Fuel oil-powered equipment is assumed to be 11 percent less efficient than natural gas-powered equipment at converting a unit of fuel to heat energy.[26] This, in conjunction with a relatively higher GHG emission rate than natural gas per unit of fuel, as shown in Table 4-3 below, results in an estimated net increase in emissions of approximately 45,000 tons of CO_2e through 2034/35 if customers relied on heating oil as their primary fuel source. By avoiding a moratorium beginning in 2023 and allowing customers to convert to natural gas instead of using fuel oil, GHG emission savings are achieved.

As noted above, the GHG saving estimates shown in Figure 1 below are based on the assumed GHG emissions rates for natural gas, fuel oil, and electricity production shown in Table 4-3. Pipeline gas and fuel oil emissions rates are assumed to remain constant over time, while emissions associated with electricity production are assumed to decline linearly to zero emissions by 2030 in accordance with the state's goal of 100% renewable electricity by 2030.

Table 4-3 GHG Emission Rates by Fuel Source

Greenhouse Gas	Pipeline Gas [lb per MMBtu][27]	Fuel Oil [lb per MMBtu][527]	2020 Electricity Production [lb per MWh][28]	2030 Electricity Production [lb per MWh]
CO_2	117	165	575	0
N_2O	0.00022	0.0013	0.24	0
CH_4	0.022	0.066	0	0

For scenarios that include DSM components, the net GHG emissions savings shown in Graphic 4 includes both the decrease in GHG emissions from avoided natural gas consumption and, if applicable for that DSM component, the increase in GHG emissions from alternative fuel consumption associated with that DSM measure (e.g., increased electric consumption due to electrification). DSM components include:

› **Energy efficiency –** The annual natural gas savings through winter 2034/35 from energy efficiency measures, shown in Table 4-4, is multiplied by the emissions rate of pipeline gas, shown in Table 4-3, to yield the GHG savings from energy efficiency. There is no alternative fuel consumption assumed for energy efficiency measures, so this GHG savings amount represents the total net GHG savings for energy efficiency per solution.

26 Assuming 85% Annual Fuel Utilization Efficiency (AFUE) for oil-fired equipment, based on U.S. Department of Energy (DOE) appliance standards for oil-fired boilers found at 10 CFR 430.32(e)(2)(iii)(A), and assuming 95% AFUE for gas-fired equipment, based on a Massachusetts study of Heating, Air-conditioning, & Refrigeration Distributors International (HARDI) data from HVAC distributors, available at https://ma-eeac.org/wp-content/uploads/TXC65_HARDI_Data_Memo_Final_2019.11.15.pdf.

27 U.S. EPA website, Emission Factors for Greenhouse Gas Inventories, available at: https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf

28 Table 1-1 of 2019 ISO New England Electric Generator Air Emissions Report, available at: https://www.iso-ne.com/static-assets/documents/2021/03/2019_air_emissions_report.pdf

- **Demand response** – For all demand response programs considered, participants are assumed to avoid natural gas consumption on peak days, as shown in Table 4-4. Peak days are defined as days with an average temperature below 10 °F, which appear in the Company's design weather pattern 5 times per heating season. The resulting natural gas savings is multiplied by the emissions rate of pipeline gas shown in Table 4-3 to estimate GHG emission savings. However, some of the demand response participants are assumed to switch to consuming fuel oil on those event days, and that fuel oil consumption, scaled up by the assumed 16% lower efficiency of fuel oil-powered equipment, is multiplied by the emissions rate of fuel oil shown in Table 4-3 to estimate an increase in GHG emissions. These emissions impacts are then summed together to yield the net GHG emissions savings associated with demand response. This increase in GHG emissions associated with switching to fuel oil consumption for demand response events is greater than the decrease in GHG emissions associated with switching off of natural gas consumption, resulting in demand response having negative net GHG emissions savings (i.e., a net increase in GHG emissions relative to the baseline). The relative magnitude of these negative net GHG emissions savings is small, however, because there are relatively few demand response event days assumed per year.
- **Electrification** – The annual natural gas savings through winter 2034/35 from electrifying customers (both existing natural gas customers and forecasted new customers, in the case of no moratorium) as shown in Table 4-4 is multiplied by the emissions rate of pipeline gas shown in Table 4-3 to estimate a GHG emission savings. The increase in annual electric consumption through winter 2034/35 from those same customers is multiplied by the emissions rate for electricity production shown in Table 4-3 to estimate the increase in GHG emissions associated with those electrified customers consuming additional electricity. These emissions impacts are then summed together to yield the net GHG emissions savings associated with electrification. As noted above, emissions associated with electricity production are assumed to decline linearly from 2020 values shown in Table 4-3 to zero emissions by 2030 in accordance with the state's goal of 100% renewable electricity by 2030.