Pollution, People, and Powerplants: Health Burdens in Peabody, MA

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Project 2015A Background

- Massachusetts Municipal Wholesale Electric Company (MMWEC) has proposed to build Project 2015A, a 55 MW “peak” power plant
- It will use natural gas with ultra low sulfur diesel as a backup
- It will require a gas compressor and 200,000-gallon diesel storage tank
- Permitted for 1250 hours/year
- 12-14 municipal partners
- It will be sited at Peabody Municipal Light Plant, where 2 existing peaker plants currently operate (70 MW combined)
Regulatory Review

- MMWEC filed the project’s Environmental Notification Form with the Executive Office of Energy and Environmental Affairs (EEA) in 2016.
- EEA Secretary did not require Environmental Impact Report (EIR) or a Community Health Impact Assessment (CHIA).
- Project exempt from MA Wetlands Protection Act.
- MA DEP approved air permit for Project 2015A.
- Peabody Board of Health has requested EIR, CHIA. That request has been echoed by Danvers, Holden, Marblehead, Wakefield Boards of Health, as well as BCAN, MCAN, Community Action Works, others.
Objectives

• Evaluate baseline health data in area surrounding Project 2015A
• Look at differences in health data in populations near Project 2015A vs. rest of the state
• Look at explanatory variables for differences in health
• Summarize vulnerability data (age, EJ, nearby facilities)
• Look specifically at pediatric health data
Area characteristics

- The Peabody Municipal Light Plant is near schools, hospitals, long term care facilities
- Other polluting facilities, including 2 PMLP power plants, are also in the area
- A 2 kilometer buffer around Project 2015A at least partially encompasses 8 environmental justice neighborhoods (or census block groups)
Methods: Health and demographic data

- CDC PLACES (2020 release)
- CDC American Community survey (2015-2019)
- Massachusetts Environmental Public Health Tracking (2017)
- MassGIS
Focus area

- There are 9 census tracts at least partially encompassed by a 2km buffer around project 2015A
Health outcomes in focus area by census tracts

Percentiles of asthma prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentiles)
- 7.5 - 9.4 (0-24%)
- 9.5 - 10.0 (25-49%)
- 10.1 - 10.9 (50-74%)
- 11.0 - 15.1 (75-100%)

Percentiles of cancer prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentile)
- 0.7-6.0 (0-24%)
- 6.1-7.3 (25-49%)
- 7.4-8.3 (50-74%)
- 8.4-14.4 (75-100%)

Data from CDC PLACES, ≥18 years
Health outcomes in focus area by census tracts

Percentiles of chronic kidney disease prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentile)
- 0.6-2.2 (0-24%)
- 2.3-2.5 (25-49%)
- 2.6-2.9 (50-74%)
- 3.0-6.3 (75-100%)

Percentiles of chronic obstructive pulmonary disease prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentile)
- 1.3 - 4.6 (0-24%)
- 4.7 - 5.7 (25-49%)
- 5.8 - 6.8 (50-74%)
- 6.9 - 17.4 (75-100%)

Data from CDC PLACES, ≥18 years
Health outcomes in focus area by census tracts

Percentiles of coronary heart disease prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentile)
- 0.6 - 4.7 (0-24%)
- 4.8 - 5.5 (25-49%)
- 5.6 - 6.4 (50-74%)
- 6.5 - 15.0 (75-100%)

Percentiles of diabetes prevalence in Massachusetts by census tract, 2019

- Peabody Peaker
- Focus area (2km)
- Town boundaries

Prevalence (percentile)
- 0.8 - 7.1 (0-24%)
- 7.2 - 8.1 (25-49%)
- 8.2 - 9.5 (50-74%)
- 9.6 - 23.9 (75-100%)

Data from CDC PLACES, ≥18 years
Health outcomes in focus area by census tracts

Percentiles of high blood pressure prevalence in Massachusetts by census tract, 2019

Percentiles of obesity prevalence in Massachusetts by census tract, 2019

Data from CDC PLACES, ≥18 years
Risk factors in focus area by census tracts

Percentiles of smoking prevalence in Massachusetts by census tract, 2019
- Peabody Peaker
- Focus area (2km)
- Town boundaries
- Prevalence (percentiles):
  - 6.3 - 11.6 (0-24%)
  - 11.6 - 14.7 (25-49%)
  - 14.7 - 17.9 (50-74%)
  - 17.9 - 39.5 (75-100%)

Percentiles of lack of health insurance prevalence in Massachusetts by census tract, 2019
- Peabody Peaker
- Focus area (2km)
- Town boundaries
- Prevalence (percentiles):
  - 3.3 - 6.3 (0-24%)
  - 6.3 - 7.8 (25-49%)
  - 7.8 - 11.2 (50-74%)
  - 11.2 - 41.0 (75-100%)

Data from CDC PLACES, ≥18 years for smoking; 18-64 years for insurance
Some census tracts have consistently worse health outcomes

Highest quartiles for:
- Cancer
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Coronary heart disease
- Diabetes
- High blood pressure
- High cholesterol
- Stroke

Highest quartiles for:
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Coronary heart disease
- Diabetes
- High blood pressure
- Stroke
Area characteristics

- The Peabody Municipal Light Plant is near schools, hospitals, long term care facilities.
- Other polluting facilities, including 2 PMLP power plants, are also in the area.
- A 2 kilometer buffer around Project 2015A at least partially encompasses 8 environmental justice neighborhoods (or census block groups).
## Health outcomes in focus area vs. rest of MA

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Focus area (pop=46,925)</th>
<th>MA (pop=6,500,655)</th>
<th>p-value</th>
<th>Adjusted p-value (smoking, total population, EJ status, insurance)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean prevalence</strong></td>
<td><strong>Mean prevalence</strong></td>
<td><strong>p-value</strong></td>
<td><strong>Adjusted p-value</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Asthma</strong></td>
<td>9.53</td>
<td>10.26</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>High blood pressure</strong></td>
<td>28.41</td>
<td>27.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cancer</strong></td>
<td>8.14</td>
<td>7.05</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>Chronic kidney disease</strong></td>
<td>2.80</td>
<td>2.59</td>
<td>&lt;0.005</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>Chronic obstructive pulmonary disease</strong></td>
<td>6.46</td>
<td>5.81</td>
<td>&lt;0.005</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td><strong>Coronary heart disease</strong></td>
<td>6.50</td>
<td>5.53</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>8.51</td>
<td>8.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High cholesterol</strong></td>
<td>30.19</td>
<td>28.90</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td>25.52</td>
<td>26.14</td>
<td></td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td>3.18</td>
<td>2.86</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
</tr>
</tbody>
</table>
On average, a higher proportion of very young and older people live in focus area compared to MA.

<table>
<thead>
<tr>
<th>Age range (years)</th>
<th>Focus area (pop=46,925)</th>
<th>MA (pop=6,500,655)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>6.48</td>
<td>5.50</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>5 to 9</td>
<td>4.66</td>
<td>5.50</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>10 to 14</td>
<td>4.98</td>
<td>5.94</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>15 to 17</td>
<td>2.89</td>
<td>3.71</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>&lt;18</td>
<td>12.52</td>
<td>15.14</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>18 to 24</td>
<td>9.31</td>
<td>10.77</td>
<td></td>
</tr>
<tr>
<td>25 to 34</td>
<td>15.33</td>
<td>15.55</td>
<td></td>
</tr>
<tr>
<td>35 to 64</td>
<td>40.42</td>
<td>40.94</td>
<td></td>
</tr>
<tr>
<td>≥65</td>
<td>21.94</td>
<td>16.86</td>
<td>&lt;0.0005</td>
</tr>
</tbody>
</table>
## Pediatric asthma prevalence lower in Peabody, but more ED visits for asthma

<table>
<thead>
<tr>
<th>Prevalence of pediatric (K-8) asthma</th>
<th>Rate of Emergency Department visit for asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age range (years)</td>
</tr>
<tr>
<td></td>
<td>Prevalence</td>
</tr>
<tr>
<td>Pediatric asthma (2016-2017)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peabody</td>
</tr>
<tr>
<td>Prevalence</td>
<td>6.2 (5.5-6.9)</td>
</tr>
<tr>
<td></td>
<td>Rate per 100,000 (95% CI)</td>
</tr>
<tr>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td></td>
<td>5 to 14</td>
</tr>
<tr>
<td></td>
<td>15 to 34</td>
</tr>
<tr>
<td></td>
<td>35 to 64</td>
</tr>
<tr>
<td></td>
<td>≥65</td>
</tr>
</tbody>
</table>
Health needs for CHIA

• Community engagement, including vulnerable groups. HIA requires community knowledge and involvement. HIA team must “identify, solicit, and utilize [community] expertise to both identify and answer questions about potentially significant health impacts.”
  • https://matracking.ehs.state.ma.us/planning_and_tools/hia/index.html

• Look closer at health outcomes and disparities, paying particular attention to more vulnerable communities.

• Measure background concentrations of particulate matter (PM) with Purple Air monitors at monitoring locations.

• Model NO\textsubscript{2}, SO\textsubscript{2}, PM\textsubscript{2.5}, PM\textsubscript{10}, CO, O\textsubscript{3}, Pb when peaker plant runs for consecutive hours on “peak” days. For example, Waters River plant ran an average of 5.2 hours per start in 2018.

• Compare cumulative emissions to health effects associated with short-term NO\textsubscript{2}, SO\textsubscript{2}, PM\textsubscript{2.5}, PM\textsubscript{10}, O\textsubscript{3} exposures.
### Air impact from Water Rivers, Project 2015A, and ambient concentrations from DEP Air Permit

<table>
<thead>
<tr>
<th>Criteria Pollutant</th>
<th>Averaging Period</th>
<th>Modeled Impact, Project Plus Waters River Station (ug/m³)</th>
<th>Ambient Background (ug/m³)</th>
<th>Modeled Impact Plus Ambient Background (ug/m³)</th>
<th>NAAQS/MAAQS (ug/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>Annual 1-Hour</td>
<td>2.53</td>
<td>10.3</td>
<td>12.8</td>
<td>100 188</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95.31</td>
<td>65.8</td>
<td>161.1</td>
<td></td>
</tr>
<tr>
<td>SO₂</td>
<td>Annual 24-Hour</td>
<td>0.01</td>
<td>1.3</td>
<td>1.3</td>
<td>80 365</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.32</td>
<td>5.6</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3-Hour</td>
<td>1.07</td>
<td>11.2</td>
<td>12.3</td>
<td>1,300 196</td>
</tr>
<tr>
<td></td>
<td>1-Hour</td>
<td>0.63</td>
<td>10.8</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>PM₂₅</td>
<td>Annual 24-Hour</td>
<td>0.29</td>
<td>5.5</td>
<td>5.8</td>
<td>12 35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.28</td>
<td>17.0</td>
<td>21.3</td>
<td></td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Annual 24-Hour</td>
<td>0.41</td>
<td>13.2</td>
<td>13.6</td>
<td>50 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.12</td>
<td>29.0</td>
<td>40.1</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>8-Hour</td>
<td>63.34</td>
<td>649</td>
<td>711</td>
<td>10,000 40,000</td>
</tr>
<tr>
<td></td>
<td>1-Hour</td>
<td>130.87</td>
<td>1,221</td>
<td>1,352</td>
<td></td>
</tr>
</tbody>
</table>
Small increases in ambient $\text{NO}_2$, $\text{PM}_{2.5}$, $\text{PM}_{10}$, $\text{O}_3$ over 1 hour-7 days associated with mortality

### Table 1
Exposures, outcomes and pooled effect sizes.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Outcome</th>
<th>Number of effect sizes</th>
<th>RR (95% CI)</th>
<th>p-value</th>
<th>PI</th>
<th>Egger’s test (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{PM}_{10}$</td>
<td>All-cause mortality</td>
<td>66</td>
<td>1.0041 (1.0034–1.0049)</td>
<td>&lt; 0.0001</td>
<td>1.0013–1.0070</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>$\text{PM}_{10}$</td>
<td>Cardiovascular mortality</td>
<td>44</td>
<td>1.0060 (1.0044–1.0077)</td>
<td>&lt; 0.0001</td>
<td>1.0016–1.0105</td>
<td>0.024</td>
</tr>
<tr>
<td>$\text{PM}_{10}$</td>
<td>Respiratory mortality</td>
<td>41</td>
<td>1.0091 (1.0063–1.0119)</td>
<td>&lt; 0.0001</td>
<td>1.0017–1.0166</td>
<td>0.209</td>
</tr>
<tr>
<td>$\text{PM}_{10}$</td>
<td>Cerebrovascular mortality</td>
<td>20</td>
<td>1.0044 (1.0022–1.0066)</td>
<td>0.0005</td>
<td>1.0001–1.0087</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>$\text{PM}_{2.5}$</td>
<td>All-cause mortality</td>
<td>29</td>
<td>1.0065 (1.0044–1.0086)</td>
<td>&lt; 0.0001</td>
<td>1.0017–1.0114</td>
<td>0.015</td>
</tr>
<tr>
<td>$\text{PM}_{2.5}$</td>
<td>Cardiovascular mortality</td>
<td>28</td>
<td>1.0092 (1.0061–1.0123)</td>
<td>&lt; 0.0001</td>
<td>1.0026–1.0158</td>
<td>0.803</td>
</tr>
<tr>
<td>$\text{PM}_{2.5}$</td>
<td>Respiratory mortality</td>
<td>20</td>
<td>1.0073 (1.0029–1.0115)</td>
<td>0.0023</td>
<td>0.9998–1.0148</td>
<td>0.606</td>
</tr>
<tr>
<td>$\text{PM}_{2.5}$</td>
<td>Cerebrovascular mortality</td>
<td>7</td>
<td>1.0072 (1.0012–1.0132)</td>
<td>0.0257</td>
<td>0.9953–1.0192</td>
<td>N/A</td>
</tr>
<tr>
<td>$\text{NO}_2$ (24-hour average)</td>
<td>All-cause mortality</td>
<td>54</td>
<td>1.0072 (1.0059–1.0085)</td>
<td>&lt; 0.0001</td>
<td>1.0031–1.0113</td>
<td>0.048</td>
</tr>
<tr>
<td>$\text{NO}_2$ (1-hour max.)</td>
<td>All-cause mortality</td>
<td>10</td>
<td>1.0029 (0.9995–1.0063)</td>
<td>0.0892</td>
<td>0.9985–1.0064</td>
<td>0.154</td>
</tr>
<tr>
<td>$\text{O}_3$</td>
<td>All-cause mortality</td>
<td>48</td>
<td>1.0043 (1.0034–1.0052)</td>
<td>&lt; 0.0001</td>
<td>1.0013–1.0073</td>
<td>0.001</td>
</tr>
</tbody>
</table>

RR, pooled relative risks; 95% CI, 95% confidence interval; p-value, significance of the association or statistical tests; PI, 80% prediction interval; N/A, not applicable (< 10 studies).

Orelanno et al., 2020 PMID: 32590284
Small increases in ambient SO$_2$ from 1 hour to 7 days associated with mortality

Table 2
Exposures, outcomes and pooled effect sizes.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Outcome</th>
<th>Number of effect sizes</th>
<th>RR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$ (24-hour average)</td>
<td>All-cause mortality</td>
<td>36</td>
<td>1.0059 (1.0046–1.0071)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SO$_2$ (24-hour average)</td>
<td>Respiratory mortality</td>
<td>23</td>
<td>1.0067 (1.0025–1.0109)</td>
<td>0.0018</td>
</tr>
<tr>
<td>SO$_2$ (1-hour max.)</td>
<td>All-cause mortality</td>
<td>4</td>
<td>1.0016 (0.9930–1.0102)</td>
<td>0.6045</td>
</tr>
<tr>
<td>SO$_2$ (1-hour max.)</td>
<td>Respiratory mortality</td>
<td>3</td>
<td>1.0052 (1.0013–1.0091)</td>
<td>0.0287</td>
</tr>
</tbody>
</table>

RR, pooled relative risks; 95% CI, 95% confidence interval; p-value, significance of the association or statistical tests; PI, 80 (<10 studies); statistically significant results in bold.
Conclusions

- On average, communities who live closer to Peabody Peaker have worse health outcomes than the rest of the MA population.
  - In particular, cancer, chronic kidney disease, chronic obstructive pulmonary disease, coronary heart disease, and stroke in adults are significantly higher in census tracts within 2km of peaker.
- Significantly more people <5 age and >=65 age live closer to the Peabody Peaker.
- There are higher rates of ER visits for asthma among children <14 age in Peabody compared to the rest of the state.
- Compared to other municipalities participating in Project 2015A, Peabody has the highest prevalence of cancer and coronary heart disease, the second highest prevalence of chronic kidney disease and diabetes, and the third highest prevalence of high blood pressure and COPD.