Reimagining Brayton Point

A guide to assessing reuse options for the Somerset community

Prepared for Coalition for Clean Air South Coast, Clean Water Action, and Toxics Action Center

March 3, 2016

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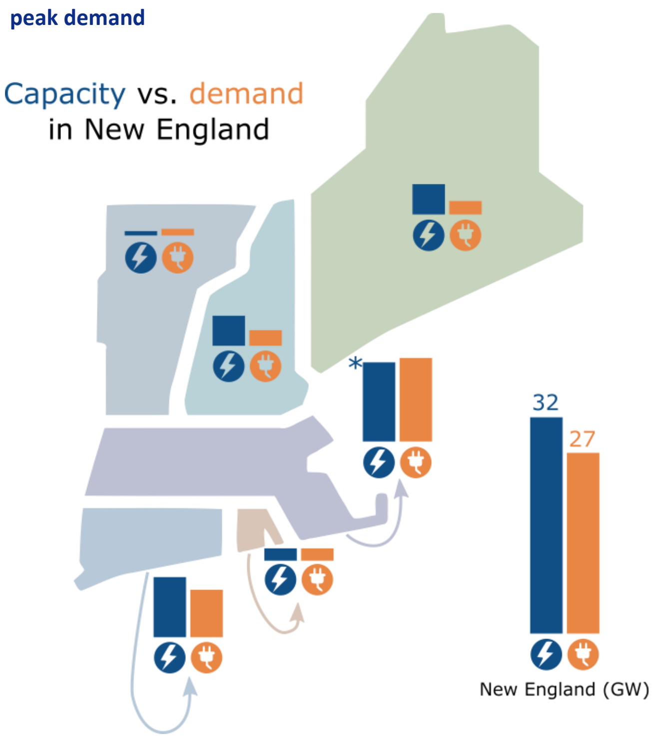
EXECUTIVE SUMMARY

In May 2017, the Brayton Point coal-fired power plant in Somerset, Massachusetts will cease operating. Despite being the largest and most advanced coal plant in the Northeast in terms of pollution controls, Brayton Point simply could not compete against cheap, abundant natural gas and an ever-increasing push for clean, renewable energy.

Over the last few years, as production from the plant declined and revenues fell, the owners of Brayton Point entered into an agreement with Somerset officials for a "Payment in Lieu of Taxes" (or PILOT) program that would gradually—and significantly—reduce the amount of taxes paid to the town as the plant moves toward retirement. Recently, the Town of Somerset worked with the Massachusetts Clean Energy Center to explore potential options for reusing the site that could, among other things, help replace some of the tax revenue that will be lost when the plant finally shuts down.

Some Somerset residents may believe that another large power plant on the site is necessary, either to produce tax revenues similar in scale to those paid by the Brayton Point plant in its heyday or to replace power generation needed to keep the lights on in Somerset and the surrounding communities. This report will demonstrate that neither of these viewpoints is correct. In dispelling these myths, we will also show that cleaner, healthier alternatives for the waterfront Brayton Point site—such as the *Clean Energy Hub* scenario described below—are entirely feasible.

Figure ES 1. New England's electricity capacity compared to peak demand



*Source: ISO-New England 2015 CELT Report; U.S. EIA Form 860 data. *MA capacity was adjusted to remove Brayton Point and Pilgrim and add in Footprint Power to the 2015 capacity baseline.*

First, it is highly unlikely that a new power plant, even a state-of-the-art natural gas combined-cycle plant like the $1 billion facility being built in Salem, would bring in the kind of tax revenues Brayton Point once did. The coal-fired facility used to pay more than $12 million a year in property taxes to Somerset, while even the legislature-supported PILOT deal in Salem will provide only a fraction of this amount for its modern new gas plant.

Second, it is important to understand that the Brayton Point power plant is just one small piece of the complex, interconnected electric grid that serves customers all over New England. Residents of Somerset receive electricity from across the region, including from sources as far away as New York and Canada. ISO-New England—the entity in charge of operating and maintaining the region's electric grid—has been planning for Brayton Point's closure for many years now. As illustrated in Figure ES 1, even with the recent announcement that Plymouth's 680 megawatt Pilgrim Nuclear Generating Station will shut down in June of 2019, there will still be a surplus of energy capacity in the southeastern Massachusetts region for many years to come. Many options exist for replacing the electricity generated at a single plant, none of which require another large fossil fuel-fired power plant in Somerset.

In addition, a new natural gas plant, while cleaner than coal, would still emit significant quantities of carbon dioxide emissions for the next 30 to 40 years. This runs counter to the Commonwealth's Global Warming Solutions Act, which requires a reduction in total greenhouse gas emissions to 80 percent below 1990 levels by 2050. In recognition of this fact, a new gas plant being built in Salem will be required to reduce its carbon dioxide emissions over time and is required to stop operating entirely by 2050.

Because there is electric grid infrastructure already in place, including a substation and major transmission lines connecting the site to the larger New England system, it makes sense to consider other types of energy generation that could leverage the existing infrastructure. In addition to natural gas generation, the Clean Energy Center examined options that include solar panels and food waste digesters, as well as an interconnection point to bring in power from future offshore wind developments. These are all technically viable energy options—with some important caveats around the size of a new gas plant and the potential need for a new natural gas pipeline.

As an alternative to a new natural gas plant, the site could include large-scale battery storage, which is being promoted statewide by the Baker Administration through the Clean Energy Center and Department of Energy Resources. Together with solar photovoltaics, a food waste digester, and an offshore wind terminal, this option would represent a *Clean Energy Hub* scenario in which clean, renewable energy sources are brought together to provide reliable electricity, promote innovative new technologies, and reclaim the waterfront area from polluting large-scale industrial use.

An additional option would be cleanup of the existing contamination on the Brayton Point site to make it suitable for non-energy, non-industrial uses such as new homes, schools, parks, shops, or offices. This would be costly, but it is still worth considering. Brayton Point is a waterfront location surrounded by residential and recreational areas in a populated part of the state. The site could be cleaned up, re-zoned, and re-vitalized into a safer, more accessible space for a multitude of non-energy uses. In this report we have focused on the potential energy uses for the site, but it is possible that other uses may prove more valuable to the town.

Each of these options has the potential to bring economic opportunities to Somerset in the form of new jobs and tax revenues for the town. But it is also important to assess the other pros and cons for each alternative. Renewable energy or electric storage can bring cleaner air and water and healthier communities. They can also provide important resource diversity for the electric grid. Large-scale natural gas generation, on the other hand, may run counter to the state's climate law and could face significant challenges such as permitting, access to sufficient natural gas, and the need for a new gas pipeline. As the community evaluates the best way to reuse this 234-acre waterfront site, it should consider all potential options for Brayton Point and the kind of future each represents for Somerset.

1. INTRODUCTION

Built in the 1960s, the Brayton Point Power Station is the largest coal-fired electric generating station in New England. At 1,600 megawatts, it is capable of burning millions of tons of coal in a year and can produce enough power to meet one-fifth of the Commonwealth's demand for electricity.

In recent years, the plant owners invested more than $1 billion to retrofit the plant with advanced pollution controls to reduce emissions of mercury, nitrogen oxides, sulfur dioxide, and particulate matter. They also added cooling towers to reduce the amount of super-heated water released into Mount Hope Bay, and an advanced fly ash reprocessing system to allow the majority of the plant's fly ash waste (a byproduct of coal combustion) to be reused rather than dumped in a landfill. Despite these advanced systems, the plant is still capable of emitting millions of tons of carbon dioxide (CO_2) each year together with still-significant amounts of sulfur dioxide, mercury, nitrogen oxides, and particulate matter, among other harmful pollutants.

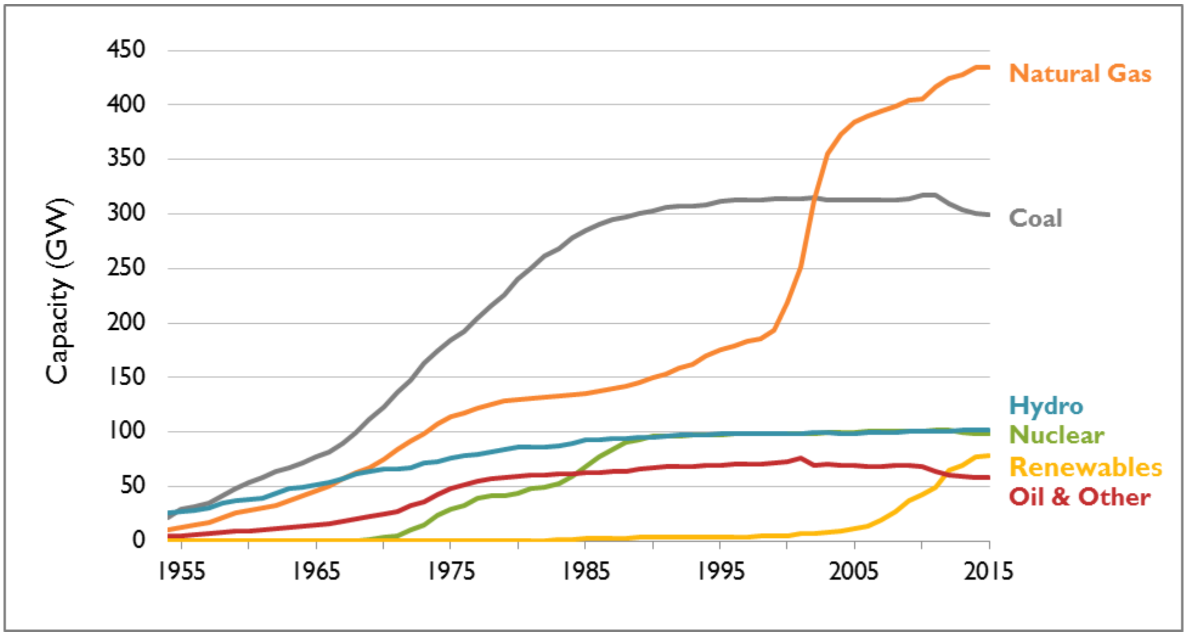
Now Brayton Point struggles to compete against cheap, abundant natural gas. As costs to maintain the aging plant in the face of more protective environmental regulations rose in recent years, energy prices and demand for electricity both fell as the price for natural gas fell and the New England region began to invest in energy efficiency and clean, renewable energy sources like wind and solar. Because it is now more expensive to operate than most other plants in the region, Brayton Point runs less and less and is unable to make enough money in the market to justify further investments to keep it operating. In early 2014, the plant owners announced what many were already expecting: the plant will close by June 1, 2017. The question now for Somerset is what to do with the site.

1.1. The times they are a-changing

Brayton Point is not alone. Across the country, the aging coal fleet is finding it harder and harder to compete with newer, cleaner, and cheaper sources of electricity.

Today, the U.S. electric system looks considerably different than it did a generation ago. Figure 1 illustrates how the mix of resources we depend on for electricity has changed since the 1950s. This graphic represents the total *capacity* of each type of generating resource over the years. In the electricity world, *capacity* refers to the total amount of each type of resource that is available to produce energy and is measured in kilowatts (kW), megawatts (MW), or gigawatts (GW).

Figure 1: U.S. installed electric generating capacity, 1954-2015

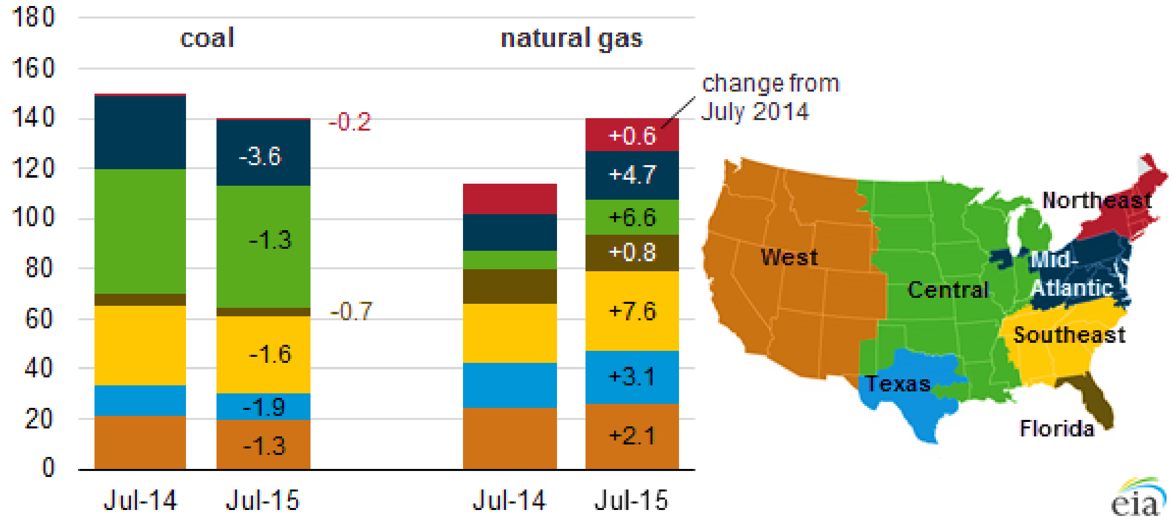


Source: EIA Form 860, cumulative summer installed capacity.

In the past 15 years alone, there has been a dramatic shift from coal, our dominant source of power over the last half-century, to natural gas. With the shale-gas boom making natural gas cheaper and more abundant, coal is losing its place of dominance, and we are becoming more and more dependent on gas for our electricity generation. In fact, the amount of new natural gas capacity installed in the United States has sky-rocketed. Renewable energy, such as wind, solar, and geothermal resources, is also growing at a rapid pace.

Even though we have built more and more natural gas generators in recent years (as reflected in Figure 1), it wasn't until the spring of 2015 that these plants actually generated more *energy* than coal facilities for the first time in history. When it happened again in July—one of the months in which the electric system typically experiences its highest demand for energy—industry experts took note. Generally, coal plants run more often and for longer stretches of time than natural gas plants, so they generate more total electricity. However, as shown in Figure 2, the amount of electricity generated from natural gas sources in July of 2015 was higher than in the same month in 2014 in every region of the United States. Meanwhile, the amount of electricity generated from coal decreased.

Figure 2. U.S. net electricity generation from coal and natural gas in July 2014 and July 2015, billion kWh



Source: EIA. 2015. Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=23252.

Here e*nergy* refers to the actual amount of electricity that is produced by each resource type in a certain amount of time and is generally measured in kilowatt-hours (kWh), megawatt-hours (MWh), or gigawatt-hours (GWh). Coal plants have historically been the workhorses of the electricity sector, and, but for April and July of last year, still produce more *energy* than natural gas plants, even though there is more natural gas *capacity*. As the costs of operating and maintaining aging coal plants continue to grow, and more and more facilities retire, natural gas is poised to become our dominant source of electricity.

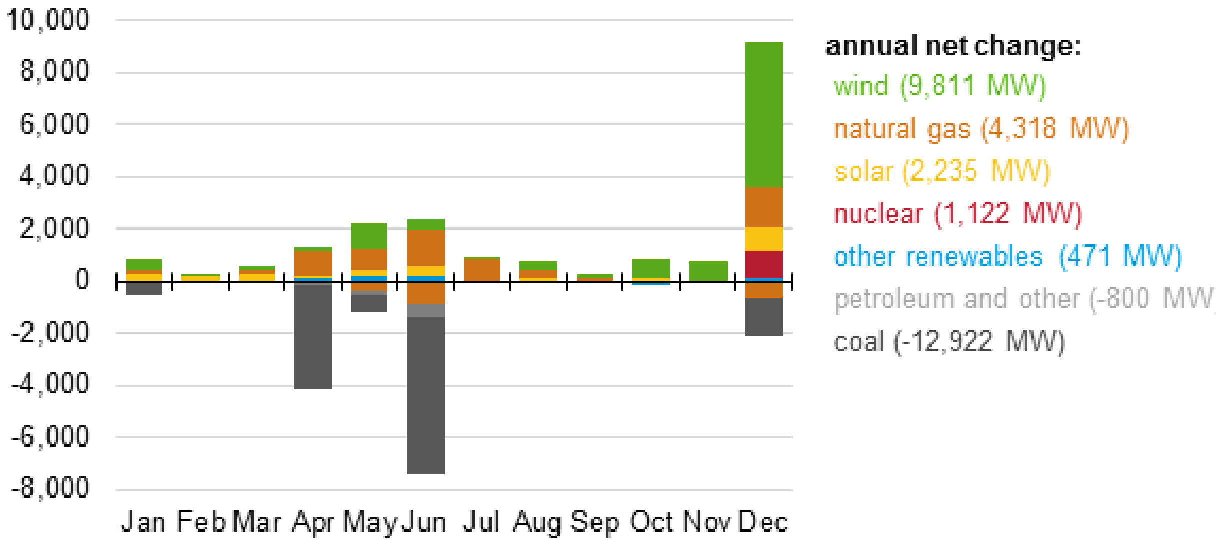
1.2. Coal generation is too expensive

The primary driver of the decline in coal capacity is that coal-fired power generation is simply becoming too expensive to compete. With the widespread use of hydraulic fracturing (often called "fracking") to unlock the country's abundant but difficult-to-extract shale gas supplies in the Marcellus region of West Virginia, Pennsylvania, Ohio, and elsewhere, the price of natural gas has plummeted. In addition to low natural gas prices, coal facilities also face increasingly stringent environmental regulations aimed at protecting human health and the environment. Regulations limiting mercury, ozone, and sulfur dioxide pollution; release of toxic wastewater; and disposal of coal ash require many aging facilities to either install expensive environmental controls or shut down. Without these regulations, communities across the country—including Somerset—would still be subsidizing the fossil fuel industry with their health and the health of their children. With these controls in place, the industry is finally internalizing some of the costs of its pollution. This raises the cost of operating coal plants and makes them less competitive in electricity markets in which clean resources like wind and solar are able to compete.

Regulations and programs to reduce greenhouse gases—such as New England's Regional Greenhouse Gas Initiative (RGGI), California's cap-and-trade program under AB 32, and the U.S. Environmental Protection Agency's recently released Clean Power Plan—also make plants fired by fossil fuels more expensive by restricting the amount of CO_2 electric generating units can emit. Because coal releases significantly more CO_2 per unit of energy than natural gas, the financial impact of these regulations on coal plants is greater than the impact on natural gas plants.

The U.S. Energy Information Administration, which provides independent data and analysis of the U.S. energy sector, noted that in 2015 most of the nation's power plant retirements would come from coal and oil resources, while substantial amounts of wind, gas, and solar capacity would be built (see Figure 3—the bars above the line represent additions of new resources, while those below the line represent retirements, by resource type).

Figure 3. Scheduled electricity generation capacity additions and retirements in 2015, in MW



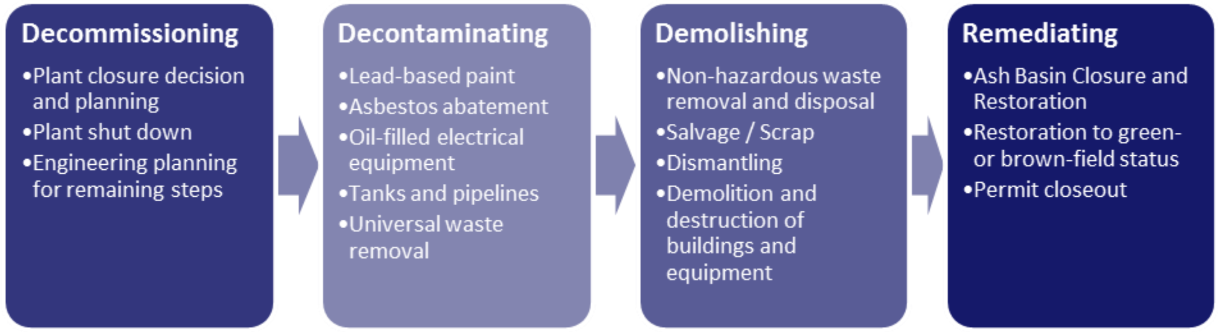
Source: U.S. Energy Information Administration, Electric Power Monthly.
Note: "Other renewables" include hydroelectric, biomass/wood, and geothermal.

1.3. What can be done with an old coal plant?

There were approximately 300 GW of coal capacity in the United States at the end of 2014. Just over 4 percent of this capacity was expected to retire by the end of 2015, with more to follow by 2020. Most of these plants will simply cease operations and retire; however, a small percentage will be replaced by a new natural gas facility on the site of the old coal plant. An even smaller percent will be repowered, meaning that the unit itself will be redesigned to burn a different type of fuel such as natural gas or biomass. Finally, some coal plants slated for retirement will actually be "mothballed," which means they will be put into an extended state of shutdown but could be brought back online at some future date if they are needed.

While there is no standardized process required for closing down a coal plant, the steps are generally grouped in the four phases shown in Figure 4: decommissioning, decontaminating, demolishing, and remediating.

Figure 4. Four steps to closing a coal plant



In the decommissioning phase, the decision is made to close the plant, it ceases operation, and valuable property (files, computers, office equipment, etc.) is moved offsite. The decontamination phase involves the removal of hazardous waste from the site. Hazardous wastes that are common at coal power plants include lead-based paints, asbestos, and PCBs (compounds formerly used in electrical equipment that were banned in the 1970s). The demolition phase includes removing and disposing of all the remaining (non-hazardous) waste, taking inventory of and selling scrap metal such as copper, salvaging reusable equipment and materials, and demolishing the remaining buildings and equipment. Finally, remediation involves the closure and cleanup (or capping) of on-site waste disposal landfills and storage basins, and restoration to green- or brown-field status. The extent of this step depends on the intended future use for the site.

Decommissioning, decontaminating, demolishing, and remediating a power plant site is expensive. And many communities are learning the hard way that adequate closure does not always occur. Some coal plant owners simply walk away and declare bankruptcy, leaving the local and state governments to deal with the contaminated site. As more and more communities experience this, some states are attempting to pass legislation to ensure that the public does not end up having to pay to make these sites safe. In Massachusetts, a bill was recently introduced entitled *An Act Relative to Decommissioning Plans for Electric Generating Facilities* (S.1788), which would allow the state's Energy Siting Board to determine whether a power plant's closure plan would be carried out "with a minimum impact on the environment at the lowest possible cost."

The actual steps that will be taken for an individual plant will depend on the future use of the site. For example, a site that will be reused as a natural gas power plant will need less demolition and remediation than a site that will be reused as housing or as a school. In addition, demolition and remediation may not always be necessary in the short term. For instance, if the value of scrap metal is low at that time, a company may decide to defer the demolition step until a time when it can offset those costs by selling copper and other valuable scrap. It is not uncommon to see derelict power plants awaiting future demolition; however, abandoning an industrial facility leaves it vulnerable to vandalism and the plant owners must continue to pay property taxes based on what remains on the site.

1.4. What's next for Brayton Point?

In anticipation of the retirement of Brayton Point, some are calling for building another large electricity generator in its place—this time using natural gas. Perhaps advocates of this plan believe the region needs the power generation to keep the lights on in Somerset and the surrounding communities, or perhaps they believe that a new power plant will restore the tax revenues once paid by Brayton Point. As this report will show, the reasoning on both counts is faulty and the community may be better served by an alternative option, such as creating a *Clean Energy Hub* on the Brayton Point site.

As the Town of Somerset explores potential options for reusing the Brayton Point site, it is important to have an understanding of how the regional electric system works and what the pros and cons of each potential reuse option might be. Over the past year, the town worked with the Massachusetts Clean Energy Center to evaluate potential reuse options for the site. The stated principles of this effort were:

- Encourage diversification of uses to promote a sustainable tax base
- Promote waterfront uses and access
- Improve quality of life (e.g., minimize air pollution and noise, create amenities)
- Leverage existing infrastructure for future uses

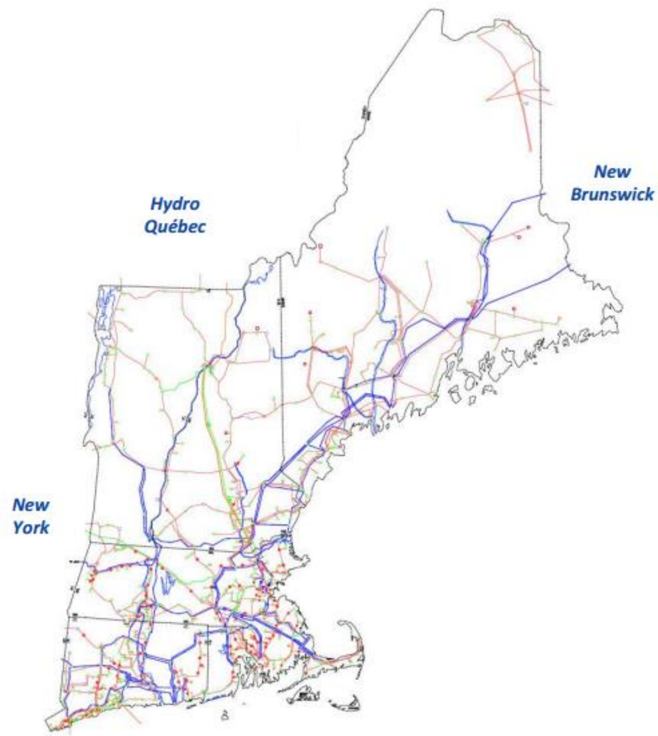
These principles would be well-served by the clean energy options that were considered by the Clean Energy Center, which included solar, food waste digesters, and an interconnection point to bring in power from future offshore wind developments. Another clean energy option—large-scale battery storage—could also be deployed on the site as part of a *Clean Energy Hub*. This report explores the benefits and challenges for each of these options.

2. KEEPING THE LIGHTS ON

Somerset and the surrounding communities are not dependent on Brayton Point—or the Pilgrim nuclear plant or any other individual generator—to keep the lights on and should not assume that a new power plant is required at the Brayton Point site. These communities are part of a much larger regional power system that is managed to ensure that every town gets the electricity it needs. Figure 5 below shows the extensive network of generating resources and transmission lines that help ensure that all parts of New England can get the electricity they need at all times.[1]

[1] Note: this map does not show the distribution-level power system, such as the utility poles and wires that bring electricity from the larger power grid to homes and businesses.

Figure 5. New England electric grid



Source: ISO New England

The New England electric system is managed as a single electric grid by an independent system operator, ISO New England. ISO New England operates under a set of rules approved by the Federal Energy Regulatory Commission that specifies all the requirements for operating the electric system, managing the numerous electric sector markets, and planning for the future.

Each day, from a control center in Holyoke, Massachusetts, ISO New England anticipates customers' needs for electricity and then manages the hundreds of generating units and thousands of miles of wires on a minute-by-minute basis to ensure that supply and demand are balanced. When Somerset's demand for electricity rises, ISO New England signals a generation unit that might be anywhere in the six New England states to increase its output. Which generator is called upon depends largely on how expensive it is to operate: the cheapest resources get turned on first, while more expensive plants are brought online only when they are absolutely needed. This is one of the main reasons that the Brayton Point plant has been losing so much money over the last several years. There are plenty of more affordable resources available in New England, so there has been very little need to turn on the expensive, 50-year-old coal plant except on the few days when demand is very high or when the price of natural gas spikes during a small number of very cold winter days.[2]

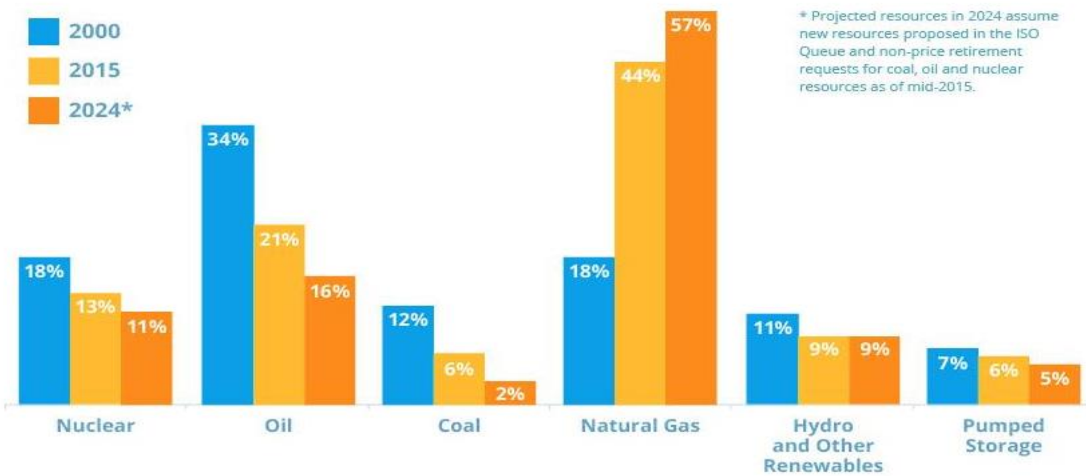
In addition to managing the electric grid, ISO New England is also responsible for preserving the *reliability* of the electric system by ensuring that there are always enough resources generating electricity to meet customers' demand. This includes making sure there is enough extra capacity to be able to handle unexpected events, such as heat waves or plants breaking down or power lines overloading.

ISO New England's obligation to provide reliable electric supply to the entire region is challenging given the significant changes in the region's electric system over time. Figure 6, from ISO New England,

[2] Schlissel, D. and T. Sanzillo. 2013. *Dark Days Ahead: Financial Factors Cloud Future Profitability at Dominion's Brayton Point*. Conservation Law Foundation and Institute for Energy Economics and Financial Analysis. Available at: http://action.clf.org/images/content/reports/brayton_point_report.pdf.

demonstrates these changes by comparing the percentage of total system capacity represented by different fuel types for past, current, and future time periods in New England.

Figure 6. Past, present, and future resource mix for New England



Source: ISO New England. Available at http://www.iso-ne.com/about/what-we-do/key-stats/resource-mix.

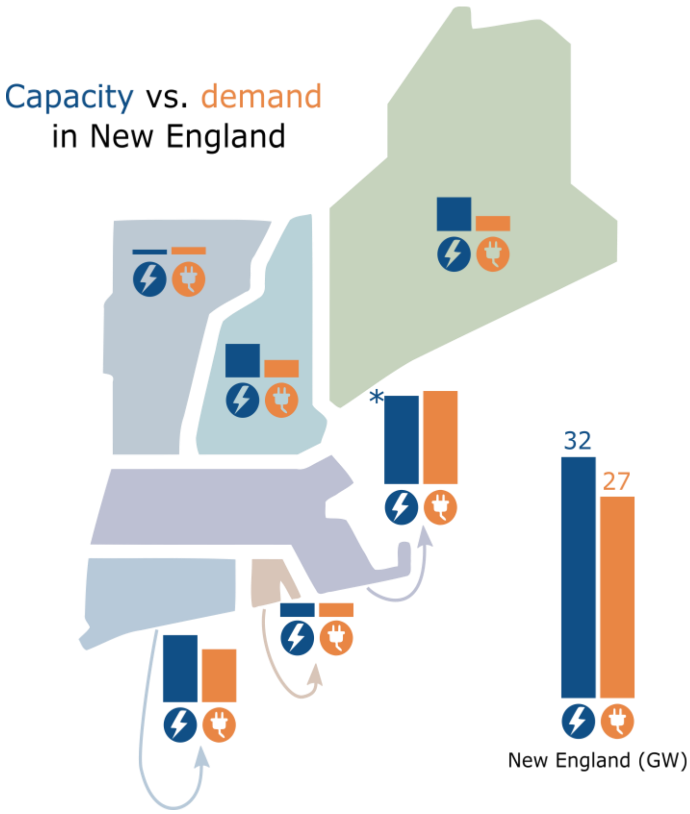
Each year, some new resources become available and some resources retire. Because of the limitations of our existing infrastructure of transmission and distribution wires, the location of both new and retiring plants is important. Without careful planning on the part of ISO New England, the retirement of a relatively large facility like Brayton Point could disrupt the reliable operation of the entire grid.

So in early 2014, when Brayton Point's owners announced their intention to retire the facility on June 1, 2017, it prompted ISO New England to study the impact the loss of this large generator would have on the New England system, as well as on the smaller southeastern Massachusetts region. ISO New England's study assessed the potential problems that could occur under a wide variety of different circumstances once Brayton Point was offline and proposed a number of potential solutions. The study found that no new generation would be needed to support the electric system at the time of Brayton Point's closure.

Additional studies on the long-term needs of the area are ongoing, and the recent announcement that the 680 MW Pilgrim Nuclear Generating Station will shut down in June of 2019 prompted ISO New England to once again assess the impacts the retirement will have on the area. In December 2015, ISO New England reported that Pilgrim's retirement would have no adverse impact on the reliable operation of the southeastern Massachusetts area or the New England region.

While certain local transmission upgrades may be required in the near term to keep the system running properly, the region will be flush with capacity even without Brayton Point and Pilgrim, and residents should not be concerned. Figure 7 depicts how much generating capacity each state has compared to how much energy is consumed by customers in that state during times of peak demand. It also shows

Figure 7. New England's electric capacity compared to peak demand



*Source: ISO-New England 2015 CELT Report; U.S. EIA Form 860 data. *MA capacity was adjusted to remove Brayton Point and Pilgrim and add in Footprint Power to the 2015 capacity baseline.*

that New England as a whole can produce much more energy than it consumes, even on the hottest days of the year when air conditioners are running at full strength and demand is greatest.

This figure does not include all distributed generation (like rooftop solar and heat pumps) nor does it account for the recent announcements of new electric generation units in Sandwich and Medway, Massachusetts and Burrillville, Rhode Island. These resources only add to the region's already abundant total generating capacity.

Customers' electric needs are supplied by a complex grid of generating and transmission resources that spans all of New England, meaning that no single generator is essential to reliability. ISO New England has already begun planning to ensure reliable electric service after Brayton Point's retirement. Planned transmission upgrades, energy efficiency measures, and renewable energy investments by both customers and utilities will make a new power plant on the Brayton Point site unnecessary.

3. Options for Replacement Energy Resources

How or if a coal plant is going to be reused after it is closed depends on the same three key factors that affect many real estate decisions: location, location, and location. For example, a waterfront property near a populated area could have tremendous value as a residential or commercial site. The Clean Energy Center explored a number of technically feasible options for reuse of the site. The feasibility of these options depends in part on overcoming the physical and regulatory restrictions that exist on the site, including: access and use restrictions due to contamination, wetlands protections, floodplain concerns, zoning, and restrictions on uses within a designated port area.

The Clean Energy Center put forward three scenarios that focus on energy uses for the site. These include two scenarios featuring natural gas generation, as well as a third scenario, called the "Mixed Energy Hub," that includes a natural gas generator, solar panels, an anaerobic digester, and an interconnection point that would bring in power from future offshore wind developments. However, new natural gas generation could face significant challenges due to permitting requirements, size constraints, and the potential need for a new gas pipeline to the site.

An alternative scenario—one that includes a technology that is currently being promoted statewide by the Baker Administration through the Clean Energy Center and the Department of Energy Resources—would be a scenario that replaces the natural gas generator with large-scale battery storage. We refer to this scenario as the *Clean Energy Hub* scenario.

While each of these choices could potentially bring benefits such as new jobs and tax revenues for the town, it is unlikely that any will fully replace the tax revenues and workforce that will be lost with the closure of Brayton Point. Whatever resources are built on the Brayton Point site, it will be crucially important for the town to negotiate with the project developer(s) to maximize the benefits to the town in terms of tax revenues or payments in lieu of taxes.

There are, however, additional factors that should be considered when evaluating possible reuse scenarios. Clean energy options, such as renewable energy or electric storage, can result in healthier communities and cleaner air and water. These same alternatives help diversify the resources serving the electricity grid so that the region is less dependent on a single fuel type (i.e., natural gas) for power. Over-reliance on a single fuel type, especially one that cannot easily be stored on site, leaves the region vulnerable to price fluctuations and fuel shortages.

Another considerable benefit, and one that large-scale natural gas generation cannot provide, is facilitating compliance with the state's climate law. In contrast, a natural gas plant will emit significant quantities of CO_2 over its lifetime. It could also face substantial challenges such as permitting and community acceptance, access to sufficient natural gas supply, and the need for a new gas pipeline. All of these factors should be part of the community's evaluation of their options for reusing the Brayton Point site, as the decision will impact residents for a long time to come.

3.1. Natural gas

One widely discussed option for reuse of the Brayton Point site is to tear down the existing facility in its entirety and construct a brand new natural gas plant in its place. This is currently being done in Salem, Massachusetts. When the Salem Harbor coal plant retired, Footprint Energy purchased the site in order to build a new combined-cycle natural gas plant in its place. Construction of that plant has been controversial and has been delayed by a number of permitting challenges. After facing many roadblocks, it is currently anticipated to begin operation in June of 2017. It should be noted, however, that due to concerns over the CO_2 emissions that it will emit over its lifetime, the Salem plant is required to reduce its CO_2 emissions over time and has a mandatory retirement date of 2050.

There are two options for a new natural gas plant at the Brayton Point site—a gas turbine or a combined-cycle plant. A gas turbine mixes natural gas with air, using this fuel-air mixture at high temperatures to spin a series of turbine blades and produce electricity. The relatively simple nature of a gas turbine makes it well suited to flexible operation—it can start up and respond to changes on the electric grid in a matter of minutes. However, it is expensive to operate, so these types of plants are generally used only at times of highest electric demand. A combined-cycle plant, on the other hand, is slower to respond to such changes but is much cheaper to operate. A combined-cycle gas plant captures the hot exhaust gas from a gas turbine and uses it to boil water into steam, which drives a secondary turbine. By capturing even more of the heat from the fuel, a combined-cycle plant is able to operate very efficiently. Most of the electricity produced from natural gas in the United States today comes from combined-cycle plants.

The capital investment costs of building new natural gas generators are between $800 and $1,000 per kW for a new gas turbine and $1,000 to $1,300 per kW for a new combined-cycle unit[3] (giving the 1,000 MW plant envisioned in one of the Clean Energy Center's scenarios a potential price tag of as much as $1.3 billion). As stated above, the low price of natural gas in recent years has made it a more attractive option when compared to coal (at $3,000 to $8,400 per kW) or nuclear (at $5,400 to $9,800 per kW).[4]

The downside is that the affordability of natural gas generation is subject to considerable uncertainty over time. Natural gas prices can fluctuate widely as a result of supply limitations (*is there enough gas and are there enough pipelines to get it where it needs to be*), weather impacts (*in the winter, people heating their homes with natural gas have priority to receive gas over electric generators*), and the effect of new environmental regulations seeking to reduce the effects of climate change or to control emissions from gas extraction processes.

The Clean Energy Center evaluated one scenario in which a small natural gas plant (400-500 MW) operates at Brayton Point and one in which a larger plant (800-1,000 MW) is constructed. Either of these options is expected to employ 10-20 workers in the long term. This low number is not surprising, as natural gas typically employs the fewest people per MW of capacity of any resource. This is true even compared to coal, as the 1,600 MW Brayton Point plant employed around 230 people.[5] As much of the spending to operate a gas plant is on the fuel itself rather than on wages, very little is invested back into the community through worker spending.

Tax revenues

Furthermore, as the Clean Energy Center pointed out, the tax revenues from a new power plant on the Brayton Point site will very likely be based on a negotiated agreement between town officials and the owner of the new plant in the form of a Payment in Lieu of Taxes or PILOT agreement. A PILOT agreement is often used as an incentive for investment in taxable infrastructure or other facilities that are deemed a public benefit. This is done by limiting or deferring the property taxes that would

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[3] Lazard. September 2014. *Lazard's Levelized Cost of Energy Analysis, Version 8.0*. Available at: https://www.seia.org/sites/default/files/resources/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf#overlay-context=research-resources/lazards-levelized-cost-energy-analysis-v80.

[4] *Ibid.*

[5] Massachusetts Clean Energy Center. 2015. *Somerset Public Meeting & Workshop: Reuse Scenarios.* June 16. Available at: http://www.cbuilding.org/project/cec-somerset.

otherwise be paid by the developer. Essentially, local taxpayers subsidize the development of the project, which might otherwise have been built elsewhere.

Communities seeking to restore their tax base after the loss of a major revenue source (like a large coal-fired generator) must carefully weigh the value the new development will bring when deciding how much they are willing to subsidize through a PILOT deal. The revenue once paid by Brayton Point—as much as $15 million annually—dropped precipitously under the PILOT deal negotiated with the town when the plant's revenues began to drop. For 2015, Brayton Point will have paid just $5.5 million to the town.

With the PILOT model gaining in popularity for the taxation of generating facilities, the town will need to negotiate with the owners of whatever resource type is installed on the site to ensure it maximizes the benefits to the town while also creating incentives for the desired development. This will be a challenge. The town may not be able to garner the level of revenue once paid by Brayton Point, no matter what energy resource is selected. Furthermore, even a very large new natural gas facility would come nowhere close to replacing Brayton Point's current workforce and economic impact.

Pipeline considerations

The Brayton Point plant is currently supplied with gas through a 20-inch pipeline. This relatively small pipeline provides a limited amount of natural gas for start-up and back-up generation and occasionally powers one of the four units at the plant. The Clean Energy Center concluded that this pipeline could likely supply natural gas to a new gas plant of 400-500 MW in size.

The Clean Energy Center estimated that adding an additional gas unit would require additional pipeline capacity into the site. The cost and feasibility of this option will depend on whether additional capacity is from a brand new pipeline or an expansion of the existing pipeline. If a new pipeline is needed, the cost of the infrastructure supporting any new connections should be included in any cost analysis for the new generator.

There is currently significant debate around whether the New England region needs additional natural gas pipeline infrastructure in order to supply existing manufacturers, home gas users, and natural gas electricity generators with the fuel they need. As New England's energy resource mix becomes more dependent upon natural gas, concerns over supply constraints will grow.

There are currently eight proposals for pipeline expansions or new construction that, if built, would bring significant quantities of additional natural gas supply into New England. One of those projects— Spectra Energy's Algonquin Incremental Market expansion project—is already under construction.

A recent study by the Analysis Group on behalf of the Massachusetts Attorney General's Office found that, despite the use of conservative assumptions…there would be no need for additional pipeline capacity to meet the needs of the region's electric generators—even during a severe winter.

There have been numerous studies to date evaluating the need for new pipelines, the cost of electricity and heating from natural gas compared to other resources, and the resultant greenhouse gas emissions in the context of the Massachusetts climate law (including a Synapse analysis on behalf of the Commonwealth). Most have been inconclusive—neither demonstrating that new natural gas pipelines are necessary to the region's energy stability nor presenting fully formed scenarios of a future without new pipelines. However, a recent study by the Analysis Group on behalf of the Massachusetts Attorney General's Office found that, despite the use of conservative assumptions about energy efficiency investments, renewable energy deployment, resource retirements, and hydropower imports, there would be no need for additional pipeline capacity to meet the needs of the region's electric generators—even during a severe winter.[6] The study also found that adding additional energy efficiency and demand response measures while also putting in place firm contracts for Canadian hydropower to be brought into the region on existing transmission lines would achieve significant cost savings *and* significantly reduce greenhouse gases.

On October 2, 2015 the Massachusetts Department of Public Utilities issued an order that sets up a framework for electric utilities to enter into contracts with proposed natural gas pipeline developers. The order is a step in the direction of making new pipelines possible. On the other hand, Governor Baker's September 29, 2015 proposal to the state legislature to fund incentives for importing hydroelectric power from Canada on a large scale could, if it comes to fruition, further eliminate the need for new pipelines.

While it is still uncertain that there would be sufficient gas available to supply a large, new gas-fired power plant at Brayton Point, siting a new gas pipeline through densely populated areas to bring additional gas to the Brayton Point site could face serious opposition from some communities. Pipeline proposals in other parts of New England, such as the Northeast Energy Direct pipeline proposed to pass through western Massachusetts and southern New Hampshire, have seen fierce opposition. Local communities are concerned with safety and with the ground, water, and air pollution associated with natural gas drilling, distribution, and combustion. Many are also concerned that an increase in the region's dependence on natural gas will both leave communities vulnerable to electricity price spikes and make it much harder to meet the state's climate goals.

Permitting requirements

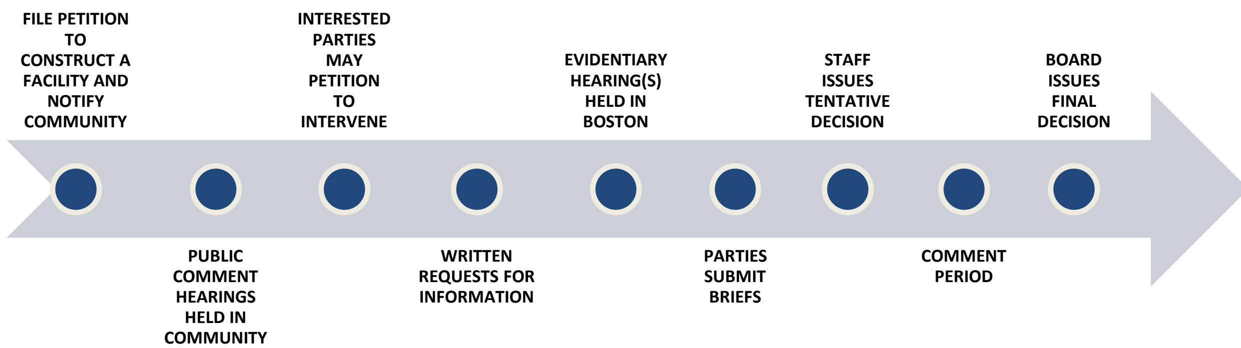
Building a new natural gas-fired unit, even at the site of an existing power plant, requires the applicant to go through a complex and sometimes lengthy permitting process. The owners of Brayton Point would need to submit applications to and receive approval from local, state, and federal regulatory entities. These include Somerset town officials, the Massachusetts Energy Facilities Siting Board, the Massachusetts Department of Environmental Protection, ISO New England, the U.S. Environmental

[6] Hibbard, P. and C. Aubuchon. 2015. *Power System Reliability in New England: Meeting Electric Resource Needs in an Era of Growing Dependence on Natural Gas*. Prepared by Analysis Group for the Massachusetts Office of Attorney General. Available at: http://www.mass.gov/ago/doing-business-in-massachusetts/energy-and-utilities/regional-electric-reliability-options-study.html.

Protection Agency, and the Federal Energy Regulatory Commission. Footprint Power, for example, had to obtain eight separate permits in order to begin construction on its new natural gas plant in Salem.

Figure 8 illustrates the extensive process for reviewing an application to site a new energy generating facility in Massachusetts. This process includes the project developer filing a petition with the siting board and notifying the public of its intent to build a new facility, public hearings being held in the affected community, the opportunity for individuals and groups to intervene in a formal hearing process (either for or against the facility), the ability to seek written discovery where parties can ask the developer to respond to relevant questions about the project, and finally, a formal decision from the nine-member review board charged with "ensuring a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost."[7]

Figure 8. Review process at the Massachusetts Energy Facilities Siting Board



Source: Energy Facilities Siting Board website. Available at: http://www.mass.gov/eea/energy-utilities-clean-tech/energy-facilities-siting-board.

A developer must also obtain the necessary environmental protection permits, ensuring that the plant will not adversely impact air or water quality in surrounding communities. These permits can take several months, if not years, to complete, depending on the agency's process and backlog. Each of these permits also provides an opportunity for parties who may be in opposition to the project to challenge their issuance, often holding up the project. This happened in Salem when local groups appealed one of the facility's air permits. The permit was ultimately upheld, but the delay forced the developer to seek a waiver from ISO New England and the Federal Energy Regulatory Commission to push back the start date by one year. Had it not obtained this waiver, the developer stood to lose a significant amount of money.

While it works to obtain permits for the physical construction of the plant, the developer must also coordinate with ISO New England to ensure that it can sell its energy into the wholesale energy markets.

[7] See http://www.mass.gov/eea/energy-utilities-clean-tech/energy-facilities-siting-board.

A new generator wishing to participate in the electric markets in New England would also bid its expected capacity into the Forward Capacity Market. The process for qualifying a new resource in the Forward Capacity Market takes four years. For example, a resource owner wishing to participate in the market beginning in June 2020 would need to begin the process of getting qualified in February 2016.[8]

Qualifying to enter the Forward Capacity Auction does not guarantee that a generator will be chosen to provide capacity, only that they will be allowed to participate. As part of the qualification process, and as part of the process to be eligible to participate in the ISO New England wholesale electricity market, a power plant developer must also undergo an analysis of how it will connect to the electric grid. In addition, the developer must go through a permitting process that includes two reliability assessments.[9] These assessments determine if transmission upgrades are needed prior to approval of plant construction. Final approval to connect to the grid may require additional analysis.[10]

Finally, in recent years, due to a number of different incentives and concerns about the availability of pipeline gas, most new natural gas-fired facilities in New England have been constructed as dual-fuel facilities, meaning they are designed to allow the facility to run on oil as well as natural gas. These facilities require large storage tanks for oil, which can lead to additional permitting challenges.

In summary, the process for siting, permitting, and constructing a large new natural gas facility can be cumbersome and expensive. While utility-scale renewable energy projects do still undergo certain permitting requirements, the solar, wind, digester, and battery storage projects described in the *Clean Energy Hub* scenario would face fewer of these obstacles.

3.2. Renewable energy development

Instead of building a large, new gas-fired power plant, renewable generation and other clean energy infrastructure may be the redevelopment choices with the best potential for the Brayton Point site. These types of investments could serve the town's goals while simultaneously attracting green industry with strong prospects for future economic growth.

The Clean Energy Center's "Mixed Energy Hub" scenario introduces new renewable resources, including 9 MW of solar panels, a 500 kW food waste digester, and an interconnection point for power from future offshore wind developments. We discuss each of these options below and suggest that an alternative—the *Clean Energy Hub* scenario in which a large-scale battery project is substituted in place

[8] For further information, see: "Qualification Process for New Generators," ISO-New England website. Available at: http://www.iso-ne.com/markets-operations/markets/forward-capacity-market/fcm-participation-guide/qualification-process-for-new-generators.

[9] ISO New England. *ISO-NE Market Rule 1: Section III.13.1.1.2.3*. Available at: http://www.iso-ne.com/static-assets/documents/regulatory/tariff/sect_3/mr1_sec_13_14.pdf.

[10] ISO New England. *Qualification Process for New Generators*.

of a new gas plant—be considered for the Brayton Point site. First, we discuss the economic considerations of renewable energy development.

Economic considerations of renewable energy development

Financial support

Federal and state incentives are available for renewable redevelopment projects that could (1) reduce the costs incurred for closing a coal unit, (2) improve the economic feasibility of developing utility-scale clean energy projects, and (3) help states meet their Renewable Portfolio Standard goals. While renewable energy projects are generally more expensive on a dollar-per-kWh basis than building a large fossil generator, the costs of renewable technologies such as wind and solar are falling rapidly. Renewables also offer significant benefits in the form of reduced air, water, and waste pollution and other community benefits. Some of the federal programs available include the following:[11]

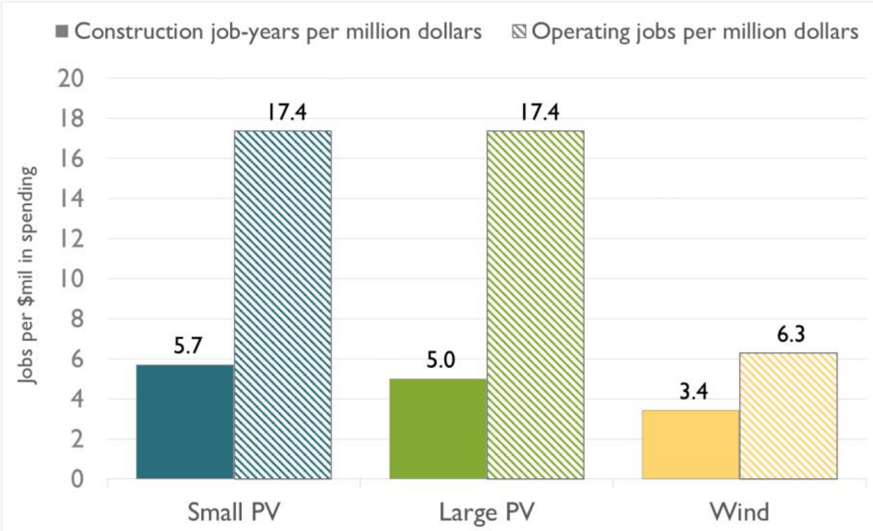
- Various U.S. Department of Agriculture loan and guarantee programs, including the Rural Energy for America Program
- The U.S. Environmental Protection Agency's Brownfield Program
- Small Business Administration's loan guarantees programs and long-term community economic development activities program
- Business energy investment tax credits
- Renewable energy bonus depreciation
- Renewable electricity production and energy investment tax credits

Job impacts

Overall, generating electricity with renewable resources creates more jobs than generation from natural gas and other fossil fuel resources on a per-MW basis. According to a recent study for Montana by Synapse, the installation (or construction) of rooftop solar photovoltaics (PV) generates the most job impacts of any resource per dollar spent (see Figure 9). For every million dollars spent on electric generation capacity installation, rooftop PV is expected to create an average of 5.7 job-years for installation and 17 operating, long-term jobs over the next 20 years. Large PV projects generate 5 job-years per million and wind farms generate 3.4 jobs per million at the installation stage.

[11] U.S. Environmental Protection Agency. *RE-Powering America's Land* webpage. Last accessed February 28, 2016. Available at: http://www.epa.gov/oswercpa/docs/re-powering_financing_fact_sheet.pdf.

Figure 9. Jobs per million dollars spent for renewable resources



Source: Synapse Energy Economics. 2014. Employment Effects of Clean Energy Investments in Montana.

More dollars are spent locally for zero-emission projects than for fossil fuel operations—especially if the fossil fuel is produced out of state. Another recent Synapse study, on the State of Washington, found that new solar PV, wind, and energy efficiency would create more jobs than new natural gas plants per dollar of spending on operations. Investments in clean energy can be thought of as capturing dollars that would otherwise have left the area. Instead of spending money on fuel, the owners of renewable energy generators pay workers who live the communities where they are located. In other words, renewable energy results in more wages for workers, which are then re-spent in the local economy. Coal and natural gas extraction, on the other hand, result in more dollars spent on fuel and equipment, very little of which comes from the local area.

Offshore wind

The Brayton Point site could become a critical component of offshore wind development in the United States. A 2014 study commissioned by the Clean Energy Center identified Brayton Point as one of the best interconnection points for offshore wind energy in the region.[12] The site was originally developed with two purposes: to support the power produced by the Brayton Point facility and also to act as a regional power hub. The existing high voltage transmission infrastructure at Brayton Point provides a strong backbone for interconnection to surrounding lower voltage systems and could accommodate up to 2,000 MW of offshore wind at an estimated cost of $20 million with minimal investment in new land-based transmission facilities. Depending on the size of interconnection required, necessary new facilities

[12] ESS Group, Energy Initiative Group, Power Systems Consultants. 2014. *Offshore Wind Transmission Study Final Report*. Prepared for Massachusetts Clean Energy Center. Available at: http://www.essgroup.com/MassCEC-Offshore-Wind-Transmission-Study.pdf.

would consist of one or two new buildings, occupying at most 5-10 acres of land on the Brayton Point site. This would leave ample room for additional job- or tax-creating activities.

While the economics of offshore wind energy projects have yet to support wide-scale development, ISO New England commissioned a study in May 2015 to further explore this issue as the region pursues aggressive greenhouse gas reduction goals.[13] Even though offshore wind carries higher upfront costs to install than onshore wind ($3,100 to $5,500 per kW compared to $1,400 to $1,800 per kW),[14] offshore wind can produce much more electricity than onshore wind due to the abundance of strong winds on the open sea. Selling more electricity means more revenue over time to offset the higher construction costs.

Massachusetts state representative Patricia Haddad and other state lawmakers have pushed for requirements for local utilities to sign long-term (20-30 year) contracts with renewable energy developers for offshore wind projects in order to lend financial certainty to their development.[15] Such contracts also protect customers by guaranteeing a low price for a portion of their bill. Compared to fossil fuel-generating sources, both onshore and offshore wind involve low operating costs and no fuel costs. The costs of operating wind are also more predictable than for sources requiring fuel, since associated fuel markets are highly uncertain in the long term (e.g., natural gas prices). Wind, on the other hand, is always free.

The economics of wind projects are partially supported by renewable energy policies. States can offer their own policies to provide incentives for wind development, such as renewable portfolio standards and tax incentives. Arguably the most important financial support policy for wind is the federal Production Tax Credit (PTC), which offers $23 per MWh of energy produced in the first 10 years of operation. This policy has been alternately renewed and cancelled in recent years, leading to uncertainty for wind developers. When the PTC has been renewed in the past, it has led to a subsequent boom in U.S. wind development.[16] In December 2015, Congress renewed the expired PTC. The new legislation will retroactively extend the full PTC through 2016, after which it will start phasing down at 80 percent of its present value in 2017, 60 percent in 2018, and 40 percent in 2019. Wind projects that start construction before the end of the period will qualify for that year's credit. With this support, wind

[13] Coste, W. 2015. "2015 Economic Study of Offshore Wind Scope of Work." ISO New England Planning Advisory Committee Meeting presentation. May 21. Available at: http://www.iso-ne.com/static-assets/documents/2015/05/a3_2015_economic_studies_scope_of_work_off_shore_wind.pdf.

[14] Lazard. *Lazard's Levelized Cost of Energy Analysis, Version 8.0*.

[15] Lawrence, M. 2015. "Haddad teams with other legislators, offshore wind leaders to make their case at State House." *The Standard-Times*. November 13. Available at: http://www.heraldnews.com/article/20151113/NEWS/151117723.

[16] See: Union of Concerned Scientists, http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/production-tax-credit-for.html#.VabRJPlViko and American Wind Energy Association, http://www.awea.org/Advocacy/Content.aspx?ItemNumber=797.

continues to become more competitive due to increased turbine capacity, taller installations (or "hub heights"), and the use of longer blades.[17]

The high historical costs of offshore wind are reflected in the absence of existing turbines off our coasts. The United States currently has 66 GW of land-based wind installed but no offshore turbines.[18] However, while there are no U.S. offshore wind projects operating yet, offshore wind is widely present in other parts of the world, and its prospects in the United States are improving. Deepwater Wind's Block Island project is slated to become the first operating offshore wind project in the United States in 2016.[19]

The Clean Energy Center included an offshore wind connection as part of its "Mixed Energy Hub" scenario for Brayton Point but did not estimate jobs or wages that would flow to Somerset. Deepwater Wind estimates that its Block Island project will employ 300 construction workers (10 workers per MW installed) but does not offer long-term operations and maintenance estimates. Deepwater officials estimate that construction of new facilities for the interconnection at the Brayton Point site would similarly employ several hundred employees for two or three years. In general, offshore wind projects require more specialized workers (e.g., engineers) than other energy projects due to the more complex installation and operation requirements.

Deepwater Wind recently proposed a 900-1,000 MW offshore wind project off of Rhode Island that would connect to Brayton Point via an offshore wind collector platform and to Long Island with a substation in Shoreham.[20] In addition to providing access to a large quantity of offshore wind energy, such a link would represent the first between Long Island and southeastern New England. It would have the potential to reduce transmission constraints, increase system reliability, and potentially avoid the construction of a new fossil fuel power plant on Long Island. This project appears to be the most promising large-scale offshore proposal to date; however, its future is far from certain. It is still undergoing permitting and its developers are attempting to acquire contracts to sell its electricity, meaning it will almost certainly miss its originally proposed 2017 operational date.

Use of the Brayton Point site for an offshore wind interconnection would generate revenue in a few ways. The interconnection facilities would generate real estate and property tax payments to the city, although these are likely to be small. More substantially, while the turbines would be located in federal waters and not typically subject to local taxes, Deepwater Wind says that it will make PILOT payments to

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[17] Wiser, R. and M. Bolinger. 2014. *2013 Wind Technologies Report*. Report No. LBNL-6809E. Lawrence Berkeley National Laboratory. Available at: http://emp.lbl.gov/publications/2013-wind-technologies-market-report.

[18] U.S. Department of Energy. 2015. "Installed Wind Capacity." *WINDExchange* webpage. Available at: http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp.

[19] More information about the Deepwater Wind Project is available at http://dwwind.com/project/block-island-wind-farm.

[20] Deepwater Wind. 2012. *New York's Offshore Energy Highway: Utility-Scale Offshore Wind Energy Combined with Regional Transmission*. Available at: http://www.nyenergyhighway.com/Content/documents/94.pdf. See also: http://dwwind.com/project/deepwater-one.

the communities impacted by their development. The company expects that such payments might cover a significant portion of what Brayton Point was paying through its PILOT.

As with new conventional generators, PILOT payments are common with both renewable energy and transmission projects. Owners of the Neptune underwater power cable connecting Long Island to New Jersey, for example, agreed to an annual $400,000 payment to the town at one landing site, for 30 years.[21] The investment needed for this 660 MW cable represents a substantially smaller investment than would be required to interconnect a large amount of offshore wind, such as the 900 MW Deepwater Wind project.

Solar PV

Utility-scale solar PV is another renewable energy option for the Brayton Point site. The Clean Energy Center estimated that up to 9 MW of solar PV could be installed at the Brayton Point site under the "Mixed Energy Hub" scenario.

There are currently over 20 GW of installed solar PV in the United States.[22] It is less expensive on a unit basis due to economies of scale compared to smaller, residential rooftop installations ($1,500 to $3,000 per kW for utility-scale versus $3,500 to $4,500 per kW for rooftop).[23] To illustrate the differences in scale: a single 9 MW utility-scale project has the same capacity as 1,800 residential rooftop installations at 5 kW each. Solar PV is not expensive to operate and has no fuel costs. And, helpfully, solar power often operates at times when the electric grid needs it most—on hot, sunny days when air conditioning usage increases and energy requirements from the grid are at or near their peak. This means that the more solar PV is on the system, the less energy and capacity is required from other, more expensive (and generally more polluting) energy resources during these critical hours.

The economics of solar PV projects are partially supported by state and federal policies. Some states, including Massachusetts, offer tax incentives or a "solar carve-out" as part of a renewable portfolio standard that specifies a certain amount of capacity or energy that must be provided by solar PV. At the federal level, the Investment Tax Credit (ITC) offers a 30 percent tax credit on PV systems; this policy is currently in place through 2019 and will ramp down to 10 percent by 2022 for commercial projects, where it will remain permanently (residential ITC falls to zero after 2022).[24] Aside from these policies, a key driver for the jump in solar PV installations in recent years stems from decreasing installation costs

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[21] See also Iberdrola Renewables Elk River Wind Power Project factsheet, available at: http://iberdrolarenewables.us.files.s3.amazonaws.com/pdf/Elk_River_fact_sheet.pdf; http://www.lighthousewind.com/frequentlyasked; http://www.dailyfreeman.com/general-news/20110822/saugerties-oks-tax-pact-for-utility-substation.

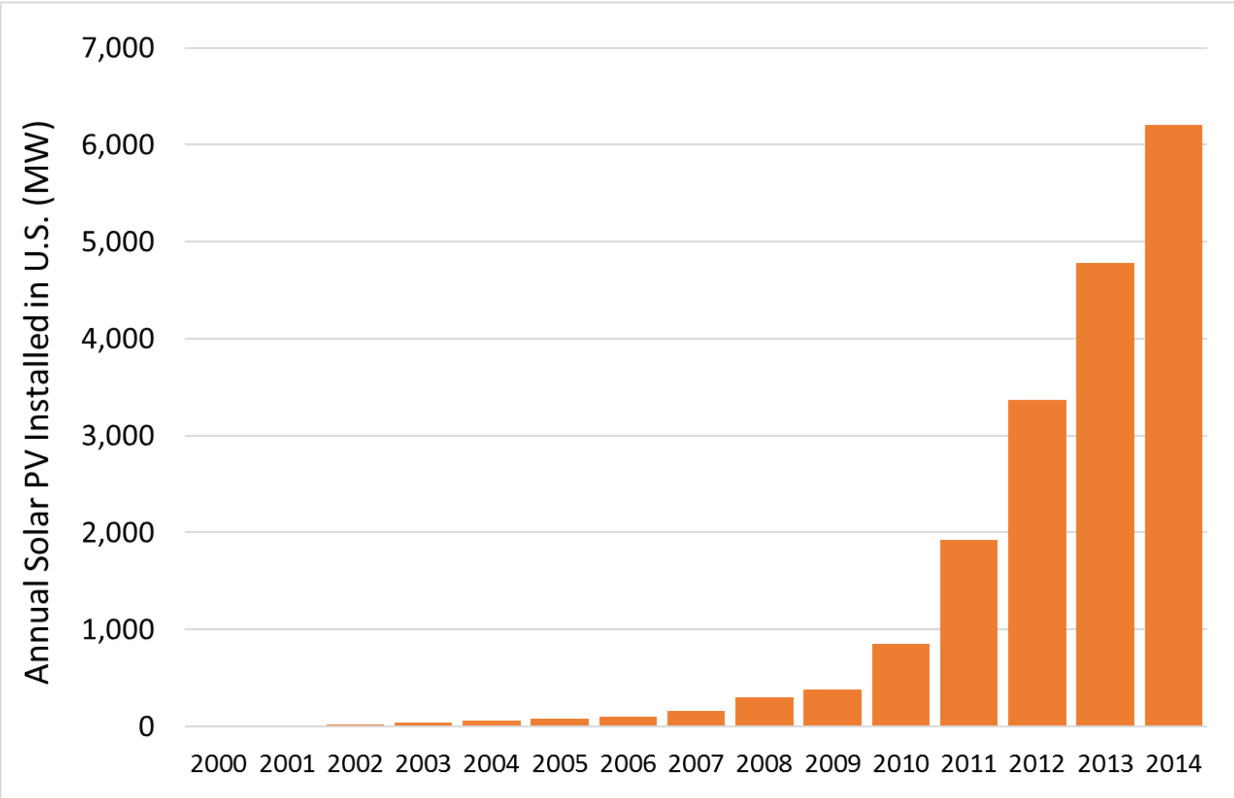
[22] Solar Energy Industries Association (SEIA). 2015. "Solar Industry Data." Available at: http://www.seia.org/research-resources/solar-industry-data.

[23] Lazard. 2014. High range of utility-scale costs are based on Synapse experience since Lazard's costs are based on U.S. southwest projects only.

[24] SEIA. 2016. "Impacts of Solar Investment Tax Credit Extension." Available at: http://www.seia.org/research-resources/impacts-solar-investment-tax-credit-extension.

due primarily to lower costs for the panels themselves. New PV installations in the United States have increased in every year since 2000.[25] Total PV capacity has increased remarkably in recent years—about half of all PV in the country (over 10 GW) was installed in 2013 and 2014 alone (see Figure 10 below).[26]

Figure 10. Total PV capacity installed in the United States in recent years



Source: GTM Research and SEIA

In its assessment, the Clean Energy Center estimated that 9 MW of solar PV would employ between one and three long-term workers each with a salary of $30,000 to $40,000 per year, bringing a total of $30,000 to $120,000 in annual wages to the region. This does not include the impacts of construction, which would provide a short-term stimulus to the region.

The property taxes for the 43-acre solar site would be worked out between the developer and the town, again in the form of a PILOT. Possible methods for determining payments from these resources include having a fixed charge per MW or taxing at a percentage of the plant's annual revenue.[27] The Emmett Environmental Law & Policy Clinic at Harvard Law School recently collected sample PILOT agreement

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[25] SEIA. 2015. "U.S. Installs 6.2 GW of Solar PV in 2014, Up 30% Over 2013." Available at: http://www.seia.org/news/us-installs-62-gw-solar-pv-2014-30-over-2013.

[26] *Ibid.*

[27] Solar Energy Industry Association. 2015. "Solar PV PILOT agreements in Massachusetts." Available at: http://www.seia.org/research-resources/massachusetts-pilots.

terms for solar PV projects in Massachusetts and found that the payments ranged from $5,261 up to $25,000 per MW of solar PV installed, with an average of around $13,000 per MW.[28] The study noted, however, that comparing the per-MW payments may not tell the whole story. This is because municipalities with their own utilities also generally negotiate to purchase power from the solar installation, which may lead to a lower PILOT in exchange for a deal on the energy.

Anaerobic digestion

The Clean Energy Center included a 500 kW anaerobic digester for food waste in its "Mixed Energy Hub" scenario. Anaerobic digestion is often used at dairy farms or wastewater treatment plants as a way of dealing with animal and human waste; and it is increasingly used for food waste.[29] Anaerobic digestion facilities break down the organic material in animal, human, or food waste in the absence of oxygen to generate methane, which can be burned to generate heat or electricity.

A digester in Somerset would help southern New England comply with recent regulations concerning food waste disposal. In 2014, the Commonwealth of Massachusetts passed a law prohibiting facilities that generate more than a ton of food waste per week from sending the waste to a landfill. Vermont, Connecticut, and Rhode Island have recently done the same. Such measures reduce the amount of useful organic material that is sent to limited landfill space and usually save business owners money through reduced dumping fees. At around $75 to $90 per ton, this area has some of the highest dumping fees in the country.[30] Most facilities for disposal of food waste focus on composting, but the Commonwealth of Massachusetts is increasingly encouraging the development of anaerobic digesters that can turn food waste into relatively clean, renewable energy.

The anaerobic digester proposed for Brayton Point would generate about 500 kW of electricity at its peak, which would be enough to power over 100 homes. While the fuel requirements vary depending on the operating conditions, a similarly sized facility proposed for Easthampton, Massachusetts would require 50 tons of food waste per day.[31] At 500 kW, this facility would generate less power than the solar array proposed to share space at the Brayton Point site, but it would produce steady power (as

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[28] Rodina, I. and S. Goho. 2013. *The Solar Property Tax Exemption in Massachusetts: Interpretation of Existing Law & Recommendations for Amendments*. Harvard Law School, Emmett Environmental Law & Policy Clinic. Available at: http://environment.law.harvard.edu/wp-content/uploads/2015/08/solar-property-tax-exemption-massachusetts-recommendations-amendments.pdf.

[29] Massachusetts Department of Energy Resources. "Anaerobic Digestion at Massachusetts Wastewater Treatment Plants." Webpage last accessed February 29, 2016. Available at: http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/anaerobic-digestion/-recovering-energy-from-organics-map.html.

[30] Berdik, C. 2014. "Massachusetts' new composting rules: What they really mean." *Boston Globe*. September 25. Available at: https://www.bostonglobe.com/magazine/2014/09/25/massachusetts-new-composting-rules-what-they-really-mean/SM9KF0Rw7I1Gq8KZTtx5dL/story.html.

[31] Tighe & Bond. 2014. *City of Easthampton – Anaerobic Digestion Feasibility Study*. Available at: http://www.easthampton.org/downloads/Easthampton%20AD%20OTE%20Report%20Final_2014-0514-reduced_secured.pdf.

opposed to power that is only available when the sun is shining) and would also produce a secondary output of fertilizer that could be sold to nearby farms or gardeners.

The economics of a digester are not quite as good as solar due to the higher cost of small thermal power plants of this type. However, a digester would be eligible for several state and federal grants, and its operator would also collect fees from producers needing to dispose of food waste. In addition, energy generated at the facility would qualify for renewable energy credits that utilities must purchase to meet renewable energy requirements in Massachusetts.

Anaerobic digestion facilities that utilize waste products (such as food waste) are judged by most to be sustainable and environmentally friendly. They do not require the large-scale cutting of forests and do not generate high levels of emissions when combusting fuel. In fact, digesters convert methane, a very potent greenhouse gas, to CO_2. The feedstock—food or other organic waste—would generally otherwise decompose and enter the atmosphere as methane gas. By burning the methane and converting it to electricity and CO_2—a less potent greenhouse gas—digesters can reduce greenhouse gas emissions and create a useful byproduct. There is still the potential for some environmental impacts, such as the ammonia waste stream associated with the solid byproduct. Nonetheless, the small scale of the project and the benefit of reducing methane that would otherwise be emitted from landfills may offset these concerns.

In the third public meeting on reuse options at the Brayton Point site, some residents expressed concern about the increased truck traffic required to fuel such a digester. One suggestion to allay these concerns and minimize truck traffic is to take advantage of Brayton Point's deep water port and deliver feedstock by barge.[32] There is also some concern that competition for feedstock will limit the facility's supply or make it too expensive. A larger food waste digester facility in North Kingston, Rhode Island broke ground in May 2015, and the Stop and Shop grocery chain started construction on its own digester in April 2015 in nearby Freetown, Massachusetts.[33,34]

The digester offers limited long-term employment. The Clean Energy Center estimates that the digester would employ two to five people, earning between $80,000 and $85,000 each. The construction impact would offer a short-term boost to the local economy that should be investigated further. As with the other resources discussed above, a PILOT would likely be used to determine revenues for the town. As such, town officials would need to negotiate to maximize benefits to the town.

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[32] Montaup and Brayton Point Power Plants Re-Use Study. *Meeting 3 Summary*. June 16, 2015. Available at: http://www.cbuilding.org/sites/default/files/2015_0616_Somerset_Mtg3Summary.pdf.

[33] Stop & Shop. 2015. "Stop & Shop celebrates Earth Day as the company breaks ground on its first anaerobic digester at the Freetown Distribution Center." Press release, April 17. Available at: http://stopandshop.com/news-and-media/ss-article-04-17-15.

[34] Faulkner, T. 2015. "R.I.'s First Anaerobic Digester Expected by End of Year." *EcoRI News*. May 28. Available at: http://www.ecori.org/renewable-energy/2015/5/28/ris-first-anaerobic-digester-expected-by-end-of-year.

Large-scale battery storage

One option that was not included in the Clean Energy Center's analysis was a scenario that includes *only* clean energy resources. We suggest a fourth scenario for the Brayton Point site that replaces the natural gas unit in the "Mixed Energy Hub" with a large-scale battery storage project. We call this the *Clean Energy Hub* scenario.

The Brayton Point site may be well-suited to host a utility-scale battery storage demonstration project. Unlike the other energy resources under consideration for the Brayton site, batteries do not generate electricity. Rather, energy storage in general and batteries in particular have the potential to reduce the need for the supply of electricity to change in lockstep with demand on the grid. Currently, as explained in Section 2 above, the supply of electricity must be matched to the demand for electricity as demand fluctuates throughout the day. Without an ability to store energy, electricity is therefore generated in a pattern that changes moment by moment to match variations in demand. Energy storage, however, can allow the grid to meet demand at a given moment regardless of how much electricity is being generated at that time.

Storage is reliable and flexible

Energy storage can have major benefits for systems that rely on conventional generation technologies, such as fossil fuel-fired power plants, by reducing the need to increase and decrease the output of such facilities on a daily basis. Storage can also increase the reliability and resiliency of a power system and has the potential to reduce costs by deferring the need to perform upgrades to transmission or distribution systems.

However, energy storage is especially important for systems with increasing reliance on renewable energy sources, such as wind and solar power. Wind and solar are intermittent resources, meaning the availability of wind and sunshine varies throughout the day and throughout the year in ways that may not always coincide with times of greatest demand for electricity.

Conventional generators of electricity, especially older coal, oil, and nuclear units, have limited flexibility to respond to changes in the supply of solar and wind power. Energy storage, however, can take in energy generated at a time of low demand (e.g., from strong winds blowing at night) and make this energy available at times when it is needed the most.

Energy storage can be charged using electricity from any kind of source. Most existing energy storage is charged with electricity generated from conventional resources. However, the ability of energy storage to compensate for the intermittency of wind and solar power makes it a crucial part of incorporating large amounts of these renewable resources onto the grid. Further, energy storage could lessen the need to rely on quick-start natural gas units to "back up" renewable resources, a theme receiving much attention these days.

A variety of energy storage technologies exist, including batteries, flywheels, and pumped storage hydropower. They are distinguished from one another primarily based on the amount of energy they can store and how quickly they can release or discharge that energy (i.e., on their power and ramping capabilities). For example, flywheel installations offer very high power capabilities and rapid (sub-second) response times. However, they cannot store very much energy and therefore cannot supply power for very long. Pumped storage hydropower, conversely, can store huge amounts of energy but has much longer response times (ranging from minutes to hours) and requires large areas of flooded land for storage reservoirs. The "size" of an energy storage installation is often described using two metrics: its maximum power *capacity*, and the maximum length of time over which it can discharge at that power rating. The product of these two metrics is the amount of energy that can be stored by the installation in question.

Compared to other forms of energy storage, battery-based systems are unique in their relatively high degree of flexibility. Battery technology has improved in recent years to the point that batteries can offer high power capabilities and response times on the order of seconds or less. Moreover, the amount of energy that can be stored by a battery installation can be arbitrarily large, as it can be increased simply by adding more cells. The primary restriction on battery storage at a given location is therefore economic rather than technical. At the moment, battery installations are often limited to 1-, 4-, or 8-hour discharge times, because the ability to store additional energy does not add sufficient additional benefit to justify the cost.

Storage is becoming cheaper

The economics of battery energy storage systems have been shifting recently for two main reasons. First and foremost, the cost of high-performance batteries has been rapidly declining. This is primarily due to increased demand from the electric vehicle market, as batteries based on lithium-ion technology can be used for both automotive and power system-based applications. The cost of battery cells has been nearly cut in half in the past five years, from almost $1,000 per kWh in 2010 to slightly over $500 per kWh in 2015.[35] Battery cell prices tend to be lower for larger installations, with industry leaders such as Tesla quoting prices of $430 per kWh for residential installations but $250 per kWh for utility-scale facilities.[36]

Increasingly, battery storage systems are able to further improve their economics by providing multiple services. Battery storage systems can defer the need for other costly electric system upgrades (like new power lines or new generating plants). The operators of battery storage systems can receive compensation for providing power at times of high demand on the electricity grid. High-power batteries are also capable of performing a service known as "power conditioning," which maintains the standard voltage and frequency of power transmitted on the grid. They can also be compensated as an ancillary (non-generation) service, which helps support the continuous flow of electricity on the power lines.

[35] Nykvist, B. and M. Nilsson. 2015. "Rapidly falling costs of battery packs for electric vehicles." *Nature Climate Change* 5. March 23. DOI: 10.1038/NCLIMATE2564. Available at: www.nature.com/articles/nclimate2564.epdf.

[36] Tesla Motors. 2015. "Powerwall: Tesla Home Battery." Webpage last accessed February 29. Available at: www.teslamotors.com/powerwall.

The combination of declining costs and the total revenue provided by these multiple services has led to a sharp uptick in the number and size of storage systems installed. For instance, the utility Southern California Edison recently installed "the largest battery energy storage project in North America," an 8 MW system with a 4-hour discharge time located near a large wind resource area in Tehachapi, California.[37] The project is designed to perform a variety of functions, including voltage regulation, relief of transmission congestion, deferral of transmission upgrades, firming support for neighboring renewables, and capacity services.

In some circumstances, battery energy storage systems have added worth because they are able to provide capacity that replaces natural gas-fired "peaker" plants (that is, plants that exist just to cover demand when it is at its highest). Inefficient gas-fired peakers are used to provide capacity at times of greatest system need, but they provide few other services. As a result, they operate a relatively small percentage of the time and are extremely expensive to run when they are needed. Recent analyses have suggested that battery energy storage systems have become cheap enough that their prices are comparable to that of peakers.[38] Moreover, peakers have slower response times than battery storage systems, reaching full capacity in minutes rather than seconds, as is achievable with batteries. In effect, this difference means that a battery installation requires less power capability than a peaker to provide the same capacity service in many cases. Battery installations can therefore be "right-sized" to a given system's needs, further reducing costs.

Storage has local benefits

There is strong interest in battery storage in Massachusetts, from both the public and the private sectors. A number of battery-related companies have their headquarters or offices in the Boston area, ranging from start-ups to mature corporations. These include NEC, A123, 24M, and Ambri (which also has a manufacturing facility in eastern Massachusetts). [39] There have been a number of initiatives from the state government in support of battery storage. Most recently, the Baker Administration announced a $10 million Energy Storage Initiative.[40] As part of this Initiative, the Massachusetts Clean Energy Center is in the process of conducting a study analyzing the energy storage industry and market in Massachusetts. It will then provide policy and regulatory recommendations aimed at supporting in-state

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[37] Office of Electricity Delivery & Energy Reliability. 2014. "Southern California Edison Tehachapi Wind Energy Storage Project." Department of Energy Global Energy Storage Database. Last accessed February 29, 2015. Available at: www.energystorageexchange.org/projects/8.

[38] Lin, J. and G. Damato. 2011. *Energy Storage – A Cheaper and Cleaner Alternative to Natural Gas-Fired Peakers*. Prepared by Strategen for the California Energy Storage Association. Available at: www.storagealliance.org/sites/default/files/White%20Papers/CESA_Peaker_White_Paper_2011-02-08.pdf.

[39] See: www.neces.com, www.a123systems.com, 24-m.com, and www.ambri.com.

[40] Executive Office of Energy and Environmental Affairs. 2015. "Baker-Polito Administration Announces $10 Million Energy Storage Initiative." Press release available at: www.mass.gov/eea/pr-2015/10-million-energy-storage-initiative-announced.html.

deployment of energy storage. This initiative will also enable the Department of Energy Resources, in cooperation with the Clean Energy Center, to fund several demonstration projects.

The combination of these considerations indicates that a large-scale battery storage installation may be a good option for the Brayton Point site, particularly given that such systems use space efficiently. The battery racks needed for an 8 MW installation similar to the one located in Tehachapi would occupy only about 1/20th of an acre.[41] Even including additional space for power electronics, maintenance equipment, housing, and so forth, this is far less than the 1-acre footprint of each building potentially available at the waterfront. A solar installation of equivalent power would occupy more than 40 acres.[42] Interconnection and siting costs are also likely to be low due to pre-existing infrastructure. A battery installation at Brayton Point could also complement solar or wind resources if co-located, balancing out the intermittency of these generators as discussed above. Moreover, battery systems co-located with solar PV installations can be less costly than systems installed independently, as some of the power electronics can be shared.

3.3. Reusing the existing infrastructure

While not appealing options, there are a few ways in which Brayton Point's existing infrastructure could be reused for electricity generation. The existing plant could be "mothballed," that is, put into a kind of hibernation and maintained with the current infrastructure in place for future use as a coal generator. The existing equipment could also be modified and the plant "repowered" to burn a different type of fuel such as biomass or natural gas. Each of these options has significant drawbacks.

Mothballing

A power plant that is shuttered but not permanently closed is said to have been mothballed. Owners of mothballed plants avoid all of the variable operation and maintenance costs that would normally be associated with operating the facility (such as purchasing fuel) but still incur costs for security, boiler servicing, and other essential maintenance activities. Mothballing is a viable option when owners cannot operate their facilities at a profit in the near term but can reasonably expect conditions to change in the future to favor the plant. Keeping a facility in mothball condition is costly, as equipment must still be inspected and maintained, maintenance workers employed, and property taxes paid. Further, the plant does not make any money because it does not generate electricity. Very few of the plants slated to shut down in the next few years are expected to be mothballed, and this is unlikely to be a cost-effective option for Brayton Point.

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[41] LG Chem. 2014. "Advanced Battery for Energy Storage System." p 11. Available at: http://www.lgchem.com/upload/file/product/2015_LGChem_ESS_eng[0].pdf.

[42] Ong, S., C. Campbell, P. Denholm, R. Margolis, R. and G. Heath. *Land-Use Requirements for Solar Power Plants in the United States*. National Renewable Energy Laboratory. Technical Report No: NREL/TP-6A20-56290. Available at: www.nrel.gov/docs/fy13osti/56290.pdf.

Fuel conversion

Fuel conversion—or "repowering"— describes reusing a generating facility's existing infrastructure but with modifications to allow the facility to operate using alternative fuels. Such fuels include biomass (wood or other plant materials) and natural gas. Equipment at coal-fired facilities is similar to that of facilities that burn other fuels to create electricity and can, therefore, potentially be converted. For some plants this might mean making a few changes to the boiler and furnace systems. For others, major overhauls and reconstruction may be required. Depending on the economics, fuel conversion may be a viable option for reusing an existing coal plant site. For plants where more extensive modifications would be necessary, fuel conversion is far less likely to make economic sense.

Overall, because the existing Brayton Point units are fairly old, converting the existing units to burn a different fuel type is unlikely to be a viable option.

3.4. Non-energy uses

Commercial redevelopment is an option for many retired power plant sites. The viability of redevelopment for commercial use is dependent on many factors, but those in urban areas on waterfront property are often the most suitable for commercial redevelopment. Site redevelopment can entail a range of final outcomes that might include keeping the facility's buildings and reusing them for commercial, residential, or public use. Frequent end uses include parkland, ballparks, museums, hotels, condos, offices, and restaurants.

A striking example of the redevelopment of a former power plant site is the Pratt Street Power Plant located in downtown Baltimore, Maryland. Shown in the photograph below, this former oil-fired power plant is now listed on the National Register of Historic Places and is the commercial home to a Barnes & Nobel, a Hard Rock Café, and an ESPN Zone.[43]

While these redevelopment projects can be very expensive, the costs can often be offset by financing assistance through various federal agencies and tax incentives, including:[44]

[43] Ghosts of Baltimore.org. Last accessed September 2015. Available at: http://ghostsofbaltimore.org/2013/09/09/now-pratt-street-power-plant.

[44] U.S. EPA. *RE-Powering America's Land*.

- Environmental Protection Agency's Brownfield Program
- Economic Development Administration's Public Works and Economic Adjustment Assistance program
- Small Business Administration's loan guarantees programs and long-term community economic development activities program
- New Markets Tax Credits

Source: WikiCommons

The Somerset community should weigh any costs carefully against the benefits that a new 234-acre waterfront development could bring to the area.

4. Global Warming Solutions Act Compliance

State and federal laws limit the amount of heat-trapping greenhouse gases—such as CO_2—that can be emitted by the power plants that generate our electricity. For the Town of Somerset, this means that choices about the best new use for the Brayton Point site need to consider the Commonwealth's plan for reducing global warming.

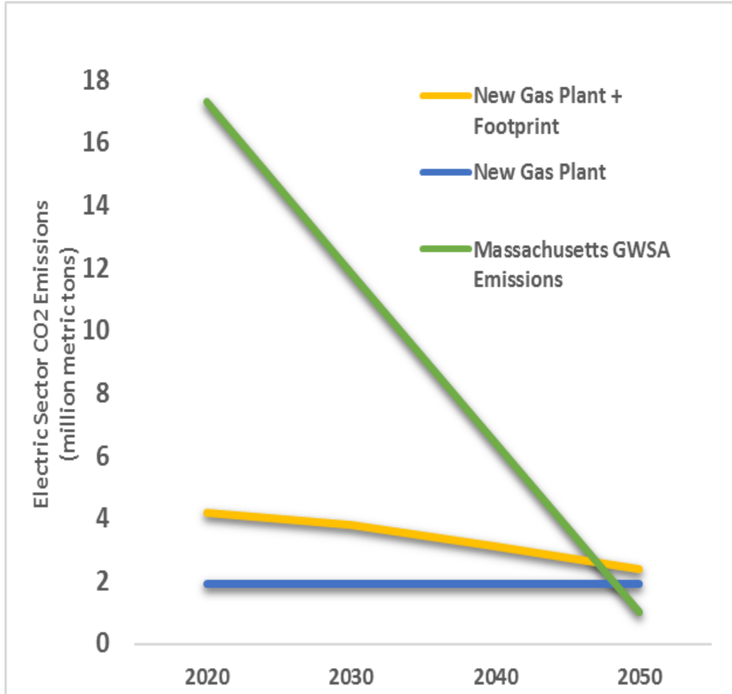
Enacted in 2008, Massachusetts' Global Warming Solutions Act (GWSA) sets us on a path to eliminate four out of every five tons of greenhouse gas emissions state-wide by 2050. Meeting this long-term goal—and the short-term goal of reducing emissions by one-quarter by 2020—is simply not possible without deep emission reductions in the electric sector. In fact, Massachusetts' climate plan calls on power suppliers to cut their emissions by one-half by 2020 in order to make up for slower progress in lowering transportation emissions.

Compliance with state law and success in meeting emission reduction targets require an ambitious, coordinated effort to modernize the electric system by eliminating waste and building zero-carbon, renewable energy resources as older resources retire. A new natural gas power plant at Brayton Point would certainly emit less CO_2 per MWh than the current aging coal plant, but small reductions may not be sufficient to assist in complying with the GWSA. The state's climate plan calls for new sources of zero-carbon electricity, not lower-carbon electricity.

The Clean Energy Center's analysis of potential alternative uses for the Brayton Point site includes options for one or two 400-500 MW natural gas generating units. The type of plant that would be constructed is not specified in the Clean Energy Center study. However, even assuming it would be the more efficient combined-cycle technology type such as the facility proposed for Salem, it would still emit significant quantities of CO_2 during its lifetime.

In New England today, these types of generators run about 50 to 70 percent of the time.[45] In the remaining 30 to 50 percent of the time, enough lower-cost generation is available in the region to supply all customers' demand for electricity. More expensive units sit idle, especially in times when less electricity is needed. Each of the new gas units included in the Clean Energy Center's scenarios would release 900,000 to 1 million tons of CO_2 into the atmosphere each year.[46] Overall, new gas units at Brayton Point would use up 3 to 7 percent of Massachusetts' permitted electric-sector emissions in 2020. By 2050, a large new gas plant would likely exceed all expected electric-sector emissions on its own, as shown in Figure 11. The green line represents electric sector emissions consistent with achieving the GWSA, according to the Massachusetts Department of Environmental Protection. It is clear that achieving the Commonwealth's climate goals will require electric generation that is very nearly carbon-free in the next 25 to 35 years.

Figure 11. Expected CO_2 Emissions in Massachusetts Electric Sector



Source: Synapse Energy Economics, 2016

As a result of these stringent emission requirements, Footprint Power, the owners of the natural gas plant being constructed on the site of the old coal-fired facility in Salem, came to a settlement agreement with Conservation Law Foundation that ensured the new plant would not inhibit the state from meeting its greenhouse gas reduction goals.[47] The 692 MW natural gas plant, while producing fewer emissions than the coal plant it replaced, would be a major source of emissions in the future. The settlement agreement included a commitment to an annually decreasing CO_2 emissions cap from 2026 to 2050, along with a firm agreement to retire the facility no later than January 1, 2050. This agreement ensured the plant operated at levels consistent with GWSA.

[45] Synapse analysis based on U.S. Energy Information Administration (EIA) data.

[46] Assumes a 670 lbs per MWh of CO_2 emission rate if running 70 percent of the time and (due to more frequent starts and stops during the years) an 800 lbs per MWh rate if running 50 percent of the time based on Synapse analysis of EIA data.

[47] Commonwealth of Massachusetts Energy Facilities Siting Board. 2014. *Final Decision on the Application of Footprint Power Salem Harbor Development LP*. February 25. Available at: http://www.mass.gov/eea/docs/dpu/siting/efsb-13-1-final-decision.pdf.

The federal Clean Air Act also limits greenhouse gas emissions from both existing and new power plants. Any modern natural gas combined-cycle power plant would meet the Environmental Protection Agency's emission rate limits (that is, limits per unit of electricity produced) for new power plants. However, Massachusetts' own climate law requires a higher standard based on the total number of tons of CO_2 emitted.

5. Conclusion

As the Somerset community works with the state and the Brayton Point property owners to determine the best option for reusing the site, they must weigh many important considerations. Three of the key considerations highlighted in this report are:

1. **In a time when climate change is at the forefront of our decision making in planning for the future, especially in coastal communities such as Somerset, consideration of a true *Clean Energy Hub* should be at the top of any list of potential options for the Brayton Point site.** A clean energy site, including solar PV, food waste digesters, battery storage, and an interconnection for large amounts of offshore wind, would help the state to meet its climate goals, diversify the region's energy sources, encourage green investments in the state, and could bring in a reasonable amount of revenue for the community if PILOTs are well-negotiated.

2. **There is no need for a large new power plant to replace the power being generated by Brayton Point.** There is more than enough power generating capacity in New England to keep the lights on in Somerset and surrounding communities after the Brayton Point plant shuts down. The reliability of the electric system is ensured by ISO New England, whose job it is to plan for the loss of individual generators like Brayton Point. ISO New England has determined that the system will be fine without Brayton Point.

3. **The community's best chance of regaining significant tax revenues following the closure of Brayton Point will be to negotiate strong PILOT payments with the owners of whatever new resources are built on the site.** As it evaluates alternatives, the town should seek to diversify the uses at the site to promote a more sustainable revenue base in the future—one that will not suddenly disappear when a plant owner closes up shop. It will be important to negotiate payment terms for whatever options are chosen that will balance the economic interests of the town with the desire to attract certain users.

There is no immediate need—and certainly no overwhelming benefit—to rush to build a large new gas-fired unit in the place of the retiring coal plant. With so many other options for reuse of the Brayton Point site, the community should carefully consider the future they wish to see for this waterfront property. Alternative options such as the *Clean Energy Hub* scenario show a vision of the future that would allow for the restoration of some of the town's tax revenues, provide clean, reliable electricity for the region, provide jobs and help advance technological innovation, and reduce pollution and other industrial burdens on the town's waterfront and surrounding communities.