Project: Bunker Hill Housing
Subject: Carbon Dioxide Emissions – Proposed Project Compared to Existing Conditions
Date: October 27, 2020

Existing Conditions

The Boston Housing Authority provided the following electricity and gas usage data for the existing Bunker Hill Housing development:

Year	2013	2014	2015	2016	2017	2018
Electricity (kWh)	7,471,680	7,006,560	6,961,120	6,824,480	6,590,000	6,960,320
Gas (Therms)	981,665	1,047,777	1,077,947			

IES averaged the six years of electricity and three years of gas data and calculated the amount of carbon dioxide (CO_2) released from this past energy usage based on standardized conversion factors from the US Energy Information Administration's most recent ISO New England Marginal Emissions Report (682 lbs/MWh for electricity and 117 lbs/MMBtu for natural gas).

	Electricity (kWh)	Gas (Therms)	Energy (MMBtu)	EUI (kBtu/sq.ft./year)	CO_2 (tons)
'13-'18 Electricity Ave.	6,969,027		23,778		2,376
13-'15 Gas Ave.		1,035,796	103,555		6,037
Existing Buildings (835,225 sq. ft.)	6,969,027	1,035,796	**127,333**	**152**	**8,414**

Propose Project

The CO_2 emissions for the proposed redevelopment were calculated using the protocols laid out in the project's Draft Environmental Impact Report dated 02/18/2020 and Petersen Engineering's Energy Use Intensity - Buildings F and D.2 memo dated 12/04/2019.

	Electricity (kWh)	Gas (Therms)	Energy (MMBtu)	EUI (kBtu/sq.ft./year)	CO_2 (tons)
Proposed Project (2,768,000 sq.ft.)	10,903,259	159,475	**53,146**	**19.2**	**4,648**

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Comparison – Current Electricity Grid CO_2 Emissions

Once complete, the entire proposed project is estimated to emit 45% less CO_2 than the existing development, despite being 3.3 times bigger in size. This improvement is a function of both the high efficiency of the proposed project and the inefficiency of the current development.

The difference in size between the existing and the proposed development can be accounted for by normalizing the results by floor area. Under this comparison metric, the proposed project emits 83% less CO_2 per square foot than the existing development.

The recent i-Tree Ecosystem Analysis from October 2020 provides a third method of quantifying the difference in emissions between the existing and proposed developments. The i-Tree report calculates that all trees currently onsite annually sequester 3.7 tons of CO_2. At this sequestration rate, there would need to be over a thousand times (1,024) as many tress as are currently onsite in order to sequester the additional CO_2 released by the inefficient existing development compared to the proposed project (3,766 tons).

It must be noted that this analysis is entirely focused on the operational CO_2 emissions of the project, i.e. the amount of CO_2 released based on the energy consumed in operating the buildings. In thinking about CO_2 emissions, one must also consider the embodied carbon, i.e. "the sum of all emissions resulting from the mining, harvesting, processing, manufacturing, transportation, and installation of the building materials that make up the project". The embodied carbon for the existing project was released at the time of its construction in 1942. Any future work performed onsite, from renovation to new construction work, will result in the addition of emissions as measured by embodied carbon. The project team understands this issue and is exploring strategies to reduce the embodied carbon for the proposed project.

Comparison – Future Electricity CO_2 Emissions

One important element of the proposed project's design is the "electrification" of the project. Every energy consuming device in the building will be powered by electricity except for the production of domestic hot water, which is fueled by natural gas. The value of this electrified design is that CO_2 emissions attributed to electricity usage will be reduced over time as the electricity grid is served by less carbon

intensive sources. For example, the New England electricity grid decreased CO_2 emissions by 37% between 2008 and 2017, a trend that is expected to accelerate in the years ahead. In contrast, there is no opportunity to de-carbonize natural gas because CO_2 is a combustion byproduct of burning natural gas.

The existing development is dominated by natural gas consumption, 82% of total energy usage, compared to an estimated 30% for the proposed project. As CO_2 emissions attributed to the electricity are reduced, the proposed project will make the same transition to lower CO_2 emissions better than the existing development because it is predominantly powered with electricity, 70%, compared to 18% for the existing development.

The following chart displays future CO_2 emissions for both the existing and proposed developments based on total energy usage (electricity + natural gas), while varying the CO_2 emissions attributed to the production of electricity. The ratio at the bottom compares the CO_2 emissions for the existing development to the proposed development and demonstrates how the proposed development improves its CO_2 emissions performance over time compared to the existing development.

	Total CO_2 Emissions (tons) from Electricity + Natural Gas			
Electricity CO_2 Intensity	Current (682 lbs/MWh)	50% Less (341 lbs/MWh)	80% (136 lbs/MWh)	100% (0 lbs/MWh)
Existing Development	8,414	7,225	6,275	6,037
Proposed Project	4,648	2,789	1,673	930
Ratio (Existing to Proposed)	1.8	2.6	3.8	6.5

Massachusetts has set a target of an 80% reduction in electricity CO_2 emissions by 2050 through the MA Clean Energy Standard. Boston has set a goal of becoming carbon neutral by 2050 (Carbon Free Boston).