Synapse
Energy Economics, Inc.

Avoided Energy Supply Costs in New England:

2009 Report

August 21, 2009

AUTHORS

Rick Hornby, Paul Chernick, Dr. Carl V. Swanson, Dr. David E. White, Ian Goodman, Bob Grace, Bruce Biewald, Chris James, Ben Warfield, Jason Gifford, and Max Chang

PREPARED FOR

Avoided-Energy-Supply-Component (AESC) Study Group

22 Pearl Street
Cambridge, MA 02139
www.synapse-energy.com
617.661.3248

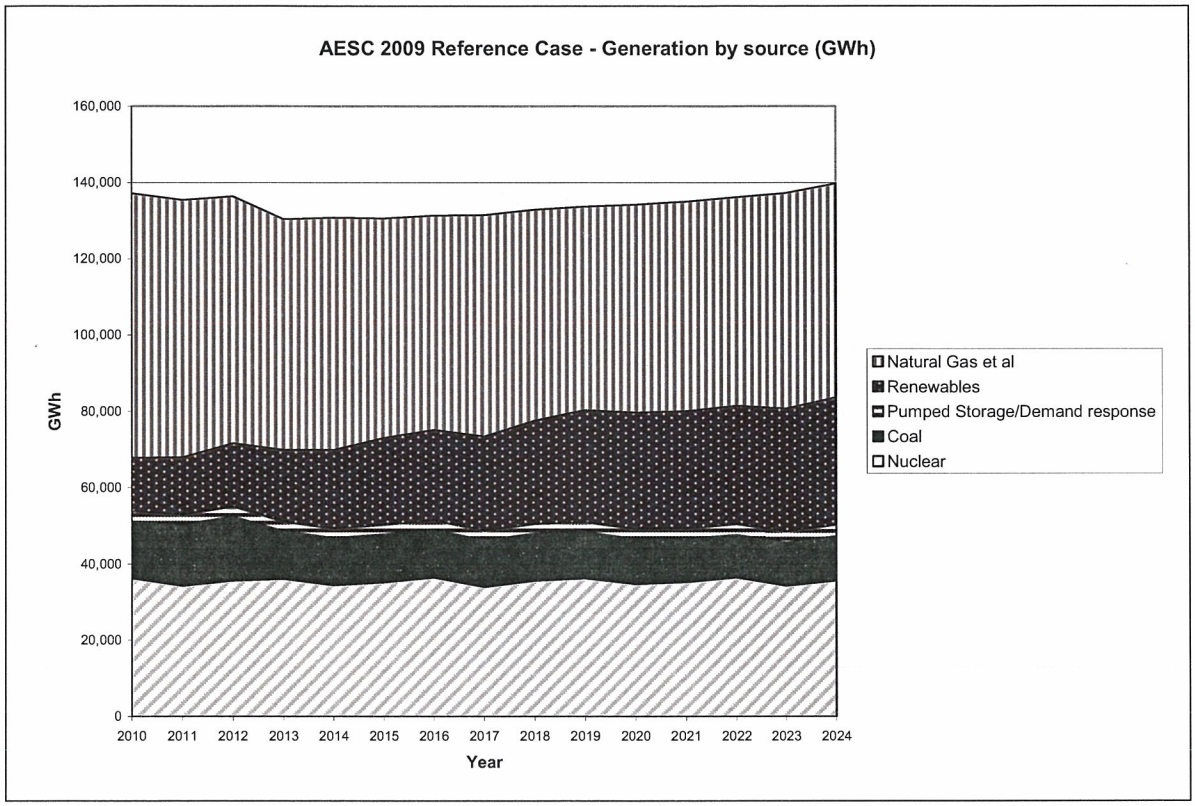
Conservation Management Board, Massachusetts Department of Public Utilities, Massachusetts Department of Energy Resources, Massachusetts Attorney General, Massachusetts Energy Efficiency Advisory Council, Massachusetts Low-Income Energy Affordability Network (LEAN) and other Non-Utility Parties, New Hampshire Public Utilities Commission, and Rhode Island Division of Public Utilities and Carriers.

The 2009 AESC Study Group specified the scope of work, selected the Synapse Energy Economics (Synapse) project team, and monitored progress of the study. The Synapse project team presented its analyses and projections to the 2009 AESC Study Group in nine substantive tasks. The draft deliverable for each task was reviewed in a conference call. The relationship between the chapters in this report and the task deliverables is as follows:

- Chapter 2. Wholesale Markets for Electric Energy, Capacity and Renewable energy—Task 3;
- Chapter 3. Wholesale Market for Natural Gas—Task 4;
- Chapter 4. Avoided Costs of Natural Gas—Task 6;
- Chapter 5. Avoided Costs of Crude Oil and Related Fuels—Tasks 5 and 9;
- Chapter 6. Avoided costs of Electricity—Task 7;
- Chapter 7. Sensitivity of Wholesale Electric Energy Prices to Changes in Key Inputs—Task 8;
- Chapter 8. Instructions for Applying avoided electricity Costs—Task 10.

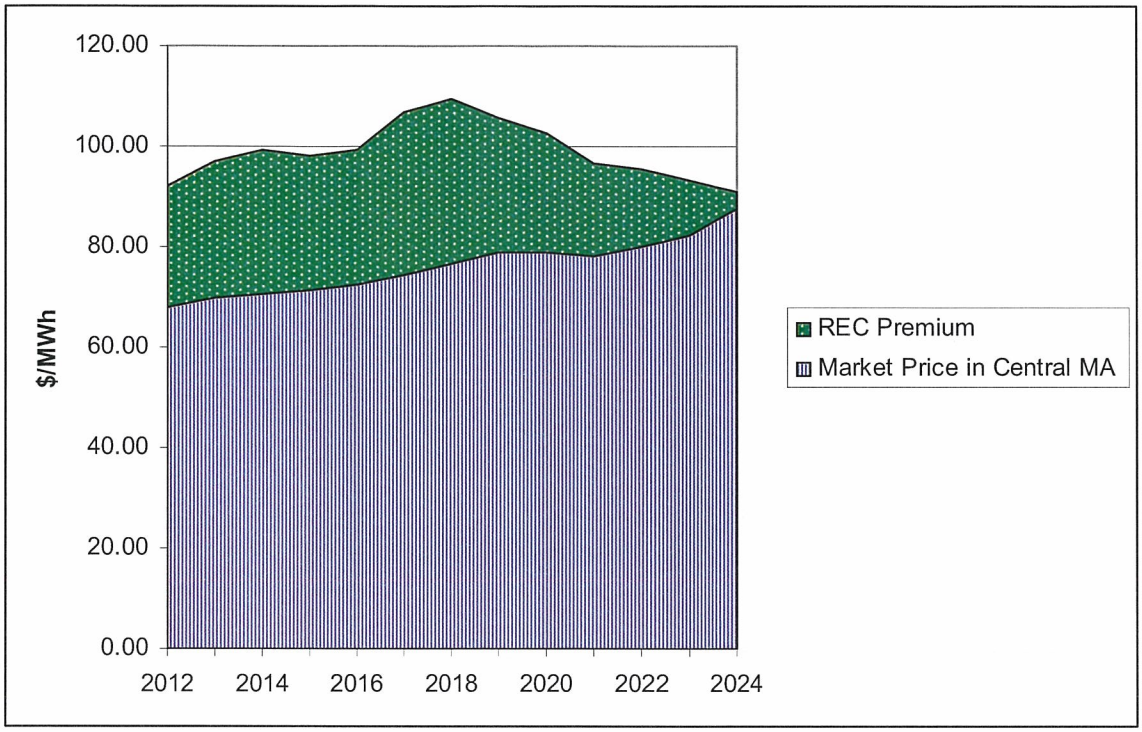
The report was prepared by a project team assembled and led by Synapse. Dr. David White and Ben Warfield of Synapse were responsible for projecting wholesale electric energy prices. Paul Chernick of Resource Insight led the analysis of wholesale capacity costs and DRIPE. Bob Grace and Jason Gifford of Sustainable Energy Advantage (SEA) provide estimates of renewable energy credit demand, supply and price. Ian Goodman and Brigid Rowan of The Goodman Group prepared an analysis of the economic development impacts of Massachusetts efficiency programs with input from Dr. William Steinhurst. Dr. Carl Swanson of the Swanson Energy Group led the analysis of avoided natural gas costs and Rick Hornby developed projections of other fuels. Chris James, Max Chang and Bruce Biewald of Synapse developed externality values for air emissions avoided due to reductions in electricity and fuel use. Rick Hornby served as project manager with support from Max Chang. Adam Auster of Resource Insight provided editorial support.

Exhibit 1-3: Reference Case, Generation by Source (GWh)



The avoided costs of RECs are a function of two factors. One is the forecast quantity of renewable energy that load serving entities (LSEs) will have to acquire in order to comply with the relevant Renewable Portfolio Standard. The second is the forecast premium over wholesale electric energy market prices that LSE will have to pay to acquire that renewable energy. The forecast REC premium is based upon an estimate of the cost of new entry of Class I renewables from 2012 onward and the forecast annual wholesale electric energy price. See Exhibit 1-4.

Exhibit 1-4: Forecast Wholesale Electric Energy Prices and REC premiums



The 15 year levelized projections of avoided electric energy costs for the 2009 and 2007 AESC studies are shown in Exhibit 1-5.

Exhibit 2-13: Average REC and APS Prices 2008 and January–March 2009
(Dollars per MWh)

		2008	2009
Conn.	Class I	$23.44	$27.71
	Class II	$0.53	$1.18
	Class III	$19.18	N/A
Mass.	Class I	$26.76	$33.47
	Class II renewable	N/A	$1.75
	Class II waste-energy	*No public values available*	
	Class III	*No public values available*	
R.I.	New	$30.25	$34.50
	Existing	$1.00	$1.25
Maine	New	$30.25	$34.50
	Existing	$0.23	$0.24
N.H.	Class I	$35.50	$37.50
	Class III	$21.75	$22.00
	Class IV	$20.00	$26.00
Data from confidential REC brokers quotations compiled by Sustainable Energy Advantage, LLC			

Sustainable Energy Advantage, LLC (SEA) estimate REC prices for new renewables RPS Tiers in the longer-term (after 2012) based on their analysis of the cost of entry of new renewable energy resources. That analysis will utilize SEA's renewable energy supply curve model to determine the marginal (or market-clearing) resource in each year through 2020 based on the difference between a levelized cost for the marginal renewable resource and the resource's commodity market value based on our reference-case forecast of wholesale electric-energy-market prices.

We will forecast REC prices for the remaining two tiers as follows:

- For all New Hampshire Class II (solar) our estimate is the lesser of (1) the alternative compliance price and (2) the difference between a levelized cost of energy estimate for solar and our production-weighted reference-case forecast of wholesale electric-energy-market prices.
- For all other RPS tiers we will escalate recent broker-derived prices at inflation.

2.5.5. *Reserve-Margin Multiplier*

Exhibit 6-30: Calculated Incremental Renewables: New and Import

Year	Supply of Class I Requirements					
	New England		IMPORTS		Total	Renewable Surplus (Shortfall)
	Existing	New	Existing	New		
	a	b	c	d	e= sum(a to d)	f=e-Class I RPS Requirement
2009	3,035	0	1825	0	4,860	294
2010	3,035	979	1825	61	5,900	272
2011	3,035	1569	1825	305	6,734	(121)
2012	3,035	2596	1825	549	8,005	(114)
2013	3,035	4502	1825	793	10,155	661
2014	3,035	5989	1825	1037	11,886	935
2015	3,035	6990	1825	1281	13,131	487
2016	3,035	8478	1825	1524	14,862	517
2017	3,035	9034	1825	1768	15,662	(443)
2018	3,035	10717	1825	2012	17,589	(62)
2019	3,035	12234	1825	2256	19,350	194
2020	3,035	13385	1825	2500	20,745	139
2021	3,035	14733	1825	2500	22,093	570
2022	3,035	15176	1825	2500	22,536	77
2023	3,035	16474	1825	2500	23,834	418
2024	3,035	17653	1825	2500	25,013	621

Over time, the net Requirements to be met by resources within ISO-New England will further reduced by an estimate of *additional* RPS-eligible imports over existing tie lines, phased in at a rate consistent with the recent historical rate of increase in RPS-eligible imports over a ten-year period.

In addition to *new* or *incremental* renewables, several states also have minimum requirements for existing renewable energy sources, or other eligible sources. The eligibility details and target percentages are summarized in Appendix C.

6.4.2. Estimated Cost of Entry for New or Incremental Renewable Energy

Our general approach to estimating renewable supply is described in Deliverable 3-1. We assume that, after a few years of transition, the price of renewable energy will be set at the cost of new entry. To estimate the new or incremental REC cost of entry[106], we constructed a supply curve for incremental New England renewable energy potential based on various resource potential studies that sorts

[106]The derivation of costs for NH Class II (solar) were performed separately.

the supply resources from the lowest cost of entry to the highest cost of entry.[107] The resources in the supply curve model are represented by 135 blocks of supply potential from resource studies, each with total MW capacity, capacity factor, and cost of installation and operation applicable to projects installed in each year.

The supply curve consists of land-based wind, biomass, hydro, landfill gas, offshore wind and tidal resources. Land-based wind is the largest source by far, modeled as 86 blocks, varying by state, number and size of turbines in each project, wind speed and distance from transmission,

The price for each block of the supply curve is estimated for each year. For each generator, we determined the levelized REC premium for market entry by subtracting the nominal levelized value of production consistent with the AESC 2009 projection of wholesale electric energy prices from the nominal levelized cost of marginal resources.[108]

- the nominal levelized cost of marginal resources is the amount the project needs in revenue on a levelized $/MWh basis;
- The nominal levelized value of production is the amount the project would receive from selling its commodities (energy, capacity, ancillary services) into the various wholesale markets; and
- The difference between the levelized cost and the levelized value represents the additional revenue the project requires to attract financing.

Unless the revenue from REC prices can make up that difference, the project is unlikely to be developed. Resource blocks are sorted from low to high REC price, and the intersection between incremental supply and incremental demand determines the market-clearing REC price for market entry. Our projections assume that REC prices for new renewables will not fall below $2/MWh, the estimated transaction cost associated with selling renewable resources into the wholesale energy market. This estimate is consistent with market floor prices observed in various markets for renewable resources.

---

[107]These assumptions are based on technology assumptions compiled by Sustainable Energy Advantage, LLC from a range of studies and interviews with market participants. Some characteristics are adapted from those used in a New England renewable energy supply curve analysis prepared by Sustainable Energy Advantage, LaCapra Associates and AWS Truewind in late 2007 and early 2008 for the Maine Governors Wind Task Force Study on behalf of the Natural Resources Council of Maine. Typical generator sizes, heat rates, availability and emission rates are consistent with technology assumptions used by ISO-New England in its scenario planning process.

[108]SEA calculated these levelized analyses using discount rates representative of the cost of capital to a developer of renewable resource projects.

(b) the current level of RPS imports; and

(c) additional imports over existing interties to neighboring control areas.

In addition, for solar and fuel-cell resources, which tend not to be resource-constrained, we separately estimated the amounts that would be driven by various policy initiatives; these amounts were also netted from gross demand.

Our projection of the cost of new entry is summarized in below in Exhibit 6-31.

Exhibit 6-31: REC Premium for Market Entry ($/MWh)

	REC Premium for Market Entry (2009$/MWh)
2012	$24.26
2013	26.87
2014	28.61
2015	26.76
2016	26.92
2017	32.30
2018	32.54
2019	26.90
2020	23.97
2021	18.67
2022	15.65
2023	10.96
2024	3.25

These results are highly dependent upon the forecast of wholesale electric energy market prices, including the underlying forecasts of natural gas and carbon allowance prices, as well as the forecast of inflation used by SEA. A lower forecast of market energy prices would yield higher REC prices than shown, particularly in the long term.

In contrast to the long-term REC cost of entry, spot prices in the near term will be driven by supply and demand, but are also influenced by REC market dynamics and to a lesser extent to the expected cost of entry (through banking), as follows:

- Market shortage: Prices approach the cap or Alternative Compliance Payment