Executive Summary

Concerns about the impacts of coal-fired electricity generation on public health, the environment, and the stability of the global climate have prompted calls across the United States to transition away from coal to natural gas and renewable. In 2011-2012, the state of Massachusetts will consider the bill “An Act Relative to a Coal-Free Commonwealth”; if passed, the bill would likely force coal-fired power plants in the state to switch to natural gas or to shut down entirely.

The bill and the debates surrounding this area present critical choices about the nature of our energy supplies. It is crucial to understand the implications of the range of policy options available. In Massachusetts, the complexity of decision-making is augmented by initiatives to increase energy efficiency and introduce offshore wind power generation, as well as by the fluctuating prices of electricity generated from coal alternatives such as natural gas.

This study explores coal-fired electricity generation and its alternatives by synthesizing impact assessments in the areas of air quality/human health, grid economics, and workforce. To mitigate the complexities inherent in analyzing electricity generation throughout Massachusetts, the study focuses on a single coal plant – Brayton Point Power Station. As it is Massachusetts’ largest coal-fired power plant, a study of the possible impacts of retaining or abolishing it will be salient to statewide policy decisions on the issue.

This study examines four possible cases for Brayton Point from now to 2020. The first case is the “business as usual” (BAU) case, where Brayton Point continues to operate as-is until 2020. The second case, natural gas, is analyzed as two sub-cases. “Retrofit” considers the impacts of retrofitting Brayton Point’s coal generators to natural gas combined-cycle generators. “Replace” considers the impacts of demolishing Brayton Point and replacing it with a new, same-capacity natural gas combined-cycle power plant. The “renewables” case replaces Brayton Point with renewable power generation from wind and solar facilities. For all cases, three forecasts for electricity demand from now to 2020 are considered: 1) with no energy efficiency, 2) with energy efficiency leading to a -0.5% decrease in electricity demand (relative to 2010), and 3) with energy efficiency leading to a -1.3% decrease in demand.

Three types of potential impacts are analyzed for each case: air quality/human health, electric grid economics, and workforce. The air quality/human health impact analysis utilizes the AMS/EPA Regulatory Model (AERMOD) to model health impacts from air pollution. Available data are also used to discuss health impacts from toxic chemicals, ecosystem impacts from various forms of pollution, and greenhouse gas emissions. The grid economics impact analysis utilizes electricity market data from ISO New England, the Independent System Operator for the New England electricity grid, to build a model of average electricity system cost. For each of the natural gas cases, the impact on wholesale electricity prices is modeled for different natural gas prices and energy efficiency scenarios. The likely impact of renewables is qualitatively discussed. The workforce impact analysis utilizes available Massachusetts employment data to compare each case. For the renewables case, the Jobs and Economic Development Impact (JEDI) models from the National Renewable Energy Laboratory (NREL) are used to calculate the impacts of replacing Brayton Point with onshore wind and solar PV installations. Data from a study of Massachusetts’ proposed offshore wind power plant, Cape Wind, are also used to estimate the workforce and economy impacts of replacement with offshore wind.

Uncertainties from the assumptions in the models used, and from the input data, are present in all analyses. The grid model assumes that Brayton Point can only be replaced with other base load operating capacity, which makes modeling the natural gas cases possible but complicates renewables modeling. It also assumes that any decreases in yearly demand will have an equal impact across the year, but these decreases may have a more significant impact on the system at times of peak demand. The air quality/health analyses assume specific emission factors but report their range for uncertainty discussions. For employment, the JEDI model default values for inputs like onshore wind turbine size and solar PV system size were assumed to be representative of reality. The offshore wind employment analyses based on the Cape Wind study also assume that Cape Wind is representative of other offshore wind projects.

Our results underline the tradeoffs that will inform any policy decision on the future of coal-fired electricity generation in Massachusetts. For the BAU case, the output from the grid economic model suggests that Brayton Point will produce 9,020,960MWh of electricity output in 2020. The air quality/ health analysis estimates 2020 carbon dioxide emissions from Brayton Point to be 7.7 metric megatons. AERMOD shows that Brayton Point emissions result in an annual mean concentration of 0.20 $\mu g/m^3$ of PM within 10km of the plant. The employment analysis estimates that the 235 current jobs will be retained at Brayton Point. Additionally, the town of Somerset received over 30% of its property tax revenue from Brayton Point in FY 2011.

For the natural gas "retrofit" case, the grid analysis shows that at low gas prices, average wholesale energy price across the energy efficiency scenarios is not significantly different from BAU. However, as gas price increases it becomes expensive to operate the retrofitted natural gas plant. The air quality/human health analysis using AERMOD shows that retrofitting reduces the amount of PM within 10km of the plant from a mean of 0.2 $\mu g/m^3$ to 0.06 $\mu g/m^3$ – resulting in an 84% improvement in health outcomes. Employment-wise, 40-110 O&M jobs will be created, less than under BAU. Property tax revenues will be somewhat higher than under BAU. For the natural gas "replace" case, the grid analysis shows a higher average wholesale energy price than under "retrofit". For air quality/health AERMOD shows that replacement reduces the amount of PM within 10km of the plant to 0.05 $\mu g/m^3$ or an 87% improvement in health outcomes, and criteria pollutants are also lower than under "retrofit". Finally, the employment analysis notes that the "replace" case is likely to create an order of magnitude more construction jobs than "retrofit", and about 40 O&M jobs. Property tax revenues will be much higher than under BAU.

For the "renewables" case, the grid analysis notes that the intermittency of wind power can lead to higher system costs. The air quality/health analyses show that no pollution will be associated with the production of electricity, but there may be life cycle emissions from construction and installation of the renewable facilities. The JEDI models for employment show an increase in construction jobs ranging from 3719 to 4064 and an increase in annual O&M jobs ranging from 228 to 259 depending on the energy efficiency scenario. Property tax revenues for Somerset will be negligible as the town itself is not well-suited to renewables siting and the jobs created will be outside of Somerset's tax area. Across all cases, energy efficiency measures will also create 831-1666 jobs.

Several case-specific findings stand out: the air quality and health implications of the BAU case remain serious despite mitigation efforts; the grid system cost of the natural gas cases could be high; and although the "renewables" case could have a significant positive impact on air pollution, health, and employment, its potential impacts on grid reliability and cost could pose significant challenges to renewables deployment.

In terms of a "coal-free Massachusetts", our analyses and the current political situation suggest that the natural gas "retrofit" or "replace" cases are relatively more feasible in the near term than "renewables". In choosing between "retrofit" and "replace", one key tradeoff is between grid system cost and environmental and health impacts. Although total grid system cost is slightly lower under the "retrofit" case, the "replace" case has improved air pollution and lower impacts on the global climate. The "retrofit" case will likely create fewer new jobs than the "replace" case because of the lack of need for new construction, but both result in higher property tax values than under the BAU case.

Our analysis is subject to uncertainty and time limitations, and any policy decision might also consider other factors rigorously such as the costs of retrofitting versus replacement. That said, we believe the importance of the grid, air quality, health, and employment issues surrounding coal-fired power generation and its alternatives make this case study model assessment of options for Brayton Point a useful guide to the wider impacts of electric-generation policy in the Commonwealth. It is our hope that it makes a valuable contribution to the current debate about going coal-free.