**Team: The Carbon Lighters -** *Alfonso E. Hernandez, Mili Kyropoulou, Alstan Jakubiec, Emir Pekdemir.*

The site at 57 Empire Boulevard in Brooklyn, adjacent to Prospect Park, is approximately 41,860 square feet and is currently underutilized by a fast food chain drive thru building. The lot is a diamond shape, oriented to the South, Southeast, North and Northwest.

The design team followed a tiered design process, initially informed by a parametric design single-space study and later developed using a higher-quality, hands-on iteration process for architectural, envelope and systems design. Given the increasing complexity of the project, a combination of analysis tools was used. All decisions were based on environmental performance analysis at every step.

The building massing was initially developed as per the site’s geometry, height restrictions and solar and wind access. Preliminary daylight simulations on a typical floorplate gave an optimal depth of 50’ for the residential units and 75’ for the retail programs, which provided room for a generous central courtyard. Further building elevation adjustments – decreased height on the south wing and increased on the north - allow for more sunlight to reach the north side of the mass. For security purposes a plinth configuration was followed, locating retail at the base and residential units above. The restaurant was located at the top of the northwest corner, to favor views to Prospect Park and the Manhattan skyline beyond. The courtyard was configured to open to the East to catch the predominant southeastern summer wind based on Brooklyn climate data (warmer air) while blocking western winter wind (frigid air).

The residential units were designed with resident access on one side (north predominantly). The main circulation between units are open air and not conditioned. The exposed wall area was increased by utilizing a sawtooth shape in plan on the south side to allow for more windows that increase daylight and ventilation potential, while maintaining privacy between units. A sun space on the southern side of each unit paired with a Trombe wall system benefits from the maximized southern exposure. This space ideally remains closed in the winter to supply with solar pre-heated air through vents, and it stays open in the summer (cross ventilation mode).

Rooms were organized longitudinally and paired with an open concept living-dining-kitchen space to allow for cross ventilation when the sun space is open during summer and for heat dissipation during winter when the sun space is closed. A translucent aerogel insulated wall was incorporated on the opposite side of the unit (adjacent to the access corridor) to maximize daylight access from that side while maintaining privacy from the building corridor. Several insulation configurations and glass types were parametrically analyzed using EnergyPlus via Honeybee & Colibri. Optimal exterior wall resistance is R-30, optimal glass is VLT 71%, SHGC is 0.37 and window assembly U-Value is 0.27.

Fully daylit units reduce electric lighting loads while increasing the health and comfort of occupants. After all optimization measures were applied, the WELL standard requirements were substantially met. The building also exceeds the strictest LEEDv4 requirements with sDA at 78% and ASE less than 7%.

Several potential HVAC systems were compared using IESVE. The optimal system for the residential spaces is a combination of radiant heating on the floor, radiant cooling on the ceiling, energy recovery ventilators for humidity control paired with a Ground Source Heat Pump system with vertical loops buried in the central courtyard and underneath the plinth.

To reduce carbon, a timber-concrete composite structure was used. This provides the building with high thermal capacity, concrete subfloors for radiant heating and a Trombe wall all supported by a main mass timber structure. Water preservation measures include low-flow fixtures for residential and commercial spaces.

Photovoltaics were designed atop a continuous roof canopy and the east and west facades and were integrated into the architecture. Roof PVs are bi axial (shown as flush mode in the renderings, 500.6 kW in size) while the façade PVs are fixed BIPVs (334 kW in size). An additional PV canopy was added in the courtyard areas with more solar access (38.3 kW in size).

This building has an EUI of 13.8 kBtu/sf/yr without PVs. With PV yield accounted for, the EUI is   
-0.86 making the building net positive. The building is also operationally carbon neutral in 2030 and 2050.