

PENPLACE
Zero Carbon Building Assessment
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EXECUTIVE SUMMARY

As part of the Arlington County entitlement process, the Amazon PenPlace project team has assessed the project's compliance with the requirements of ILFI Zero Carbon certification. This report summarizes the findings of this one-time feasibility assessment and provides the estimated total CO₂e emissions for the Amazon PenPlace project. The PenPlace design reflects Amazon's commitment to the Climate Pledge and goal to be net-zero carbon emissions by 2040. Further, our findings indicate that achieving Zero Carbon certification is likely feasible for the project; however, at this time of this report, Amazon is not yet ready to commit to pursuit of the Zero Carbon certification.

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 ₂ e/m ²)	Feasible
4. No on-site combustion (except back-up generators)	Feasible

Overview

This report includes the most recent 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 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. No further updates will be provided to the County as the design progresses; however, a whole building lifecycle assessment will be conducted on the final design as part of pursuit of the LEED credit MRc Building Lifecycle Impact Reduction. The LEED design application documentation will be shared with Arlington County via LEED Online.

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.

Although all electric kitchen equipment will be strongly encouraged for retailers, natural gas infrastructure is planned as an option where electricity-based equipment will not adequately serve the cooking needs of the tenant, and where efforts have been made to find alternative solutions and minimize combustion impacts, in alignment with ILFI's Exception I06-E14 4/2016.

Therefore, 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 findings of this one-time feasibility study. The feasibility study was conducted using the 100% Schematic Design set. 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.

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.

To be more explicit about methodology, the embodied carbon estimate was completed by calculating the detailed quantities of the various materials included in the foundation, structure, enclosure, and interiors. For each material, a corresponding CO₂-equivalent emission was applied. This allowed the team to totalize the estimated embodied carbon emissions of the project.

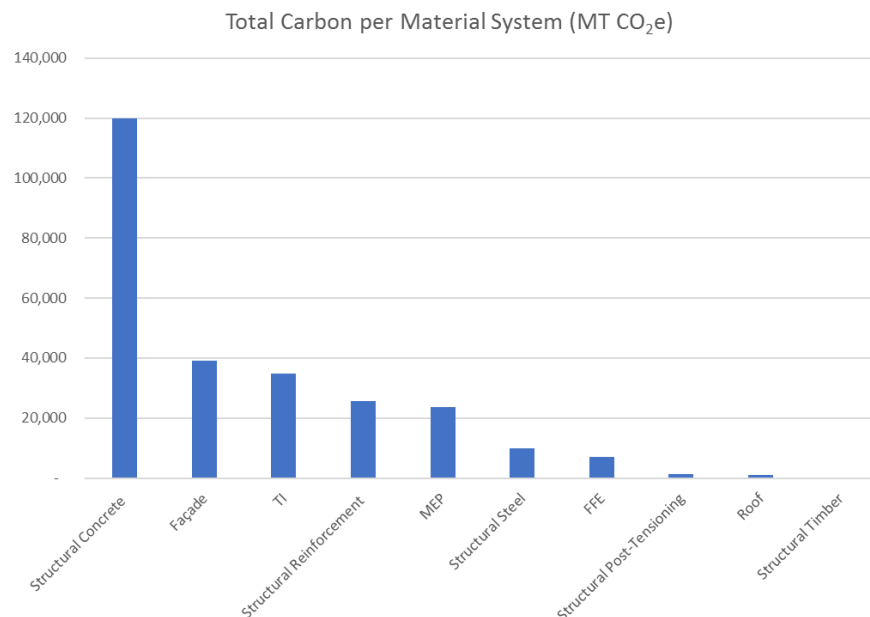


Figure 1: Total Carbon by Material

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

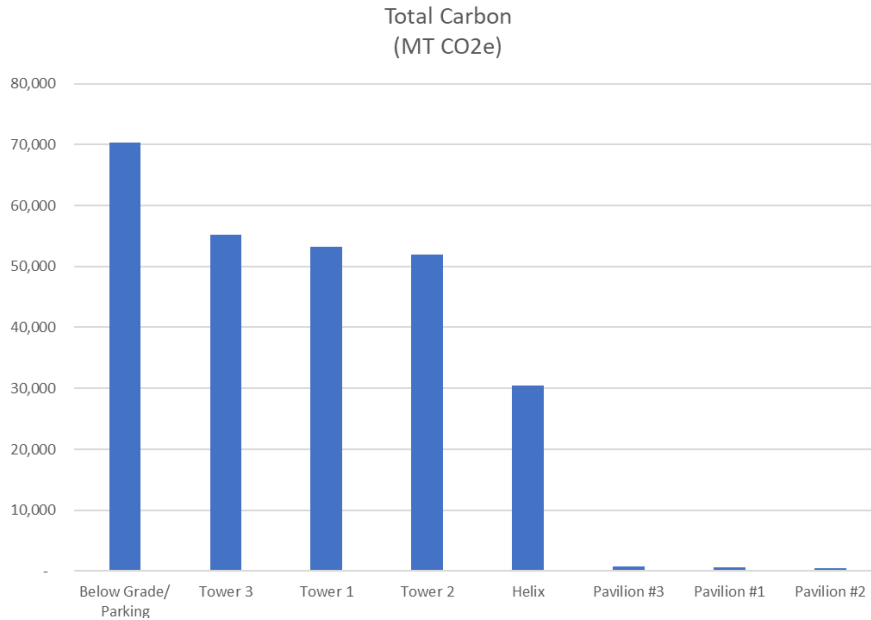


Figure 2: Total Carbon by Building

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. As such, the team has identified the following opportunities for reduction in embodied carbon:

- Reduced carbon structural materials, including concrete and steel reinforcing. Performance based concrete specifications will allow for mixes with lower GWP.
- Wood-based structure for the pavilions. Biogenic materials are selected where possible to lower carbon emission.
- Low-GWP façade material selections and quantities including reduced aluminum mullion quantities through larger (7.5-ft wide) panel sizes and spandrel material selection
- Low-GWP insulation specification, including HFC-free foams
- Low-GWP finish materials, both within shell and core and future TI fit-out, through EPD-based product review and selection

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.

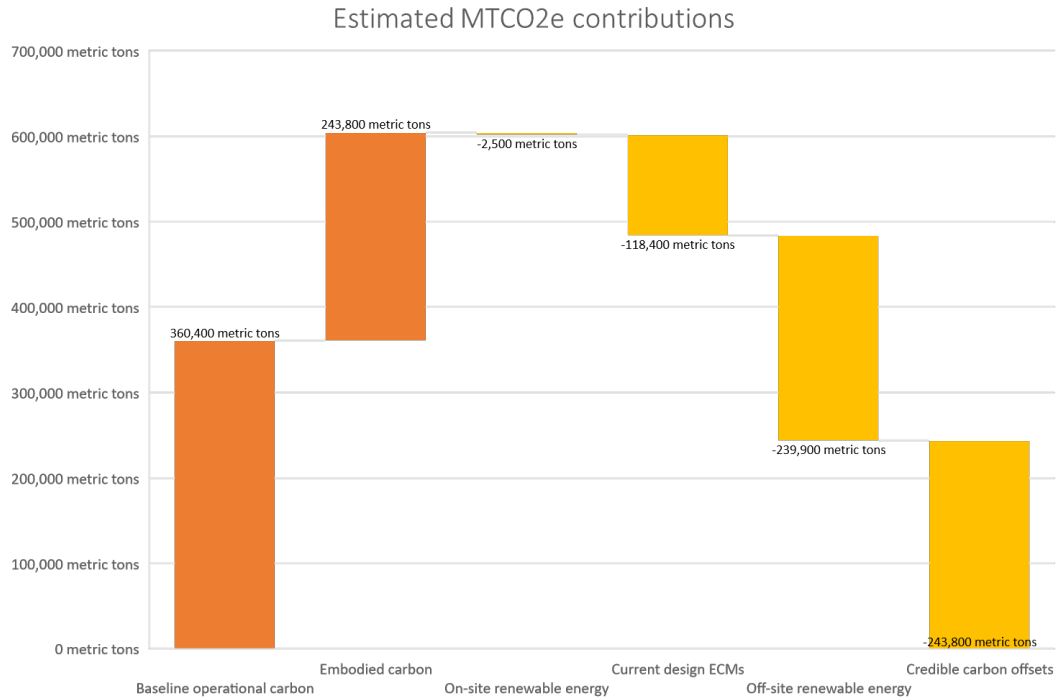


Figure 3: Path to Zero Carbon

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.

ASSOCIATED COSTS SUMMARY

The costs for any specific design and construction measures to achieve zero carbon are not included in this report, as these costs are not necessarily tracked separately given that the goals of low carbon design are integrated into the project

Costs for carbon offsets for the entire project embodied carbon emissions would likely range from \$3 to \$5 million.

Costs for ILFI Zero Carbon certification are undetermined. Projects above 750,000 SF require a custom quote from ILFI. It is estimated the cost would be between \$100-300,000 dollars.

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.