AESC 2024

Presentation of Results

Updated February 12, 2024

Synapse Team

Using this document

- This document summarizes the methodologies and findings in the AESC 2024 Study.
- Much more information and detail is available in the AESC 2024 Study report itself.
- All materials relevant to AESC 2024 can be found online at https://www.synapse-energy.com/aesc-2024-materials.
- Figures and tables throughout this document utilize the numbering in the AESC 2024 Study report for cross-referencing purposes.
- Note: This document is an updated version of the one posted on February 7, 2024. It contains additional information from the AESC 2024 report as well as minor corrections to text.

Authors of the AESC 2024 Study include Synapse Energy Economics, Sustainable Energy Advantage, Northside Energy, Les Deman Consulting, and Resource Insight.

Outline

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2. Chapter results
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1. Main findings

Table 2. Illustrative avoided costs for hypothetical energy efficiency measure installed in Massachusetts, AESC 2024 Counterfactual #1 versus AESC 2021 Counterfactual #1

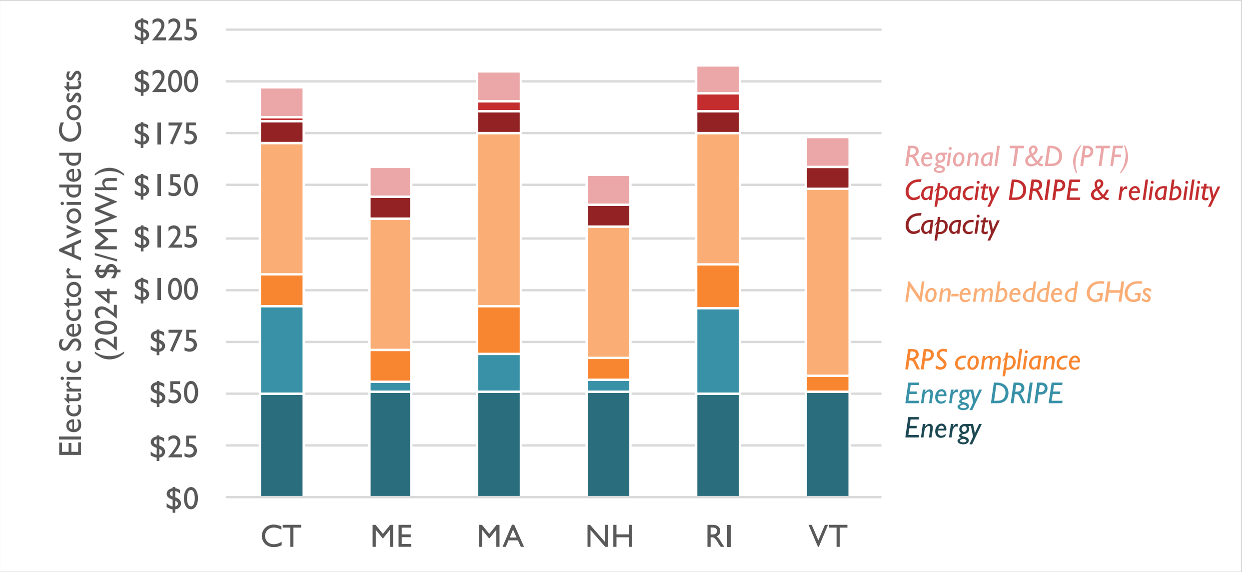
		AESC 2021	AESC 2024	Differ-ence	% Differ-ence	Notes
Energy	*2024 $/MWh*	$46	$50	$4	9%	*4*
RPS compliance	*2024 $/MWh*	$12	$23	$10	85%	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$13	$19	$6	42%	*6*
GHG non-embedded	*2024 $/MWh*	$51	$83-143	$32-92	63-180%	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$123**	**$175-235**	**$52-112**	**43-91%**	
Capacity	*2024 $/kW-year*	$48	$53	$6	12%	*9*
Capacity DRIPE	*2024 $/kW-year*	$19	$24	$5	27%	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$95	$69	-$26	-28%	*11*
Value of reliability	*2024 $/kW-year*	$1	<$1	<-$1	-55%	*9*
Capacity subtotal	***2024 $/kW-year***	**$162**	**$146**	**-$16**	**-10%**	-
Capacity subtotal	***2024 $/MWh***	**$33**	**$30**	**-$3**	**-10%**	*12*
Total	***2024 $/MWh***	**$156**	**$205-265**	**$49-109**	**32-70%**	-

All values are 15-year levelized costs.
For states that use a social cost of carbon, a 2% discount rate is used for this illustrative example. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

- This illustrative table only shows values for Massachusetts, using the historical Massachusetts tabulation of avoided costs. See Slide 6 for notes.
- The following slides summarize results for more counterfactuals and all states.
- **Energy** costs in AESC 2024 are higher due to increases in near-term gas prices and deferral of zero-marginal-cost clean energy resources, relative to AESC 2021.
  - **Energy DRIPE** trends follow energy cost trends for the same reasons.
- **RPS compliance** costs are higher due to increased RPS stringencies and increased technology costs.
- **GHG non-embedded** values are higher due to updated estimates of the social cost of greenhouse gases (SC-GHG).
  - In this illustrative example, non-embedded GHG costs focus on an SC-GHG and use a discount rate of 2%.
  - The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.
- **Capacity** costs are similar, despite a shifting market structure beginning in 2028.
  - **Capacity DRIPE** values are higher due to a change in methodology for this illustrative table. MA values are now weighted across all MA regions, which includes some price-separated regions in some early years, with very large DRIPE values.
- **Regional transmission (PTF)** costs are lower due to a change in primary reference source.

1. Main findings

Figure 1. Illustrative application of AESC 2024 wholesale avoided costs (Counterfactual #1) to a hypothetical energy efficiency measure



- This is a mockup with **<u>illustrative</u>** numbers that shows the avoided cost variations across states, using an illustrative energy efficiency measure. Cost tabulations are based on methods used in previous years and are not necessarily predictive of what will be used in future years.
- Key differences among state results:
  - Different states use different non-embedded GHG costs (SCC, MAC) or different methodologies. Social cost of GHGs is based on a 2% discount rate in this illustrative example.
  - States count DRIPE differently (CT and RI include regional DRIPE; MA, ME, and NH include in-state DRIPE only, and VT doesn't include any DRIPE).
  - Some states (RI, MA, others) are subject to regionally separated capacity prices in some of the near-term years.

1. Main findings, across counterfactuals

	Counterfactual #1 “AESC Classic”: Avoided costs for EE, ADM, and building electrification	**Counterfactual #2** Avoided costs for building electrification only	**Counterfactual #3** Avoided costs for EE only	**Counterfactual #4** Avoided costs for DR and BTM Storage only	**Counterfactual #5** All-in DERs	**Counterfactual #6** Avoided costs for BTM Storage only: Programmatic *and* non-programmatic measures	**Sensitivity #1** High Gas Price *(sensitivity on Counterfactual #1)*	**Sensitivity #2** Increased Clean Electricity *(sensitivity on Counterfactual #5)*
Energy Efficiency	*No*	Yes	*No*	Yes	Yes	Yes	*No*	Yes
Building Electrification	*No*	*No*	Yes	Yes	Yes	Yes	*No*	Yes
Demand Response	*No*	Yes	Yes	*No*	Yes	Yes	*No*	Yes
BTM Storage	*No*	Yes	Yes	*No*	Yes	*No (Programmatic and non-programmatic)*	*No*	Yes
Transportation Electrification	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distributed Generation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transitions to winter peaking in study period?	*No*	*No*	Yes (mid-2030s)	Yes (mid-2030s)	Yes (mid-2030s)	Yes (mid-2030s)	*No*	Yes (mid-2030s)
RPS and other renewable policies	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7	As described in Chapter 7, plus an IRCEP policy described in Chapter 12

Notes: A “Yes” indicates that the relevant DSM component is included (e.g., modeled) within that counterfactual. A “No” indicates that the DSM component is not incorporated into the modeling in 2024 or any future year. Unless otherwise stated, a “No” only removes the programmatic resources associated with each DSM component (e.g., energy efficiency associated with codes and standards is modeled in all scenarios, as is storage or demand response owned or funded by entities other than program administrators). The “IRCEP” policy is described in detail in Chapter 12: Sensitivity Analysis.

1. Main findings, across counterfactuals

ES-Table 3. Illustrative avoided costs for hypothetical energy efficiency measure installed in Massachusetts, all AESC 2024 counterfactuals

		CF #1	CF #2	CF#3	CF#4	CF#5	CF#6	S#1	S#2	Notes
Energy	*2024 $/MWh*	$50	$47	$51	$51	$50	$50	$61	$45	*4*
RPS compliance	*2024 $/MWh*	$23	$23	$24	$22	$23	$23	$22	$23	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$19	$18	$19	$19	$19	$19	$21	$18	*6*
GHG non-embedded	*2024 $/MWh*	$83-143	$83-143	$83-143	$83-143	$83-143	$83-143	$83-143	$83-143	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$175-235**	**$171-231**	**$177-237**	**$176-236**	**$175-235**	**$175-234**	**$187-246**	**$169-229**	
Capacity	*2024 $/kW-year*	$53	$40	$40	$56	$49	$59	$56	$34	*9*
Capacity DRIPE	*2024 $/kW-year*	$24	$25	$24	$48	$31	$73	$23	$31	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	$69	$69	-
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$146**	**$133**	**$134**	**$174**	**$149**	**$201**	**$149**	**$133**	-
Capacity subtotal	***2024 $/MWh***	**$30**	**$27**	**$27**	**$35**	**$30**	**$41**	**$30**	**$27**	*11*
Total	***2024 $/MWh***	**$205-265**	**$198-258**	**$204-264**	**$211-271**	**$205-265**	**$216-275**	**$217-277**	**$196-256**	-

All values are 15-year levelized costs.
For states that use a social cost of carbon, a range of results using a 1.5% and a 2% discount rate are used in this illustrative example.
The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

- This illustrative table only shows values for Massachusetts, using the historical Massachusetts tabulation of avoided costs. See following slide for notes.
- The appendix to this presentation contains slides that summarize results for all states.
- Energy
  - Energy prices in CF#2 are slightly lower than in CF#1, in line with this scenario having slightly lower load.
  - Energy prices are highest in CF#3, due to high loads.
  - Energy prices in CF#4 and CF#5 are more aligned with CF#2 in the early years, but increase in the 2030s as winter peaks rise.
  - Energy prices in S#1 are 22% higher than in CF#1, in line with higher gas price assumptions starting in 2026.
- RPS compliance
  - RPS compliance costs are generally similar due to overall similarities in energy costs.
- Capacity
  - Capacity costs in CF#2 are slightly lower than in CF#1, as a result of lower loads. Capacity costs in S#1 are similar to CF#1, as a result of similar demand requirements.
  - Capacity prices in winter peaking scenarios (CF#3, CF#4, CF#5, CF#6, S#2) tend to decrease as reserve margins increase. Reserve margins increase due to (a) lumpy capacity additions preceding years with load increases and (b) capacity being built to address reliability issues outside the peak demand days (e.g., non-peak days when wind output is low).

Notes for slides 3-6

(Notes 1-12 are also broadly applicable to the Appendix slides)

Notes:

- [1] All costs are shown levelized over 15 years. All costs are shown for Massachusetts and are tabulated using the historical method in Massachusetts. Costs have not been adjusted for risk premiums or T&D loss factors.
- [2] All avoided costs are estimated based on the methods states have previously used to tabulate avoided costs. These methods may change in the future.
- [3] AESC 2024 data is from the AESC 2024 User Interface. AESC 2024 values are levelized over 2024-2038, using a real discount rate of 1.74%.
- [4] Energy, energy DRIPE, and GHG non-embedded costs are based on annual average numbers.
- [5] Costs of RPS compliance are the sum of the per-MWh cost for all RPS programs active in this state.
- [6] Electric energy and cross-DRIPE includes intrazonal energy DRIPE, E-G DRIPE, and E-G-E DRIPE. Interzonal effects are not included.
- [7] GHG non-embedded costs include a 2% social cost of carbon for AESC 2021. For AESC 2024, GHG non-embedded costs for Connecticut, Maine, New Hampshire, and Rhode Island are based on a marginal abatement cost derived from the electric sector; GHG non-embedded costs for Massachusetts and Vermont are shown based on a range of a range of social cost of GHGs representing 1.5% and 2% discount rates. AESC 2024 social cost of GHG costs include impacts from CO2, CH4, and N2O pollution and exclude impacts from upstream emissions. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.
- [8] GHG non-embedded costs subtract embedded costs (RGGI, state-specific costs in MA) from the social cost of GHGs.
- [9] Capacity, capacity DRIPE, and reliability values are shown for cleared values only. Uncleared values are not included.
- [10] Capacity DRIPE values include intrazonal effects only. Interzonal effects are not included.
- [11] “Regional Transmission (PTF)” values only include regional transmission costs. This cost does not include more localized transmission costs and does not include any distribution costs. These other avoided costs may be specifically calculated in each jurisdiction.
- [12] Capacity values are converted to energy values using a load factor of 56%.

Key drivers for differences among state results:

- All avoided costs are tabulated based on each state’s historical method of tabulation. The sole exception is non-embedded costs in NH, where Study Group members have directed us to use the New England electric-sector MAC, contingent upon the NH EM&V discussion and approval.
- Different states use different non-embedded GHG costs (SCC, MAC) or different methodologies. Social cost of greenhouse gases is shown with a range of 1.5-2% discount rates.
- States count DRIPE differently (CT and RI include regional DRIPE; MA, ME, and NH include in-state DRIPE only, and VT doesn’t include any DRIPE).
- Some states (RI, MA, others) are subject to regionally separated capacity prices in some of the near-term years.

2a. Natural gas

Table 4. Summary of 15-year levelized Henry Hub, Algonquin Citygate, and basis differentials for AESC 2024 and AESC 2021

		Henry Hub	Algonquin Citygates	Basis
AESC 2021 (2021–2035)	*2024 $/MMBtu*	$3.56	$4.74	$1.18
AESC 2024 (2024–2038)	*2024 $/MMBtu*	$3.48	$5.64	$2.16
Percent change	*%*	-2%	19%	-

Table 5. Avoided cost of gas for all retail customers for all end uses assuming no avoidable margin

		Southern New England	Northern New England
AESC 2021 (2021–2035)	*2024 $/MMBtu*	$7.32	$7.22
AESC 2024 (2024–2038)	*2024 $/MMBtu*	$6.39	$6.32
Percent change	*%*	-13%	-12%

See slide 21 for information on non-embedded GHG costs for natural gas. These costs are additive to the costs shown here.

- Avoided costs of natural gas tend to be lower than in AESC 2021, due to lower long-term price projections.
  - Near-term prices are comparatively high, but only last for 2 years.
- For both southern New England and northern New England, avoided natural gas costs are lower in AESC 2024 compared to AESC 2021.
  - This is due to a reduction in gas commodity prices at the upstream supply points and at Henry Hub.

2b. Fuel oil and other fuels

- Avoided costs of fuel oil tend to be moderately higher than in AESC 2021, due to higher near-term and long-term price projections.
  - Primary factor driving avoided fuel oil costs and fuel oil prices is the price of crude oil, which is about 19 percent higher for the 20-year period from 2024 to 2043 in AESC 2024 than in AESC 2021.
- Avoided costs for fuel oil products and other fuels by end use are based on market prices.

Table 6. Avoided costs of retail fuels (15-year levelized, 2024 $ per MMBtu)

	Residential								Commercial		Transportation	
	No. 2 Distillate	Propane	Kerosene	B5 Biofuel	B20 Biofuel	B50 Biofuel	Cord Wood (Delivered)	Wood Pellets	No. 2 Distillate	No. 6 Residual (low sulfur)	Motor Gasoline	Motor Diesel
AESC 2021 (2021–2035)	$27.14	$43.79	$33.41	$27.14	$24.42	-	$23.52	$25.36	$25.11	$17.77	$24.92	$25.70
AESC 2024 (2024–2038)	$30.60	$58.11	$38.47	$30.19	$25.58	$30.32	$29.37	$30.73	$28.59	$21.58	$27.16	$28.76
Change from AESC 2021 to AESC 2023	12.8%	32.7%	15.2%	11.2%	4.7%	-	24.9%	21.2%	13.8%	21.5%	9.0%	11.9%

See slide 21 for information on non-embedded GHG costs for natural gas. These costs are additive to the costs shown here.

2c. Common electric assumptions

- Various parts of the AESC 2024 avoided cost modeling use the same assumptions for the electric sector
- Demand
  - Annual conventional load and EV load trajectories based on ISO New England's 2023 CELT forecast, with some modifications
  - Different counterfactuals assume different load components for energy efficiency, building electrification, and active demand management measures
  - Model a single weather year for all future years (2002)
- Supply
  - Assume that current renewable policies are in effect. This includes all laws that are currently on the books, as well as policy that is viewed as likely to happen by relevant state agencies.
  - Assume units with FCM commitments are built; model builds other power plants (e.g. gas plants, battery storage) dynamically
  - Use the EnCompass model to dynamically calculate a capacity supply curve for forecasting capacity prices
- Input prices
  - Natural gas: Based on blend of near-term NYMEX futures with long-term prices from AEO 2023
  - RGGI: Based on RGGI floor price and historical prices
- All modeling covers the years from 2024-2050; prices after 2050 are extrapolated
- Models used:
  - EnCompass – An electric-sector production-cost and capacity-expansion model
  - REMO – A set of models developed by Sustainable Energy Advantage that estimate forecasts of scenario-specific renewable energy build-outs, as well as REC and clean energy certificate (CEC) price forecasts
  - FCM Model – A spreadsheet model that coordinates outputs on supply and demand with inputs from ISO New England's Forward Capacity Market (only used for power years from June 2024 through May 2028)

2c. Comparison of load across Counterfactuals

Figure 24. Loads by component, CF#1

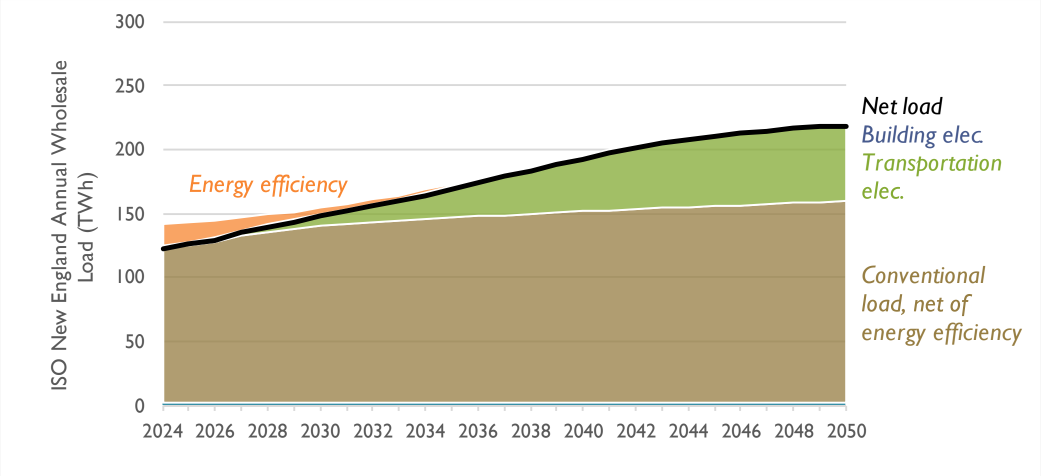
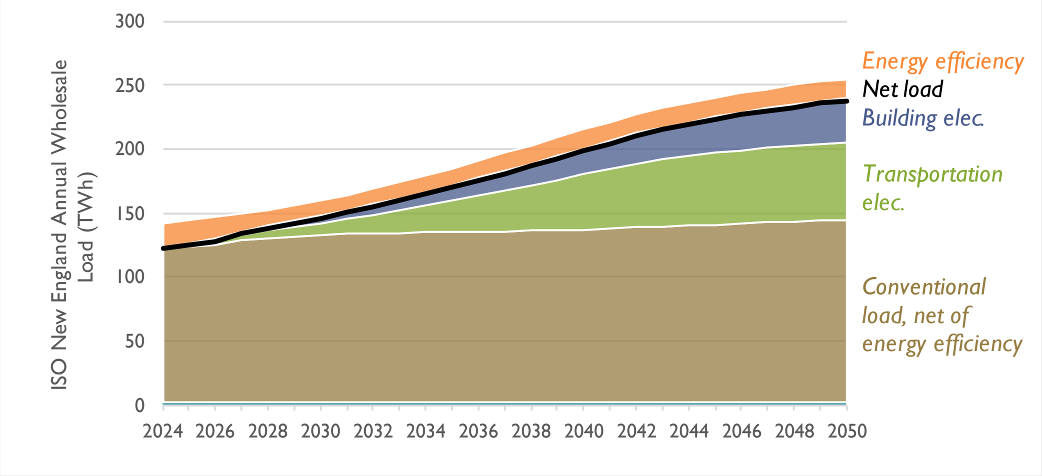


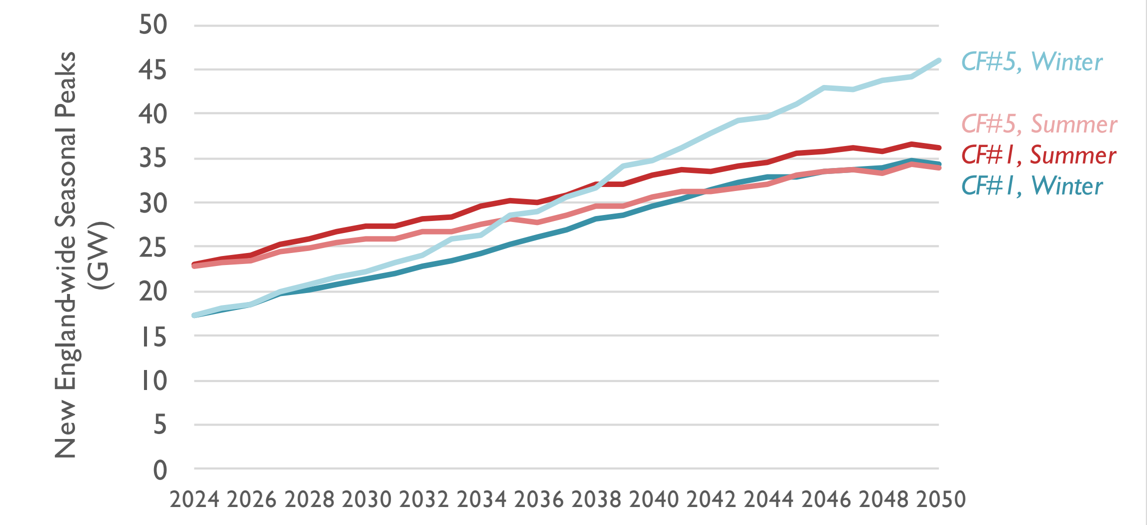
Figure 25. Loads by component, CF#5



- Current annual load is about 125 TWh
- Counterfactual #1
  - Includes transportation electrification and non-programmatic BTM storage and DR.
  - Does <u>not</u> include any new energy efficiency or building electrification built after 2023.
  - Reaches load levels of about 220 TWh by 2050.
- Counterfactual #5
  - Includes transportation electrification.
  - <u>Does</u> include new energy efficiency and building electrification measures, as well as both programmatic and non-programmatic DR and BTM storage, throughout the study period.
  - Reaches load levels of about 240 TWh by 2050.
- Other counterfactuals:
  - Not shown due to overall similarity to either Counterfactual #1 or Counterfactual #5.
  - S#1 uses the same shape as CF#1. CF#2 looks like CF#1, but lower loads due to the inclusion of EE.
  - CF#3 looks like CF#5 but with higher loads due to the exclusion of EE.
  - CF#4, CF#6, and S#2 use the same loads and load shapes as CF#5.

2c. Comparison of coincident seasonal peaks across Counterfactuals

Figure 26. Seasonal peaks



Notes: Summer months include June through September. Winter months include October through May.

- Current coincident summer peak load is about 25 GW.
- Current coincident winter load is about 20 GW.
- Counterfactual #1
  - Remains summer-peaking throughout the study period, despite a gap closing between summer peak and winter peak.
  - By 2050, summer peaks are 36 GW. Increases are largely driven by (a) transportation electrification and (b) conventional load additions.
  - Winter peaks approach summer peaking levels in the mid-2040s.
  - CF#2 trends are similar to CF#1, but lower due to inclusion of EE. S#1 trends are identical to CF#1.
- Counterfactual #5
  - System becomes winter-peaking in 2035, due to increased deployment of heat pumps.
  - Summer peaks resemble those in CF#1.
  - CF#3 trends are similar CF#5, but higher due to exclusion of EE. CF#4, CF#6, and S#1 trends are identical to CF#5.
- Bumpiness in trends is caused by different load components having different rates of increase. As one component increases faster than another (e.g., building electrification vs. transportation electrification, or State A additions vs. State B additions), coincident peaks change in discontinuous ways.

2d. Modeling capacity

- **Current market:**
  - For power years from June 2024 through May 2028, we used the FCM Model, a spreadsheet model that coordinates outputs on supply and demand with inputs from ISO New England's Forward Capacity Market, as in AESC 2021.

- **Future market:**
  - *Assumptions:*
    - Modeling of the future capacity market beyond June 2028 was based on best available information as of Fall 2023 about proposed changes to the ISO New England Capacity Market.
    - This includes assumptions that (1) ISO New England switches to a seasonal, prompt market and (2) resource capacity accreditation is based each resource's marginal ability to avoid loss of load events.
  - *Methods:*
    - To calculate resource accreditation values and reserve margin requirements, we conducted a Monte Carlo analysis using 20 years of stochastic load and generation data published by ISO New England.
    - Using these accreditation value and reserve requirement results, we dynamically modeled the capacity market in EnCompass for each counterfactual.
  - *Results:*
    - Counterfactuals with lower seasonal peaks and more net firm capacity tend to have lower capacity prices than counterfactuals with higher seasonal peaks and less net firm capacity.
    - Reserve margins are inversely correlated with capacity prices. A tighter market will have higher prices, and a market with excess capacity will have lower prices.
    - Fluctuations in firm capacity and peak load drive year-on-year variations in prices.

2d. Avoided capacity costs

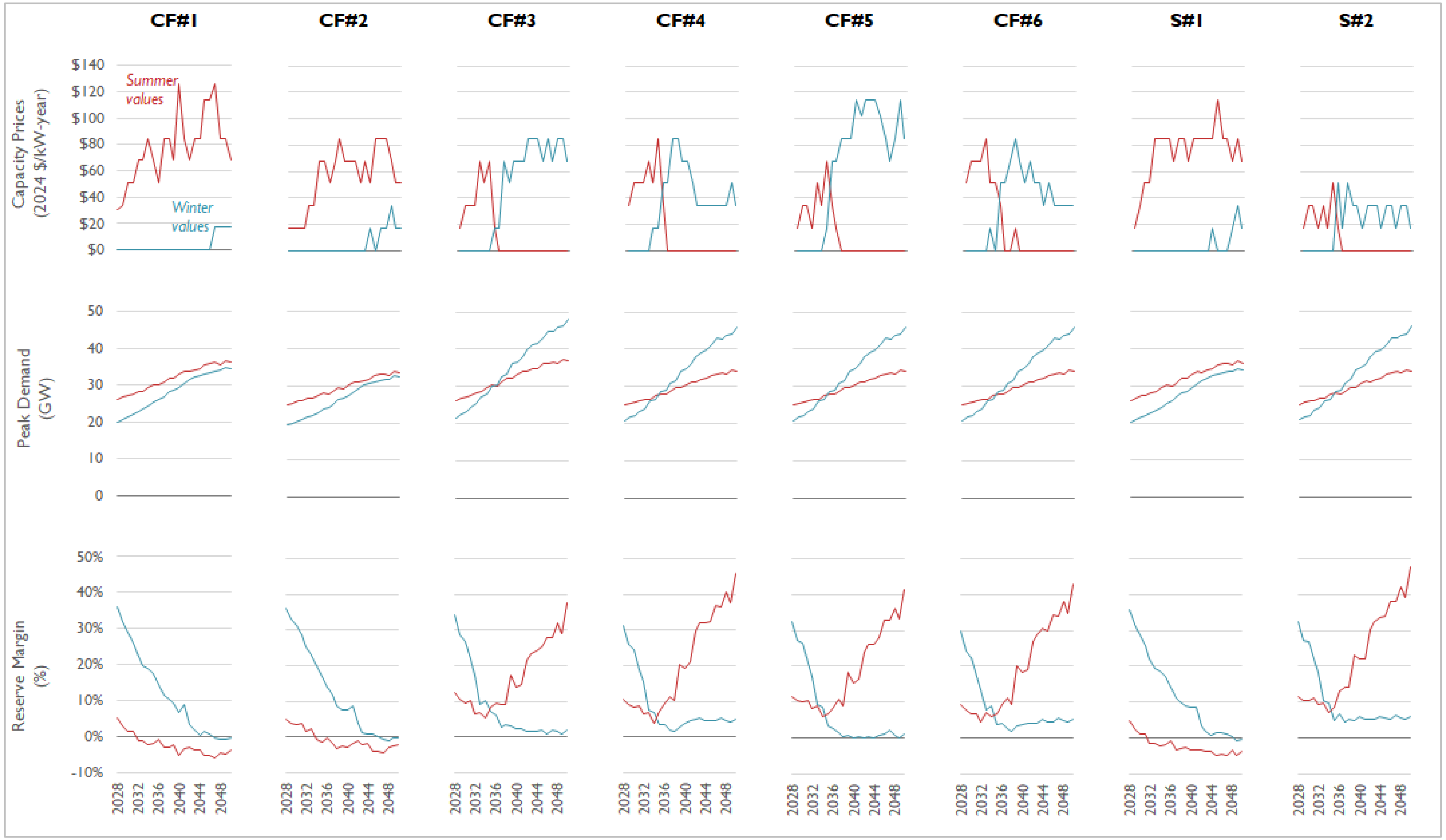
Figure 24. Seasonal capacity prices for all modeled scenarios during the new capacity market structure period (post-FCA 18) (2024 $/kW-year)

Year	FCA #	Summer								Winter							
		CF#1	*CF#2*	*CF#3*	*CF#4*	*CF#5*	*CF#6*	*S#1*	*S#2*	*CF#1*	*CF#2*	*CF#3*	*CF#4*	*CF#5*	*CF#6*	*S#1*	*S#2*
2028	19	$31	$17	$17	$34	$17	$51	$17	$17	$0	$0	$0	$0	$0	$0	$0	$0
2029	20	$34	$17	$34	$51	$34	$68	$34	$34	$0	$0	$0	$0	$0	$0	$0	$0
2030	21	$51	$17	$34	$51	$34	$68	$51	$34	$0	$0	$0	$0	$0	$0	$0	$0
2031	22	$51	$17	$34	$51	$17	$68	$51	$17	$0	$0	$0	$0	$0	$0	$0	$0
2032	23	$68	$34	$68	$68	$51	$85	$85	$34	$0	$0	$0	$0	$0	$0	$0	$0
2033	24	$68	$34	$51	$51	$34	$51	$85	$17	$0	$0	$0	$17	$0	$17	$0	$0
2034	25	$85	$68	$68	$85	$68	$51	$85	$51	$0	$0	$0	$17	$17	$0	$0	$0
2035	26	$68	$68	$17	$34	$34	$34	$85	$17	$0	$0	$17	$51	$68	$51	$0	$51
2036	27	$51	$51	$0	$0	$17	$0	$68	$0	$0	$0	$17	$51	$68	$51	$0	$17
2037	28	$85	$68	$0	$0	$0	$0	$85	$0	$0	$0	$68	$85	$85	$68	$0	$51
2038	29	$85	$85	$0	$0	$0	$17	$85	$0	$0	$0	$51	$85	$85	$85	$0	$34
2039	30	$68	$68	$0	$0	$0	$0	$68	$0	$0	$0	$68	$68	$85	$68	$0	$34
2040	31	$126	$68	$0	$0	$0	$0	$85	$0	$0	$0	$68	$68	$114	$51	$0	$17
2041	32	$85	$68	$0	$0	$0	$0	$85	$0	$0	$0	$68	$51	$102	$68	$0	$34
2042	33	$68	$51	$0	$0	$0	$0	$85	$0	$0	$0	$85	$34	$114	$51	$0	$34
2043	34	$85	$68	$0	$0	$0	$0	$85	$0	$0	$0	$85	$34	$114	$51	$0	$34
2044	35	$85	$51	$0	$0	$0	$0	$85	$0	$0	$17	$85	$34	$114	$34	$17	$17
2045	36	$114	$85	$0	$0	$0	$0	$114	$0	$0	$0	$68	$34	$102	$51	$0	$34
2046	37	$114	$85	$0	$0	$0	$0	$85	$0	$0	$17	$85	$34	$85	$34	$0	$34
2047	38	$126	$85	$0	$0	$0	$0	$85	$0	$17	$17	$68	$34	$68	$34	$0	$17
2048	39	$85	$68	$0	$0	$0	$0	$68	$0	$17	$34	$85	$34	$85	$34	$17	$34
2049	40	$85	$51	$0	$0	$0	$0	$85	$0	$17	$17	$85	$51	$114	$34	$34	$34
2050	41	$68	$51	$0	$0	$0	$0	$68	$0	$17	$17	$68	$34	$85	$34	$17	$17

- Displayed results focus only on years in new capacity market structure (e.g. 2028 and later)
- All values are displayed in terms of 2024 $/kW-year.
- Measures can receive capacity benefits for both summer and winter savings: for a given counterfactual and year, a measure’s summer savings are multiplied by the summer price and then added to that measure’s winter savings multiplied by the winter price.
- Values of “$0” are actually $0 (i.e., they are not a small number that rounds to $0).

2d. Avoided capacity costs (cont.)

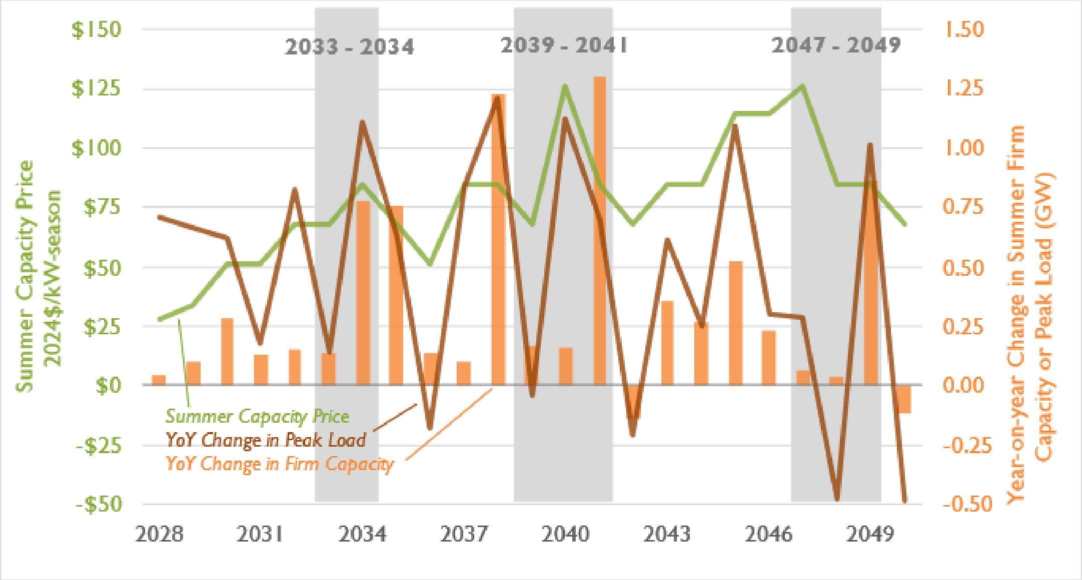
Figure 24. Comparisons of capacity prices, peak demand, and reserve margins across all modeled scenarios during the new capacity market structure period (post-FCA 18)



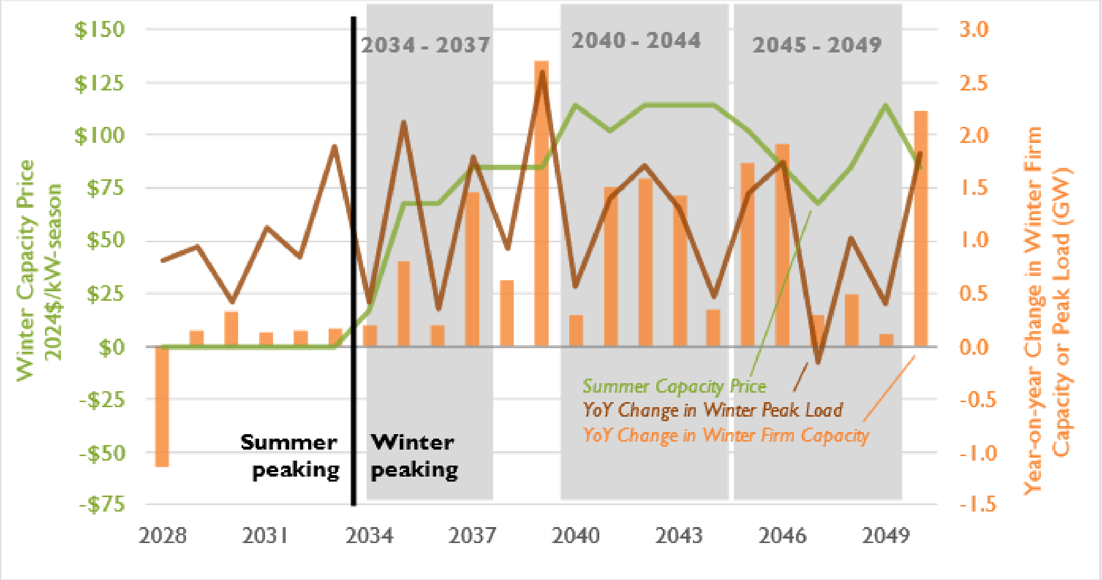
- Displayed results focus only on years in new capacity market structure (e.g. 2028 and later).
- In general, capacity markets are driven by (a) peak demand, (b) firm capacity, and (c) resource availability during non-peak periods.
- Reserve margins are defined as firm capacity divided by peak demand.
- Firm capacity is the product of of nameplate capacity and a resource's ELCC. A resource's ELCC is determined based on the incremental ability of a MW of that resource to avoid loss-of-load events. In general, ELCCs for a certain resource will decline as more capacity of the specific resource is added, with this trend being especially true for wind and solar.
- Capacity prices are driven by changes in reserve margin (which are a function of changes in firm capacity and peak loads).
- In general:
  - Reserve margins are inversely correlated with capacity prices. A tighter market will have higher prices, and a market excess capacity will have lower prices.
  - If year-on-year change in peak load is greater than year-on-year change in firm capacity, reserve margins will increase, resulting in lower capacity prices. The converse also holds true.
  - Higher winter reserve margins in out-years are indicative of capacity built to provide coverage during non-peak events (e.g., winter doldrums).

2d. Avoided capacity costs (cont.)

CF#1: trends in capacity prices, year-on-year change in firm capacity and peak loads



CF#5: trends in capacity prices, year-on-year change in firm capacity and peak loads



- Reserve margins and capacity prices are inversely correlated.
  - A higher reserve margin means the market is long on capacity, leading to lower capacity prices.
  - A lower reserve margin means the market is tight on capacity leading to higher prices
- The relative magnitudes of the changes in peak load and firm capacity in each year drive the trend in the reserve margin.
  - If firm capacity increases by more than the peak load increases, the reserve margin will increase, causing the capacity price to go down.
  - If peak load increases by more than firm capacity increases, the reserve margin will decrease, causing the capacity price to go up.
- Firm capacity may increase in unexpected ways relative to peak demand increases. This includes situations such as:
  - When a model “overbuilds” firm capacity (because the size of resource additions are prescriptive and/or because the model is anticipating peak demand increases in the near future.
  - Capacity built to provide coverage during non-peak events (e.g., winter doldrums).

2e. Avoided energy costs

- On a levelized basis, the 15-year AESC 2024 annual all-hours price for Counterfactual #1 is $50 per MWh, compared to the equivalent value of $46 per MWh from AESC 2021.
  - This represents a price increase of 9 percent.
  - Prices shown below represent averages over large periods of time. Hourly prices (available in the AESC 2024 user interface) may vary.
- Relative to Counterfactual #1, counterfactuals and years with higher loads and peaks tend to have higher energy prices, while counterfactuals with lower loads and peaks tend to have lower energy prices. The increase in energy prices observed in AESC 2024 is primarily due to higher near-term wholesale gas prices and a deferral of zero-marginal-cost clean energy to later in the study period, relative to AESC 2021.

Table 8. Comparison of energy prices for Massachusetts (2024 $ per MWh, 15-year levelized)

	Annual All hours	Winter Peak	Winter Off-Peak	Summer Peak	Summer Off-Peak
AESC 2021 Counterfactual 1	$46.11	$52.90	$51.02	$36.88	$33.71
AESC 2024 Counterfactual 1	$50.36	$61.22	$57.34	$57.34	$33.55
AESC 2024 Counterfactual 2	$47.42	$57.41	$53.44	$53.44	$32.27
AESC 2024 Counterfactual 3	$50.92	$62.27	$58.79	$58.79	$31.53
AESC 2024 Counterfactual 4	$50.30	$61.42	$58.20	$58.20	$30.94
AESC 2024 Counterfactual 5	$50.38	$61.64	$58.06	$58.06	$31.12
AESC 2024 Counterfactual 6	$49.70	$60.75	$57.56	$57.56	$30.46
% Change: Counterfactual 1	9%	16%	12%	55%	0%
% Change: Counterfactual 2	3%	9%	5%	45%	-4%
% Change: Counterfactual 3	10%	18%	15%	59%	-6%
% Change: Counterfactual 4	9%	16%	14%	58%	-8%
% Change: Counterfactual 5	9%	17%	14%	57%	-8%
% Change: Counterfactual 6	8%	15%	13%	56%	-10%

Notes: All prices have been converted to 2024 $ per MWh. Levelization periods are 2021–2035 for AESC 2021 and 2024–2038 for AESC 2024. The real discount rate is 0.81 percent for AESC 2021 and 1.74 percent for AESC 2024. AESC 2021 values are from the AESC 2021 User Interface, while AESC 2024 values are from the AESC 2024 User Interface. Summer on-peak hours are daytime weekday hours in summer months (June through September) while summer off-peak hours are nighttime weekday and weekend hours in summer months. Meanwhile, winter on-peak hours are daytime weekday hours in winter months (January through May and October through December) while winter off-peak hours are nighttime weekday and weekend hours in winter months.

2f. Avoided cost of RPS compliance

Table 10. Avoided cost of RPS compliance (2024 $ per MWh)

	CT	ME	MA	NH	RI	VT
AESC 2021 Counterfactual 1	$10	$9	$14	$10	$18	$5
AESC 2024 Counterfactual 1	$17	$16	$25	$12	$23	$8
AESC 2024 Counterfactual 2	$17	$16	$25	$12	$23	$8
AESC 2024 Counterfactual 3	$18	$17	$26	$12	$24	$8
AESC 2024 Counterfactual 4	$17	$16	$24	$12	$22	$8
AESC 2024 Counterfactual 5	$17	$16	$25	$12	$23	$8
AESC 2024 Counterfactual 6	$17	$16	$25	$12	$22	$8
Pcnt Change: Counterfactual 1	*79%*	*83%*	*71%*	*21%*	*25%*	*67%*
Pcnt Change: Counterfactual 2	*79%*	*83%*	*71%*	*21%*	*25%*	*67%*
Pcnt Change: Counterfactual 3	*92%*	*91%*	*79%*	*24%*	*32%*	*70%*
Pcnt Change: Counterfactual 4	*77%*	*80%*	*70%*	*21%*	*22%*	*66%*
Pcnt Change: Counterfactual 5	*78%*	*82%*	*71%*	*21%*	*24%*	*66%*
Pcnt Change: Counterfactual 6	*79%*	*81%*	*74%*	*21%*	*23%*	*66%*

- Relative to AESC 2021, AESC 2024 has higher prices for meeting RPS compliance
  - This difference is attributable to near-term shortages and cost increases for materials and labor, delays in offshore wind deployment and regional transmission expansion, and increases in the long-term cost of entry due to the lasting effects of the war in Ukraine and the COVID-19 pandemic.
  - The cost of RPS compliance is also impacted by increased RPS stringencies in multiple states and the addition of new RPS categories such as Maine Class I Thermal, Massachusetts Clean Peak Standard (CPS), and the Massachusetts Greenhouse Gas Emissions Standard (GGES) for municipal light plants.
- Renewable builds across scenarios with the same load components are identical (e.g., CF#1 and S#1); differences in REC pries are due to differences in supply-demand tension, as well as availability of “discretional” REC supply (e.g., from biomass or imported RECs).
- Renewable builds and renewable costs tend to be similar across scenarios through the mid-2030s, due to scale of assumed renewable procurements outside RPS programs.

2g. Non-embedded greenhouse gas costs

- AESC 2024 offers three different non-embedded GHG costs. These prices may be useful in different states according to different policy contexts.

Table 11 and Table 12. Comparison of GHG costs under different approaches in Counterfactual #1

	2024 $ per short ton				2024 cents per kWh			
	AESC 2021	AESC 2024	Difference	% Difference	AESC 2021	AESC 2024	Difference	% Difference
Social cost of greenhouse gases (SC-GHG or “damage cost”) at 1.5% and 2% discount rates	$144 (2% only)	$249 to 415	$104 to 270	72 to 187%	5.50 (2% only)	8.95 to 15.37	3.45 to 9.88	63 to 180%
New England-based marginal abatement cost, derived from the electric sector	$141	$173	$32	23%	5.35	6.47	1.11	21%
New England-based marginal abatement cost, derived from multiple sectors	$557	$581	$24	4%	22.25	21.71	-0.56	-2%

Notes: All values shown are levelized over 15 years. All AESC 2024 values except the SCC are levelized using a 1.74 percent discount rate (the 2.0 percent SCC is levelized using a 2.0 percent discount rate, while the 1.5 percent SCC is levelized using a 1.5 percent discount rate). All AESC 2021 values are levelized using a 0.81 percent discount rate, except SCC which uses a 2 percent discount rate, then converted into 2024 dollars. $ per short ton values shown above remove energy prices, but not embedded costs, while cents per kWh values also remove embedded costs (e.g., RGGI, MA 310 7.74, MA 310 7.75). All values quoted use a summer on-peak seasonal marginal emission rate and include a 9 percent energy loss factor. All values shown are only inclusive of point-of-consumption CO2 GHGs and do not include upstream GHGs or GHG cost impacts related to CH4 or N2O.

2g. Non-embedded greenhouse gas costs (cont.)

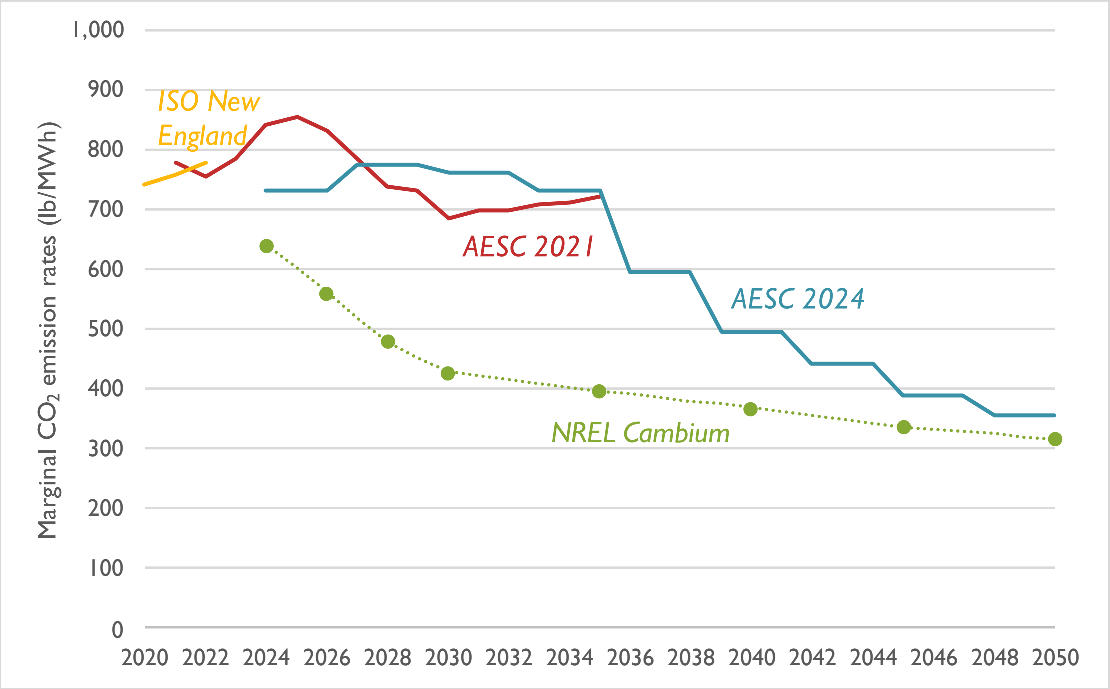
- Values shown below are non-embedded gas costs estimated using a social cost of greenhouse gases with a 2% discount rate.
- All values shown are levelized over 15 years.
- All units are in 2024 $/MMBtu.

Natural Gas			Fuel Oils						
Residential	Commercial	Industrial	Residential	Commercial			Industrial		
			Distillate Fuel Oil	Distillate Fuel Oil	Residual Fuel Oil	Weighted Average	Distillate Fuel Oil	Residual Fuel Oil	Weighted Average
$14.56	$14.56	$14.56	$20.37	$20.37	$20.35	$20.37	$20.37	$20.35	$20.37

Other Fuels									
Residential							Industrial	Transportation	
Cord Wood	Pellets	Kerosene	Propane	Biofuel (B5)	Biofuel (B20)	Biofuel (B50)	Kerosene	Motor Gasoline	Motor Diesel
$0.00	$0.00	$20.68	$16.98	$19.35	$16.30	$10.19	$20.68	$19.31	$20.34

2g. Marginal emission rates

Figure 52. Marginal emission rates



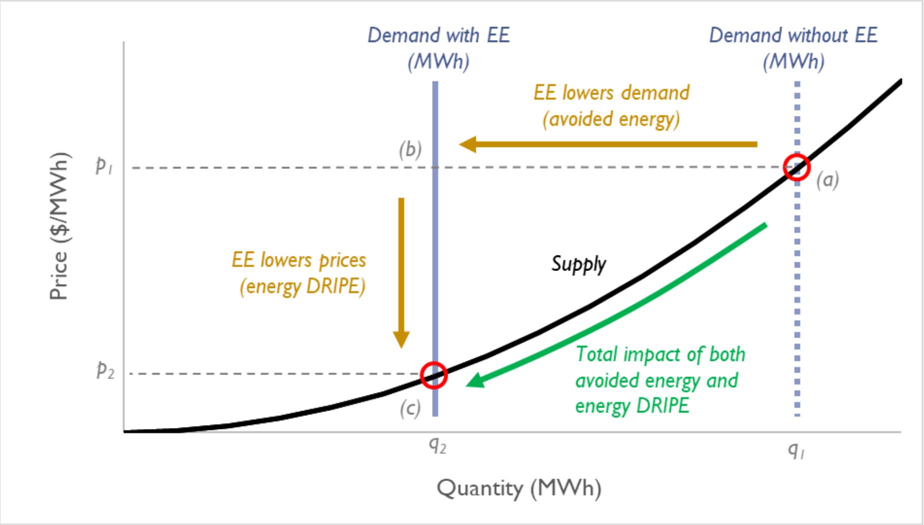
Notes: ISO New England data is from the 2022 Air Emissions Report; NREL Cambium data is from the 2022 MidCase for New England. NREL Cambium data is provided for 2024, 2026, 2028, 2030, 2035, 2040, 2045, and 2050. All other data points shown in this figure are interpolated. ISO New England values are short-run marginal emission rates; all other series are long-run marginal emission rates.

- As in AESC 2021, we observe a marginal emission rate (MER) that resembles a gas plant in the near term in AESC 2024.
  - Over time, clean energy tends to make a larger and larger share of the differences in load, leading to a steadily decreasing MER.
  - The MER in AESC 2024 falls in the mid-2030s, as compared to AESC 2021, because AESC 2024 assumes a delay in some large renewable procurements.
  - In the near term, AESC 2024 MERs resemble data from ISO New England and long-run marginal emission rates (LRMERs) from NREL's Cambium modeling. NREL's MERs fall at a faster rate than those calculated in AESC 2024 because NREL does not make the same assumptions regarding large renewable procurements.
- MERs in AESC 2024 are calculated across a large subset of combinations of CFs.
  - They are weighted by the deltas between CF loads to emphasize observations with larger load differences and reduce noise.
  - In addition, a smoothing trend is applied to results, since these modifications do not fully address the lumpiness related to clean energy deployment.
  - An analogous methodology is used for marginal heat rates.

2h. DRIPE

- Demand Reduction Induced Price Effect (DRIPE)
- AESC 2024 models:
  - Energy DRIPE
  - Capacity DRIPE
  - Natural gas DRIPE
  - Cross-DRIPE (which carry over dynamics between the gas and energy markets)
  - Oil DRIPE
- DRIPE results in AESC 2024 differ from those in AESC 2021 because of updated information changes in utility long-term energy purchases, updated market data, and new commodity forecasts.
- We find:
  - Similar energy DRIPE values due to a number of factors (including changes in energy prices, changes in load, and changes in hedging assumptions) that largely offset one another.
  - Generally similar trends in capacity DRIPE values, with values that are highly variable year-to-year in both AESC 2024 and AESC 2021, especially in the near-term years due to market price separation.
  - Lower gas supply and electric-to-gas DRIPE values due to decreases in price shifts.
  - Higher gas-to-electric cross-DRIPE values due to increases in price shifts.
  - Higher oil DRIPE values, due to changes in the underlying projection of crude oil prices.

Example figure depicting separate and non-overlapping avoided energy and energy DRIPE effects



Note: This example figure depicts impacts in the energy market, but the principles are the same for all other DRIPE categories. This figure also uses "EE" as an example measure. DRIPE effects can be calculated for any measure (EE or otherwise), including measures that increase the demand of a commodity.

2i. Avoided T&D costs

- In AESC 2024, we present four separate threads for analysis of avoided T&D costs, building on the analysis performed in the 2021 AESC.

1. Updating the avoided costs for regional pool transmission facilities (PTF) based on future costs: The value is reduced to $69 per kW-year from the previous value of $95 per kW-year (in 2024 $). This value is adjusted due to a change in underlying data sources.
2. Reviewing utility approaches to generic avoided cost values for non-PTF transmission and distribution and evaluating these approaches on a common evaluation rubric to facilitate cross-comparison and learning.
3. Reviewing utility approaches to calculating geographically localized avoided costs, such as for non-wire alternatives (NWA).

2j. Value of improved reliability

- AESC 2024 examines how changing electric loads can change reliability in several ways, which differ among generation, transmission, and distribution.
- These calculations utilize the value of lost load (VoLL)—the value a consumer derives from avoiding an outage.
  - AESC 2024 projects a value of $61 per kWh.
  - This value is about 26 percent less than the value derived in AESC 2021 ($82 per kWh in 2024 dollars), as a result of specifying the value to the New England states.
  - Generation Reliability
    - Effect of increasing reserve margins and improving on generation reliability.
    - In AESC 2024, we find 15-year levelized values of $0.38 per kW-year for cleared benefits and $4.82 per kW-year for uncleared benefits. These are 25 to 50 percent lower than the same values estimated in AESC 2021, after adjusting for inflation.
    - The primary differences for these changes include a reduction in the assumed VoLL (as described above) and different input parameters related to the capacity market supply and demand curves.
  - T&D Reliability
    - As in AESC 2021, we provide an example methodology of how utilities might calculate a value of reliability associated with T&D.

2k. Sensitivities

- In AESC 2024, we evaluate avoided costs under two different sensitivities:
- Sensitivity #1: A natural gas price sensitivity with higher gas prices than were used in Counterfactual #1 (“High Gas Price Sensitivity”).
  - In this sensitivity, the Henry Hub gas price depicts a future with higher gas prices as a result of lower gas recovered per well and lower assumed rates of technological improvement. This high gas price forecast is best used for examining likely avoided costs in a future where the long-term fundamentals behind natural gas prices are different than in the main counterfactuals, and where the grid is allowed to respond and build different resources accordingly.
- Sensitivity #2: A sensitivity which models a future with many distributed energy resources (DER) and increased levels of non-emitting electricity (“Increased Clean Electricity Sensitivity”).
  - This sensitivity models a clean electricity goal of 90 percent regionwide by 2035 as a hypothetical Increased Regional Clean Electricity Policy (IRCEP) that functions like a new, additional RPS policy covering New England.

2k. High Gas Price Sensitivity (Sensitivity #1)

- **Overview:**
  - All prices are compared to Counterfactual #1.
  - In the High Gas Price Sensitivity, energy prices are 20 percent higher, capacity prices are 6 percent higher, RPS compliance costs are 3 to 10 percent lower, and non-embedded GHG costs are similar or lower (depending on the approach selected).
- **Energy Prices:**
  - Energy prices are higher due to higher gas prices, which is the fuel that powers the marginal resource in most hours.
- **Capacity Prices:**
  - Capacity prices are similar, as a result of overall similar requirements to meet peak demand.
- **Non-embedded GHG cost:**
  - The non-embedded GHG cost is unchanged in jurisdictions that utilize a social cost of carbon but is lower in jurisdictions that utilize a marginal abatement cost because one of the inputs to this value is the energy price. Generally speaking, higher energy prices will produce lower non-embedded GHG costs. For a similar reason, RPS compliance costs are lower, as renewables participating in the RPS policies are able to cover more of their costs through energy market revenues.

2k. Increased Clean Electricity Sensitivity (Sensitivity #2)

- **Overview:**
  - All prices are compared to Counterfactual #5.
  - Energy prices are 11 percent lower, capacity prices are 32 percent lower, RPS compliance costs inclusive of the hypothetical IRCEP policy unchanged, and non-embedded GHG costs are unchanged.
- **Energy Prices:**
  - Near-term energy prices are similar to Counterfactual #5. Energy prices diverge from those in Counterfactual #5 in the early 2030s when additional renewable resources come online. The increase in renewable resources reduces energy prices because they have zero-marginal operating costs.
- **Capacity Prices:**
  - Capacity prices in the Clean Electricity Sensitivity are identical or similar to prices in Counterfactual #5 from FCA 15 through FCA 22.
  - Beginning in FCA 23, the Clean Electricity Sensitivity features a decrease in capacity prices due to higher levels of exogenous renewable energy being deployed by the IRCEP program. The additional exogenous renewable energy provides extra firm capacity, which leads to larger reserve margins and shifts in the capacity market supply curve to the right. As a result, the capacity market clears at a lower price.
- **RPS Compliance:**
  - Costs of RPS compliance are very similar. This is due to the overall similarities in the scenarios in the near term, and market dynamics in the longer term that essentially place a ceiling on REC prices in several jurisdictions.
  - IRCEP value is relatively low. This is because (a) the policy does not start until 2030 and only gradually increases to 90% by 2035 and (b) because 90% is not very different from 80%. In other words, this sensitivity is not markedly different from CF#5 in the 15 years in the near term (it is identical to CF#5 for the first six years).
  - IRCEP value varies across states. It is allocated to each state based on the degree to which that state is already meeting or an exceeding a 90% clean energy target. States that are already meeting this target have compliance costs of $0/MWh.

2I. Appendices

Report appendices

- Appendix A: Usage instructions
- Appendix B: Detailed Electric Outputs
- Appendix C: Detailed Natural Gas Outputs
- Appendix D: Detailed Oil and Other Fuels Outputs
- Appendix E: Common Financial Parameters
- Appendix F: User Interface
- Appendix G: Marginal Emission Rates and Non-embedded Environmental Cost Detail
- Appendix H: DRIPE Derivation
- Appendix I: Matrix of Reliability Sources
- Appendix J: Guide to Calculating Avoided Costs for Cleared and Uncleared Resources
- Appendix K: Scaling Factor for Uncleared Resources

Standalone Excel-based appendices

- Appendix C: Detailed Natural Gas Outputs
- Appendix D: Detailed Oil and Other Fuels Outputs
- Appendix K: Scaling Factor for Uncleared Resources

2m. User Interface

- Excel workbook containing hourly load and price data for 2024-2050 for each region; extrapolates values through 2060.
- Eight different versions, one for each counterfactual.
- Includes Excel versions of Appendix B and Appendix J.
  - Used for calculating avoided costs for electricity
- Dynamically provides avoided costs for different regions and counterfactuals.
- Dynamically calculates DRIPE values based on DRIPE vintage.
- Users can view avoided costs according to the traditional AESC costing periods (summer onpeak, etc.), or set up their own costing periods where they focus on peak prices or peak loads.
- Training video is available on Synapse's website. Please reach out if you have further questions.

Next steps

- Program administrators in New England will be using this data in their benefit-cost analyses.
- Synapse is available to contract for additional work related to AESC 2024.
  - Please reach out to Pat Knight (pknight@synapse-energy.com) for related inquiries.

Contact

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Appendix

Comparison table: CF#1

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$50	$51	$50	$51	$50	$51	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$23	$11	$21	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$42	$5	$19	$5	$41	$0	*6*
GHG non-embedded	*2024 $/MWh*	$63	$63	$83-143	$63	$63	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$171**	**$134**	**$175-235**	**$130**	**$175**	**$149-210**	
Capacity	*2024 $/kW-year*	$52	$52	$53	$52	$54	$52	*9*
Capacity DRIPE	*2024 $/kW-year*	$9	$3	$24	$3	$41	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$130**	**$123**	**$146**	**$124**	**$163**	**$120**	-
Capacity subtotal	***2024 $/MWh***	**$26**	**$25**	**$30**	**$25**	**$33**	**$25**	*12*
Total	***2024 $/MWh***	**$197**	**$159**	**$205-265**	**$155**	**$208**	**$173-235**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: CF#2

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$47	$48	$47	$48	$47	$48	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$23	$11	$21	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$40	$5	$18	$5	$40	$0	*6*
GHG non-embedded	*2024 $/MWh*	$66	$66	$83-143	$66	$66	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$169**	**$134**	**$171-231**	**$130**	**$173**	**$146-207**	
Capacity	*2024 $/kW-year*	$39	$38	$40	$38	$40	$38	*9*
Capacity DRIPE	*2024 $/kW-year*	$9	$3	$25	$3	$41	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$117**	**$110**	**$133**	**$110**	**$150**	**$107**	-
Capacity subtotal	***2024 $/MWh***	**$24**	**$22**	**$27**	**$22**	**$31**	**$22**	*12*
Total	***2024 $/MWh***	**$193**	**$156**	**$198-258**	**$152**	**$204**	**$168-229**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: CF#3

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$51	$52	$51	$51	$50	$52	*4*
RPS compliance	*2024 $/MWh*	$17	$16	$24	$11	$22	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$42	$5	$19	$5	$42	$0	*6*
GHG non-embedded	*2024 $/MWh*	$62	$62	$83-143	$62	$62	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$172**	**$135**	**$177-237**	**$130**	**$176**	**$150-211**	
Capacity	*2024 $/kW-year*	$39	$39	$40	$39	$41	$39	*9*
Capacity DRIPE	*2024 $/kW-year*	$8	$3	$24	$3	$41	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$117**	**$111**	**$134**	**$111**	**$150**	**$108**	**-**
Capacity subtotal	***2024 $/MWh***	**$24**	**$23**	**$27**	**$23**	**$31**	**$22**	***12***
Total	***2024 $/MWh***	**$195**	**$157**	**$204-264**	**$152**	**$207**	**$172-233**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: CF#4

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$51	$52	$51	$51	$50	$52	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$22	$11	$20	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$42	$5	$19	$5	$42	$0	*6*
GHG non-embedded	*2024 $/MWh*	$62	$62	$83-143	$62	$62	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$170**	**$134**	**$176-236**	**$130**	**$174**	**$150-211**	
Capacity	*2024 $/kW-year*	$55	$55	$56	$55	$57	$55	*9*
Capacity DRIPE	*2024 $/kW-year*	$57	$7	$48	$8	$89	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$181**	**$131**	**$174**	**$132**	**$214**	**$124**	-
Capacity subtotal	***2024 $/MWh***	**$37**	**$27**	**$35**	**$27**	**$44**	**$25**	*12*
Total	***2024 $/MWh***	**$207**	**$161**	**$211-271**	**$156**	**$218**	**$175-236**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: CF#5

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$50	$51	$50	$51	$49	$52	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$23	$11	$21	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$41	$5	$19	$5	$41	$0	*6*
GHG non-embedded	*2024 $/MWh*	$63	$63	$83-143	$63	$63	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$169**	**$134**	**$175-235**	**$129**	**$174**	**$149-210**	
Capacity	*2024 $/kW-year*	$48	$48	$49	$48	$50	$48	*9*
Capacity DRIPE	*2024 $/kW-year*	$22	$4	$31	$4	$54	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$140**	**$121**	**$149**	**$121**	**$173**	**$117**	-
Capacity subtotal	***2024 $/MWh***	**$28**	**$25**	**$30**	**$25**	**$35**	**$24**	*12*
Total	***2024 $/MWh***	**$198**	**$159**	**$205-265**	**$154**	**$209**	**$173-234**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: CF#6

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$49	$50	$50	$50	$49	$51	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$23	$11	$21	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$41	$5	$19	$5	$41	$0	*6*
GHG non-embedded	*2024 $/MWh*	$63	$63	$83-143	$63	$63	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$169**	**$134**	**$175-234**	**$129**	**$174**	**$148-210**	
Capacity	*2024 $/kW-year*	$58	$58	$59	$58	$59	$58	*9*
Capacity DRIPE	*2024 $/kW-year*	$105	$11	$73	$12	$137	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	$1	<$1	$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$233**	**$138**	**$201**	**$139**	**$266**	**$127**	-
Capacity subtotal	***2024 $/MWh***	**$47**	**$28**	**$41**	**$28**	**$54**	**$26**	*12*
Total	***2024 $/MWh***	**$217**	**$162**	**$216-275**	**$158**	**$228**	**$174-235**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: S#1

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$60	$61	$61	$61	$60	$61	*4*
RPS compliance	*2024 $/MWh*	$15	$14	$22	$11	$19	$7	*4, 5*
Electric energy and cross-DRIPE	*2024 $/MWh*	$47	$6	$21	$6	$47	$0	*6*
GHG non-embedded	*2024 $/MWh*	$53	$53	$83-143	$53	$53	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$175**	**$134**	**$187-246**	**$130**	**$178**	**$159-220**	
Capacity	*2024 $/kW-year*	$55	$55	$56	$55	$57	$55	*9*
Capacity DRIPE	*2024 $/kW-year*	$6	$3	$23	$3	$38	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$130**	**$126**	**$149**	**$127**	**$164**	**$124**	-
Capacity subtotal	***2024 $/MWh***	**$27**	**$26**	**$30**	**$26**	**$33**	**$25**	*12*
Total	***2024 $/MWh***	**$201**	**$159**	**$217-277**	**$156**	**$212**	**$184-245**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

Comparison table: S#2

		CT	ME	MA	NH	RI	VT	Notes
Energy	*2024 $/MWh*	$45	$46	$45	$45	$44	$46	*4*
RPS compliance	*2024 $/MWh*	$16	$15	$23	$11	$21	$7	*4, 5*
IRCEP compliance	*2024 $/MWh*	$1	$1	$0	$1	$0	$0	
Electric energy and cross-DRIPE	*2024 $/MWh*	$40	$5	$18	$5	$40	$0	*6*
GHG non-embedded	*2024 $/MWh*	$68	$68	$83-143	$68	$68	$90-152	*4,7,8*
Energy subtotal	***2024 $/MWh***	**$169**	**$134**	**$169-229**	**$130**	**$172**	**$144-205**	
Capacity	*2024 $/kW-year*	$33	$32	$34	$32	$34	$32	*9*
Capacity DRIPE	*2024 $/kW-year*	$22	$4	$31	$4	$54	$0	*9,10*
Regional Transmission (PTF)	*2024 $/kW-year*	$69	$69	$69	$69	$69	$69	*11*
Value of reliability	*2024 $/kW-year*	<$1	<$1	<$1	<$1	<$1	<$1	*9*
Capacity subtotal	***2024 $/kW-year***	**$123**	**$105**	**$133**	**$106**	**$156**	**$101**	-
Capacity subtotal	***2024 $/MWh***	**$25**	**$21**	**$27**	**$22**	**$32**	**$21**	*12*
Total	***2024 $/MWh***	**$194**	**$156**	**$196-256**	**$152**	**$204**	**$165-226**	**-**

All values are 15-year levelized costs.
For states that use a social cost of greenhouse gases, a range of results across 1.5-2% discount rates is shown. The AESC 2024 report recommends the use of the EPA-derived SC-GHG, which includes costs for 1.5% and 2% discount rates.

