MA ENERGY EFFICIENCY ADVISORY COUNCIL

→ CONSULTANT TEAM

2018 AESC REGIONAL AVOIDED COST STUDY: UPDATE ON DRAFT RESULTS

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2018 AVOIDED COST STUDY (AESC)

- **2018 Avoided Cost Study (AESC) is nearing completion**
  - Avoided Energy Supply Component ("AESC")
- **Intended for use in the next Three-Year Plan, for the 2019-2021 programs; study results are due on March 30th**
- **Developed through and prepared for AESC study group**
  - Regional study, participation of six New England states
  - Dozens of participants in the AESC study group process
  - Weekly AESC study group calls, mid-October through March
- **AESC study is prepared every three years**
  - 2015 AESC was the most recent prior study, which has been used for the 2016-2018 programs
- **AESC is a regional study, but each state decides how to apply the study results in its state, and which values to apply**
- **Synapse team is the contractor for the 2018 AESC study**

AESC 2018 – Draft Report

Presentation of draft results

Prepared for the March 29, 2018 MA EEAC Meeting (Subset of the slides used by the Synapse team for the March 15, 2018 webinar and AESC study group meeting)

Synapse Energy Economics, Resource Insight, Sustainable Energy Advantage, Northside Energy, Les Deman Consulting

AESC 2018 – Avoided Cost Values

1. Main values:
   a) Natural gas
   b) Fuel oil & other fuels
   c) Common electric assumptions
   d) Avoided capacity
   e) Avoided energy
   f) Avoided cost of compliance with RPS
   g) Non-embedded environmental costs
   h) DRIPE (price effects)
   i) Avoided T&D costs
   j) Value of improved reliability
   k) Sensitivities
   l) Appendices
   m) User Interface

1. Summary of Main Findings, AESC 2018

Table ES-1. Summary of Costs (WCMA, Summer On-Peak) -- DRAFT 03/28/18

	AESC 2015	AESC 2015	AESC 2018	AESC 2018, relative to AESC 2015		Notes
	2015 cents/kWh	*2018 cents/kWh*	*2018 cents/kWh*	*2018 cents/kWh*	*% Difference*	
Avoided Retail Capacity Costs	2.91	3.05	1.72	-1.33	-44%	3,4,5,6,7
Avoided Retail Summer On-Peak Energy Costs	6.29	6.60	4.63	-1.97	-30%	8,9,11
Avoided Renewable Energy Credit	0.96	1.01	0.39	-0.62	-61%	8,10,11
Subtotal: Capacity and Energy	**10.16**	**10.66**	**6.75**	**-3.92**	**-37%**	
CO2 Non-Embedded	**4.84**	**5.08**	**4.36**	**-0.72**	**-14%**	5
Transmission & Distribution	**-**	**-**	**2.11**	**2.11**	**-**	3,5,12
Reliability	**-**	**-**	**0.01**	**0.01**	**-**	3,5,7,13
Capacity DRIPE	-	-	0.91	0.91	-	5,7
Intrastate Energy, Own Fuel, and Cross-Fuel DRIPE	1.17	1.22	1.47	0.24	20%	8,14
Subtotal: DRIPE	**1.17**	**1.22**	**2.38**	**1.15**	**94%**	**-**
TOTAL FOR AESC 2018 STUDY	**16.16**	**16.97**	**15.61**	**-1.36**	**-8%**	**-**
MA TOTAL VS. 2015 (no CO2 non-embedded)	**11.33**	**11.89**	**11.24**	**-0.64**	**-5%**	

- Generally lower avoided costs when comparing with AESC 2015
  - Main drivers are lower costs for natural gas & RGGI; new or revised methodologies for capacity, DRIPE
  - New chapters on avoided T&D and value of reliability
  - Can customize costing periods for different "peak" or other periods, by prices or loads; all hours (8760 hours)
- Main differences for MA are shown in red in the table above

2a. Natural gas

- AESC 2018 Henry Hub is 19 percent lower than the AESC 2015 base case on a levelized basis; AESC 2018 Henry Hub is 5 percent lower than the AESC 2015 update
- Drivers of wholesale price changes in Henry Hub:
  - Higher gas production
  - Downward adjustment in breakeven drilling and operating costs in the major shale and tight gas producing regions

Summary of 15-year levelized Henry Hub, Algonquin Citygate, and basis differentials

	Units	Henry Hub	Algonquin Citygates	Basis
AESC 2015 (2016–2030)	2018 $/MMBtu	$5.44	$6.23	$0.80
AESC 2018 (2018–2032)	2018 $/MMBtu	$4.38	$5.39	$1.01
Change from AESC 2015 to AESC 2018	%	-19.4%	-13.6%	26.3%

Notes: All values are in 2018 $/MMBtu. AESC 2015 levelized costs are for 15 years (2016–2030) at a discount rate of 2.43 percent. AESC 2018 levelized costs are for 15 years (2018–2032) at a discount rate of 1.34 percent

2b. Fuel oil and other fuels

- We find that avoided levelized costs for residential fuel oil and other fuels are generally higher than was estimated in AESC 2015, while levelized costs for commercial fuel oil is slightly lower than was estimated in AESC 2015.
- The primary source of this difference is a change in data sources from the previous AESC study.

Comparison of avoided costs of retail fuels (15-year levelized, 2018 $/MMBtu)

	Residential						Commercial	
	No. 2 Distillate	Propane	Kerosene	BioFuel	Cord Wood	Wood Pellets	No. 2 Distillate	No. 6 Residual (low sulfur)
AESC 2015 (2016–2030)	$20.15	$19.26	$21.98	$19.61	$7.14	$8.12	$19.63	$17.29
AESC 2018 (2018–2032)	$22.17	$31.11	$19.88	$22.83	$13.40	$21.60	$18.47	$16.26
Change from AESC 2015 to AESC 2018	10.0%	61.5%	-9.6%	16.4%	87.8%	165.9%	-5.9%	-5.9%

2d. Avoided capacity costs

- Avoided capacity costs are driven by actual and forecast clearing prices in ISO New England's Forward Capacity Market (FCM).
- Forecasted capacity prices are based on the experience in recent auctions and expected changes in demand, supply, and market rules.

AESC 2018 capacity prices (2018 $ / kW-month)

Commitment Period (June to May)	FCA	AESC 2018	AESC 2015
2018/2019	9	$9.81	$13.60
2019/2020	10	$7.28	$11.85
2020/2021	11	$5.35	$11.89
2021/2022	12	$4.74	$12.29
2022/2023	13	$4.84	$12.20
2023/2024	14	$4.94	$11.93
2024/2025	15	$5.22	$12.55
2025/2026	16	$5.65	$12.55
2026/2027	17	$6.13	$12.64
2027/2028	18	$6.60	$12.37
2028/2029	19	$7.07	$13.08
2029/2030	20	$7.54	$13.42
2030/2031	21	$6.60	-
2031/2032	22	$7.07	-
2032/2033	23	$7.54	-
2033/2034	24	$6.60	-
2034/2035	25	$7.07	-
2035/2036	26	$7.54	-
15-year levelized		$6.52	$12.32
Percent Difference		-47%	-

Notes: All prices are in 2018 $ per month. Levelization periods are 2015/2016 to 2029/2030 for AESC 2015 and 2018/2019 to 2032/2033 for AESC 2018. Real discount rate is 2.43 percent for AESC 2015 and 1.34 percent for AESC 2018.
Source: AESC 2015 Exhibit 5-32.

2e. Avoided energy costs

- Key drivers of these lower prices include lower overall demand for electricity (even in a future with no incremental energy efficiency), lower Henry Hub natural gas prices, lower RGGI prices, more renewables (caused by changes to the RPS in states like Connecticut and Rhode Island), and the addition of a new transmission line from Canada.
- This decrease is similar to the change in avoided energy costs observed between the 2013 AESC study and the 2015 AESC study

15-year levelized cost comparison for WCMA region (2018 $ / MWh)

	Annual All hours	Winter Peak	Winter Off-Peak	Summer Peak	Summer Off-Peak
AESC 2015	$59.38	$65.18	$59.64	$60.54	$47.27
AESC 2018	$48.56	$55.67	$51.41	$42.91	$36.72
AESC 2015 Pcnt Diff	-18%	-15%	-14%	-29%	-22%

Notes: All prices have been converted to 2018 $ per MWh. Levelization periods are 2016–2030 for AESC 2015 and 2018–2032 for AESC 2018. The real discount rate is 2.43 percent for AESC 2015 and 1.34 percent for AESC 2018.
Source: AESC 2015 Exhibit 1-5, TCR workbook.

2g. Non-embedded GHG costs

Carbon dioxide

- Two possible approaches: one based on global avoided cost of CO_2, and one based on a New England-centric value
  - Global cost is based on avoided cost of Carbon Capture and Sequestration (CCS), about $100/short ton
  - New England-centric value based on estimated current US cost of offshore wind, about $318/short ton (also noted the European cost of offshore wind)
  - We have performed our initial calculations using the $100/short ton value, but have left it up to the PA's to determine which value should be used in their calculations

Nitrogen oxides

- Based on review of the literature—reasonably large range of values that are typically in the range of $13,000 to $60,000 per ton of N
- Heavily driven by assumed value of statistical life
- Estimated value of $31,000 per ton of N ($0.3 to $2 per MWh)
- Not applied in Appendix B

2h. DRIPE – Price Effects

- Demand Reduction Induced Price Effects (DRIPE)
- Refers to the reduction in prices in the wholesale markets for capacity and energy, relative to the prices forecast in AESC 2018 which result from the reduction in quantities of capacity and of energy required from those markets due to the impact of efficiency and/or demand response programs
- AESC 2018 models DRIPE benefits induced by reduced demand on electricity (energy and capacity), natural gas (supply and transportation), and oil markets
- DRIPE results in AESC 2018 differ from those in AESC 2015 because of differences in analytical approach, assumptions about hedging and decay, new commodity and capacity forecasts, and changes in market conditions.
- We find higher energy DRIPE values, higher capacity DRIPE values, lower natural gas supply DRIPE values, and lower natural gas transportation DRIPE values
- AESC 2018 DRIPE values are zone-specific, rather than state-specific

2i. Avoided T&D costs

- Developed a standardized approach to estimating generic avoidable T&D costs.
- Identified the portion of the pooled transmission facility (PTF) that would be allocated to Local Networks, thus calculating an avoided cost of $93/kW-year for PTF facilities. Avoided PTF cost is a new issue in AESC 2018.
- In addition, the various utilities may have some avoidable local transmission and distribution costs.
- For non-PTF transmission, and for distribution, we discuss methods for estimating avoided T&D costs in the absence of recent or forecast load growth.
- We also review the methods in use by the utilities and program administrators, and we identify areas in which the methods could be refined to better match the criteria.

2j. Value of improved reliability

- New issue in AESC 2018
- Reducing electric loads can improve reliability in several ways, which differ among generation, transmission, and distribution.
- Our analysis addresses the effect of increased reserve margins on generation reliability, the value of unserved energy, the potential and obstacles in estimating the effect of load levels on T&D overloads and outages, and the value of lost load.
- The average benefit of reducing unserved energy through higher generation reserves, including offsets for reductions in capacity cleared, would be about $1/kW-year over five years for cleared resources and $3 to $4/kW-year over 10 years for uncleared load reductions.

2m. User Interface

- Users will be able to view avoided costs according to the traditional AESC costing periods (summer on-peak, summer off-peak, winter on-peak, winter off-peak), or set up their own costing periods where they focus on peak prices or peak loads
  - Useful for active demand management and other demand-side resources
- Excel workbook containing hourly load and price data for 2018-2035 for each region, for 8760 hours
- Also dynamically calculates DRIPE values
- Updates are ongoing

WHAT DO 2018 AESC RESULTS MEAN FOR 2019-2021 PROGRAMS?

- **Too soon to tell for certain**
  - Only the draft report is available (final report due March 30)
  - Need to analyze effects and implications of new AESC values
- **Overall, programs and most measures likely will still be cost-effective with lower avoided costs**
- **Effects will vary based on nature of the program and measure, and the strategy and savings shape**
  - Targeted to summer or winter load, on-peak or off-peak?
  - Focused on energy savings or capacity savings, or both?
- **Active demand management may be affected significantly by lower capacity avoided costs**
  - But there are several offsetting factors, including higher capacity DRIPE and increased T&D avoided costs
- **Stay tuned**

APPENDIX

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HOURLY AVOIDED ENERGY COSTS FOR ALL HOURS OF YEAR

- **2018 AESC is providing hourly avoided energy costs for all hours of the year – 8760 hours**
- **Will enable the users of the AESC study to calculate avoided energy costs for a variety of "peak" energy costing periods, while providing some flexibility**
  - AESC users could calculate peak periods that better match the load shape (savings shape) and value (avoided costs) of EE and active demand management resources
  - Avoided energy costs for the hours of highest peak energy hours (e.g., 40 or 80 hours, or 88 hours/1% of hours) based on highest energy demand or highest energy prices
  - May be particularly useful for active demand management strategies
  - Alternatively, AESC users could use all 8760 hours in their cost-effectiveness screening

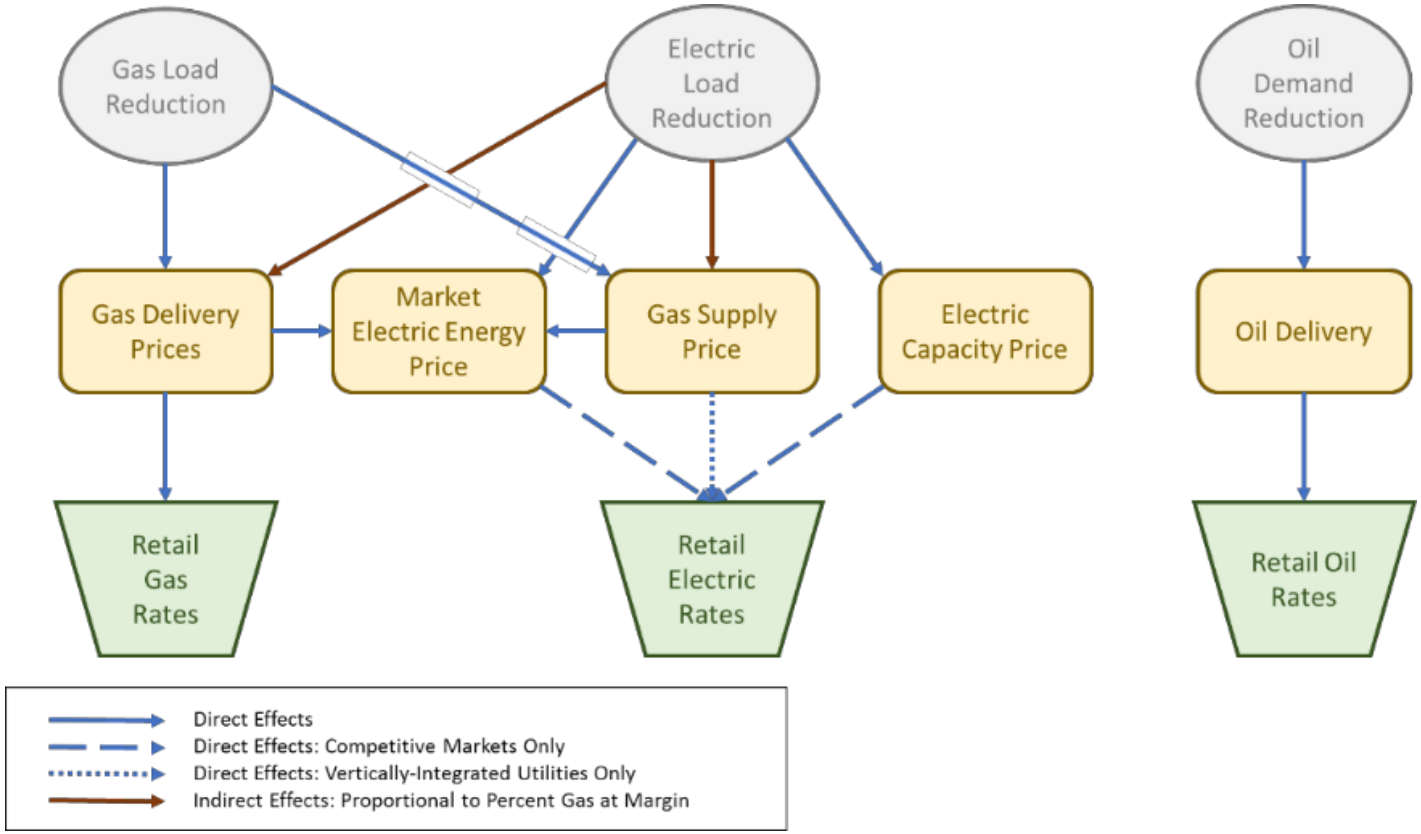
CAPACITY AVOIDED COSTS ARE CRUCIAL FOR DEMAND MANAGEMENT

- **Active demand management measures operate for a small number of hours (often less than 1% of all hours, or less than 88 hours a year)**
  - Therefore, even very significant changes in avoided peak *energy* costs may have a relatively small effect
- ***Capacity* avoided costs matter most, and were a core task in the 2018 AESC study**
  - Resources bid into the Forward Capacity Market (FCM)
  - Resources not bid into the FCM, but would affect the Installed Capacity Requirement (ICR) and future forecasts
- **But the capacity avoided costs values in 2018 AESC are lower than 2015 AESC capacity values**
- **Capacity price effects (DRIPE) also important**
  - Capacity DRIPE avoided costs are higher in 2018 AESC study (above the 0 value in 2015 AESC)

Notes for Table ES-1

1. Values are shown for the WCMA reporting zone, summer on-peak, on a 15-year levelized basis; all values are in 2018 dollars.
2. AESC 2015 values levelized (2016-2030) escalated with a factor of 1.050
3. Assumes load factor of 55%
4. Avoided cost of capacity purchases
AESC 2015 cost (2015 $/kW-year) of $140.10/kW-year
AESC 2018 cost (2018 $/kW-year) of $83.09/kW-year
5. Distribution loss adjustment of 8.0%
6. Reserve margin adjustment of 17.2%
7. This analysis assumes that 100% of capacity, capacity DRIPE, and reliability values are cleared or bid into the capacity market
8. Wholesale risk premium adjustment of 8.0%
9. Avoided wholesale energy cost (2018 $/MWh) of $42.91/MWh
10. AESC 2018 REC price (2018 cents/kWh pre-adjustment) of 0.36 cents/kWh
11. Retail cost = avoided wholesale cost x (1 + risk premium)
12. Assumes T&D cost (2018 $/kW-year) of $94.00/kW-year
13. Assumes reliability value (2018 $/kW-year) of $0.58/kW-year, and a VOLL of $25.00/kWh
14. "Energy DRIPE" is the sum of intrastate electric energy, own-fuel, and electric cross-DRIPE values. In both AESC 2015 and AESC 2018, these DRIPE values represent the Massachusetts-wide (zone-on-zone) value, but not the Rest-of-Pool amount.
15. All AESC 2015 data from Exhibit 1-2 in AESC 2015. Small differences in values are due to rounding, except for (a) CO2 non-embedded costs and (b) energy DRIPE which have been adjusted to reflect the wholesale risk premium.

2h. DRIPE


Gas Load Reduction
Electric Load Reduction
Oil Demand Reduction
Gas Delivery Prices
Market Electric Energy Price
Gas Supply Price
Electric Capacity Price
Oil Delivery
Retail Gas Rates
Retail Electric Rates
Retail Oil Rates
Direct Effects
Direct Effects: Competitive Markets Only
Direct Effects: Vertically-Integrated Utilities Only
Indirect Effects: Proportional to Percent Gas at Margin