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Update to the Analysis of the Impact of Cape Wind on Lowering New England Energy Prices

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1. Summary

Charles River Associates (CRA) has conducted an updated analysis of the impact of the Cape Wind project on lowering the ISO New England wholesale electricity market. Cape Wind, a 468 MW offshore wind power project planned for Nantucket Sound, is expected to provide enough power to supply approximately 4 percent of projected 2014 demand in Massachusetts and approximately 2 percent of total projected 2014 New England demand. This additional supply will reduce the need for generation from other power plants with higher operating costs and pollutant emissions, primarily fueled by natural gas, oil, and coal. Using updated input assumptions, CRA has projected wholesale power prices over the period 2014-2038, for scenarios with and without Cape Wind in service, and quantified the expected reduction in wholesale power prices and wholesale electricity costs that would result from the power supplied by the project. In addition, CRA estimated the effect of the Cape Wind project on employment in New England.

Key differences in input assumptions compared to CRA's 2010 analysis include:

- Lower peak demand projections, while the energy demand forecast remained flat.
- Larger price spread between natural gas and fuel oil.
- Absence of a national carbon scheme.
- Additional generation retirements, driven by environmental regulations.

The principal findings of the updated analysis are:

- **Adding Cape Wind would lead to a reduction in the wholesale cost of power averaging $286 million annually over the years 2014–2038, resulting in an aggregate savings of $7.2 billion over 25 years.**
- **With Cape Wind in service, over the years 2014–2038, the price of power in the New England wholesale market would be $1.86/MWh lower on average.**
- **Over the combined 16-year period spanning construction and the first 15 years of operations Cape Wind would create an average net addition of 514 jobs in Massachusetts and 1,119 jobs in New England.**

2. Approach

2.1. Methodology to assess Wholesale Price Impact

In New England, electric power is bought and sold through a competitive wholesale market.[1] As a result of industry restructuring, New England utilities and other load serving entities own and operate almost no generating capacity, but rather make wholesale purchases from the competitive market, the costs of which are ultimately recovered through retail rates charged to end-use customers. Most New England customers pay a retail rate closely tied to prices set in periodic Standard Offer Service auctions, which in turn closely ties to expected wholesale power costs. Wholesale power costs are therefore a good measure of electricity costs for consumers in the New England Region. CRA has estimated the savings from Cape Wind by comparing wholesale power costs for the region with and without the project in service.

Introducing Cape Wind's additional supply into the competitive wholesale power market will lower prices by displacing higher cost generation. Power in New England is priced hourly, with the market price set by the offer from the highest-cost source of supply needed to meet demand. In each hour that the price is set by power plants with lower operating costs, rather than higher-cost units displaced by the supply from Cape Wind, the wholesale clearing price will be lower and electricity costs reduced. The variable operating cost of wind turbine generators is almost zero, so electricity from Cape Wind will be offered at the bottom of the regional supply stack in every hour it is available. Hence, Cape Wind will displace higher-cost generation and the associated greenhouse gas emissions in almost every hour of every year, resulting in a reduction in the market price. CRA has estimated these price decreases for each hour of each year from 2014 through 2038 and calculated the associated reduction in wholesale power costs.

The projections provided in this report cover the 2014 through 2038 time period and rely on the following key input assumptions:

- Natural gas and oil prices are based on reference case described in the Energy Information Administration (EIA)[2] Annual Energy Outlook (AEO) 2012 (Early Release), published in January 2012. We note that EIA's 2012 projections for natural gas have declined amid the increasing development of shale plays, while projections

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1 Power can be purchased through spot markets administered by ISO New England, or though bilateral transactions and forward electricity markets. The power sold from Cape Wind will affect prices in all of these markets, regardless of whether the output is sold under contract or through the spot markets. In fact, all generation, even if under contract, must be scheduled through the ISO New England spot markets. Power that is under contract for physical delivery is simply included at the bottom of the supply stack, therefore directly affecting the spot market. Likewise, expectations about prices in the spot market drive the pricing for forward transactions.

2 EIA, an administration with the US Department of Energy, provides data and forecast for the energy sector. The AEO provides a comprehensive, long-term view on energy supply, demand, and prices, based on fundamental modeling of the markets for each energy commodity. The 2012 AEO (Early Release) is available at: http://www.eia.gov/forecasts/aeo/er/

for oil prices increased relative to EIA's 2009 forecast that was used in CRA's prior analysis.

- Electricity demand growth as projected by ISO New England in its preliminary 2012 RSP forecast, presented in February of 2012. ISO New England's current forecast for gross peak demand are approximately 4% lower than 2009 CELT projections, while the current gross energy forecast is about 3% higher. Adjusting for Passive Demand Resources resulted in both energy forecasts being basically identical.
- Economic retirements of generating resources as projected in the 2012 Draft Integrated Resource Plan (IRP) of the Connecticut Department of Energy & Environmental Protection (DEEP), issued in January 2012. Economic retirements are assumed in response to environmental regulations. In particular the new Air Toxins Rules are expected to require investments in abatement technologies, which can render the continued operations of certain generation facilities uneconomical.
- Absence of a federal greenhouse gas program. The uncertainty surrounding timing and form of any potential carbon regulation did not warrant an inclusion in the analysis at this time. CRA did assume the continuation of the Regional Greenhouse Gas Initiative, covering all New England states.
- Inflation of 1.67 percent annually, based on the assumptions in the AEO 2012 (Early Release).

Additional detail about these assumptions is included in an appendix to this report.

CRA used the GE MAPS electricity market model to develop a fundamental forecast of market prices and generator dispatch for the New England Market. The GE MAPS model is a security-constrained dispatch model that simulates the chronological, hourly operation of an electricity market. The model takes the specified, cost-based bids for each generator in the market, along with other generating unit operating assumptions and performs a least-cost dispatch subject to limits on the flow of power across power lines and other elements of the transmission system. The model finds the least-cost dispatch of power plants and calculates hourly prices for electricity for each location within the New England market using the same basic approach that is applied in the actual operation of the power system and wholesale market.

CRA's analysis relied on forecasted production patterns that Cape Wind provided for the project. The production profile includes, for each month of the year, an average value for each hour of the day. In reality, there will be day-to-day fluctuations not captured in these patterns. Test data for the project site indicate that the hourly fluctuations during the summer months are coincident with warmer weather and higher electric demand. For example, due to the summer sea breeze effect, above average wind speeds have been recorded by Cape Wind's Scientific Data Tower on Horseshoe Shoal during twelve of the past thirteen peak electric demand events in New England. Hence, CRA's estimates are likely to understate the potential benefits during summer peak hours.

2.2. METHODOLOGY TO ASSESS EMPLOYMENT IMPACTS

The Cape Wind project is expected to affect employment both directly and indirectly. Manufacturing, construction, installation, and operating activities will create jobs in New England that are directly tied to the project. In addition the reduction in wholesale power prices and the associated increase in economic wealth of New England electricity consumers are expected to fuel job growth across the region.

CRA obtained third party estimates for the direct employment impacts of Cape Wind. The indirect employment impacts were estimated using Mr. Daly's estimate of above-market costs and CRA's projections of the wholesale market price impacts of adding Cape Wind. For the purposes of estimating the indirect employment impacts, CRA has not prepared a separate estimate the job impacts that would result from reductions in wholesale energy costs, but rather applied a jobs multiplier projection that was presented by a third party during the course of the Department of Public Utilities' investigation of a Cape Wind power purchase agreement with National Grid in D.P.U. 10-54.

3. Results

3.1. WHOLESALE PRICE IMPACT

Figure 2 shows CRA's estimates of difference in the average New England wholesale power prices with and without Cape Wind in service. Over the 25 years covered by the analysis, prices would be an average of $1.86/MWh lower with the project than without. As shown in Figure 3, the effect on wholesale electricity prices is even more pronounced for Massachusetts, where the project will be interconnected with the New England grid. The average price reduction for that zone is $1.95/MWh.

Figure 1: Wholesale Price Reduction for New England

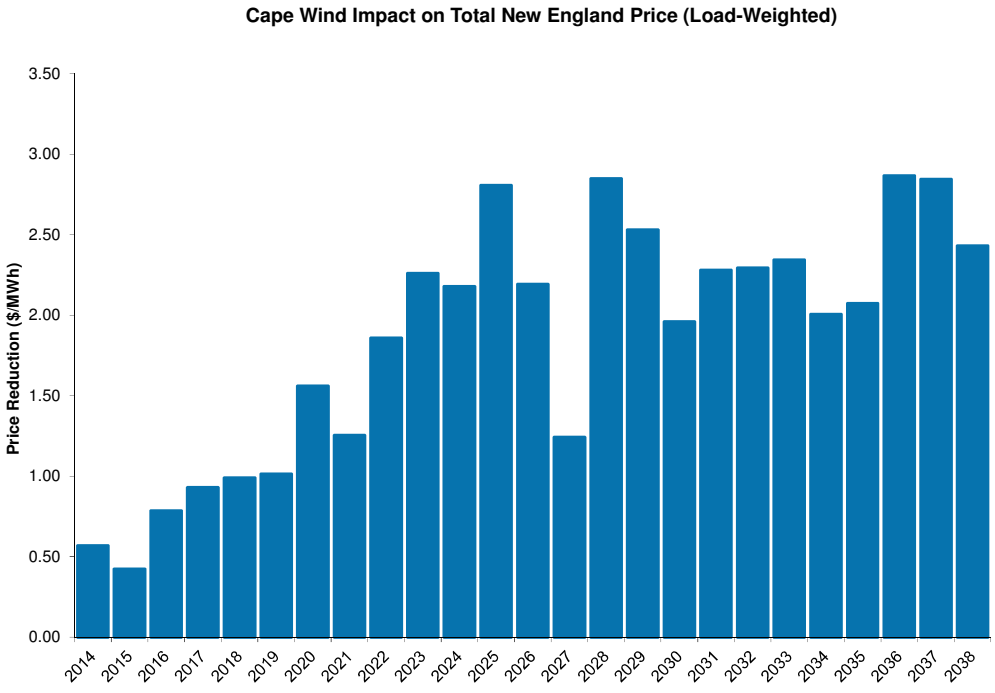
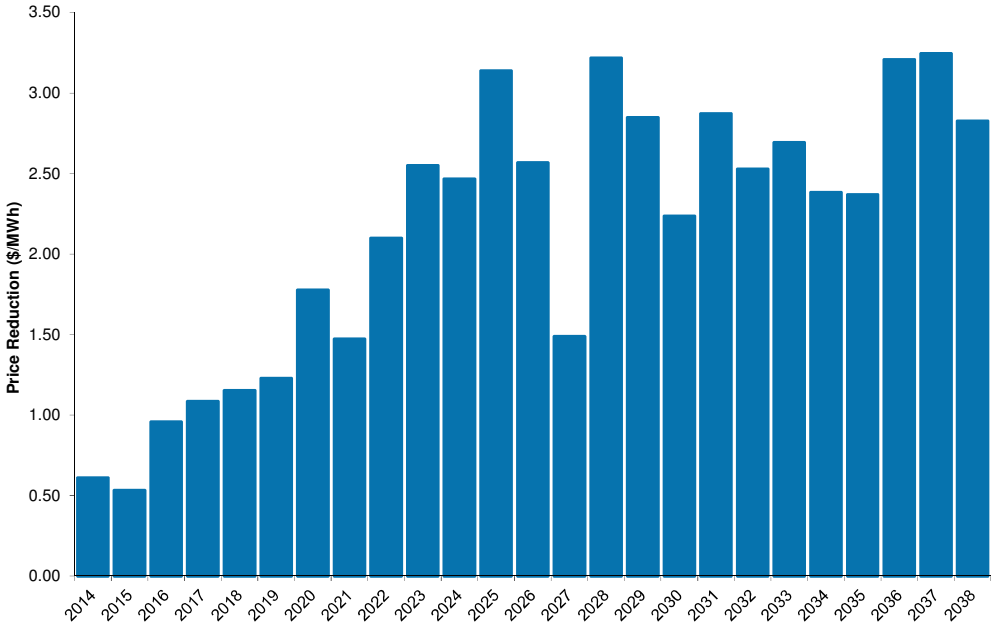


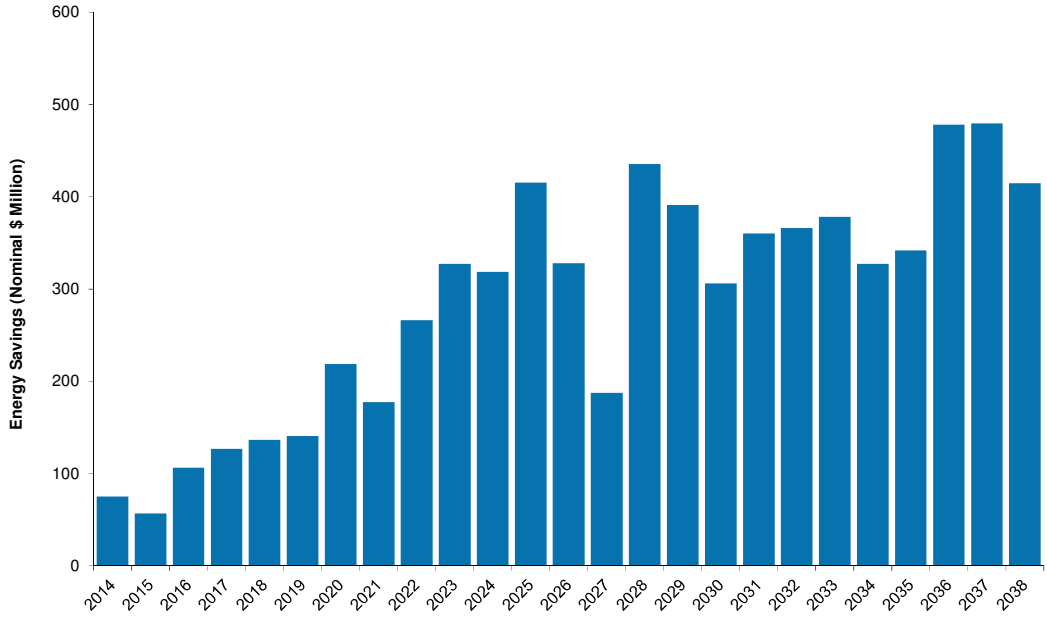
Figure 2: Wholesale Price Reduction for Massachusetts



3.2. Estimated Savings in Electricity Costs

Figure 4 shows the expected savings in electricity costs associated with the forecasted reduction in wholesale market prices. The cost savings range between $57 million and $480 million annually, totaling $7.2 billion over the 25 year period. The savings fluctuate from year-to-year due primarily to the addition of new generating capacity added to meet regional demand growth. Because minimum efficient scale for new power plants is generally large, on the order of 500 MW, adding a new plant creates an initial surplus, which depresses the electricity price, and prices then rise as the surplus is absorbed by demand growth.[3]

Figure 3: Projected Reduction in Wholesale Power Costs with Cape Wind in Service



3.3. Change in New England Generation Mix

In order to illustrate how the Cape Wind project would change the generation mix for New England, Figure 5 shows the change in generation for non-wind resources for a representative year, 2016. As shown in Table 1, the expected pattern is very similar for other years. The output of Cape Wind will displace other generation from fossil fueled power plants, burning primarily gas, oil, and coal. Additionally, Cape Wind is also expected to displace imports, or contributes to exports, for a reduction in total net imports to New

[3] Additionally, the price impact and cost savings fluctuate from year-to-year based on the timing of scheduled maintenance and forced outages for generating units, the latter of which are assigned randomly within CRA's model.

England. The impact of the Cape Wind project on pumped storage hydro facilities in New England is very limited.

Figure 4: Change in Other New England Generation with Cape Wind in Service, 2016

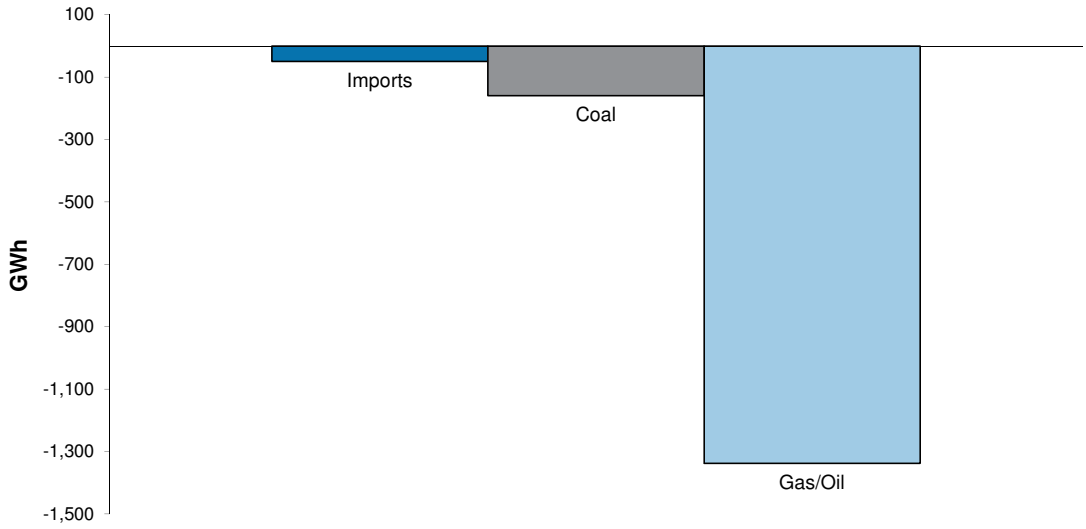


Table 1: Change in Non-Wind Generation by Fuel Type (GWh)

	2016	2020	2025	2030
Coal	(159)	(126)	(50)	(8)
Gas/Oil	(1,387)	(1,430)	(1,485)	(1,528)
Imports	(49)	(96)	(75)	(29)
Hydro	(7)	(31)	(21)	(11)
Demand Response	(3)	(3)	(15)	(11)

3.4. PRINCIPAL CHANGES FROM PRIOR ANALYSIS

These findings show a marked increase in the expected reduction in wholesale energy prices caused by the addition of the Cape Wind project. CRA's earlier report, completed in January 2010, showed an average annual savings of $185 million and total savings of over $4.6 billion. Our current estimates increase these numbers to $286 million and $7.2 billion, respectively.

There are two major contributors to this increase:

- **Increased unit retirements**. As discussed in more detail in the Appendix, CRA used the unit retirements that the Connecticut Public Utilities Regulatory Authority adopted in its recent Integrated Resource Plan (IRP). Relying on a study by The Brattle Group, Connecticut assumed that more resources retire, sooner, than CRA had

included in our 2010 report. This increase in retirements is sensible, given continued low capacity prices in the region and low energy margins (related to historically low natural gas prices). Fewer operating units lead to tighter reserve margins and, consequently, more hours when high-cost resources, such as oil-fired peakers or voluntary demand response, are deployed. In outer years, when we maintain a tight balance between supply and demand, the assumed economic retirement of large amounts of gas-fired steam generators decreases the "price buffer" between efficient combined-cycle gas turbines (CCGT), and high-cost peaking units and demand resources in New England's dispatch stack. The decreased buffer increases the likelihood of Cape Wind's price impact in a given hour being determined by the offer spread of CCGT versus oil-fired peakers (or demand resources), instead of the relatively smaller spread between gas-fired steam generators and oil-fired peakers (or demand resources).

- **Increased price spread between natural gas and fuel oil**. In most hours of the year, electricity prices in New England are set by gas-fired generation. As natural gas prices have fallen, so too have wholesale energy prices in most hours. In the hours with the highest load, however, or in the event of outages at major gas-fired facilities, high-cost resources—whose offer prices are not linked to natural gas prices—set the clearing price. Rising oil prices over the past years have increased the cost of oil-burning generation resources. The Cape Wind project reduces the frequency with which these non-gas resources are used. With falling gas prices and higher oil prices, the gap between the cost of gas-fired and high-cost resources has increased, and so too has the value of reducing the need for these high-cost resources.

3.5. IMPACT ON EMPLOYMENT ACROSS NEW ENGLAND

The Cape Wind project is expected to create 805 jobs in manufacturing and construction during the three years of its development and construction. Once on-line, the operation of the project is expected to create, directly, 154 permanent jobs in New England. The reduction of wholesale electricity prices (offset in part by the above-market cost of the power purchase agreement) is expected to lead to additional job growth. As shown in table 2, Cape Wind is expected to create an average net addition of 514 jobs in Massachusetts and 1,119 jobs across New England over the 16-year period between 2013 and 2028.

Table 2: New England Jobs created by Cape Wind

	Massachusetts employment impacts related to construction and operation	Employment Impact due to Change in Electricity Cost		Net Employment Impact	
		Massachusetts	New England	Massachusetts	New England
2013	805	-	-	805	805
2014	959	(100)	166	859	1,125
2015	959	(161)	30	798	989
2016	154	(10)	337	144	491
2017	154	41	455	195	609
2018	154	51	492	205	646
2019	154	60	501	214	655
2020	154	279	947	433	1,101
2021	154	142	676	296	830
2022	154	370	1,161	524	1,315
2023	154	502	1,470	656	1,624
2024	154	462	1,380	616	1,534
2025	154	691	1,860	845	2,014
2026	154	452	1,342	606	1,496
2027	154	62	566	216	720
2028	154	658	1,799	812	1,953
16-yr Average	295	219	824	514	1,119

APPENDIX: KEY ASSUMPTIONS

A.1 FORECASTED DEMAND

- Demand and peak loads for 2014-2020 are based on the preliminary 2012 ISO-NE RSP forecast, the most recent forecast for New England. Zonal load forecast were derived by applying the regional proportions of the 2011 CELT Report.
- CRA's load forecast is net of Passive Demand Resources (PDR), as projected in the 2012 ISO-NE RSP forecast. PDR values for 2012-2014 are taken directly from ISO-NE's forecast. CRA did not adopt ISO-NE's "proof-of-concept" numbers beyond 2014. Instead, starting in 2015 CRA grew PDR at the same rate as the growth in peak load.
- Beyond 2020, CRA escalated loads at the growth rate for 2020 (1.1%), as growth rates demonstrated a clear downward trend in the later years of ISO-NE's forecast period.
- CRA's market simulations reflect ISO-NE's projections of hourly electricity demand by zone.

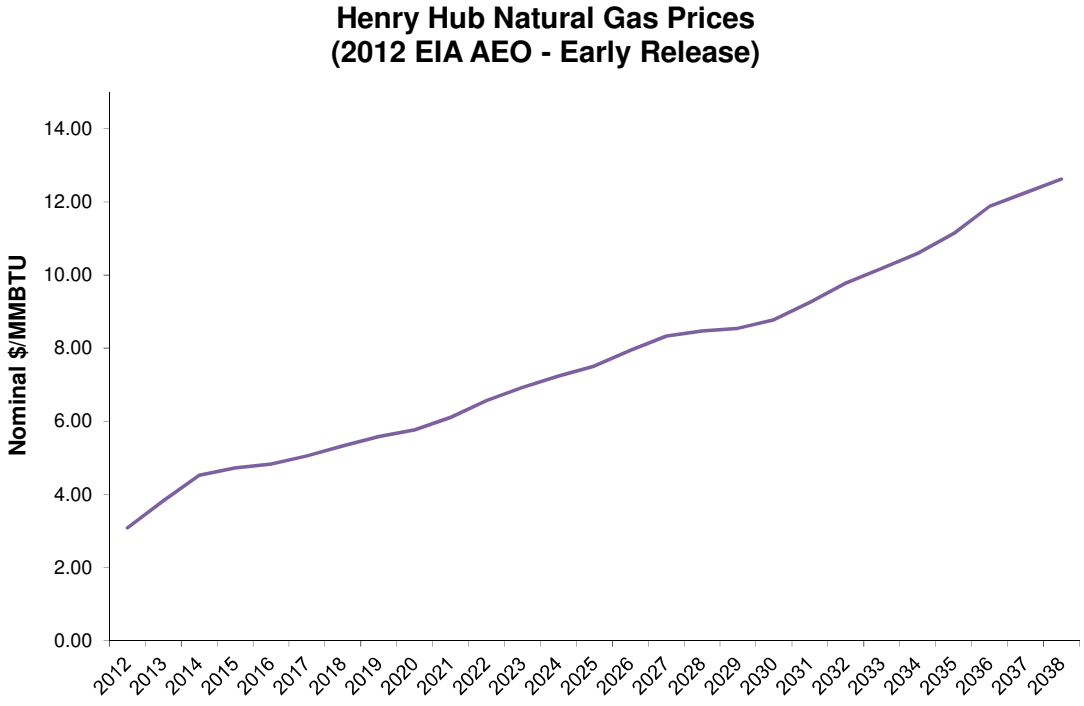
Table 3: Load Forecast

Year	2012 CELT Energy (GWh)	2012 CELT Peak(MW)	Growth Rate
2012	132,710	26,468	
2013	132,228	26,603	0.5%
2014	132,303	26,866	1.0%
2015	133,834	27,404	2.0%
2016	135,279	27,935	1.9%
2017	136,562	28,403	1.7%
2018	137,804	28,767	1.3%
2019	138,992	29,079	1.1%
2020	140,150	29,389	1.1%
2021	141,643	29,702	1.1%
2022	143,153	30,019	1.1%
2023	144,679	30,339	1.1%
2024	146,220	30,662	1.1%
2025	147,779	30,989	1.1%
2026	149,354	31,319	1.1%
2027	150,945	31,653	1.1%
2028	152,554	31,990	1.1%
2029	154,180	32,331	1.1%
2030	155,823	32,675	1.1%
2031	157,483	33,024	1.1%
2032	159,162	33,376	1.1%
2033	160,858	33,731	1.1%
2034	162,572	34,091	1.1%
2035	164,305	34,454	1.1%
2036	166,056	34,821	1.1%
2037	167,825	35,192	1.1%
2038	169,614	35,567	1.1%

A.2 FUEL PRICES

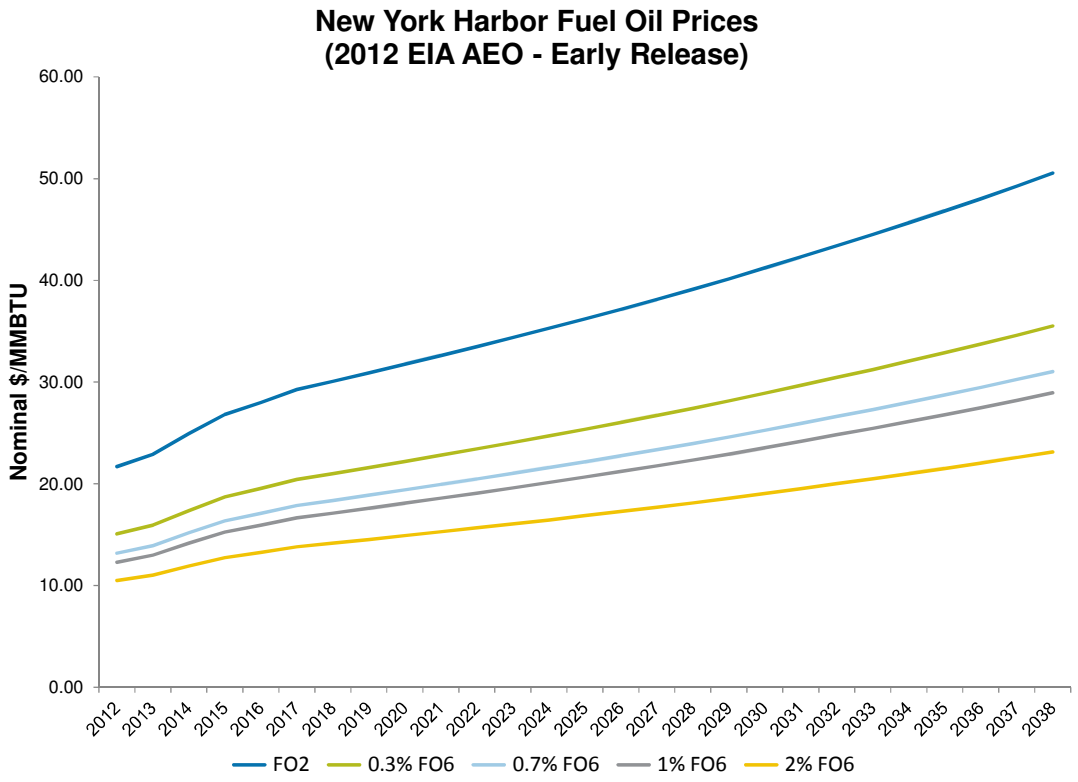
The gas forecast is based on the reference case forecast of the US EIA Annual Energy Outlook (AEO) 2012 (Early Release), released January 2012.

Figure 5: Henry Hub Natural Gas Prices (Nominal $/MMBtu)



Oil prices are based on the crude oil price forecast of the US EIA Annual Energy Outlook (AEO) 2012 (Early Release), released January 2012, and the historical price relationships between crude oil and products.

Figure 6: Fuel Oil Prices (Nominal $/MMBtu)



A.3 Carbon Policy

CRA assumed the absence of a federal carbon policy, and the continuation of the Regional Greenhouse Gas Initiative (RGGI), which provides regional CO2 allowance auctions for the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. RGGI allowances are assumed to remain flat at a price floor of $1.89/ton, consistent with the results of RGGI auction Nos. 11 through 14.

A.4 Generation Retirements

CRA's assumptions regarding generation retirements are based on the projections in the 2012 Draft Integrated Resource Plan (IRP) of the Connecticut Department of Energy & Environmental Protection (DEEP), issued in January 2012. Retirements include both planned retirements and assumed economic retirement. Economic retirements are assumed to result from environmental regulations, mainly compliance with EPA's new Air Toxics Rule that triggers the need for capital investments in abatement technologies for certain power plants.

Table 4: Generation Retirements

Unit Name	Summer Capacity (MW)	State	Retirement Year	Retirement Reason
AES Thames	183	CT	2012	Planned
Brayton Pt 4	435	MA	2016	Economic
Bridgeport Harbor 2	130	CT	2013	Economic
Holyoke 6/Cabot 6	10	MA	2015	Planned
Holyoke 8/Cabot 8	10	MA	2015	Planned
Middletown 4	400	CT	2015	Economic
Montville 6	47	CT	2016	Economic
Salem Harbor 1	80	MA	2012	Planned
Salem Harbor 2	78	MA	2012	Planned
Salem Harbor 3	150	MA	2012	Planned
Salem Harbor 4	437	MA	2012	Planned
Schiller 4	48	NH	2015	Economic
Schiller 6	48	NH	2015	Economic
Yarmouth 1	52	ME	2015	Economic
Yarmouth 2	51	ME	2015	Economic
Yarmouth 3	116	ME	2015	Economic

A.5 INFLATION ASSUMPTIONS

All values in this report are in nominal dollars, assuming an average annual inflation rate of 1.67 percent. The assumption is based on the inflation rates applied in the AEO 2012 (Early Release), shown in Table 3.

Table 5: Inflation Rates

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Wholesale Price Index (1982=1.00)									
All Commodities	2.00	1.98	2.00	2.04	2.09	2.13	2.16	2.20	2.23
Annual Inflation Rate	7.99%	-1.00%	1.05%	2.21%	2.45%	1.74%	1.80%	1.48%	1.58%

	2020	2021	2022	2023	2024	2025	2026	2027	2028
Wholesale Price Index (1982=1.00)									
All Commodities	2.26	2.30	2.34	2.37	2.41	2.44	2.48	2.52	2.55
Annual Inflation Rate	1.48%	1.53%	1.62%	1.54%	1.55%	1.44%	1.58%	1.47%	1.19%

	2029	2030	2031	2032	2033	2034	2035		2011-2035
Wholesale Price Index (1982=1.00)									
All Commodities	2.58	2.61	2.65	2.68	2.71	2.75	2.79		
Annual Inflation Rate	1.16%	1.30%	1.29%	1.32%	1.22%	1.37%	1.41%		**1.67%**