Chapter 7 Greenhouse Gas Emissions

7.1 INTRODUCTION

This chapter evaluates potential changes to greenhouse gas (GHG) emissions associated with the operation of the Build Alternative. GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic (resulting from human activity), that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. Water vapor, carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

7.2 POLLUTANTS OF CONCERN AND METHODOLOGY

The EPA identifies GHGs that could potentially be included in the scope of an EIS: CO_2, N_2O, CH_4, and fluorinated gases, which include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). CO_2 is the primary pollutant of concern from anthropogenic sources. CO_2 is by far the most abundant GHG and is emitted from any combustion process (both natural and anthropogenic), including power generation and other industrial processes such as the manufacture of cement, mineral production, metal production, and from the decay of organic matter. CH_4 and N_2O are also emitted by power generation facilities. There are no significant direct or indirect sources of fluorinated gases associated with the operation of the Build Alternative; therefore, these pollutants were not included in the analysis.

In accordance with the EPA, emissions of the GHGs of concern are considered and expressed in terms of carbon dioxide equivalents (CO_2e). CO_2, CH_4, and N_2O differ in their ability to trap heat in the atmosphere; CO_2 has a heat trapping ability of 1; CH_4 has a greater heat trapping equivalent of 25, which means that each metric ton of CH_4 has a heat trapping equivalent of 25 metric tons of CO_2; and N_2O has a much greater heat trapping equivalent of 298. As such, the emission rates of each pollutant must be multiplied by its equivalent rate to convert it to CO_2e emission rates.

In light of the global scope of the impacts of GHG emissions, and the incremental contribution of each single action to global concentrations, the EPA recommends agencies use projected GHG emissions associated with proposed actions as a proxy for assessing the proposed actions' potential effects on climate change in a NEPA analysis. In accordance with this guidance, the GHG emissions of the Build Alternative were considered by taking into account the greatest potential annual operational emissions.

For the purposes of this analysis, direct emissions from the on-site combustion equipment were analyzed for the high end of the range of potential natural gas consumption to provide a conservative estimate of the maximum potential output from the Main Facility (Preferred Alternative Project Component A), which is approximately 140MW. Calculations were based on fuel consumption information from a review of relevant equipment specifications for the configuration that would result in the maximum potential natural gas consumption (and therefore emissions). The output is dependent on the load of combined cycle generation system, operating at higher power when the load is greater and operating at lower power when the load is reduced. “Normal” output will vary throughout the operating day. Baseload power is expected to utilize the combined cycle generation system at 60MW but will operate at 30MW when NEC load is reduced. The other units will participate in the PJM market and operate primarily during the grid peak load conditions when the pricing in the market is favorable. This is expected to be 4-7 hours per day, primarily during weekdays. For the Build Alternative, this was five 22MW natural gas turbines operating at full capacity 24/7 for the year, because the facility is specifically being designed to operate during both normal conditions and during emergency conditions (i.e., in islanded mode) when power from the commercial grid is not available. During emergency conditions when the need for very precise power output frequency is higher, it is possible that short-term GHG emission rates would be higher because the emission control systems may not be fully operational during these conditions. However, emergency conditions are not normally quantified because the number of times such a condition would occur, and the duration of each occurrence, is unknown. In addition, GHG emissions generated by the proposed facility during an emergency would likely be offset by a reduction in GHG emissions from the commercial plants that would be offline or underutilized, and not likely result in a net increase in regional GHG emission rates during those periods. Commercial sources which currently provide power to sections of NJ TRANSIT service areas include Jersey Central Power and Light (JCP&L) and Public Service Electric & Gas (PSE&G).

The project also includes a nanogrid, which would consist of two generators powered by two natural gas-fired reciprocating engines to provide electricity for traction and signals for the southern portion of the HBLR. Designated as Preferred Alternative Project Component F, it would be located at HBLR Yard and Shop. The output of these generators is approximately 2MW each for a total of up to 4MW from the nanogrid. These engines would be designed to run primarily during emergency conditions (i.e., islanded mode, when the commercial power supply was interrupted). However, under normal conditions, they would be run for one hour each month for maintenance, so they are a potential source of GHG emissions. Emissions were calculated for the 12 total hours each engine would be run annually, and these values were added to the emissions output of the Main Facility.

Emissions from fuel consumption estimates were converted to equivalent GHG emission estimates. Indirect emissions, such as from on-road vehicles are associated with employee commutes and deliveries, are considered to be minimal for this project when compared with the emissions from the natural gas turbines and were therefore not considered in this analysis. Under emergency conditions, the nanogrid engines would be operated continuously, until commercial grid power was restored, but the increase in emissions would be offset by reductions in emissions from the commercial grid, since it would not be supplying power to the substations that normally provide power to the southern portions of HBLR.

Indirect GHG emissions resulting from the operations of the Main Facility would include the emissions resulting from the offsite production of electricity. The ability to deliver electrical power from the commercial grid to the Main Facility would be available, but off-site power requirements for the Main Facility are expected to be minimal, as the Main Facility would be designed to meet its own power needs, even under emergency conditions. As noted above, the nanogrid engines which would supply the southern sections of the HBLR would be started during emergency conditions, and would not require off-site power, so would have no indirect emissions from their operation. Chapter 18, "Indirect Effects and Cumulative Impacts," presents a discussion of indirect emissions that result from the manufacture of equipment and materials required to construct the proposed Project.

7.3 POLLUTANTS OF CONCERN AND MAJOR EMISSION SOURCES

GHG emissions from the proposed Main Facility are predominantly attributable to the combustion of natural gas. The proposed Main Facility would not have any other industrial processes releasing GHGs and would not operate fleet vehicles. The greatest proportion of potential GHG emissions from the proposed project would be CO_2. While CH_4 and N_2O would be emitted in varying quantities depending on operating conditions, these emissions, although small when compared to total CO_2 emissions, were also considered.

In addition, while there would be other sources of GHG emissions associated with the proposed Main Facility, such as direct emissions from the emergency black-start generators, employee commuting, and truck deliveries (as well as construction-related emissions), these emissions are minimal when compared with the natural gas combustion emissions. As such, the estimation of CO_2e emissions for the Build Alternative focuses on emissions from the combustion of natural gas.

7.4 IMPACTS OF THE PROJECT ALTERNATIVES

7.4.1 No Action Alternative

Under the No Action Alternative, the microgrid would not be constructed and NJ TRANSIT and Amtrak would continue to rely on the commercial grid for traction power in the core service territory during normal conditions. During emergency conditions, traction power would not be available for NJ TRANSIT and Amtrak rail lines in this core service area and rail transportation would not be possible. Because of this rail service outage, less-efficient travel modes would be required compared to the current conditions. The potential benefits to regional air quality during emergency conditions (providing public transportation powered by clean-burning natural gas and more efficient and modern equipment, rather than the use of other modes of transportation with greater GHG emissions) would not be realized. In 2015, New Jersey GHG emissions for electrical generation were 17.7 MMTCO2e (of a total of 100.9 MMTCO2e). The current sources of NJ TRANSIT electrical power in 2018 was from natural gas (59.2%), nuclear (36.1%), renewables (3.3%), and coal (1.4%), according to U.S. Energy Information Administration.

Under the No Action Alternative, other planned and programmed transportation improvements would take place by 2021. These include projects for which commitment and financing have been identified in NJ TRANSIT's Resilience Program, Amtrak initiatives that will affect operations on the Northeast Corridor, and HCIA plans for warehousing development on portions of the Koppers Koke property. These projects are independent of the proposed Project and would not provide traction power for public transportation during emergency conditions.

7.4.2 Build Alternative – Main Facility Turbines

Preliminary estimates of CO_2e emissions that would be generated annually by the proposed plant with the greatest potential emissions (five 22MW natural gas turbines) have been estimated by conservatively assuming that each of the five gas turbines would consume 237 million Btu (MMBtu) gas turbines per hour and would operate continuously (8,760 hours per year). This is considered a high-end estimate because the turbines would not need to run at maximum capacity all of the time. The simple-cycle plant and the combined-cycle plant configurations would have identical GHG emissions because both would employ five 22MW natural gas turbines. Any additional steam turbines would be run from steam generated by exhaust heat from the natural gas turbines and would not require any additional natural gas usage, so would not increase emissions. Under this worst-case scenario, the Main Facility would generate the following amounts of GHG gases:

CO_2e Emission Rates

CO_2

Based on this worst-case scenario, the following equations were used to estimate the amount of CO_2 emissions associated with the worst-case Build Alternative:

$$\frac{237\text{ MMBtu}}{\text{turbine-hour}} \times \frac{8{,}760\text{ hours}}{\text{year}} \times 5\text{ turbines} \times \frac{110\text{ lb }CO_2}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}} = 570{,}933\text{ tons of }CO_2\text{ per year}$$

Where,

The factor of 110 lb of CO_2/MMBtu was obtained from EPA's AP-42 Table 3.1-2a, "Compilation of Air Pollutant Emission Factors." (EPA 2000)

As the global warming potential of CO_2 is 1, the CO_2e emission rate of CO_2 is also 570,933 tons per year.

In addition to CO_2, the other GHGs released from the combustion of natural gas are CH_4 and N_2O. Using emission factors also from AP-42's Table 3.1-2a, the following emission rates for each of these pollutants, as well as their CO_2 equivalents, are estimated as follows:

CH_4

$$\frac{237\text{ MMBtu}}{\text{turbine-hour}} \times \frac{8{,}760\text{ hours}}{\text{year}} \times 5\text{ turbines} \times \frac{0.0086\text{ lb }CH_4}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}} = 44.6\text{ tons of }CH_4\text{ per year}$$

Since the global warming potential of CH_4 is 25 times that of CO_2, the CO_2e emission rate for CH_4 is 1,115 tons per year.

N_2O

$$\frac{237\text{ MMBtu}}{\text{turbine-hour}} \times \frac{8{,}760\text{ hours}}{\text{year}} \times 5\text{ turbines} \times \frac{0.003\text{ lb }N_2O}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}} = 15.6\text{ tons of }N_2O\text{ per year}$$

Since the global warming potential of N_2O is 298 times that of CO_2, the CO_2e emission rate for N_2O is 4,649 tons per year.

CO_2e

The total amount of CO_2e generated by the worst-case Build Alternative, therefore, is estimated to be:

570,993 + 1,115 + 4,649 = 576,757 tons of CO_2e per year

The accidental release of methane would be a rare occurrence and can only occur when a unit is placed in maintenance mode for a controls upgrade by the original equipment manufacturer (OEM). During maintenance, the release would only consist of the gas downstream of the block valve and the gas turbine. To limit the volume released, the cross-section of piping will be minimized, which is a standard practice for power plant operations.

7.4.3 Build Alternative – Main Facility Black-Start Engines

The natural gas-fired reciprocating engines that would run the black-start generators for the Main Facility (Preferred Alternative Project Component A) would need to be run one hour per month for maintenance, for a total of 12 hours of operation per year for each engine.

The black-start engines would be sized approximately 2,175 brake horsepower (bhp[11]) each, and each would consume approximately 6,705 Btu per bhp-hour. Annual heat input for two black-start engines would be:

$$\frac{6{,}705 \text{ Btu}}{\text{bhp-hour}} \times 2{,}175 \text{ bhp} \times \frac{12 \text{ hours}}{\text{year}} \times \frac{1 \text{ MMBtu}}{1{,}000{,}000 \text{ Btu}} \times 2 \text{ engines} = 350.001 \text{ MMBtu per year}$$

This would contribute the following amounts of CO_2e emissions:

CO_2

$$\frac{350.001 \text{ MMBtu}}{\text{year}} \times \frac{110 \text{ lb } CO_2}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000 \text{ lb}} = 19.25 \text{ tons of } CO_2 \text{ per year}$$

CH_4

$$\frac{350.001 \text{ MMBtu}}{\text{year}} \times \frac{0.0086 \text{ lb } CH_4}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000 \text{ lb}} = 0.0015 \text{ tons of } CH_4 \text{ per year}$$

Since the global warming potential of CH_4 is 25 times that of CO_2, the CO_2e emission rate for CH_4 is 0.038 tons per year.

N_2O

$$\frac{350.001 \text{ MMBtu}}{\text{year}} \times \frac{0.003 \text{ lb } N_2O}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000 \text{ lb}} = 0.0005 \text{ tons of } N_2O \text{ per year}$$

Since the global warming potential of N_2O is 298 times that of CO_2, the CO_2e emission rate for N_2O is 0.156 tons per year.

[11] bhp – "brake horsepower," which is power output in horsepower at the engine drive shaft under unloaded conditions. This is used to calculate the emissions for reciprocating engines using fuel-specific conversion factors.

The total amount of CO_2e generated by the Build Alternative for the two black-start engines would be 19.444 tons of CO_2e per year (Table 7-1).

Table 7-1 Greenhouse Gas Emissions (in Tons of CO_2e per Year) for Two Black-Start Engines in the Build Alternative

GHG Constituent	Emission Rate (lb/MMBtu)	Warming Potential Factor	Tons of CO_2e per year
CO_2	110	1	19.250
CH_4	0.0086	25	0.038
N_2O	0.003	298	0.156
		Total	**19.444**

7.4.4 Build Alternative – Nanogrid Engines

The natural gas-fired reciprocating engines that would run the nanogrid generators at the HBLR Headquarters (Preferred Alternative Project Component F) would need to be run one hour per month for maintenance, for a total of 12 hours of operation per year for each engine.

The nanogrid engines would be sized approximately 2,889 bhp each, and each would consume approximately 6,616 Btu per bhp-hour. Annual heat input for two engines would be:

$$\frac{6{,}616\ \text{Btu}}{\text{bhp-hour}} \times 2{,}889\ \text{bhp} \times \frac{12\ \text{hours}}{\text{year}} \times \frac{1\ \text{MMBtu}}{1{,}000{,}000\ \text{Btu}} \times 2\ \text{engines} = 458.737\ \text{MMBtu per year}$$

This would contribute the following amounts of CO_2e emissions:

CO_2

$$\frac{458.737\ \text{MMBtu}}{\text{year}} \times \frac{110\ \text{lb}\ CO_2}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} = 25.230\ \text{tons of}\ CO_2\ \text{per year}$$

CH_4

$$\frac{458.737\ \text{MMBtu}}{\text{year}} \times \frac{0.0086\ \text{lb}\ CH_4}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} = 0.0020\ \text{tons of}\ CH_4\ \text{per year}$$

Since the global warming potential of CH_4 is 25 times that of CO_2, the CO_2e emission rate for CH_4 is 0.049 tons per year.

N_2O

$$\frac{458.737\ \text{MMBtu}}{\text{year}} \times \frac{0.003\ \text{lb}\ N_2O}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} = 0.0007\ \text{tons of}\ N_2O\ \text{per year}$$

Since the global warming potential of N_2O is 298 times that of CO_2, the CO_2e emission rate for N_2O is 0.205 tons per year.

The total amount of CO_2e generated by the Build Alternative for the two nanogrid engines would be 25.484 tons of CO_2e per year (Table 7-2).

Table 7-2 Greenhouse Gas Emissions (in Tons of CO2e per Year) for Two Nanogrid Engines in the Build Alternative

GHG Constituent	Emission Rate (lb/MMBtu)	Warming Potential Factor	Tons of CO_2e per year
CO_2	110	1	25.230
CH_4	0.0086	25	0.049
N_2O	0.003	298	0.205
		Total	**25.484**

7.4.5 GHG Impacts

The total estimated amount of CO_2e generated by the worst-case of the Build Alternative is 576,801.9 tons per year of CO_2e (576,757.0 + 19.4 + 25.5 = 576,801.9). This is only 0.47% of the 123,458,720 tons per year of CO_2e generated in the state of New Jersey (US Energy Information Administration [EIA] 2018). As discussed above, in 2015, New Jersey GHG emissions for electrical generation were 17.7 MMTCO2e (of a total of 100.9 MMTCO2e). The NJ TRANSITGRID emissions of 0.577 MMTCO2e/year would be 3.3% of GHG emissions from power production in New Jersey. This would also be 0.00953% of the total GHG emissions of the United States in 2014, and 0.00141% of the world GHG emissions in 2014 ("Climate Analysis Indicators Tool (CAIT) Version 2.0. (Washington, DC: World Resources Institute, 2014)" World Resources Institute. Retrieved 2019-01-08). In addition, since the Build Alternative would replace the source of electricity currently being produced by commercial power plants for NJ TRANSIT and Amtrak operations in the core service territory, during normal operating conditions there is the potential that a large percentage of the emissions generated by the Main Facility would be offset by corresponding reduction in CO_2e emissions by commercial power plants due to a reduction in demand for electricity from those sources as a result of the Proposed Project. The current sources of NJ TRANSIT electrical power in 2018 was from natural gas (59.2%), nuclear (36.1%), renewables (3.3%), and coal (1.4%), according to U.S. Energy Information Administration. During emergency conditions, when commercial power is not available, public transportation provided by the proposed Project would continue to be available. This could result in a reduction of GHG emissions during this time, as commuters would not be required to use modes of transportation (e.g., personal automobiles) that are less efficient.

In addition, all of the possible equipment options would be consistent with the 2015 update to the New Jersey State Energy Master Plan, which outlines the State’s energy goals and provides strategies and recommendations for reducing overall emissions from power plants. Specifically, the project helps meet Goal 2, “Promote a Diverse Portfolio of New, Clean, In-State Generation,” through the development of a microgrid project “to address enhanced energy resilience.” (New Jersey Board of Public Utilities and New Jersey Department of Environmental Protection 2015)

7.5 SUMMARY OF SIGNIFICANT ADVERSE IMPACTS AND MITIGATION MEASURES

The proposed Project is part of NJ TRANSIT's response to the need for increased resiliency in the face of severe weather or man-made events, that may occur more frequently or increase in severity in the future. The Build Alternative is consistent with state and federal policies aimed at minimizing GHG emissions by offsets to the existing commercial grid.

The Build Alternative, therefore, would not have a significant adverse GHG impact, and no mitigation measures are proposed to specifically reduce GHG emissions. Nevertheless, measures to reduce emissions would be incorporated into the design of the Main Facility, as per EPA recommendations. These include SCR and oxidation catalyst systems, which substantially reduce nitrogen oxide and carbon monoxide emissions, and cause small reductions in N_2O and CH_4 emissions. While it is possible that short-term GHG emission rates would be higher under emergency conditions because the emission control systems may not be fully operational during these conditions, GHG emissions generated by the proposed facility during an emergency would likely be offset by a reduction in GHG emissions from the commercial plants that would be offline, and not contributing to regional GHG emission levels. Additional measures may be identified in the Title V permitting process.

The energized assets of the proposed Project will be less reliant on electricity from the commercial power grid. The reduced commercial demand could offset some GHG emissions generated by older and less efficient equipment, which would be beneficial to regional GHG emissions. During emergency conditions, the availability of public transportation would reduce the need for less-efficient transportation modes, which could result in reduced GHG emissions during commercial power grid outages, also a beneficial impact of the proposed Project.