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Carbon Pricing for New England

Joseph Cavicchi

NEPOOL Participants Committee Meeting
August 6, 2020

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Disclaimer

Much of the material presented herein is included in the Analysis Group, Inc. June 2020 report, Carbon Pricing for New England, Context, Key Factors, and Impacts. This report was prepared at the request of the New England Power Generators Association, but is an independent report by Joseph Cavicchi and Paul Hibbard of Analysis Group, Inc. and the report's analysis and conclusions reflect the independent judgment of the authors alone, and do not necessarily align with NEPGA or NEPGA's members.

The full report is available at: https://www.analysisgroup.com/Insights/publishing/carbon-pricing-for-new-england-context-key-factors-and-impacts/

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Overview

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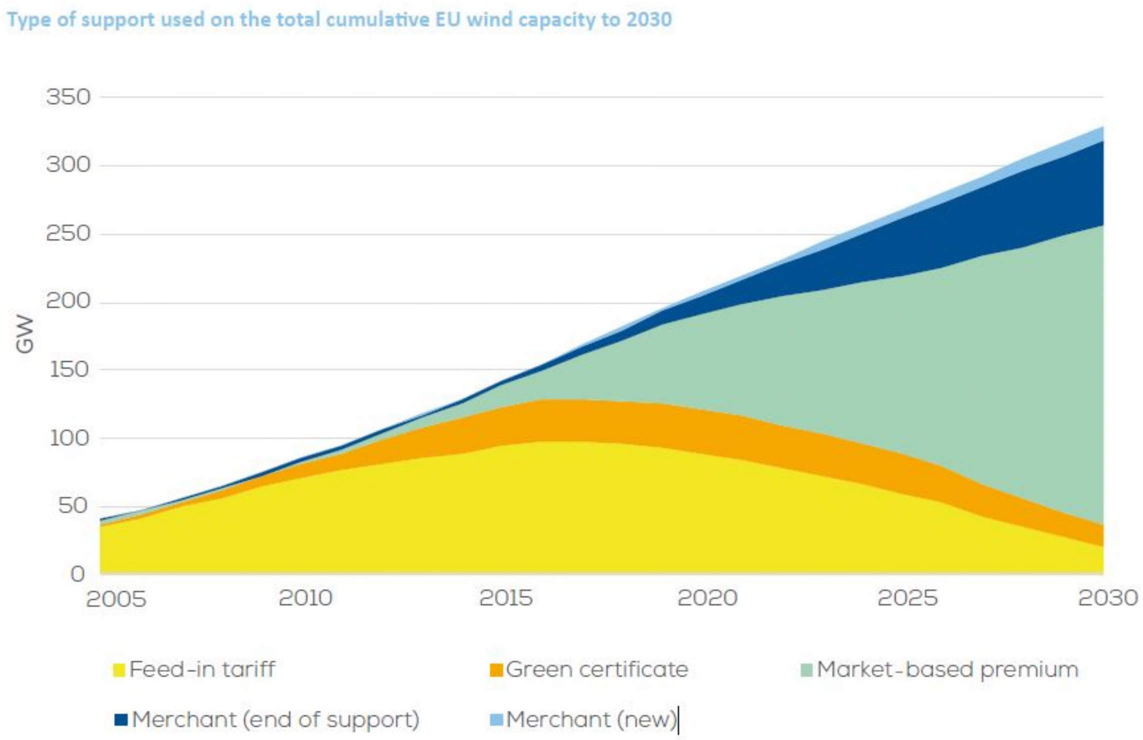
Experience with markets that include the cost of carbon is evolving:

- In western Europe state supported long-term renewable resource contracts are expiring over the next several years creating demand for innovative generation resource financial hedging arrangements that will become more important as renewable resource costs decline.



- Wind farms relying on feed-in premiums and contracts for differences will represent the majority of assets with almost 230 GW or 67% of the total European capacity. This capacity will be partially exposed to the market.
- In 2030 fully market-exposed wind capacity could represent 90 GW, most of it being older projects no longer receiving financial support.

Source: WindEurope, The value of hedging: New approaches to managing wind energy resource risk, November 2017.

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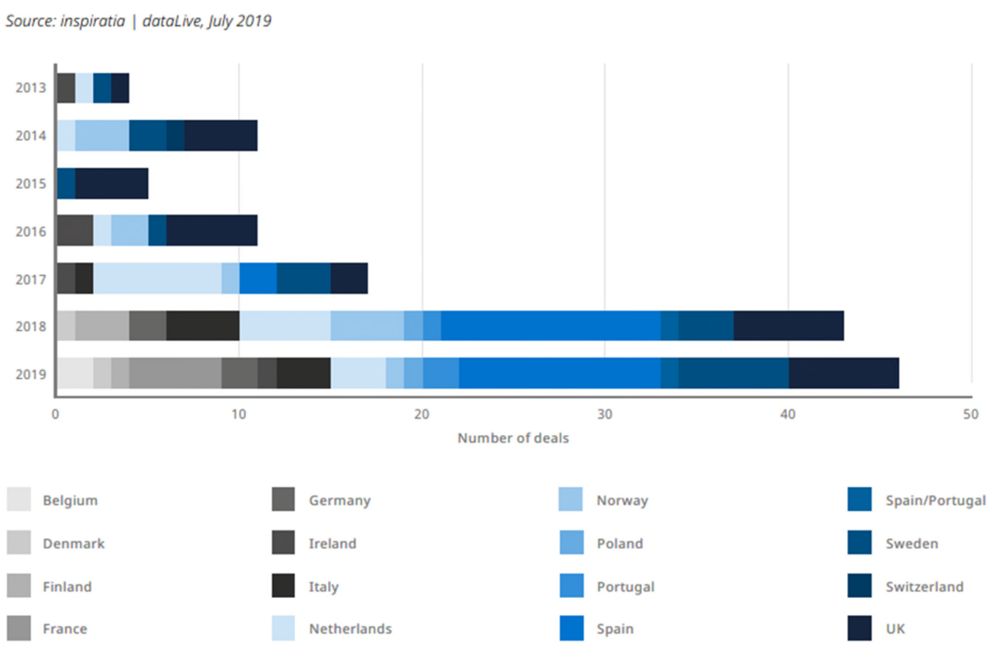
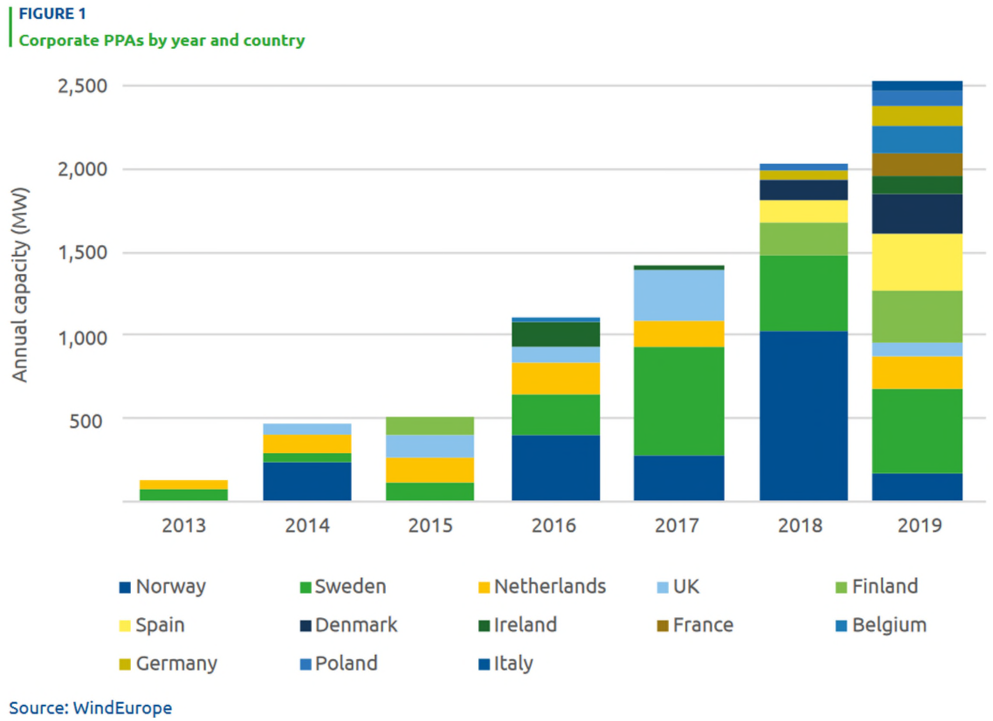
Experience with markets that include the cost of carbon is evolving:

- Similar to the US, corporate PPAs that provide innovative generation resource financial hedging arrangements are becoming more important as renewable resource costs decline.





Sources: Europe's Subsidy-free Transition – The Road to Grid Parity, DLA PIPER, December 2019.
Introduction to Corporate Sourcing of Renewable Electricity in Europe, Re-Source, January 2020.

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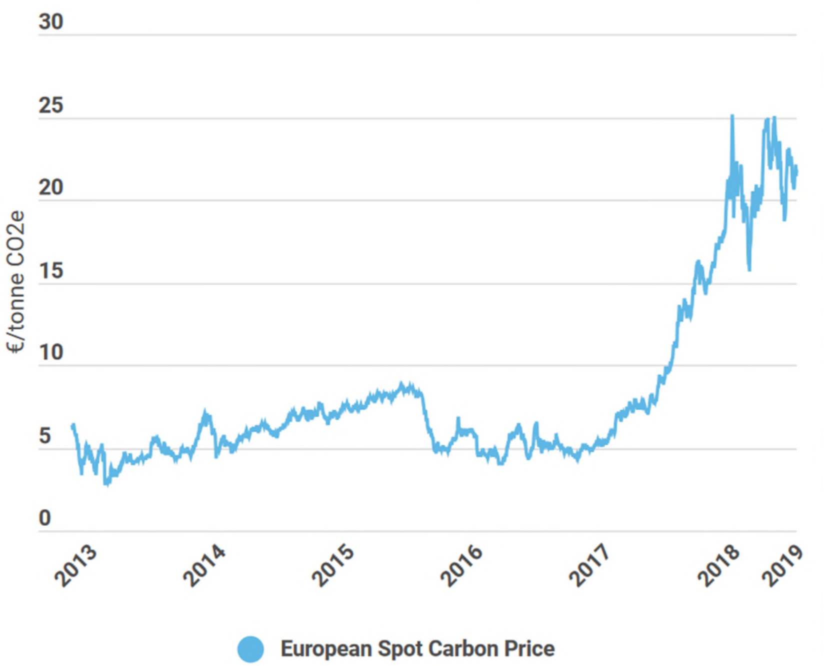
Experience with markets that include the cost of carbon is evolving:

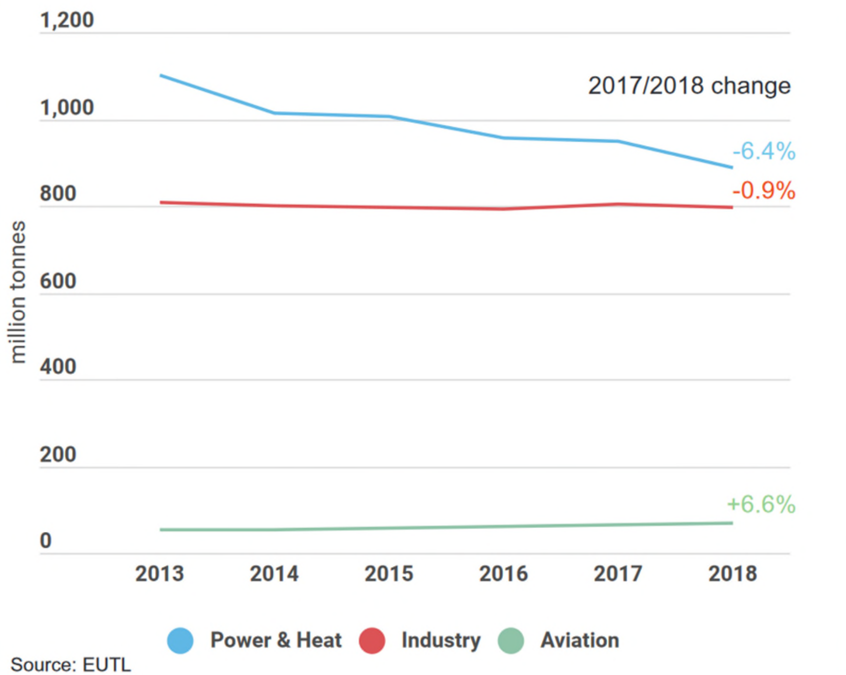
- Increased recognition that carbon pricing levels must be high enough to incentivize efficient decision making and support innovation.

FIG 1: PRICE DEVELOPMENT IN THE EU ETS SINCE JANUARY 2013



Source: Intercontinental Exchange (ICE)

FIG 2: EU ETS EMISSIONS, 2013-2018



Source: EUTL

Source: Mazzoni, M., Ruf, P., The European Carbon Market: The Impact of Higher Carbon Prices on Utilities and Industries, ICIS, May 2019.

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AG Report: Key Findings

- Achieving greenhouse gas emission (GHG) reductions on the trajectory envisioned by New England states requires significant growth in the use of electricity for transportation and heating.
- An effective multi-sector price on carbon can help guide the region through a challenging transformation:
  - Provides appropriate price signals to energy consumers that allows for a more accurate assessment of the trade-offs when assessing electricity as a fuel for transportation and heating as opposed to fossil fuels.
  - Signals to investors in low and zero-emission technologies a commitment to incorporate the social costs of continued reliance on fossil fuels.
  - Allows for technology-neutral competition among both existing and new zero-emission resources in the electric sector, providing incentives to minimize costs and pursue innovation.
  - Provides a platform for private investments in innovative approaches to reduce GHG emissions.
  - Reduces incentives for future state directed investments in zero-emission resources.
  - Avoids the potential for stranded investment costs that can result when long-term contract prices are likely to no longer be economic.
- A progressively increasing price on CO_2 emissions that falls in a range of $25–35/short ton CO_2 in 2025 and $55–70/short ton CO_2 in 2030 and 2035 can support market-based investment in clean-energy technologies going forward.

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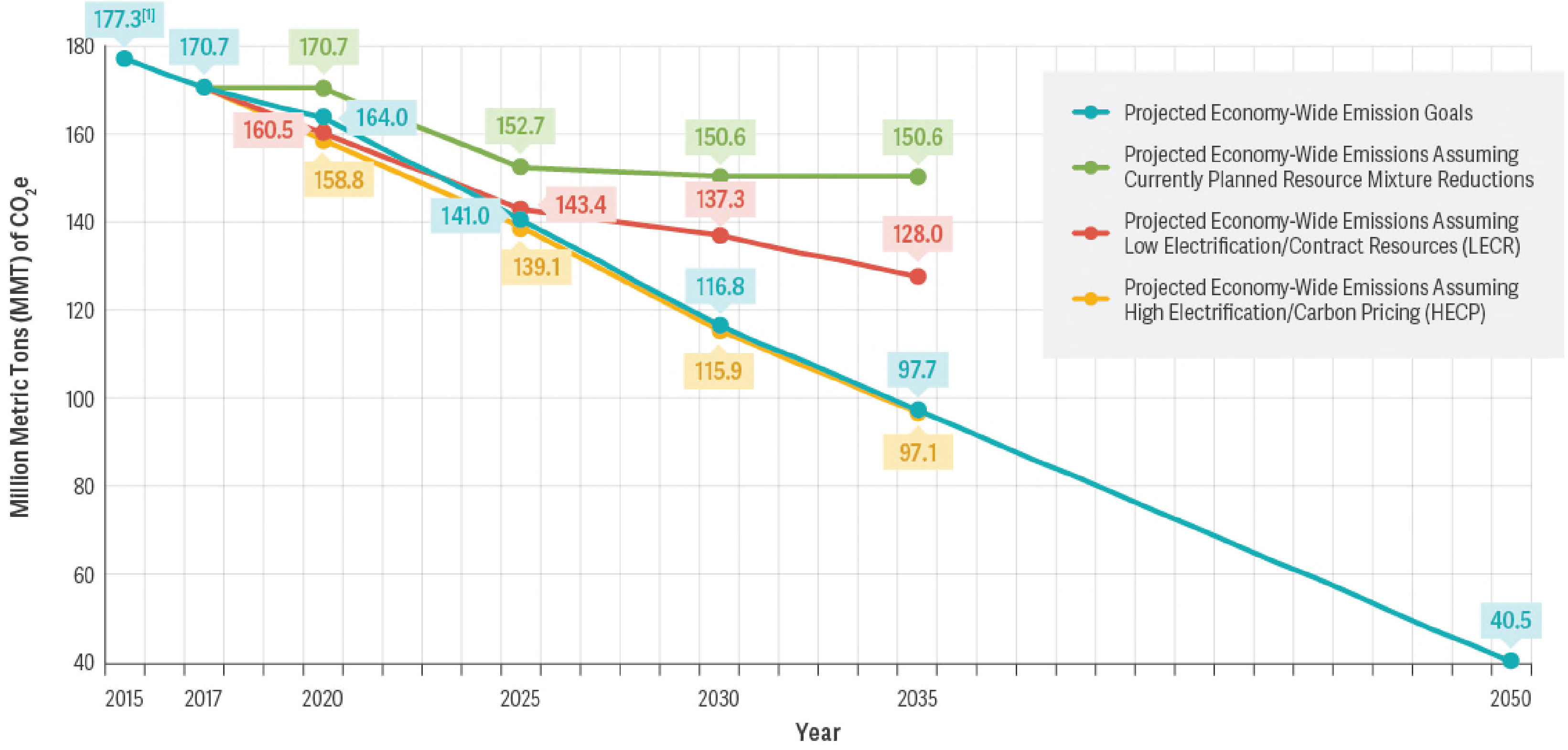
AG Report: Key Findings

New England Emission Reduction Standards Compared with Power Sector Emission Reductions from Currently Planned Renewable Resource Additions and Increased Electrification



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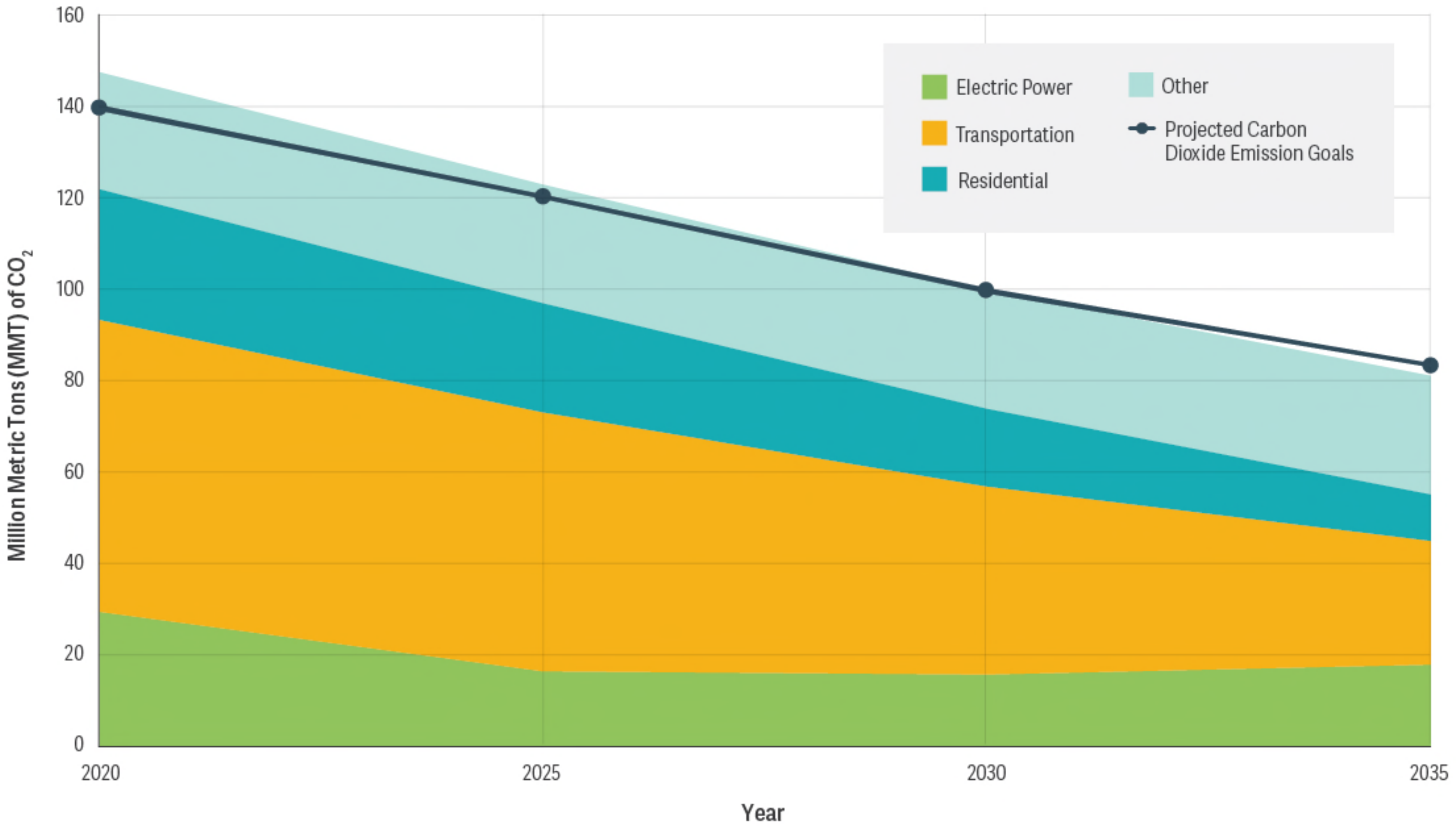
Projected CO2 Emissions Changes by Sector: High Electrification



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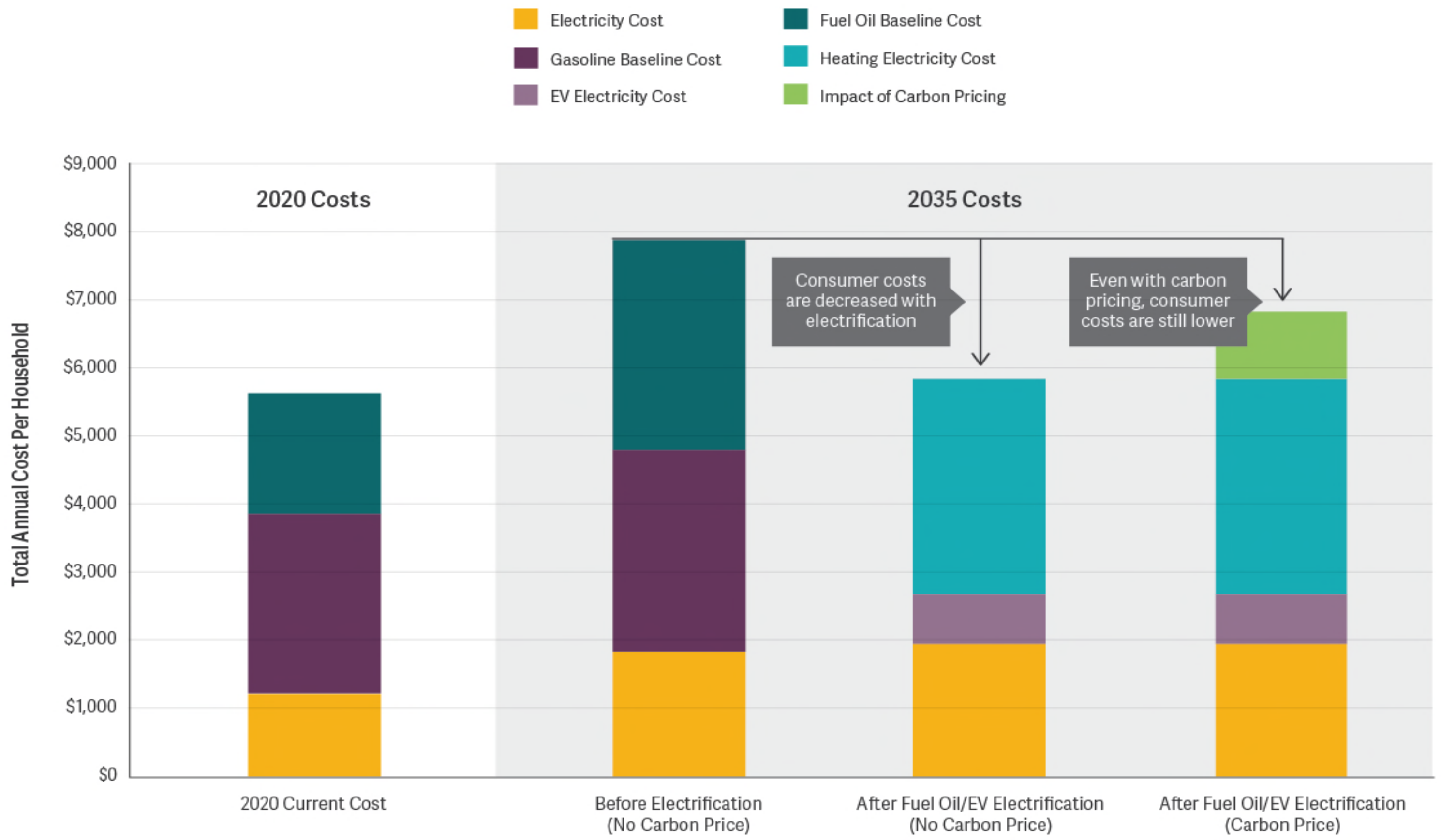
Estimated Average Annual Consumer Energy Costs for Households that Adopt Electric Vehicles and Convert Home Heating System from Fuel Oil to Electric Heat Pumps



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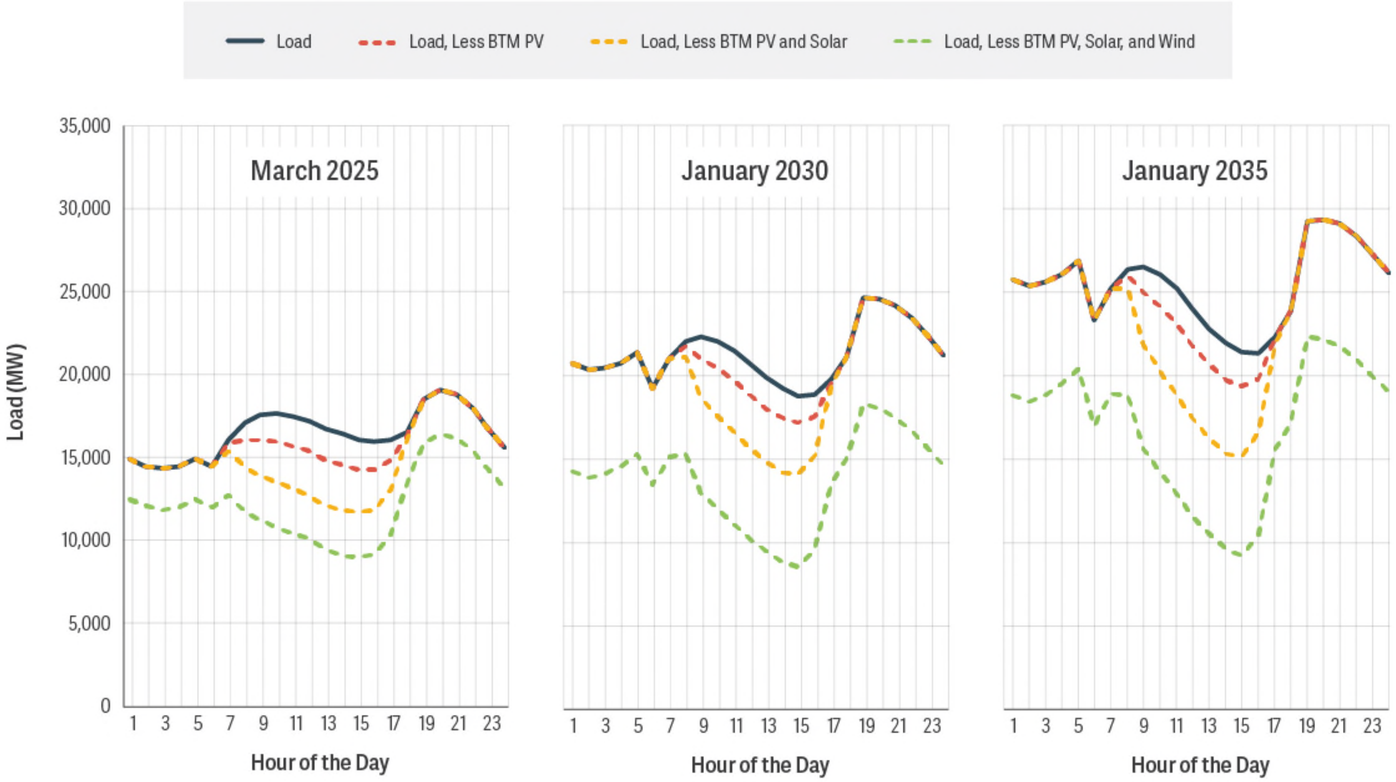
AG Report: Key Findings

Average Ramp-Ups for the Month that the Peak Ramp Occurs – High Electrification (HECP) Winter



Note:
[1] The reported months are those in which the maximum ramp-up net of renewables occurs.

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Implementation: The Pathway to Efficient Decarbonization

- The pathway will be the most important driver of the cost, technological, and reliability challenges customers and industry stakeholders face. The transformation will:
  - Require investments in transportation, heating, and power system infrastructure
  - Accelerate the development and commercialization of a wide array of energy-related technologies and services.
  - Change the location, size, fuel needs, and operational characteristics of the power supply infrastructure.
- The implementation of an effective multi-sector price on carbon can help guide the transformation:
  - The key considerations associated with the introduction of a multi-sector carbon price are well understood.
  - Regional agreement is critical to develop a framework upon which carbon prices can be established.
  - The disposition of the carbon revenues requires careful evaluation.
- New England’s GHG reduction objectives can be met more efficiently with effective multi-sector carbon pricing.

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AG Report: Methodology

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Analytic Method

- **Production Cost Modeling:** Use of production cost model to simulate the operation of the New England power system for 2025, 2030, and 2035 and identify the carbon price.
- **Base Case and Resource Mixture:** Existing and expected energy demand, supply resources, unit retirements, and unit operational characteristics are consistent with recent analyses of the New England Independent System Operator (ISO-NE). Generating resources include offshore wind generation projects that have received regulatory approval and additions envisioned in current state law/policy.
- **Electrification:** Hourly load profile is modified to reflect increased electricity demand.
  - High Electrification (HECP): assumes up to (1) 25% (2025), 60% (2030), and 90% (2035) of consumers driving light-duty vehicles (LDVs) switch to electric vehicles; and (2) 25% (2025), 50% (2030), and 75% (2035) of residential homes currently heating with oil, propane, or natural gas switch to electric heat.
  - Low Electrification (LECR): assumes up to (1) 25% (2025), 35% (2030), and 60% (2035) of consumers driving light-duty vehicles (LDVs) switch to electric vehicles; and (2) 12.5% (2025), 17.5% (2035), and 30% (2035) of residential homes currently heating with oil, propane, or natural gas switch to electric heat.

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Modeled Resource Mixture

	Low Electrification/Contract Resources (LECR)			High Electrification/Carbon Pricing (HECP)		
	2025	2030	2035	2025	2030	2035
Existing Derated Capacity After Retirements (Excludes BTM PV)	28,818	29,895	30,923	28,818	30,465	32,543
Assumed Additions (Derated Capacity)						
Solar Additions	7	115	0	577	685	570
Battery Storage Additions	50	250	700	50	250	2200
Onshore Wind Additions	0	182	0	0	182	182
Additional Renewable Resources Distant from Load	0	0	0	0	0	1090
Offshore Wind Additions	1020	480	0	1020	960	0
Installed Capacity (Derated Capacity)	**29,895**	**30,923**	**31,623**	**30,465**	**32,543**	**36,585**
Imports	1,188	1,188	1,188	1,188	1,188	1,188
Total Capacity	**31,083**	**32,110**	**32,810**	**31,653**	**33,730**	**37,772**
Assumed Behind-the-Meter PV and Energy Efficiency						
Behind-the-Meter PV	950	1,183	1,392	950	1,183	1,392
Energy Efficiency in Peak Hour	5,519	6,725	8,477	5,982	8,292	10,311

Notes:

[1] Capacity represents the total existing capacity at the start of each year prior to adding additional resources. Onshore wind, offshore wind, and solar capacity is derated at factors of 26%, 30%, and 28.5%, respectively. For additional detail, see source [B].

[2] Existing capacity as of 2025 includes approved renewable resource additions and expected or at-risk unit retirements of approximately 5,500 MW of capacity of aging coal-, oil- and gas-fired generation stations.

[3] Between 2019 and 2025, 5,238 MW of capacity is expected to come online. These additions include approved offshore wind, the Canadian Interconnection, and others.

[4] Import capacity is obtained from the 2019 CELT Report.

[5] The *2016 Act to Promote Energy Diversity* directed Massachusetts electricity distribution companies to procure 1,600 MW of offshore wind by 2027. In May 2018, it was announced that the 800 MW Vineyard Wind project had been selected. The *2018 Act to Advance Clean Energy* authorizes state officials to procure an additional 1,600 MW by 2035. See sources [C], [D], and [E].

[6] In June of 2019, the Connecticut state government passed *An Act Concerning the Procurement of Energy Derived from Offshore Wind* which enabled the Commissioner of Energy and Environmental Protection to issue solicitations totaling up to 2,000 MW. All 2,000 MW must be reached by the end of 2030. See sources [C], [F]

[7] In 2018, Rhode Island issued an RFP for 400 MW of offshore wind. In May 2018 it was announced they had selected Deepwater Wind's 400 MW Revolution Wind Project. See sources [C], [G].

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Electrification Assumptions & Methodology

- **Electric Vehicles:**
  - Assumed EV market share increase according to electrification scenarios.
  - Assumed the increased electricity demand is allocated equally to all 365 days in the year
  - Assumed battery charging concentrated in the overnight hours (75 percent between 6 PM – 5 AM and 25 percent between 5 AM – 6PM).
- **Heating Electrification:**
  - Assumed electric heating market share increase according to electrification scenarios.
  - Allocate the annual increase in electricity consumption to the daily level based on a representative weather year, consistent with that assumed in the model.
  - The increase in daily electricity demand is distributed geographically based on a ratio of potential switching household in each ISO-NE zone to the total potential switching households.
  - The daily increase is allocated using an estimated New England daily heating load profile from Electric Power Research Institute.

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AG Report: Detailed Modeling Results

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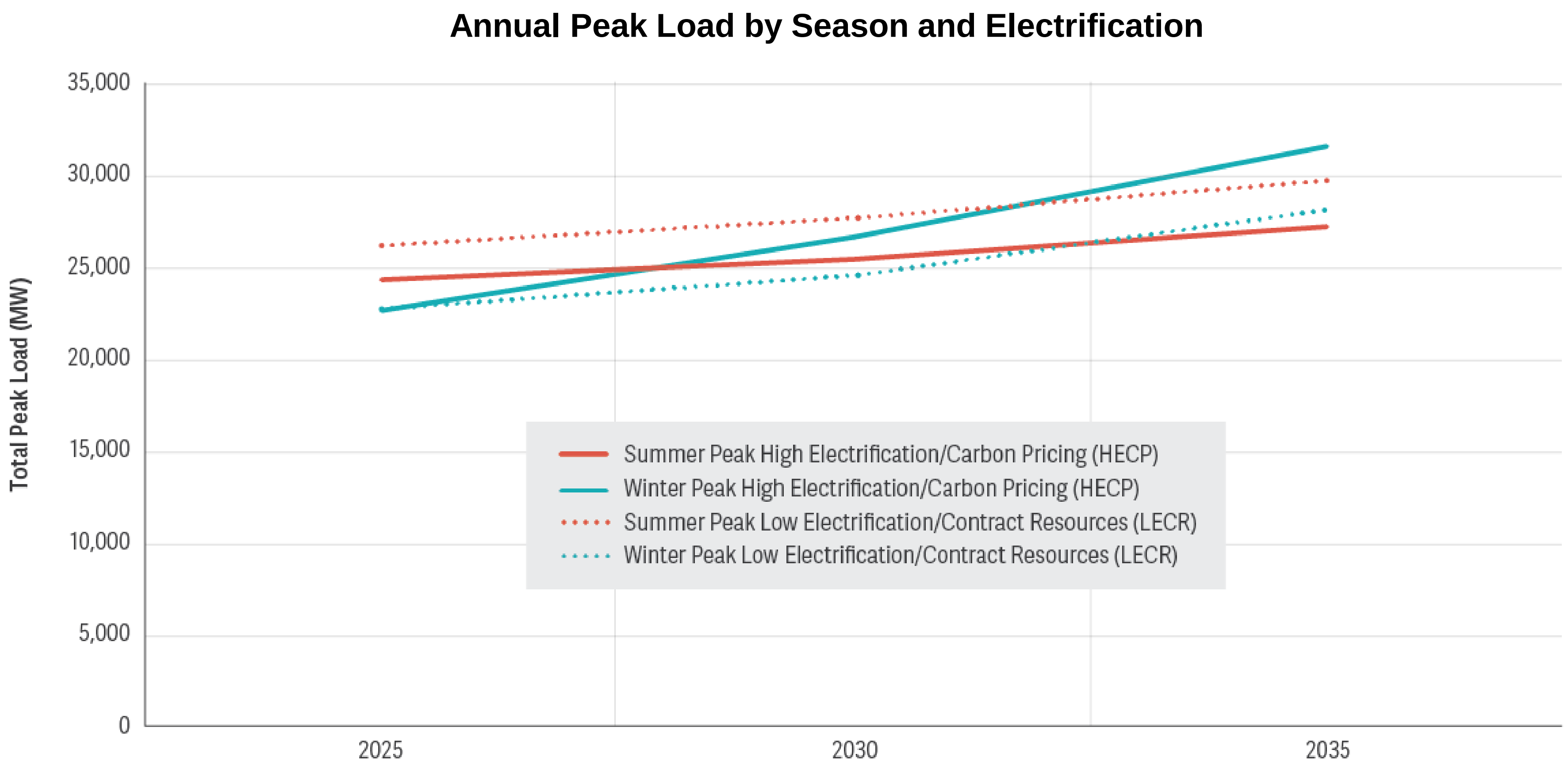
The Growth in the Winter Peak Demand Is Substantial



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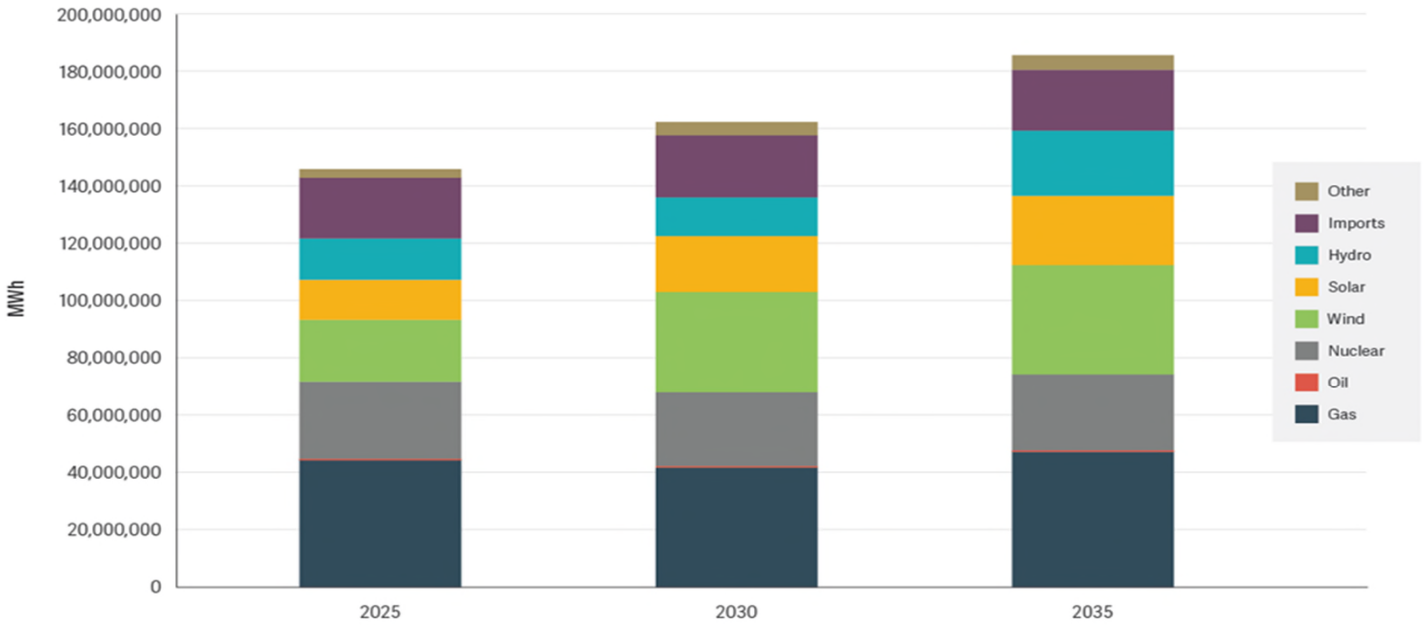
Significant Growth In Renewable Resources Needed to Support Region's Objectives

Generation Mixture – High Electrification (HECP)



Notes:

[1] Imports = Imports between ISO-NE and HQ, independent of the New England Clean Energy Connect contract and imports/exports between ISO-NE and NYISO and NB. The NECEC contract appears in the Hydro category; Other = landfill gas, biomass, refuse. Solar includes both utility-scale and behind-the-meter.

[2] The HECP scenario assumes 25% (2025), 50% (2030), and 75% (2035) of residential homes currently heating with gas, oil, or propane switch to electric heating and 25% (2025), 60% (2030), and 90% (2035) of consumers driving light-duty vehicles switch to electric vehicles. It also assumes additional EE (25% increase over assumed 2035 EE) and adds additional storage and zero-emission resources needed to accommodate increased electrification and maintain New England's progress towards meeting its carbon reduction standard. Finally, it adds a $25/short ton price on carbon in 2025, $65/short ton in 2030, and $70/short ton in 2035.

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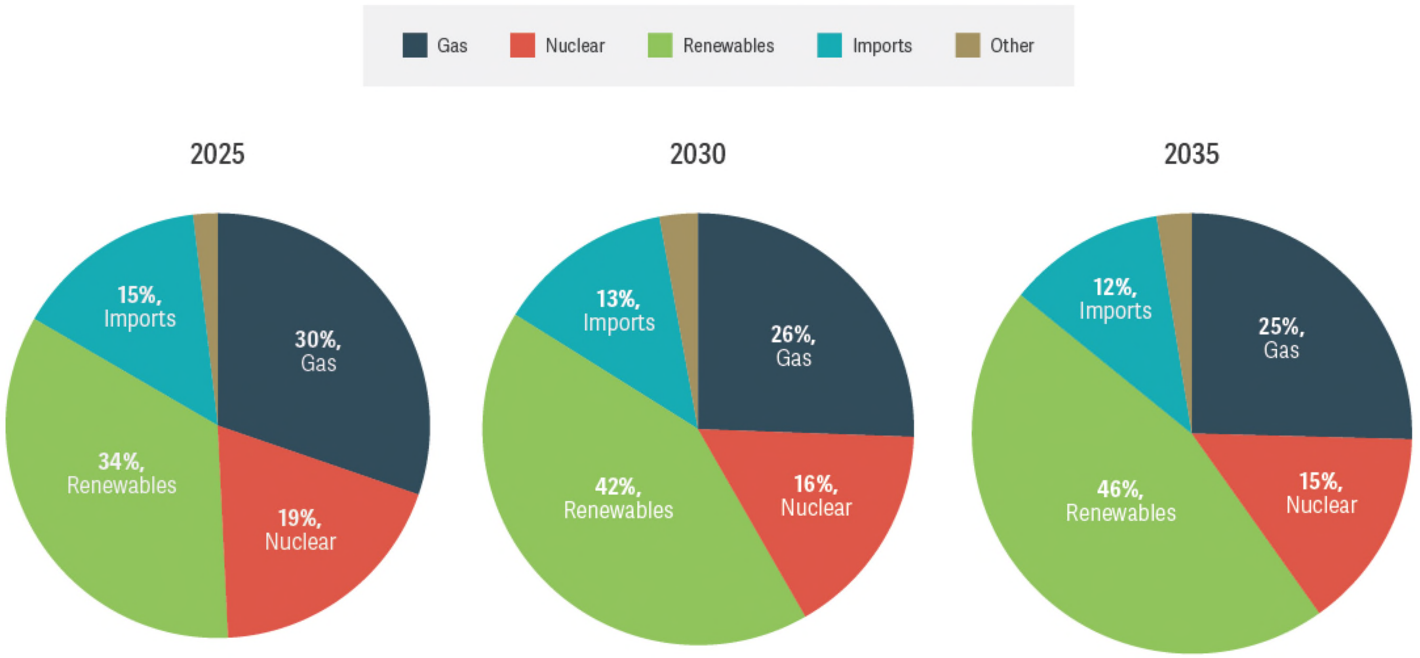
Generation Mixture – High Electrification (HECP)



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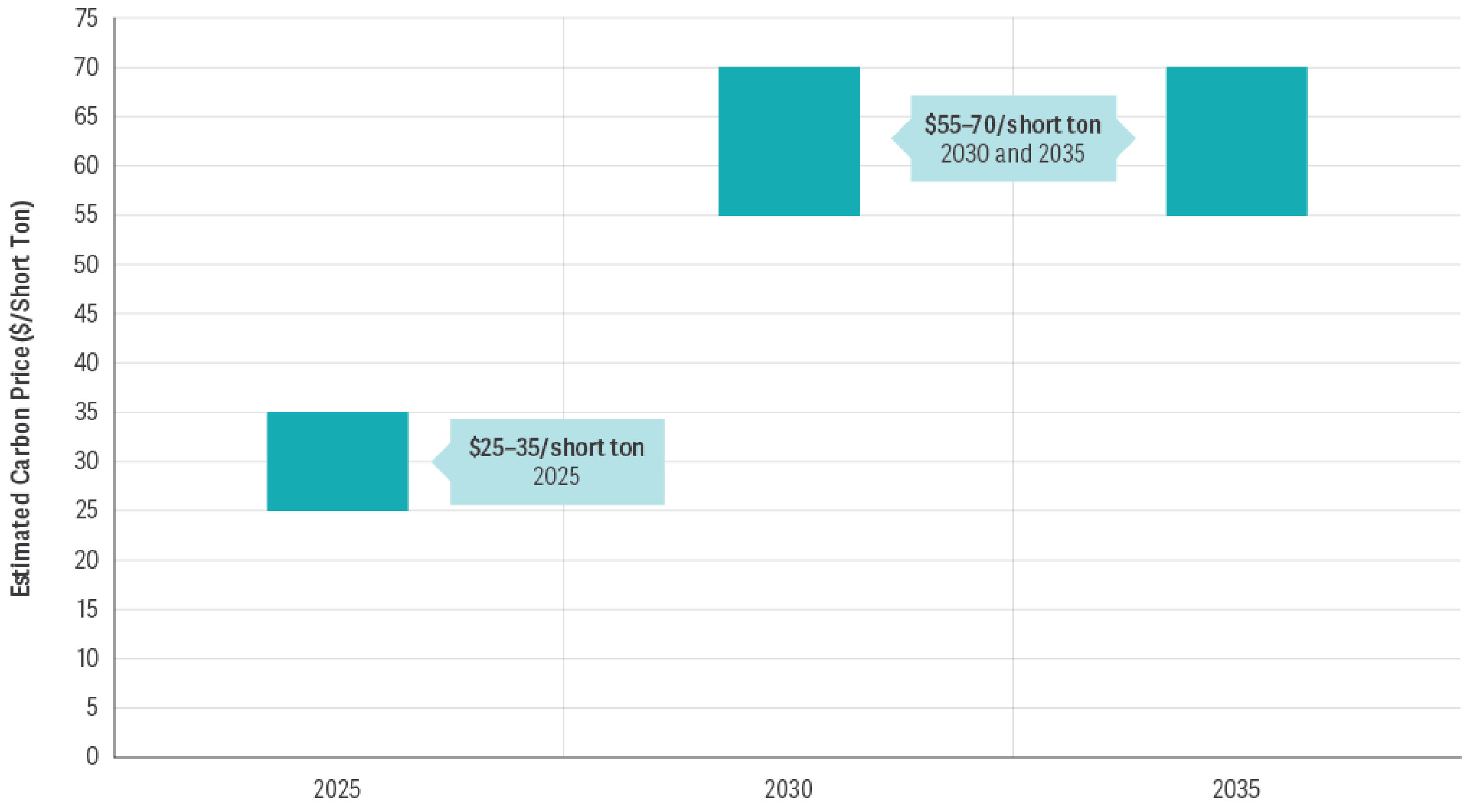
A progressively increasing price on emissions of CO_2 can support future investment in renewable resources



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A progressively increasing price on emissions of CO_2 can support future investment in renewable resources

- To meet projected GHG reductions in 2030 and 2035, additional offshore wind and/or renewable resources distant from consumer loads are necessary:
  - Resources require higher CO_2 emissions price to be viable without subsidies.
  - Wide range in carbon pricing reflects uncertainty in the costs for more advanced renewable resources.
- CO_2 pricing improves the efficiency of the wholesale markets:
  - Spurs innovation.
  - Minimizes consumer cost.
  - Reliably addresses the rapid rising electricity demand associated with electrification.
- Residual carbon revenues can be returned to consumers using approaches that maintain the benefits of the price signals and while diminishing the financial impacts.

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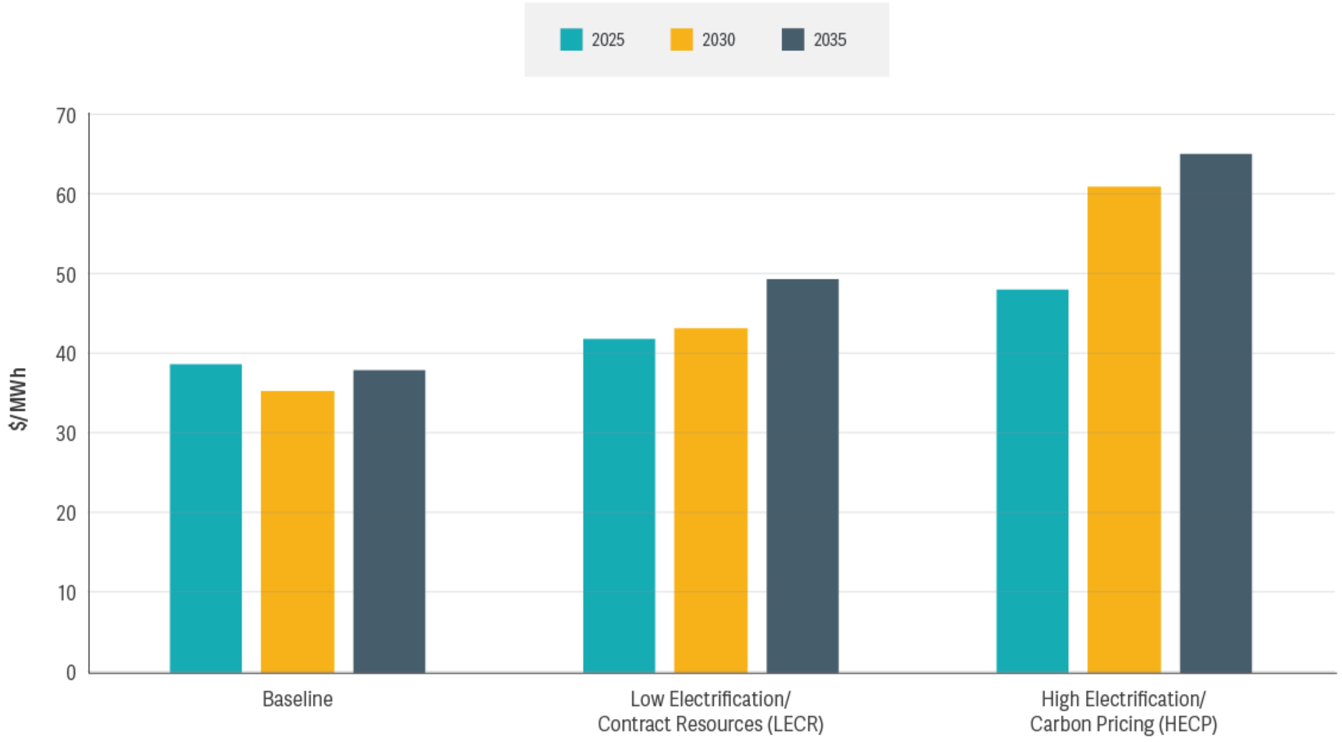
Carbon pricing impact on projected wholesale energy prices

**Projected Annual ISO-NE Locational Marginal Prices (LMPs)
Assuming a Carbon Price**



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Additional Observations

- Addition of several thousand megawatts of large-scale renewable resources will put downward pressure on wholesale energy prices as the frequency of zero-price energy hours grows.
  - Risks longer-term financial prospects for the increased quantities of renewable resources.
- With technological evolution, the risk of contracting with resources that appear uneconomic grows.
  - Could lead to increased costs for consumers.
- The commitment to a durable market attribute that appropriately incorporates the cost of carbon allows all resources to compete and ensures not only that zero-emission resources are compensated equitably, but that all other resources whose production is needed to ensure reliable system operations are compensated equitably.
- Consumers can be expected to respond to price signals and adopt new technologies to minimize costs as electricity becomes a more significant part of the monthly budget.

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Additional Observations

- Replacing considerably more of the remaining fossil fuel resource output with off-shore wind and battery storage would not readily eliminate the region’s reliance on fossil fuel resources.
- The impact of increased additions of off-shore wind and battery storage resources requires:
  - Recognition that there can be multi-day periods of sustained reduced renewable generation where load will likely be met by dispatchable gas resources
  - Battery charge/discharge patterns that need to accommodate multi-day system operational needs.
  - Consistent operation of the most efficient gas-fired resources with more capacity operating in the winter and spring seasons.

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Implementation: The Pathway to Efficient Decarbonization

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The implementation of an effective multi-sector price on carbon can help guide the transformation

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