memo

To:	New England Stakeholders
From:	ISO New England System Planning Department
Date:	December 17, 2018
Subject:	High-Level Assessment of Potential Impacts of Offshore Wind Additions to the New England Power System During the 2017-2018 Cold Spell

Introduction

In late December 2017 and early January 2018, New England was gripped by a cold weather stretch of extended duration, with all major cities in New England averaging temperatures below normal for at least 13 consecutive days, including 10 days with average temperatures more than 10 degrees Fahrenheit below normal. This 16-day cold spell (December 24, 2017 through January 8, 2018) resulted in a temporary, but dramatic spike in the price of natural gas in New England, which in turn triggered heavy use of oil for electricity production and high wholesale electricity prices.

Following the cold spell, in response to a request from the Massachusetts Clean Energy Center (MassCEC) and using data provided by MassCEC, the System Planning Department at ISO New England performed a high-level assessment of the potential impacts offshore wind could have had on the power system and region, under similar cold-spell conditions. The assessment focused on the impact on production costs, environmental emissions, fossil fuel savings, and Locational Marginal Prices (LMPs).

This memo summarizes the results of that high-order-of-magnitude analysis. The analysis used gross assumptions in all calculations as follows:

- Limited number of offshore site locations provided by MassCEC
- Simplicity of system operations that does not capture all complexities of real-time operations, such as generators that might have frequently switched fuels or used mixes of oil and natural gas
- Use of annual rates for reductions of environmental emissions
- Estimates of heat rates for generating units
- Generic fuel prices and heat content of fossil fuels

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Estimated Energy Production from Offshore Wind Resources

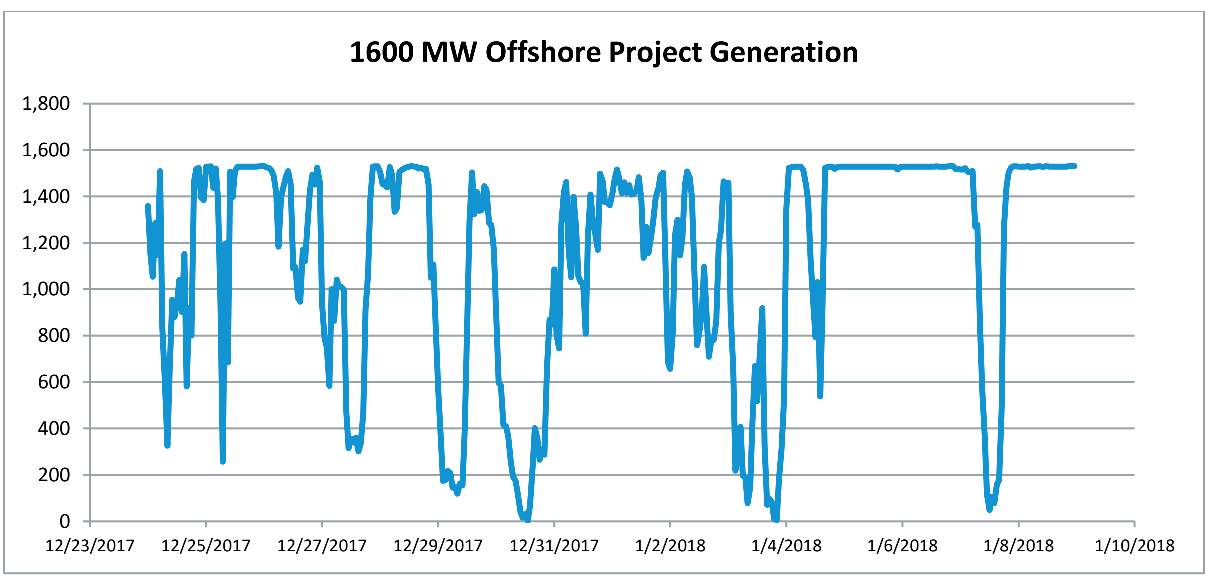
MassCEC provided the ISO with offshore wind production estimates for three offshore project scenarios of varying nameplate sizes: 400 MW, 800 MW, and 1600 MW. These estimates are based on wind speeds that were recorded for three offshore sites (Sites A, B, and C) during the cold spell period spanning from December 24, 2017 through January 8, 2018 (16 days). The offshore wind production estimate for each project scenario is shown in Table 1.

Figure 1 illustrates the estimated daily production of the 1600 MW project and shows that there are times when no wind production would have been expected during the 16-day period. This observation is consistent with the “cut-out periods” observed from existing New England wind facilities during the same 16-day period.

Table 1
MassCEC Offshore Wind Production Estimates (MWh)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
MassCEC Production Data (MWh)	106,865	215,569	435,257
Average Capacity Factor Over 16-day Cold Spell Period (% of nameplate capacity)	70%	70%	71%

Figure 1
Estimated Offshore Wind Production for MassCEC 1600 MW Project Scenario Based on Wind Speeds Recorded from December 24, 2017 through January 8, 2018 (MW)



During this same 16-day period, the load served in New England was approximately 6.4 terawatt hours (TWh). Based on the production data provided by MassCEC, the energy production from the three offshore project scenarios represent, respectively, 2%, 3% and 7% (rounded percentages) of the New England load served during the period.

During this same 16-day period, the native New England generation was approximately 5.3 TWh. Based on the production data provided by MassCEC, the energy production from the three offshore project scenarios represent, respectively, 2%, 4% and 8% (rounded numbers) of the native New England generation during the period.

High-Level Avoided Production Cost Estimates

High-level estimates for avoided production costs were computed by assuming that the offshore wind production would successfully displace marginal fossil production during the 16-day period. Resulting ranges of high-level avoided production costs (in Millions of $) are shown in Table 2.

Table 2
High-Level Avoided Production Cost Estimates ($ Millions)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
MassCEC Production Data (MWh)	106,865	215,569	435,257
Avoided Production Costs ($ Millions)	20-25	40-45	80-85

Estimated Avoided CO_2 Emissions

Annual average locational marginal unit (LMU) CO_2 emission rates in New England were used to estimate CO_2 emissions that could have been avoided by the additional offshore wind production. As in the computation of the high-level avoided production cost estimates, this analysis relies on the assumption that the offshore wind production would successfully displace any marginal, CO_2-emitting generation.

Actual CO_2 emissions from the New England generation fleet during the 16-day period were 2.07 million short tons. Estimated avoided CO_2 emissions for each scenario are shown in Table 3 and compared to actual CO_2 emissions.

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Table 3
Gross Approximation of Avoided CO_2 Emissions Using Annual Average New England LMU CO_2 Emission Rates (Short Tons and % of Actual New England CO_2 Emissions)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
MassCEC Production Data (MWh)	106,865	215,569	435,257
Estimated Avoided CO_2 Emissions (Short tons)	53,800	108,500	219,200
Estimated Avoided CO_2 Emissions (% of actual New England CO_2 emissions)	3%	5%	11%

Estimated Avoided Fuel Use

Using the offshore wind production estimates, displaced amounts of coal, oil, and natural gas production were determined for each project scenario during the 16-day period under study. These displaced amounts of fossil production were then in turn translated into fuel savings. Amounts of fuel savings were derived using each unit's primary fuel type and do not reflect changes in fuel consumption that could occur with active fuel switching during the actual cold spell event. Actual fuel amounts consumed for power production during the period were approximately 144,000 short tons of coal, 9 billion cubic feet of natural gas, and 2.4 million barrels of oil.

Table 4, Table 5, and Table 6 show order-of-magnitude results of avoided fossil fuel use resulting from the offshore wind production. The analysis does not include market dynamics, such as changes in bidding strategies of resources, resulting from the addition of wind production.

Table 4
Gross Estimates of Avoided Coal Use (Short Tons and % of Actual Use)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
Estimated Displaced Coal Production (MWh)	8,700	9,500	10,800
Estimated Avoided Coal Use (Short tons)	4,300	4,700	5,300
Estimated Avoided Coal Use (% of actual consumption)	3%	3%	4%

Table 5
Gross Estimates of Avoided Natural Gas Use (Billion Cubic Feet and % of Actual Use)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
Estimated Displaced Natural Gas Production (MWh)	34,900	114,600	248,000
Estimated Avoided Natural Gas Use (Billion cubic feet)	0.25	0.83	1.81
Estimated Avoided Natural Gas Use (% of actual consumption)	3%	9%	20%

Table 6
Gross Estimates of Avoided Oil Use (Barrels and % of Actual Use)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
Estimated Displaced Oil Production (MWh)	52,700	56,000	87,700
Estimated Avoided Oil Use (Barrels)	96,300	102,300	160,200
Estimated Avoided Oil Use (% of actual consumption)	4%	4%	7%

Changes in Average Day-Ahead LMP at the Hub

Table 7 shows approximate day-ahead LMP changes that could have resulted from the 400 MW, 800 MW and 1600 MW offshore projects. In reality, real-time events that occur on the system, including deviations in offshore wind production between the day ahead and the real time, could cause additional real-time LMP variations that are not captured in this analysis.

Table 7
Approximate Average Day-Ahead LMP Changes at the Hub ($/MWh)

	400 MW Project (Site A)	800 MW Project (Sites A + B)	1600 MW Project (Sites A + B + C)
MassCEC Production Data (MWh)	106,865	215,569	435,257
Average Day-Ahead LMP Changes (at the Hub, in $/MWh)	-6 to -4	-8 to -6	-13 to -11

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