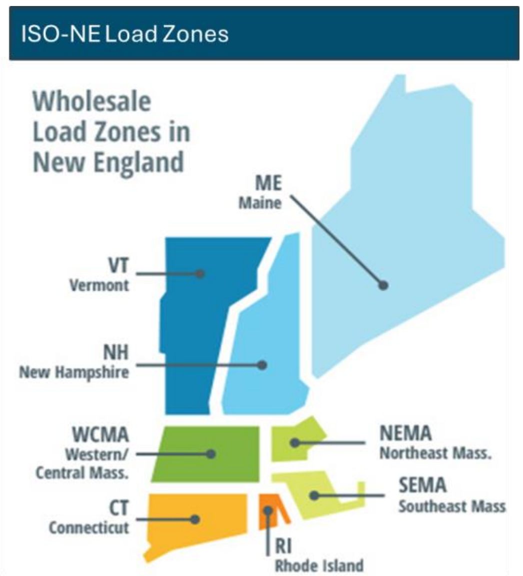
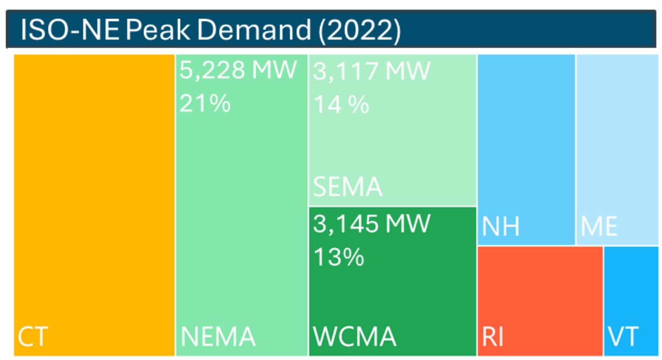
DECARBONIZING THE PEAK: BACKGROUND

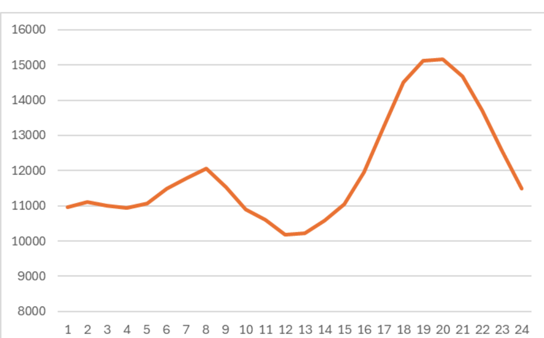
Q. What is the "peak?"

Electricity consumption fluctuates daily and seasonally. The "peak" refers to the maximum demand on an electricity system over a particular time period (e.g., daily peak, seasonal peak, etc.). According to ISO New England (ISO-NE), nearly half the regional peak demand across New England is from Massachusetts.





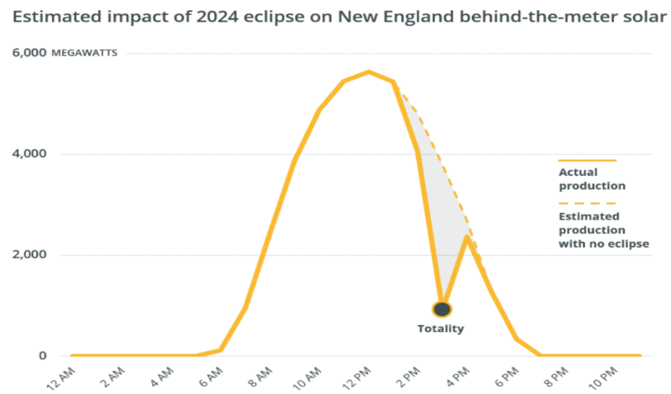
Electricity demand generally follows predictable patterns of consumer behavior and the weather. For example, during a typical day, electricity usage increases each morning as people wake up and businesses open. Electricity usage typically peaks in the early evening and falls to its lowest point overnight as people sleep. (For illustration, the daily electricity peak demand curve for Tuesday, September 5, 2024 from ISO-NE is provided below.)



On September 5, 2024, the lowest level of electricity consumption was between 10,000 megawatts (MW) and 11,000 MW overnight and around midday, while the highest levels were closer to 15,000 MW during the evening hours. While daily peaks vary throughout the year, this minimum amount tends to be around 9,000 MW. This minimum demand is called "base load." Due to the large volume of solar installations across the New England region, including customer-owned or behind-the-meter solar, demand during the middle of a sunny day is relatively low.

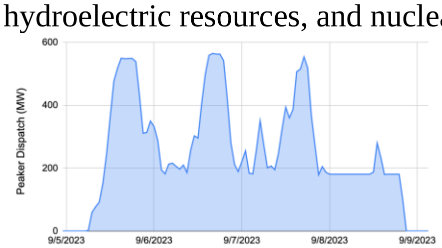
Weather also drives electricity demand. Today in New England, peak electricity usage typically coincides with hot summer temperatures when high-energy consuming air conditioners are cooling homes and businesses, sometimes over multiple days. As more vehicle and heating electrification occurs, these patterns are expected to change and evolve.

The need for power supply can also be caused by unexpected outages to power plants, constraints on the transmission system, or decreased production from renewable generation due to weather or other events that disrupt wind or solar resources. For instance, the 2024 solar eclipse was an unusual example of a supply disruption. In the chart below, energy production by the region's behind-the-meter solar resources decreased rapidly when the moon eclipsed the sun. ISO-NE was able to maintain system reliability by backfilling the loss of solar generation with energy from dispatchable resources. In this scenario, these facilities were called upon to address a sudden energy shortage. As wind and solar deployment increases in the region, there will continue to be a need for resources that can quickly respond to changes in supply and maintain the integrity of the system.



Q. What are peaker plants, how are peaker plants different from other power plants, and how are they used?

In New England, as deployment of wind and solar energy and battery storage increases, an increasing share of base load needs will be met from renewable and zero-carbon sources; however, other resources will be needed as we transition to these sources. Power plants that are efficient and can provide constant output are, from an operational perspective, ideal for meeting base load demand. These "base load" plants include, for example, combined cycle natural gas plants, which are the highest efficiency fossil fuel plants, traditional hydroelectric resources, and nuclear facilities.

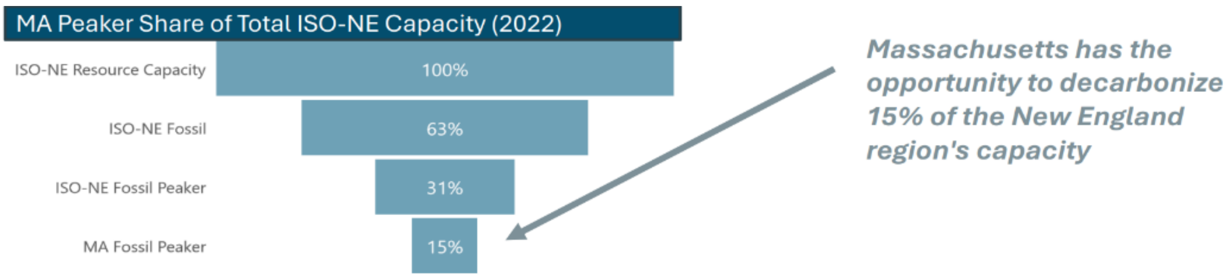


"Peaker plants" are generating units that can turn on quickly to meet short-term needs, such as demand spikes or supply disruptions. According to ISO-NE, there are nearly 100 generating units across New England that operate as peaker plants.[1] The name "peaker plant" refers to their traditional role in providing power during peak periods. Peaker plants generate energy infrequently, typically to meet daily peaks or multi-day peaks during periods of grid stress, as illustrated in the adjacent graph of Canal Generating Station Unit 2 (located in Sandwich, MA).

There are approximately 50 peaker generating units in Massachusetts, located in communities across the state, including in or near Environmental Justice communities. The majority of these peaker plants run on natural gas or oil and comprise approximately 15% of ISO-NE's total resource capacity.

[1] According the Government Accountabiility Office (GAO), there are approximately 1,000 peaker generating units across the U.S.

DECARBONIZING THE PEAK: BACKGROUND



Peaker plants typically run between 5% and 15% or less of their nameplate capacity—i.e., a facility's maximum potential output—and account for only a small percentage of total generation. This is in comparison to "base load" power plants, which provide constant output to meet base load needs and tend to be highly efficient.

Q. How are peaker plants financed?

Typically, peaker plants have low initial capital costs but high variable costs primarily driven by fuel costs. The decision to run is strongly determined by prevailing wholesale market prices for energy, which are strongly linked to demand for electricity and the price of fuel. For instance, when demand for electricity is high, energy prices tend to be high too. Those high prices incentivize peaker plants to provide energy, which will operate only if the energy market price is high enough to cover their variable costs. In the hours they run, peaker plants tend to set the wholesale market price for electricity that generators receive. Peaker plants can also earn revenue by selling ancillary services, which are essential for safely and reliably operating a power system.

Many peaker plants receive a significant portion of their total revenues from ISO-NE's capacity market, which was designed to ensure system reliability. Capacity payments are based on how much energy a particular resource could hypothetically supply at any given moment, rather than by how much energy it actually does supply over the course of any particular day or year.

Q. How are electricity demand and the peak expected to change over the next decade?

According to ISO-NE, by the mid-2030s, peak demand for electricity will increase substantially and shift from summer to winter. By 2050, peak demand could also vary significantly on a year-to-year basis depending on if there is a mild or severe winter.

ISO-NE projects that some resources needed to maintain reliability during the harshest conditions may run only for a few days once every few years. Reducing peak demand could alleviate the need for such rarely used facilities.

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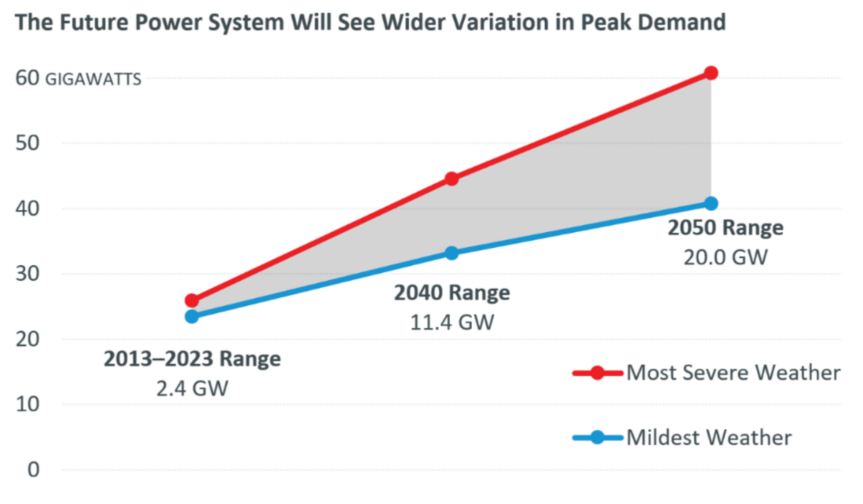

Q. What impact do peaker plants have on emissions?

Despite their infrequent operations, peaker plants have an outsized impact on emissions. Because they are less efficient than other plants and often burn fuels like oil, they are higher emitters for the amount of power they provide. In 2022, for example, the Mystic Generating Station located in Everett, Massachusetts, which ran as a peaker plant, accounted for a third of emissions from in-state generation, with peaker plants contributing more than 10 percent of Massachusetts greenhouse gas emissions in 2022. In addition to emitting GHGs through the combustion of fossil fuels, peaker plants also have local air quality impacts from emissions of, for example, nitrogen oxides, sulfur dioxides, particulate matter, and ground-level ozone.

Q. Why is decarbonizing the peak challenging and important?

Increased reliance on intermittent renewable energy sources like solar and wind and changes in the magnitude, timing, and season of peak demand due to electrification of the transportation and building sectors may increase significantly the need for peaking capacity on the system in the coming decades, according to the *2050 Clean Energy and Climate Plan*. To meet the Commonwealth's GHG emissions targets, less carbon intensive resources will need to be relied upon to meet peak demand.

Additionally, limited natural gas infrastructure in New England results in constrained fuel availability during the coldest winter days. During these periods, natural gas is diverted to prioritize building heat, and some power plants switch to combustion of oil if economic to support the electric demand. As the building sector moves increasingly toward electrified heating and cooling with heat pumps, natural gas demand for on-site combustion in furnaces may be reduced, but electric demand will increase. Therefore, as winter peaks increase, there is potential for more of electricity to be produced using oil on the coldest days.

Q. What are alternatives to peaker plants?

There are alternative options on the demand and supply side to help meet peak demand. For example, well-designed utility rates, such as time-variable rates, and demand response programs can incentivize consumers to use less energy during high-demand periods and, thus, contribute to lowering the peak. Demand response programs shift electricity usage to lower-usage periods by paying consumers to use less electricity during high-demand periods, which can mitigate the peak, reduce the amount of energy needed from peaker plants, and lower overall system costs. Replacing of out-of-date electric heating systems can also help reduce peak demand. For example, according to the U.S. Department of Energy, heat pumps can cut electricity use by 50% when compared to electric resistance heating systems (e.g., base board or space heating). Approximately 16% of households in Massachusetts use some form of electric resistance heating, according to the Harvard Kennedy School's Belfer Center.

On the supply side, grid-scale and customer-owned solutions are available that can be optimized to help meet peak demand, and existing peaker plant locations can offer opportunities to implement these alternatives. For example, their existing grid connection can support renewable energy and storage development, while providing economic benefits to the host communities.

Today, thermal power plants provide important attributes to the electric grid in the form of firm, dispatchable capacity. As the region continues to decarbonize the electric sector, it will be necessary to explore various existing and nascent technologies that are able to replace traditional facilities in the future.

Q. What is combined heat and power?

Combined heat and power (CHP), also known as cogeneration, uses a single fuel to generate both heat and electricity at the same time. A CHP system captures waste heat from the electricity generation process and uses it to produce more electricity, heat buildings or water, or power an industrial process. The combined facility is more efficient than separate electricity generation and heating systems, with typical system efficiencies of 65% to 80%.

CHP systems can be economically viable for consumers with predictable and consistent heat and power needs, such as factories, hospitals, multifamily apartments, universities, wastewater treatment plants, and military campuses. CHP can also be integrated into district energy systems, which use a network of pipes to heat and/or cool multiple buildings.

Most CHP systems operate continuously, which reduces regional electricity demand. Thus, CHP systems currently play an important role in helping to meet peak demand. Massachusetts currently has 248 CHP systems with a capacity of 1,575 MW. Most CHP systems in the Commonwealth are powered by natural gas. As Massachusetts transitions away from fossil fuels, CHP systems will need to transition and/or their end users will need to find alternative means of meeting their energy needs, including through electrification and thermal energy systems.