Clean Energy Analytics

The Benefits and Costs of 2016 Massachusetts Clean Energy Legislation (H-4568)

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Introduction

The Massachusetts legislature recently enacted new law (H-4568) on July 31st, 2016 (signed by Governor Baker on August 8th) in an effort to promote energy diversity, reliability, and clean energy. We believe the intended underlying rationale is to reduce greenhouse gas (GHG) emissions in support of the prior Global Warming Solutions Act (GWSA). This legislation establishes contractual obligation goals that Massachusetts electric utilities meet through a competitive bidding process for power purchases from large hydro and offshore wind (OSW) projects. It also provides rules to support and encourage emerging energy storage technology, small hydro, plus additional distributed generation and conservation through commercial Property Assessed Clean Energy (PACE) financing. Little quantified analysis of the regulations has appeared in public to our knowledge. Clean Energy Analytics (CEA), an independent energy consulting firm, in an effort to provide the public, energy industry and environmental community with a perspective on the potential major benefits and costs of this sweeping new regulation undertook this analysis.

Executive Summary

CEA's analysis shows that if the hydro and OSW resource portions of this legislation are fully implemented, it would lead to over 40% reduction in Massachusetts GHG emissions from electric power generators by 2027. But since electric power is contributing only 20% of the total GHG emissions in Massachusetts, the impact on total reduction of GHG emission is roughly 9%. Accomplishing the above GHG reduction will result in additional cost to electric customers of between $5.70 and $8.50 for a typical 600 kWh/month residential customer. The resulting unit cost for reducing GHG emissions from fossil fuels is approximately 30 to 40 $/MT CO_2 for hydro and 160 to 250 $/MT CO_2 for the OSW projects. Assuming that one of the goals of this legislation is to reduce overall GHG emission in Massachusetts, these estimates can provide a basis for comparison to other solutions.

The hydro and OSW resources called for in the legislation provide benefits from reduced dependence on natural gas. This will potentially reduce the risk of natural gas and electric price spikes from pipeline constraints during the winter season. Introduction of large scale renewable resources could lower wholesale electric market prices. These savings can be passed on to ratepayers offsetting some of the contract costs for the hydro and OSW. Potential risks from lower wholesale energy prices, not evaluated in this high level analysis, include potential early retirement of key generating resources and increased capacity prices which can result in reversing GHG reduction gains and erode energy price savings.

The legislative approach was to direct support to large-scale hydro and OSW. Utilizing markets to advance goals as an alternative, such as cap and trade (RGGI for CO_2 and Clean Air Interstate Rule success in reducing SO_2 and NO_x) or carbon tax (as in British Columbia) have proven effective, efficient and supportive of innovations. These approaches can reduce GHG emission from all sectors of the economy, including the 80% of MA CO_2 emissions from sources other than power plants. Inclusion of all emission sources can provide a basis to economically optimize consumer expenditure towards meeting GWSA goals.

CEA study assumptions

CEA analyzed New England ISO electric generation resources to assess the impact of new renewable resources on energy prices and GHG emissions. The quantitative analysis is built upon publicly available information and it is a high level attempt to quantify benefits and costs associated with H-4568. This study focuses on years 2023 through 2027 when major elements of energy legislation are introduced into the market. It uses the ISO gross demand forecast which has a small decline through 2025 (minus the behind-the-meter PV and minus the passive demand resources). The analysis assumes the same annual system demand trajectory to continue for 2026 and 2027. It incorporates capacity additions and retirements outlined in the CELT Report, such as Pilgrim station's planned retirement in 2019.[1] Beyond the time horizon of the CELT Report, we have assumed a generation mix with increasing renewable resources in compliance with the annual changes in RPS requirements, plus new large hydro and OSW resources per the legislation. We assumed both new hydro and OSW facilities will be price taker resources on the ISO-NE grid. This analysis assumes that Massachusetts will be responsible for the costs and receive 100% of the GHG benefits of the hydro and OSW resource commitments under H-4568.

The total hydro power cost is the sum of the energy and transmission costs. For this analysis, hydro generation is assumed to be supplied from Canadian resources starting in 2023 to deliver 9.45 million MWh/year for twenty years. Cost of transmission to deliver hydro energy is based on the redacted public Northern Pass proposal, which has a cost of $1.66B and will deliver 6.3 TWh per year[2]. Capital cost estimate used in this analysis was scaled to 9.45 TWh specified in H-4568 legislation. An 11% blended cost of capital is used to compute a twenty-year delivery cost of $33/MWh. The legislation calls for "guarantee energy delivery in winter months" however likely Canadian suppliers are also winter-peaking entities. These suppliers may require a premium to supply Massachusetts firm energy during these winter peak demand periods. Depending upon the firmness of the winter energy supply, CEA used two scenarios: (1) a low cost based on average annual wholesale price of electricity in New England, and (2) at a 10% premium above the average wholesale price.

The new offshore resources are assumed to add 400 MW increments annually from 2024 through 2027 (1600 MW total OSW additions). The range of cost for delivered OSW power is based on estimates from "Massachusetts Offshore Wind Future Cost Study" by University of Delaware, Special Initiative on Offshore Wind[3]. It projects a high-end cost of ₵16.2/kWh to a low of ₵12.8/kWh through 2028. These cost estimates include transmission cost for delivery to ISO-NE and a net capacity factor of 46%. Costs used for both hydro transmission and OSW PPA are increased by 2.75% remuneration payment to EDCs allowed under H-4568.

Fossil-fired generation costs are estimated using forward fuel prices. Future prices for carbon emission allowances are based on the Regional Greenhouse Gas Initiative (RGGI)[4] projections and were included in cost of generation from fossil-fired resources. Although the legislation provides rules to support and

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[1] http://www.iso-ne.com/system-planning/system-plans-studies/celt

[2] The Northern Pass Clean Energy RFP Overview, Public Version Redacted,

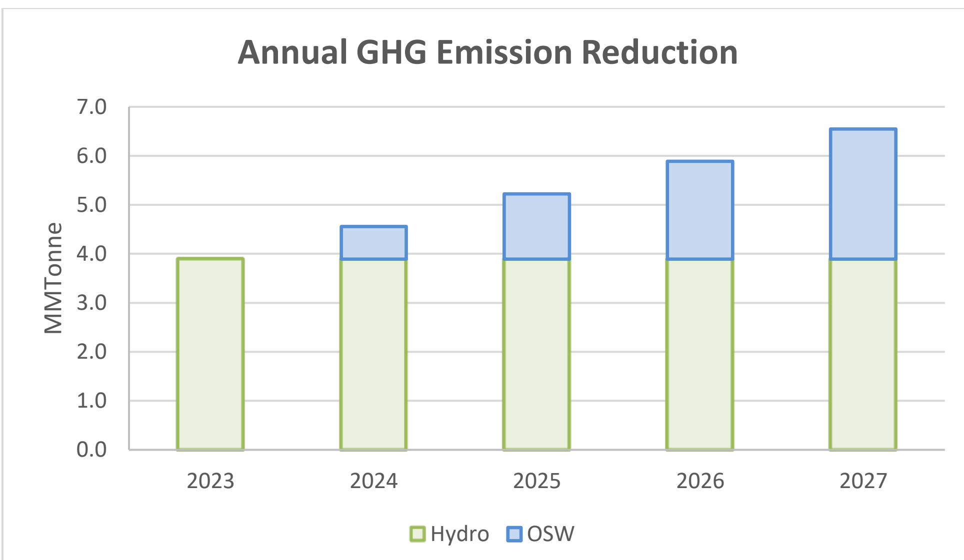
[3] https://www.ceoe.udel.edu/File%20Library/About/SIOW/MA-Offshore-Wind-Future-Cost-Study-FINAL-14-Mar-16.pdf

[4] Draft_Results_RGGI_N+E_Reference_Case_2016_06_17

encourage emerging energy storage technology, small hydro, plus additional distributed generation and conservation through commercial Property Assessed Clean Energy financing; this analysis focused on the hydro and OSW impacts. All costs are expressed in 2016 dollars and do not include inflation.

GHG Reduction Results

The new hydro and OSW energy resources will displace existing marginal fossil-fuel-fired units, such as natural gas. This will reduce CO_2 emissions by an estimated 3.9 million metric tons (MMT) from hydro purchases and by about 2.7 MMT from offshore wind purchases for a total reduction of 6.5 MMT by 2027(see graph). The above reduction is 40% of existing Massachusetts electric system GHG emissions which are estimated at 15 MMT for 2014 according to Massachusetts Office of Energy and Environmental Affairs (EEA).[5] It should be noted that today, electricity generation is not the leading GHG emitter in Massachusetts with an estimated total of 75 MMT. Other Massachusetts sources of GHG emissions according to EEA include: transportation at 30 MMT, residential & commercial (primarily heating) 20 MMT, and industrial and others at 10 MMT. The impact of the new resources on the total Massachusetts GHG emission is approximately an 8.7% reduction. Massachusetts has already reduced GHG emissions by approximately 20 MMT since 1990 primarily through switching generation from coal and oil to natural gas. In 2015, regional coal stations served less than 2% of New England's power generation and natural gas approximately 43%.



Impact on Electric Service Costs

The New England Independent System Operator (ISO-NE) manages the transmission grid and coordinates power plant generation within the New England states to meet the regional demand for electricity. Through a daily bidding process, ISO-NE selects generators in an ascending bid price order to meet the system demand. The bid price for each generator represents its marginal operating costs such as fuel. The bid price of the last generator needed to meet the system demand sets the wholesale

[5] http://www.mass.gov/eea/agencies/massdep/climate-energy/climate/ghg/greenhouse-gas-ghg-emissions-in-massachusetts.html

energy price for electricity paid to all generators, the locational marginal price (LMP). Resources with low variable cost or with limited ability to control output will bid a low price to insure selection and are referred to as price taker resources. These include renewable resources as well as contracted resources with firm volume requirements. OSW and hydro generation are such resources and assumed to bid as price takers and receive the ISO-NE wholesale electricity price. This price had an annual average for 2015 of $41/MWh[6]. As additional price taker resources are incorporated into the system, they displace higher operating cost alternatives and lower the system LMP, thereby reducing revenue all generators collect for their power. The lower LMP provides saving that can be passed onto customers, offsetting some if not all of the new clean power contract costs, i.e. transmission cost of hydro and the total Power Purchase Agreement (PPA) obligation for OSW. However, this does not account for the possibility that the reduction in LMP may be short-lived and it can be eroded through the capacity market as indicated in the ISO paper[7]. This analysis is focused on the energy market effect of the energy legislation and does not attempt to quantify this potential secondary impact.

CEA's analysis indicates that new hydro purchases called for under H-4568 could reduce ISO-NE LMP by approximate $3.70/MWh by 2027. Similarly, addition of 1,600 MW of OSW could further reduce LMP by about $2.70/MWh for a combined $6/MWh (0.6 ₵/kWh)[8] of price suppression by 2027. Another possible benefit, not quantified here, is the potential reduction in natural gas prices. As gas-fired generators are displaced by new hydro and OSW resources, demand for natural gas is diminished, resulting in reduced pipeline congestion and reduced price spikes for natural gas[9] during winter peak periods. These price reductions will benefit all customers on the ISO-NE grid as well as natural gas customers in New England.

Once the reductions in LMP costs are netted against the OSW PPA obligations and hydro transmission investment cost, the increased cost to a typical Massachusetts residential consumer's (600 kWh/month) bill is expected to be in the range of $5.70 to $8.50 per month by 2027. The analysis indicates the cost increase would be roughly in the range of $1.10 to $1.60/month for imported hydro energy in 2027, followed by the additional cost for OSW in the range of $4.50 to $6.90 by 2027 (see graph). A recent poll by the Energy Policy Institute at University of Chicago (EPIC) and The Associated Press-NORC Center for Public Affairs Research (see NYT article, Sept. 15, 2016[10]) indicate 57 percent of Americans are willing to pay at least one dollar a month to reduce carbon emissions. The same poll shows that 39% would pay at least $10/month to reduce GHG emissions.

[6] http://www.iso-ne.com/static-assets/documents/2016/05/2015_imm_amr_final_5_25_2016.pdf; see page 58, table3-2

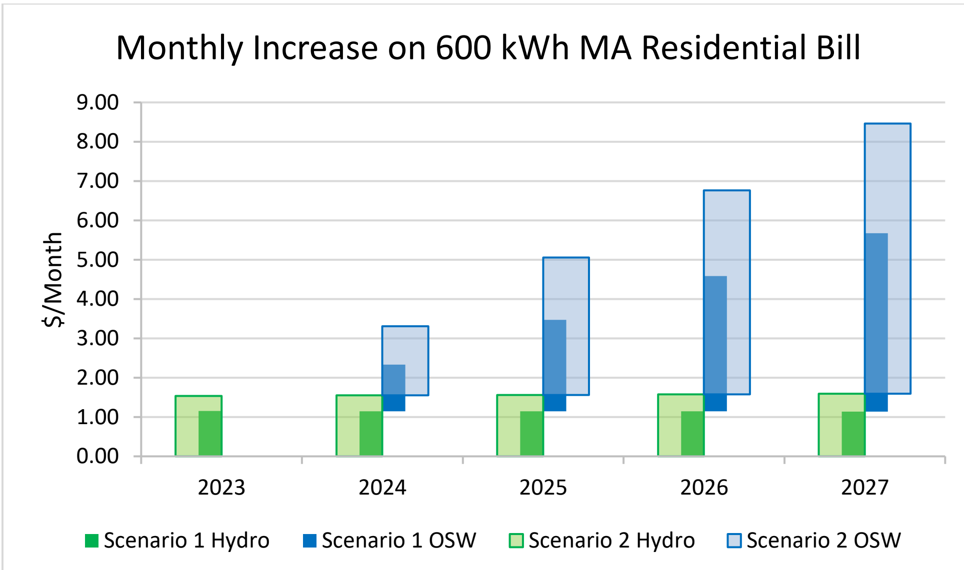
[7] Page 3 - https://www.iso-ne.com/static-assets/documents/2015/10/iso-ne_discussion_paper_--_capacity_market_and_renewable_energy_future_--_revised_version_--_10-30-2015.pdf

[8] Note that the price suppression effect diminishes for increasing increments of additional renewable resources on the grid.

[9] "Assessing Natural Gas Supply Options for New England and their Impacts on Natural Gas and Electricity Prices" http://competitive-energy.com/docs/2014/02/CES_REPORT_NaturalGasSupply_20140131_FINAL.pdf

[10] http://www.nytimes.com/2016/09/15/upshot/americans-appear-willing-to-pay-for-a-carbon-tax-policy.html?mwrsm=Email&_r=0

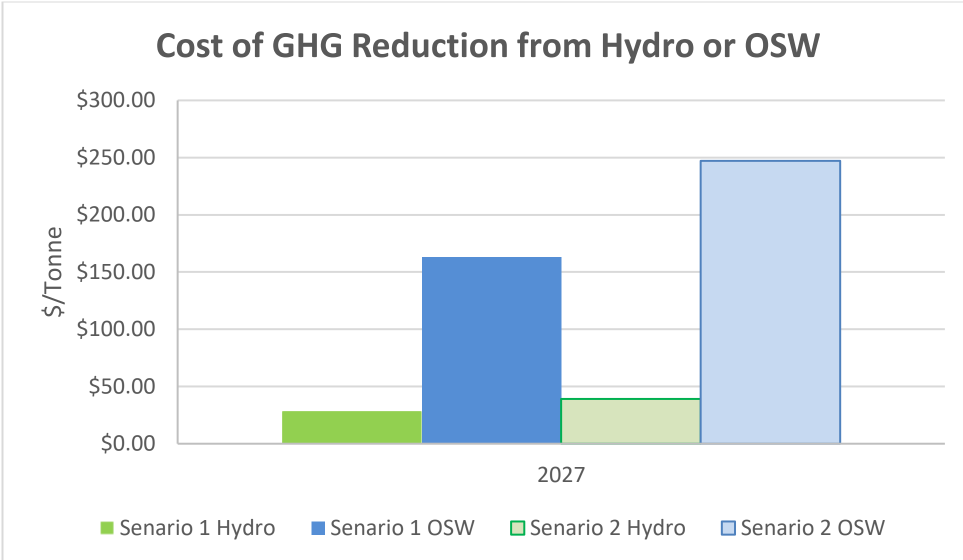
As indicated earlier, price suppression benefits of new additional renewable resources may be short lived as suggested by ISO-NE. In a recent discussion paper entitled "The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future"[11] ISO states: "Additional renewables are expected to decrease wholesale electric energy prices, which in turn will increase capacity prices to meet resource adequacy needs. The shift in revenues from energy to capacity market will also affect the resource mix, putting additional financial pressure on energy-market-dependent resources." CEA has not attempted to estimate any potential capacity price increases.



Effectiveness for GHG Reduction

The incremental cost increase in connection with H-4568 implementation may be viewed as the cost to reduce GHG emissions. The CEA analysis shows that clean imported hydro will reduce GHG emissions at a cost of approximately $30 to $40/MT CO_2. Similarly, OSW will incrementally reduce GHG emissions for a cost of between $160 to $250/MT. A recent U.S. government study reportedly used three economic models which estimated the social cost of an additional ton of carbon at $37/MT to the economy. Another study at Stanford estimated the social cost at $220/MT CO_2.[12] Synapse, a consulting firm, has estimated that the mid-case levelized price over the period 2020-2050 at $41/MT.[13] While the proposed OSW cost from a GHG emission perspective may seem high, this analysis did not attempt to quantify any potential indirect benefits, such as making Massachusetts a hub for offshore energy.

[11] https://www.iso-ne.com/static-assets/documents/2015/10/iso-ne_discussion_paper_--_capacity_market_and_renewable_energy_future_--_revised_version_--_10-30-2015.pdf
[12] "Estimated social cost of climate change not accurate, Stanford scientist say" Stanford News, January 12, 2015
[13] "2015 Carbon Dioxide Price Forecast", Synapse Energy Economics Inc., March 3, 2015.



Effectiveness on Diversity and Reliability

The hydro and OSW resources in the legislation should provide benefits from reduced dependence on natural gas. CEA projects that if both the new hydro and OSW resources are added to the grid by 2027 New England natural gas consumption would decrease by about 313 MMcf/day. To provide a perspective, this amount is slightly less than the Spectra/Algonquin Incremental Market (AIM) pipeline capacity (of 342 MMcf/day) scheduled to start operation in November 2016. Electricity generation from natural gas would drop from approximately 43% to 31% grid-wide and down to 16% for Massachusetts. As reliance on natural gas is reduced, New England will be more insulated against seasonal natural gas price volatility.

Other Risks

Hydro project cost consists of an energy purchase price plus the cost of transmission lines to deliver the energy. While the existing estimates for transmission cost may be based on best available information, there may be many additional unforeseen construction issues with the new transmission. Any such cost over-runs could be borne by the ratepayer. Alternatively, a transmission service contract with firm cost caps and satisfactory liquidated damage protection would potentially mitigate these risks at a price premium.

OSW facilities of the size discussed here are new to North America and any cost estimate may be subject to unforeseen price risks. There are location variables that can impact construction costs and add uncertainty to the total project cost in deep-water installations. However, due to Europe's extensive experience with offshore wind projects, these estimates are increasingly more reliable. US DOE believes significant cost decreases to today's cost estimates are potentially achievable.[14] CEA believes cost estimates from University of Delaware report "Massachusetts Offshore Wind Future Cost Study" are consistent with US DOE expectations. Fixed priced power purchase agreements can limit ratepayer

[14] "Energy, Interior Chiefs Talk Up Offshore Wind Power Plans", State House New Service, Sept. 9, 2016

exposure to unforeseen and potential cost overruns. Each project also requires review by regulatory bodies which could decide their viability on the basis of cost effectiveness.

Summary/Observations

The recent legislation has potential impact to the “market based” solution approach promoted in the 1997 rules deregulating power generation. It strongly encourages certain large scale clean energy resources and favors these resources over those of the current market-based generation system. It does so “to promote energy diversity” as well as attempt to manage toward the GWSA targets.

The analysis does show a significant reduction in total annual natural gas usage and thus likely lowers dependency on this fuel source. However, risks still remain for very cold winter periods if either or both of the resources cannot deliver expected power.

Roughly 40% of Massachusetts GHG emission comes from transportation, 28% from residential/commercial, 12% from industrial/other, while only 20% now comes from electricity generation. CEA’s analysis shows if the new hydro and OSW resources are added to the regional grid, the cost for reducing total Massachusetts GHG emissions by 6.5 MT is between $70 and $100 a year for a typical residential customer. Many Massachusetts customers may consider this a worthwhile investment, others may not. Are we doing enough in other areas to reduce GHG emissions and would they produce a lower cost solution for a similar volume of GHG reduction?