Massachusetts Peaker Power Plants

Energy Storage Replacement Opportunities

Across Massachusetts, 23 oil- and gas-fired peaker power plants and peaking units at larger plants help meet statewide peak electric demand. These facilities include both combustion turbines designed to ramp up quickly and meet peak demand, and older steam turbine facilities now operated infrequently as peaker plants. Two thirds of Massachusetts peaker plants burn primarily oil, and more than 90% are over 30 years old—resulting in numerous inefficient plants with high rates of greenhouse gas and criteria pollutant emissions for every unit of electricity generated. Moreover, many of these plants are located disproportionately in urban, low-income and minority communities, where vulnerable populations already experience high levels of health and environmental burdens. These plants are typically small and run infrequently, suggesting they may be good targets for replacement with energy storage. Massachusetts has set aggressive clean energy and energy storage deployment targets, providing an opportunity to replace inefficient, high-emitting peaker plants in vulnerable communities throughout the state with energy storage and solar.

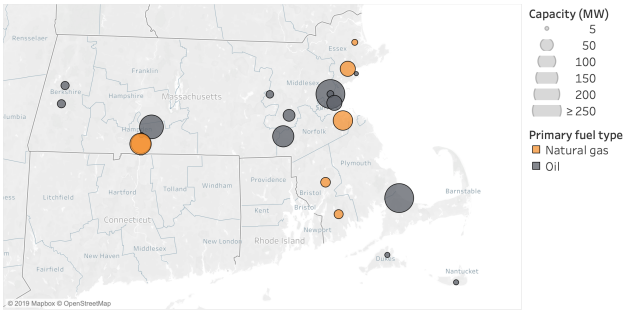

Figure 1: Peaker plants across Massachusetts

State policy and regulatory environment

Massachusetts has enacted a suite of policy targets to support clean energy adoption and emission reductions that could facilitate replacement of peakers with solar and storage. Key targets include:

- **2025:** Deployment of 1,000 MWh of energy storage
- **2030:** 35% of electricity from renewable resources, including a solar carve-out
- **2050:** 80% reduction in greenhouse gas emissions below 1990 levels

The state is also developing a Clean Peak Energy Standard to support clean resources meeting peak electric demand, and has established a Community Clean Energy Resiliency Initiative which may support the deployment of energy storage to provide backup in emergencies.

The grid in Massachusetts is operated by the New England Independent System Operator (ISO-NE), which determines local requirements for power capacity on the grid. The Northeast Massachusetts/Boston (NEMA) and Southeastern Massachusetts (SEMA) load zones are import-constrained, meaning that local deployment of clean resources such as solar and storage may also be required to replace local peaker plants in these regions.

Massachusetts peaker plants

Peak electricity demand in Massachusetts is partially met by 23 gas turbines, internal combustion engines, and underutilized aging steam plants. Features of these plants suggest that many would be good targets for replacement with energy storage, including:

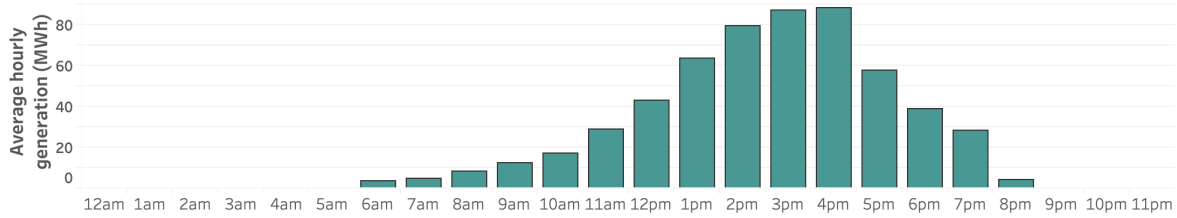

Figure 2: Average hourly generation from the Framingham peaker plant. The plant typically meets peak afternoon loads. It also runs an average of 3.3 hours each start up. Batteries can serve a similar role on the grid.

- **Small:** More than half of the plants are under 25 MW.
- **Aging:** 21 of 23 plants are over 30 years old, and 19 are over 40 years old.
- **Inefficient:** 18 plants are less efficient than the national average for similar facilities.
- **Short runtimes:** 16 of the plants run less than four hours every time they are started up, which can be met easily with batteries (see Figure 2).
- **Infrequently used:** 19 operate at a capacity factor of under 1%—that is, they generate 1% of the electricity that they would if they were running constantly at full power all year. Shrewsbury even reports negative electricity generation because it uses electricity to run on standby.

One new 200 MW peaker plant, West Medway II, has been proposed. In addition, the Nantucket facility has proposed a 16.4 MW expansion. These proposed facilities may provide a decision-making opportunity to consider solar+storage alternatives.

Emissions and the environment

Two thirds of Massachusetts peaker plants and units burn primarily oil and the remainder use primarily natural gas, although many burn both. Carbon dioxide and nitrogen oxides emission rates—pollution per unit of electricity generated—tend to be high from both sets of facilities, which is likely a function of both the age of the facilities and the fuels used. Seven of the 12 units for which we have data generate more than 5% of their electricity on days already exceeding federal ozone or particulate matter concentration standards in the nearby area, suggesting they may be exacerbating already poor air quality. These facilities can directly emit particulate matter, and also produce nitrogen oxides and sulfur dioxide. These pollutants react in the atmosphere to form secondary particulate matter and ozone, which have cardiovascular and respiratory health impacts.

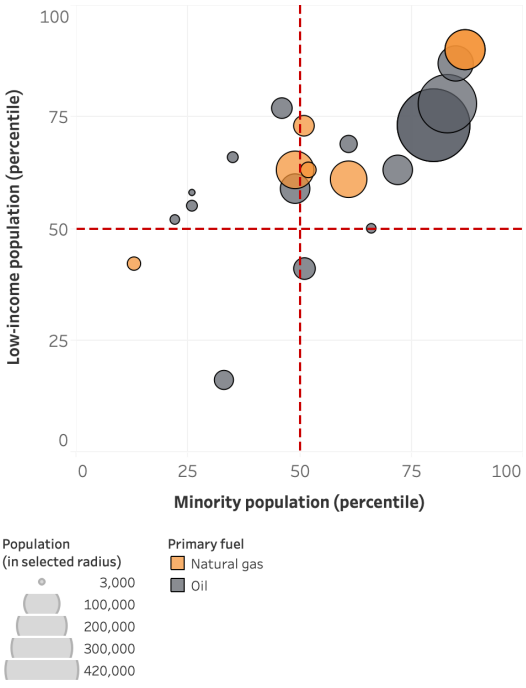

Figure 3: Demographic distribution of Massachusetts peaker plants. Bubbles reflect population size. Axes mark percentiles for low-income and minority populations living within three miles of each facility.

Nearby populations

A third of Massachusetts peaker plants have more than 100,000 people living within a three-mile radius. Populations living within three miles of these

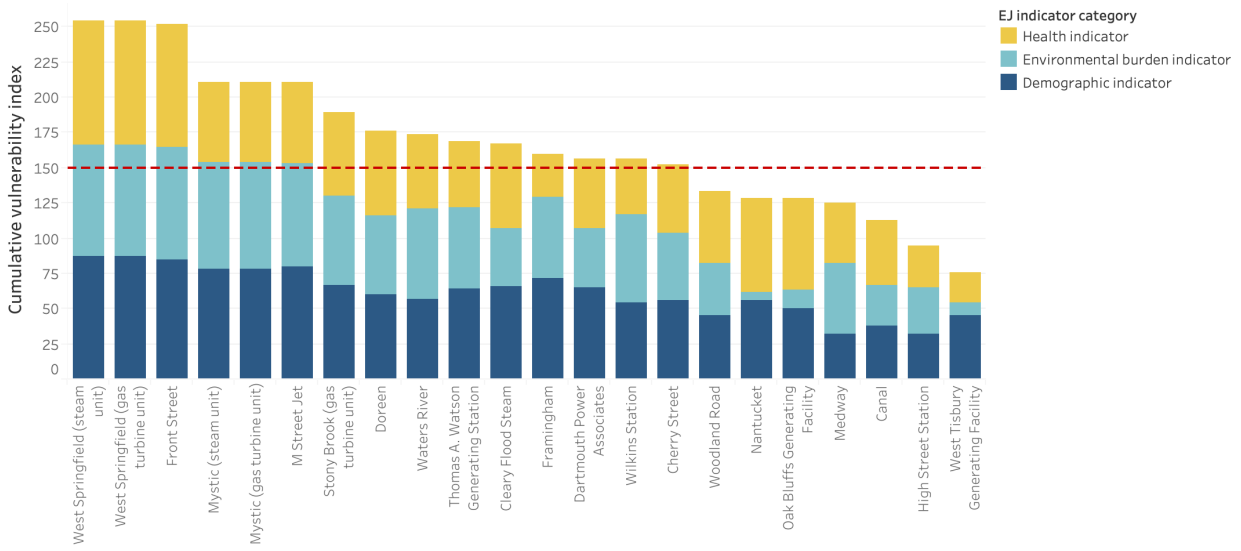

Figure 4: The cumulative vulnerability index reflects a set of environmental, human health and demographic indicators for populations living within three miles of each plant. The score is based on a comparison of indicators to statewide values: if a plant ranked at the median percentile for all indicators, it would score 150, which is indicated by the red dashed line.

plants tend to be disproportionately low-income and minority populations: communities near 19 of the plants are above the 50th percentile statewide for low-income populations (that is, they have low-income households than half of Massachusetts census tracts), and 14 are above the 50th percentile for minority populations (see Figure 3). Eight units (at six facilities) are located within state-defined environmental justice areas, defined as communities with 25%+ population reporting as non-white, 25%+ households linguistically isolated, and/or median household incomes less than 65% of the statewide median. Many communities also have a high cumulative exposure to environmental health burdens from numerous sources. We developed a cumulative vulnerability index that integrates data on health burdens (asthma, heart attacks, premature birth rates); environmental burdens (ozone, particulate matter, toxics, traffic proximity, lead paint, and hazardous facilities); and demographic indicators (low-income, minority, linguistically isolated, and non-high school educated populations). The cumulative vulnerability index for populations living within three miles of each facility is shown in Figure 4.

Summary

Massachusetts peaker plants are typically aging, oil-burning, inefficient facilities, and are located disproportionately in low-income and minority communities. The state's energy storage goals provide an opportunity to target the more inefficient and polluting facilities, particularly in urban areas, for replacement with cleaner alternatives. In the attached table, we provide operational, environmental and demographic data for Massachusetts peakers and nearby populations. In the attached table, we provide operational, environmental and demographic data for Massachusetts peakers and nearby populations. Indicators such as nearby population, emission rates, heat rate (a measure of efficiency), operation on poor air quality days, capacity factor, typical run hours, location in an environmental justice community or in an import-constrained load zone can also inform whether a given plant might be a good target for replacement with storage or solar+storage.

Massachusetts peaker plant operational and demographic data. For methods see www.psehealthyenergy.org.

	Plant description					Operation and emissions							Demographics (3-mile radius)			
Name (EIA ID)	**Status**	**City**	**Fuel**[1]	**MW**[2]	**Load zone**[3]	**Age**[4]	**Capacity factor**[5]	**Run hours/ start**[6]	**Heat rate**[7] MMBtu/ MWh	**CO_2 rate**[8] tons/ MWh	**NO_x rate**[9] g/MWh	**% MWh high ozone days**[10]	**Pop.**	**% non-white** (percentile)[11]	**% low-income** (percentile)[12]	**CVI**[13]
Canal (6125)	Operating; proposed 350 MW expansion (Canal 3)	Sandwich	Oil	1165	SEMA	51	1.0%	43.1	9.8	0.73	495	0.8%	9,437	8% (26)	21 % (55)	113
Cherry Street (9038)	Operating	Hudson	Oil	17.3	WCMA	68	0.2%	NA	11.4	0.79	13,616	NA	37,114	18% (51)	16% (41)	152
Cleary Flood Steam[14] (1682)	Operating; proposed 3 MW battery	Taunton	Natural gas	28.3	SEMA	53	0.7%	10.5	15.1	1.22	1,743	7.8%	32,898	18% (51)	32% (73)	167
Dartmouth Power Associates[15] (52026)	Operating	Dartmouth	Natural gas	24.7	SEMA	10	6%	6.8	11.0	0.66	52	7.0%	19,356	19% (52)	25% (63)	156

[1]Primary fuel; many plants burn both oil and natural gas
[2]Installed nameplate capacity (plant size)
[3]Load zone within ISO New England territory; NEMA and SEMA have import constraints
[4]Age of oldest unit in 2019
[5]Percent of time running as compared to running all year at full capacity
[6]Average number of hours plant runs each time it is turned on
[7]Heat rates are energy burned per unit of electricity generated; high heat rates reflect low efficiency
[8]Direct carbon dioxide emissions per unit of electricity generated; does not include upstream emissions
[9]Nitrogen oxides (NO_x) emitted per unit of electricity generated; NO_x contributes to ozone and particulate matter formation
[10]Percent of generation on days nearby monitors record exceedances of federal ozone standards
[11]Percentile minority population indicates percent of census tracts across the state with lower fraction of non-white populations
[12]Percentile low-income population indicates percent of census tracts across the state with lower fraction of households below double the federal poverty limit
[13]Cumulative Vulnerability Index combines state percentiles for demographic, health and environmental exposure indicators. A median on all values would score 150.
[14]Steam turbine unit at 146 MW gas combined cycle plant
[15]Gas turbine unit at 97 MW gas combined cycle plant

Doreen (1631)	Operating	Pittsfield	Oil	21.1	WCMA	50	0.1%	3.1	17.9	1.29	9,725	0%	33,745	15% (46)	37% (77)	176
Framingham (1586)	Operating	Framingham	Oil	42.6	NEMA	50	0.1%	3.3	30.7	2.21	7,631	10%	68,444	34% (72)	25% (63)	160
Front Street (7396)	Operating[16]	Chicopee	Oil	8.1	WCMA	41	0.4%	NA	10.2	0.82	14,354	NA	98,467	54% (85)	50% (87)	252
High Street Station (1670)	Operating	Ipswich	Natural gas	10.9	NEMA	82	0.1%	NA	9.6	0.63	10,676	NA	14,212	4% (13)	16% (42)	95
M Street Jet (10176)	Operating	Boston	Oil	69	NEMA	40	0.3%	2.9	13.4	1.09	858	7.3%	269,760	49% (83)	38% (78)	211
Medway (1592)	Operating	Medway	Oil	135	NEMA	49	0.3%	3.1	26.9	2.18	6,412	1.8%	29,104	10% (33)	7% (16)	125
Mystic GT[17] (1588)	Proposed 2022 retirement	Everett	Oil	14.2	NEMA	50	0.2%	3.3	32.0	2.34	7,316	8%	417,951	44% (80)	33% (73)	211
Mystic ST[18] (1588)	Proposed 2022 retirement	Everett	Oil	617	NEMA	62	3.3%	78.8	12.0	0.96	965	1.9%	417,951	44% (80)	33% (73)	211
Nantucket (1615)	Operating; proposed 16.4 MW expansion	Nantucket	Oil	8.1	SEMA	31	0.4%	NA	15.6	1.26	6,410	NA	7,569	29% (66)	19% (50)	128
Oak Bluffs (1597)	Operating	Oak Bluffs	Oil	8.1	SEMA	50	0.3%	NA	11.2	0.90	16,241	NA	9,314	11% (35)	27% (66)	128
Shrewsbury[19] (1599)	Operating	Shrewsbury	Oil	14	WCMA	50	-0.1%	NA	NA	NA	NA	NA	48,661	28% (65)	15% (40)	154
Stony Brook GT[20] (6081)	Operating	Ludlow	Oil	170	WCMA	37	0.3%	NA	14.1	1.14	7,671	3.2%	23,462	25% (61)	29% (69)	189

[16]Proposed 2019 partial non-price retirement
[17]Gas turbine unit at 2,736 MW gas combined cycle plant
[18]Steam turbine unit at 2,736 MW gas combined cycle plant
[19]Shrewsbury operates on standby and frequently reports negative generation; the rankings therefore do not apply, but this operation suggests it may be viable for replacement.
[20]Gas turbine unit at 534 MW gas combined cycle plant

Thomas A. Watson[21] (1660)	Operating	Braintree	Natural gas	116	SEMA	10	4.3%	4.9	9.7	0.61	80	2%	105,621	25% (61)	24% (61)	169
Waters River (1678)	Operating	Peabody	Natural gas	64.9	NEMA	48	1.5%	6.0	12.9	0.62	2,146	1.6%	111,900	17% (49)	25% (63)	174
West Springfield GT[22] (1642)	Operating	West Springfield	Natural gas	137	WCMA	51	2.1%	3.6	10.1	0.47	236	6%	127,116	60% (87)	56% (90)	254
West Springfield ST[23] (1642)	Operating	West Springfield	Natural gas	113.6	WCMA	70	0.7%	11.9	15.1	0.92	559	7.3%	127,116	60% (87)	56% (90)	254
West Tisbury (6049)	Operating	West Tisbury	Oil	5.4	SEMA	44	0.4%	NA	15.4	1.25	22,556	NA	3,068	8% (26)	22% (58)	76
Wilkins Station (6586)	Operating	Marble-head	Oil	5.4	NEMA	44	0.1%	NA	7.4	0.60	11,494	NA	69,074	17% (49)	23% (59)	156
Woodland Road (1643)	Operating	Lee	Oil	20.4	WCMA	60	0.1%	3.8	16.7	1.28	9,104	NA	7,239	6% (22)	20% (52)	133

[21]Gas turbine unit at 217 MW gas combined cycle plant (aka Potter II)
[22]Gas turbine unit at 251 MW gas peaker plant
[23]Steam turbine unit at 251 MW gas peaker plant