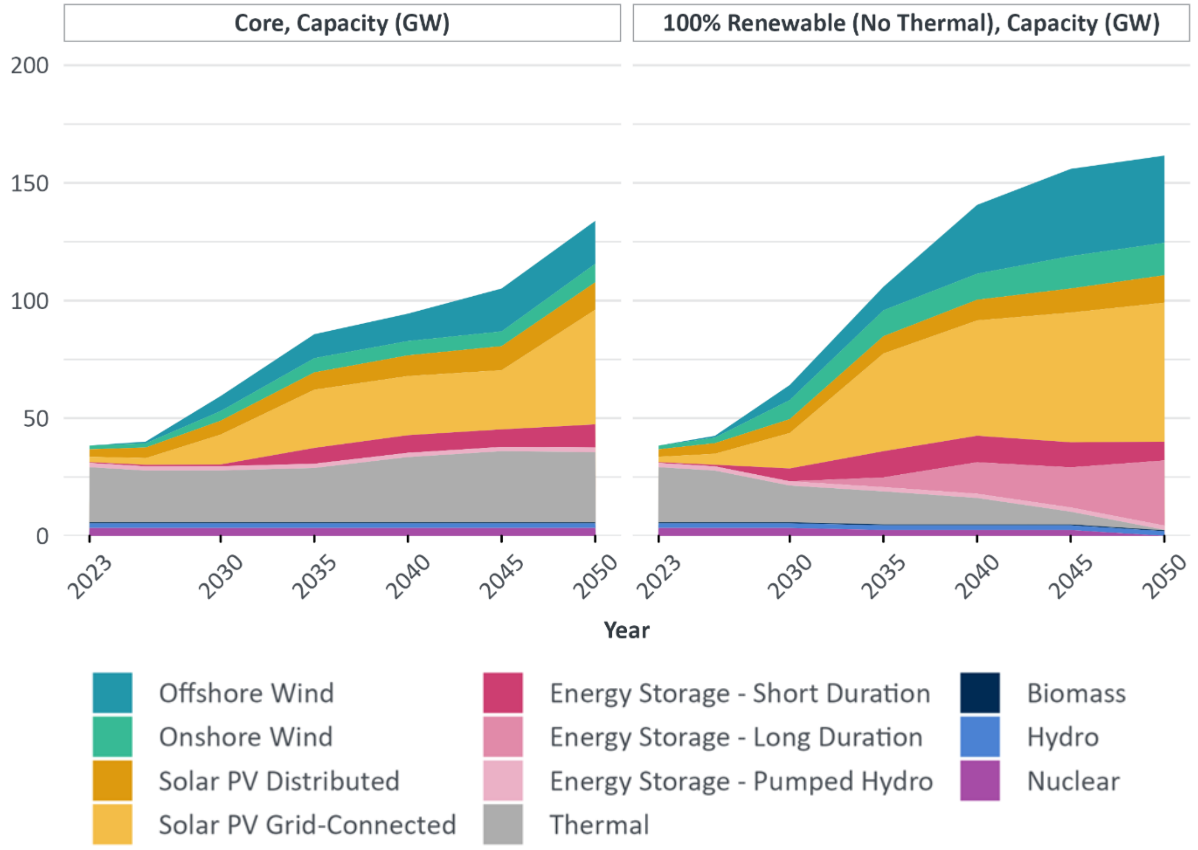


The Role of Thermal Generation with Clean Fuel

Cost-effective power sector decarbonization involves high renewables, storage and load flexibility – plus thermal generation (with clean, carbon-neutral fuels), used sparingly

- In Core pathway, dispatchable **clean thermal provides just the last 5-10% of energy** (but substantial capacity) to cover infrequent periods of extended renewable shortfall
- Cost is higher if <u>all</u> generation must be renewable (100% Renewable Generation, with no dispatchable clean thermal)
  - Large amounts of long-duration storage needed to cover infrequent renewable droughts
  - Much <u>additional</u> renewable generation is needed to charge it
  - These additional renewable and storage resources would be utilized infrequently

Electricity Capacity In New England
Core (with Thermal) vs 100% Renewable (No Thermal)



Key Policy Implications – Utilize Clean Fuels for Cost-Effective Decarbonization

Thermal Electricity Generation with Clean Fuel Facilitates High Renewable Penetration

- Maine's goal of 100% clean electricity by 2040 would be challenging and more costly if it relies solely on renewables and storage to meet all power needs, rather than augmenting with clean thermal generation for the last few percent
- A practical and cost-effective approach will **keep thermal generating capacity available, but operate it only sparingly** utilizing clean, carbon-neutral fuels (renewable natural gas, hydrogen, biodiesel) to maintain reliability during infrequent periods of low renewable output (e.g., the "last 5-10%")

Ensure that Fuels Become Cleaner with Time

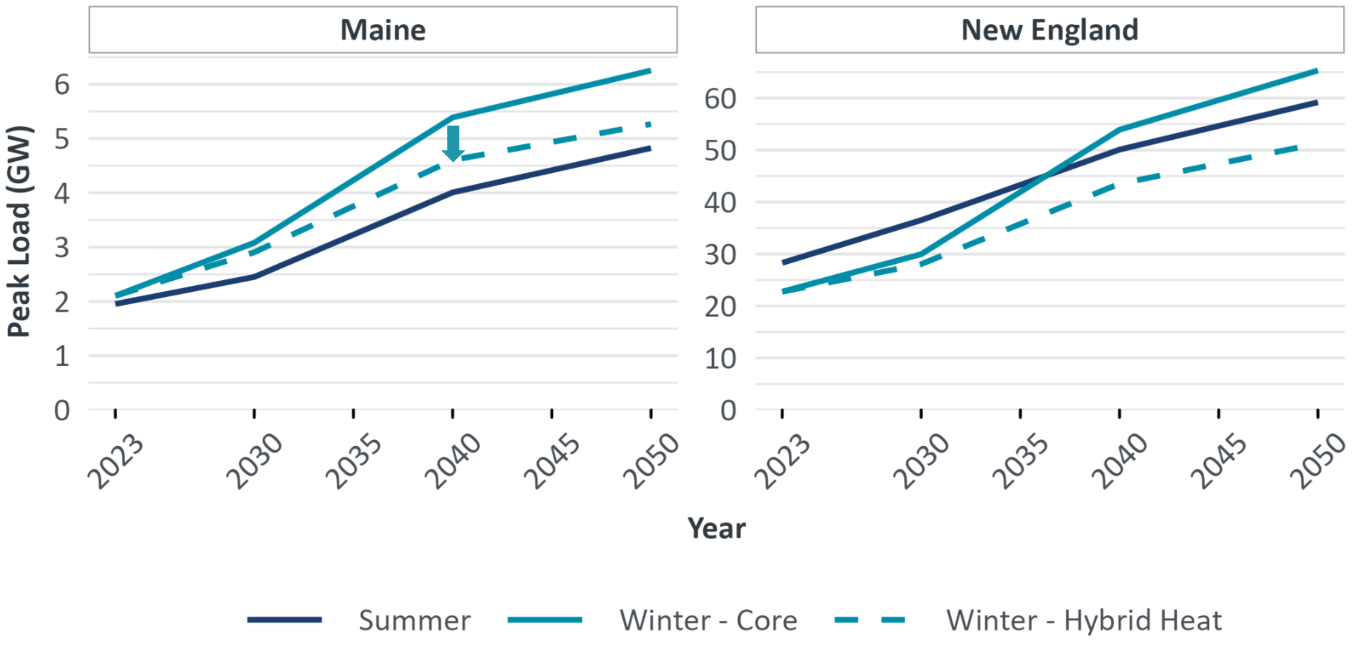
- Some fuels will still be needed (for electric reliability, hard-to-decarbonize sectors like heavy transport, hi-temp industrial processes); ensure that remaining fuels become cleaner over time
  - E.g., blending a rising share of clean fuels, to ensure emissions continue to fall even as some fuel use persists
- Clean fuels will have limited availability and will be costly, so must be used judiciously, where they are most valuable

Hybrid heating (heat pump with fuel backup) limits electric demand peaks

Continuing widespread heat pump adoption is critical. While heat pumps work well in cold conditions, backup fuel-fired heating (with low-carbon fuel) can limit winter electric demand peaks

- Lower peak could reduce electricity costs
- However, fueling, maintaining and replacing the fuel-fired systems would offset most of the electric cost savings
  - Also need enabling technology (not yet available) that co-optimizes electric/fuel operations, to avoid over-reliance on fuel
- Backup fuel could play a role in a phased transition
  - Initial partial electrification, followed by weatherization or expanded heat pump capacity to displace remaining fuel

Seasonal Electricity Peak, 2023-2050



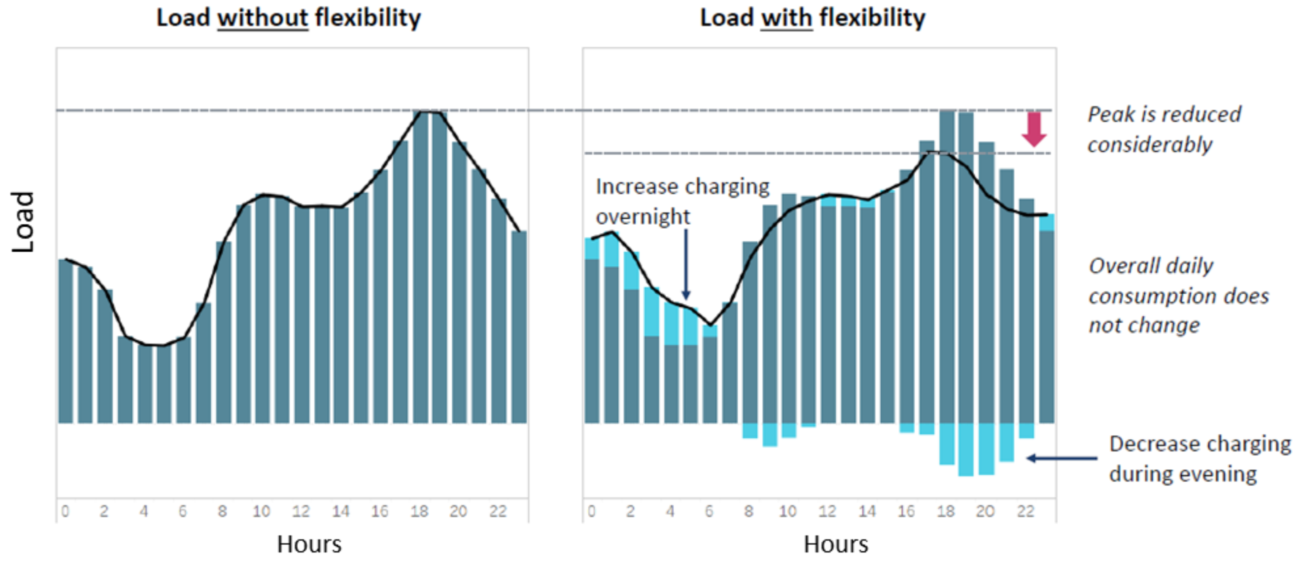
Note: Coincident peak electric loads in the summer and winter in the absence of load flexibility, grossed up 5% to account for line losses. Winter peaks for other pathways are the same as Core since underlying primary energy demand is the same. "Summer" peak is the same across all pathways, including Hybrid.

Flexible loads decrease electricity system peaks, and thus costs

Load flexibility can significantly reduce electricity demand peaks

- Flexibility comes predominantly from **shifting EV charging** schedules
  - EVs are a very large load, inherently flexible
- Flexibility helps control electric system peaks, **limiting T&D upgrades, generation, and storage needs**, and associated costs
- Absent load flexibility, electric peaks grow substantially
  - Higher peaks require more renewable and thermal generation, more storage, more transmission and distribution—increasing costs

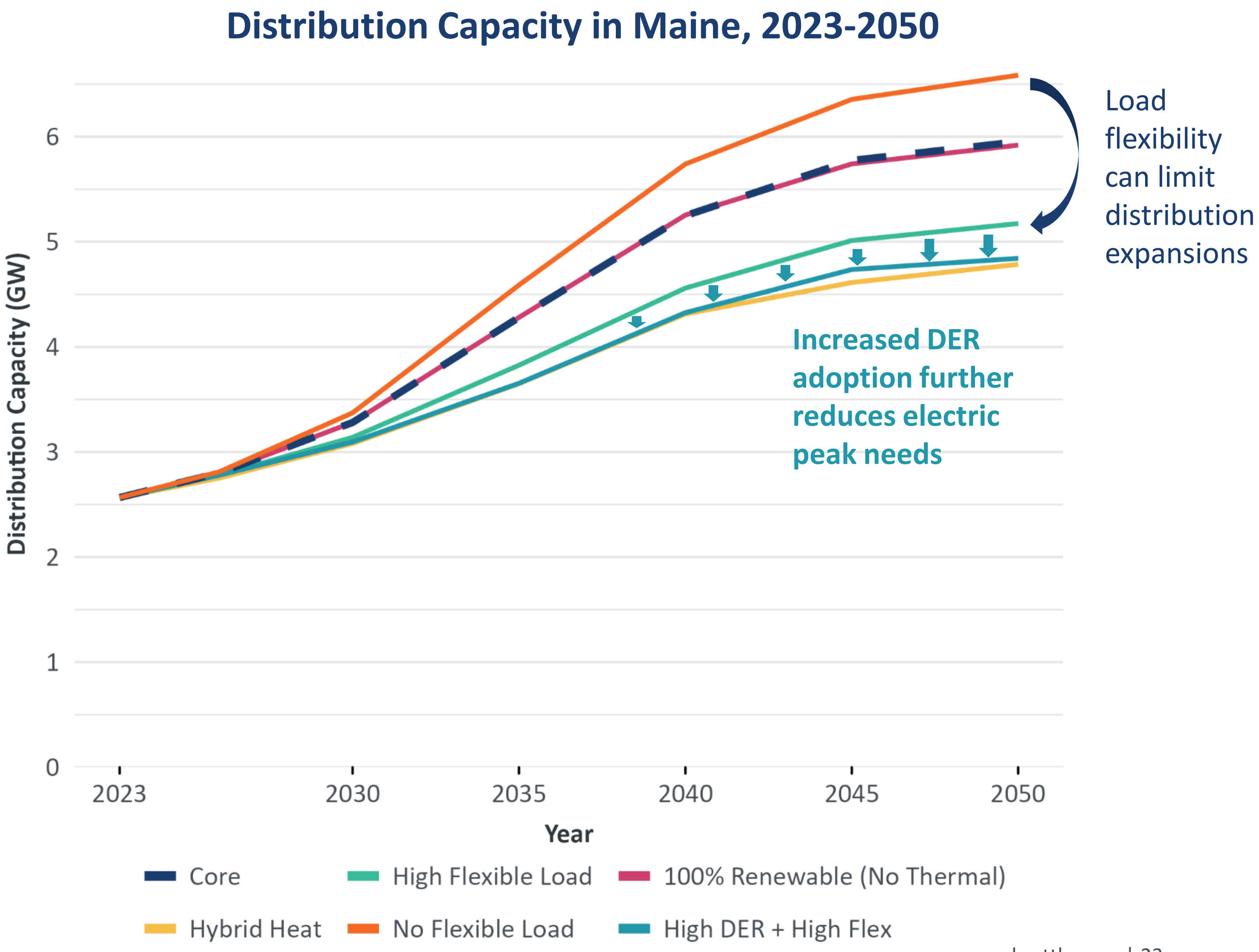
Load Flexibility: Electric Vehicle Charging



Distributed energy resources (DERs) further reduce system peak

Increasing adoption of DERs would further reduce electricity demand peaks and associated costs

- But the potential savings may be outweighed by the cost of the DERs themselves, if deployed widely
- Instead of deploying uniformly across the system, it will likely be more cost-effective to **target DER adoption in strategic locations** where they can defer or avoid distribution system upgrades



Key Policy Implications – Enable Flexible Load, Hybrid Heat to Manage Peak

Electrifying Transportation is Key to Cost Effective GHG Reductions and Electricity Grid Investment

- Electrifying transportation is essential since it directly **displaces motor fuels** and their GHG emissions; it also provides a **large amount of flexible load** that will help to integrate intermittent renewables
- Facilitating EV purchases and increasing **access to charging** in both urban and rural areas will be key

Load Flexibility is a Cost-Effective Approach to Reducing Peak Loads

- Implement **EV managed charging** programs and explore other opportunities for load flexibility, such as behind-the-meter storage, virtual power plants, demand response, and time-of-use rates
- Deploy **DERs in strategic locations** to defer or avoid distribution upgrades and reduce soft costs

Maximize Benefits from Heat Pumps While Managing System Peaks Through Flexibility

- The eventual balance of hybrid vs. fully electric heating need not be determined immediately; there may be **value in keeping options open** as technological progress and implementation challenges become clearer
- Implement tools such **as integrated controls for dual-fuel heating systems**, thermostat control programs, and innovative rate design to enable consumers to help manage system peaks

Key Policy Implications – Overarching Topics (1/2)

Consider Equity Impacts

- With approximately 121,000 customers in Maine qualifying for the Low-Income Assistance Program (LIAP), it is crucial to develop **policy mechanisms that minimize upfront costs for low-income customers**, to facilitate adoption and ensure equitable access to clean energy solutions
- Policy mechanisms could include income-qualified grants, low-cost financing, and information and technical assistance programs to help citizens understand the new technologies, their benefits and requirements

Address Barriers to Adoption

- Pathways assume customer adoption rates of decarbonization technologies, but barriers such as high initial cost of new equipment, customer unfamiliarity, and simple inertia could slow the pace. Consider **rebates and cost assistance**, and adopt a **managed transition** approach to home electrification
- Facilitate deployment of new generation by **streamlining siting and permitting**, and adopt a **long-term approach** for system upgrades rather than incremental expansions for each project

Key Policy Implications – Overarching Topics (2/2)

Invest in the Workforce Transition

- The energy transition will necessitate a **sizable workforce** to install and maintain the end-use and supply-side infrastructure needed for Maine's clean energy transformation
- Maine should create and continue to implement **programs offering career advice, training, on-the-job training, and coordination with local employers**. These can be administered by local colleges and technical schools, and could target vulnerable or disadvantaged populations where possible

Regional Coordination and Cooperation

- To achieve Maine's clean energy and GHG reduction goals, **regional coordination and cooperation** with other states and entities will be necessary—e.g., on issues including power system generation and transmission investments, power system operations, EV adoption, and heat pump adoption
- Regional coordination will be **essential to managing costs and ensuring reliability**, since many of these systems are regional in nature, and also because the greater scale of coordinated efforts will be more cost-effective

Key Policy Priorities

Electrification of heating and transport is key to achieving clean energy goals

Diverse resources including renewables, storage, and clean fuels enable cost-effective pathways

Define which energy resources qualify as "clean" (in addition to renewables) to facilitate meeting the last 5-10% of energy needs

Enabling load flexibility will help to limit infrastructure needs and thus manage electricity system costs

Q&A

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Thank You

Comments & questions: geo@maine.gov

Website: maine.gov/energy

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