

PENPLACE

Zero Carbon Building Assessment

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PREPARED BY:

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EXECUTIVE SUMMARY

The PenPlace design reflects Amazon’s commitment to the Climate Pledge and goal to be net-zero carbon emissions by 2040. As part of the Arlington County entitlement process the project team has assessed compliance with the ILFI Zero Carbon certification, to confirm the total embodied carbon emissions associated with the project. The analysis provides that estimated the total CO2e emissions and indicates that achieving Zero Carbon certification is likely feasible for the project.

Table 1: Zero Carbon Building Assessment Summary

| Zero Carbon Requirements | Feasibility Assessment |
|---|---|
| 1. 25% improvement over ASHRAE 90.1 – 2010 energy use | Feasible* |
| 2. 100% on-or off-site renewable energy | Feasible |
| 3. Carbon offsets for construction and materials (including maximum of 500 kgCO _{2e} /m ²) | Likely feasible; additional study needed to confirm total embodied carbon |
| 4. No on-site combustion (except back-up generators) | Likely feasible; Impact of retail kitchen equipment would need confirmation |

*Uncertainty of building occupancy may impact feasibility

Overview

This report includes the current project estimates of the operational and embodied carbon, generated using the International Living Foundation Institute (ILFI) Zero Carbon guidelines. The operational carbon estimate is a result of the latest energy modeling report dated August 2, 2021. The embodied carbon estimate is based on a combination of early modeling in Tally and design quantities along with a compilation of reference project data and industry sources. More detailed whole building lifecycle assessment will be conducted at later stages of the project.

OPERATIONAL ENERGY

Performance Summary

The proposed energy model is projected to achieve an energy savings of 32.8% and an energy cost savings of 31.5% over the ASHRAE 90.1-2010 baseline building. The model includes all Towers (and their retail pavilions), the garage, and the Helix. The current design case complies with the Zero Carbon Requirement #1, a 25% energy improvement requirement.

Note that ILFI Zero Carbon certification requires reporting operational 12 months of operational energy performance. Energy models may not predict actual energy performance due to variations such as occupancy, building operation, weather, etc. It is recommended to include an adequate performance buffer to account for this variation when considering ILFI Zero Carbon certification.

Table 2: Operational Carbon Performance Summary

| Model | Total Annual Energy Use (Mbtu) | EUI (kBtu/sf/yr) | Annual Energy Utility Cost (\$) |
|-------------------------------|--------------------------------|------------------|---------------------------------|
| PenPlace Proposed Design Case | 163,324 | 40.8 | \$2,352,292 |
| ASHRAE 90.1 Baseline Case | 243,211 | 60.7 | \$3,432,364 |

Baseline & Design Case Details

Building energy modeling was performed by Buro Happold. The Design Case reflects the project intent and available design information, and the Baseline Case revises the Design Case in accordance with ASHRAE 90.1 Appendix G. The two models were then simulated for a full year and compared to determine energy use intensity (EUI), relative annual energy savings, and relative annual utility cost savings.

HVAC SYSTEM

The HVAC system includes a 100% electric central utility plant including a centralized chilled water plant and distributed heating, and offers improved energy efficiency, water efficiency, and demand management capabilities. Electric water-cooled centrifugal chillers provide high-efficiency hydronic cooling. Heat from the chillers is rejected via cooling towers in a closed condenser water loop. Variable primary pumps serve both the condenser water loop and the chilled water loop, which routes from the CUP to the individual buildings. In addition, thermal chilled water storage is provided to allow for demand management during peak cooling conditions.

At the tower building level two-pipe fan coil units utilize the incoming chilled water service for cooling, while any heating requirements are met by electric resistance heating. Electric resistance heating will be at the dedicated outdoor air unit(s) and, if required, at the fan coil units. For the Helix and meeting center, central station air handlers serve the majority of spaces while fan coils supplement smaller areas.

The ASHRAE 90.1 Baseline model uses the Baseline HVAC system as prescribed by Section G3.1.1. In this case: System type 8, VAV with PFP Boxes. This is a variable air volume air system (variable control fans) with parallel fan boxes and electric reheat, chilled water primary cooling and electric resistance heating.

KITCHEN EQUIPMENT

Although all kitchen design decisions have not yet been completed and food/beverage vendors have not been selected, the kitchen equipment within the Central Kitchen and Amazon's COE spaces are planned to be 100% electric.

Natural gas infrastructure is planned for retailers. ILFI may provide an exception for retail natural gas usage, but this would need to be confirmed.

The project complies with the intent of Zero Carbon Requirement #4, no on-site combustion, but additional confirmation would be necessary should the project choose to pursue certification

Renewable Energy

The current design includes PV arrays, with a currently planned capacity of 360 kW, located on the penthouse roofs of the Towers. The remaining energy for the project will be served by 100% renewable power from an ~80MW offsite array in Southern Virginia. The combination of these two systems is in compliance with the Zero Carbon Requirement #2, 100% on-or off-site renewable energy.

EMBODIED CARBON

Performance Summary

The following is the total projected embodied carbon at PenPlace based on the 100% Schematic Design. The estimate includes the foundations, structure, enclosure, and interiors includes all Towers (and their retail pavilions), the garage, and the Helix.

The preliminary estimate indicates with a moderate level of confidence that the ILFI Zero Carbon embodied carbon requirement is feasible, provided the project is able to achieve at least a 10% reduction in embodied carbon emissions from this baseline.

Table 3: Embodied Carbon Summary

| Carbon Emissions | Value |
|---------------------------|---|
| Total Embodied Carbon | 243,848 MT CO ₂ e |
| Embodied Carbon Intensity | 502 kg CO ₂ e/m ² |

Baseline & Design Case Details

The initial 100% SD estimate was developed by MKA (project structural engineer) and NBBJ (project architect). The foundation and structure were estimated based on the 100% SD design using Tally and the enclosure and interiors were estimated using 100% SD project design quantities along with a compilation of reference project data and industry sources.

Note that this estimate was originally planned to serve as the project baseline; however, the Tower areas changed between SD and DD as a result of test fit studies. Therefore, the estimate is currently being updated to reflect the DD design areas and will ultimately be the new project baseline. Details of the most current estimate are shown in graphical format on the following pages.

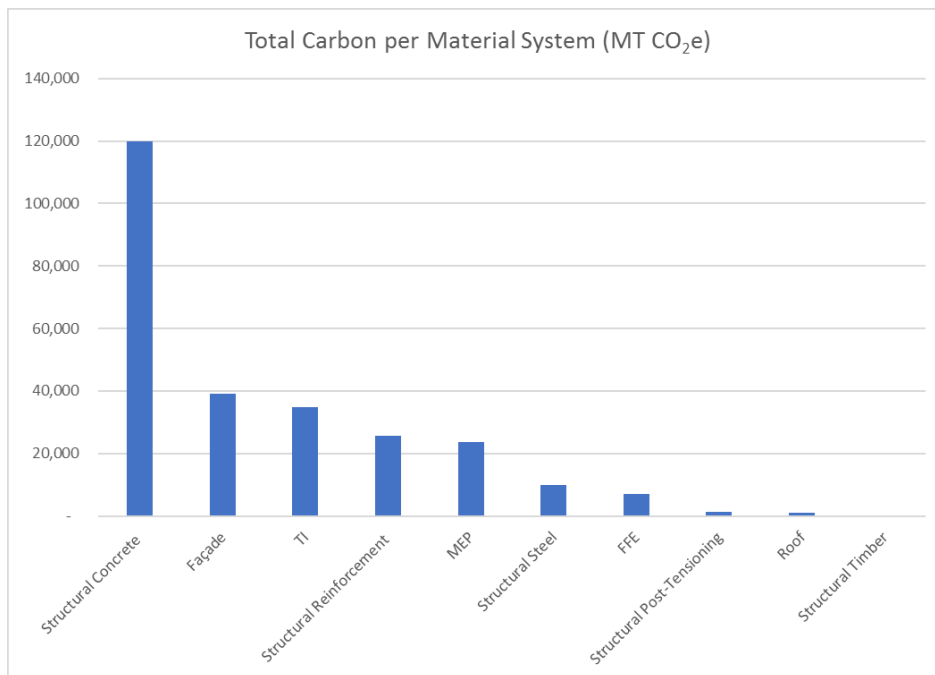


Figure 1: Total Carbon by Material

As shown in Figure 1 on the previous page, structural concrete is by far the largest contributor to the overall embodied carbon of the project, as expected.

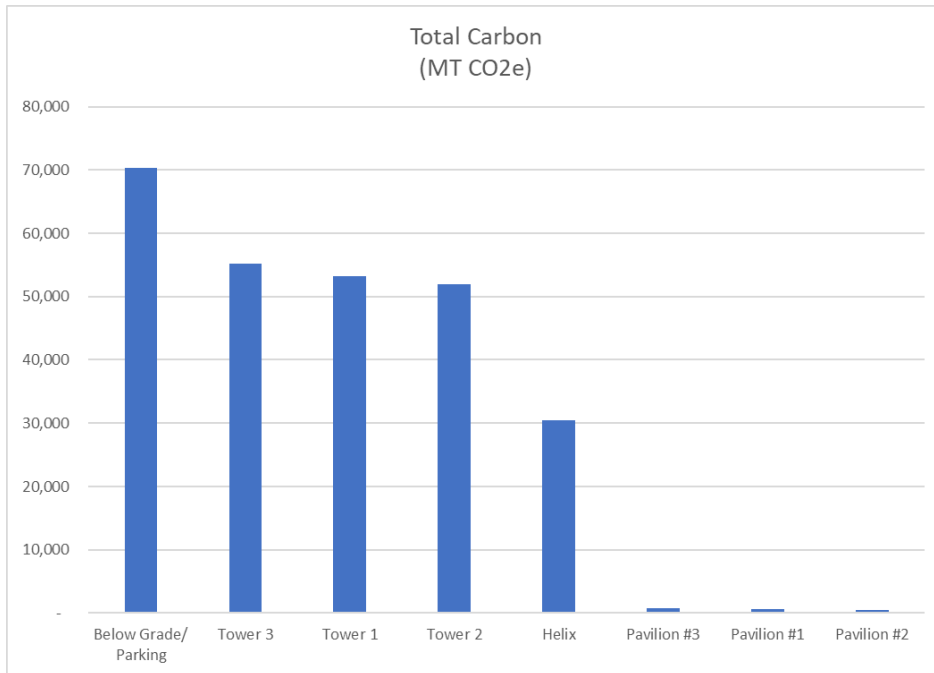


Figure 2: Total Carbon by Building

As shown in Figure 2, the Towers and parking garage are the biggest contributors of total embodied carbon and thus offer the largest opportunity for optimization.

DECARBONIZATION OPPORTUNITIES

PenPlace intends to employ a decarbonization strategy which focuses on the materials that offer the biggest opportunity for impact (structural concrete, façade). Some opportunity areas include:

- Reduced cement through concrete mix design and sourcing
- Enclosure design / cladding mullion spacing
- Exterior insulation products
- Interior finishes

CREDIBLE OFFSETS

In order to meet Amazon’s Climate Pledge and to align with Arlington County’s Green Building Policy, a carbon offset purchase is planned to offset the embodied carbon of the project. These offsets will be Certified Emission Reduction (CER) or Verified Emission Reduction (VER) offsets certified by Green-e Climate, in alignment with the ILFI Zero Carbon requirements. The resulting carbon footprint of the project will be neutralized with credible offsets and will comply with the Zero Carbon Requirement #3.

POTENTIAL PATH TO ZERO CARBON

The PenPlace potential path to compliance with Zero Carbon is shown graphically below. It is meant to be read from left to right, with the current estimates for the carbon contributions from operational and embodied carbon are shown first. The current estimates for carbon offsets from on-site and off-site renewable energy, project energy conservation measures (ECMs), and credible offsets are ordered from smallest to largest¹.

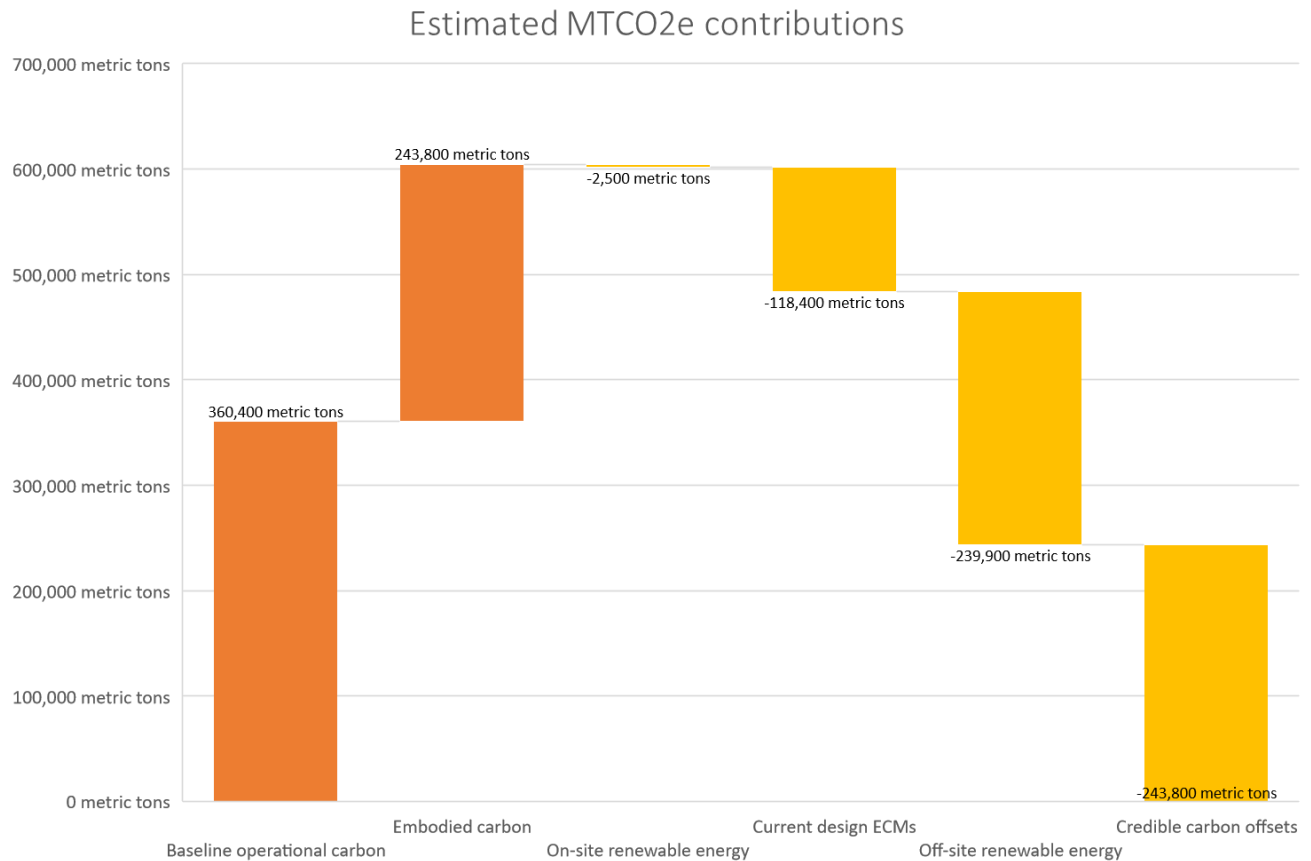


Figure 3: Path to Zero Carbon

The operational carbon contribution is based on a 15-year period to reflect the ILFI renewable energy purchase period requirement. The contribution from the off-site array is based on approximately 25-30% of the array’s output being used to offset this project. As shown in the graph, reaching net zero carbon emissions from these sources is possible.

¹ Note that carbon contributions from refrigerant leakage have not been included in the analysis as they are not yet addressed as part of ILFI Zero Carbon.