The American Geophysical Union (AGU) headquarters building was originally designed to incorporate symbolism representing the Earth and space sciences studied by its members. Maintaining the integrity of the original design was paramount to AGU, its neighbors as well as the Historic Preservation Office. As a result, Hickok Cole looked for a way to make an architectural statement with this renovation that situated the building firmly in the conversation about the need for Net Zero Energy buildings while retaining the original, beloved character of this headquarters.
The result is an architecture whose iconic nature suits the need for a statement building. Two changes, in particular, amplify the building’s urban presence: the PV array—supported on sculptural, zinc clad columns—proudly announces the generation of energy; the opening up of the building at the prow and at the street level allow the architecture to literally align the architectural language with AGU’s goal to connect with the public.

The building will be a landmark for the city, for the country, and for the struggle to reign in man’s contribution—via the built environment—to climate change. This is a pivotal moment in the language of architecture. Where once a building’s heating and cooling system was signified by a rectangular mass of penthouse structure, there will now be a canopy of solar panels. The irony is that this canopy becomes the third part of a tri-partied, “classical” building composition: buildings will have a base, middle, and top once more.

1. Solar Photovoltaic (PV) Array
2. Dedicated Outdoor Air System (DOAS) with Exhaust Air Heat Recovery
3. Stormwater Collection and Reuse
4. Enhanced Dynamic Glazing System
5. Radiant Ceiling Cooling System
6. Hydroponic Phytoremediation (Hy Phy) Wall
7. DC Powered Workspace and Lighting
8. Central Active Stair
9. Municipal Sewer Heat Exchange System
EXPLANATION OF STRATEGIES

**GENERATION**

1. Solar Photovoltaic Array
This solar PV array includes 720 solar panels making up a 250 kilowatt system. It includes 24 panels on a vertical, south-facing surface and 696 panels laid out horizontally and elevated above the penthouse roof. The panels are from manufacturer Sunpower, and at just over 22% efficiency, they are some of the most efficient on the market.

**RECLAMATION**

2. Dedicated Outdoor Air System with Exhaust Air Heat Recovery
The DOAS will provide a dedicated means of ventilation for the building. This system will condition the air prior to delivering it inside, while at the same time recovering the outgoing exhaust air’s heat to help raise the temperature of the incoming fresh air for space heating needs.

6. Hydroponic Phytoremediation Wall
While this wall looks like a standard green wall or vertical garden, it will actually work a little harder. When installed it will be an active rather than passive wall and function as part of the building’s ventilation system. In conjunction with the DOAS, the wall will filter and improve indoor air quality, all while reducing the amount of outside air necessary. The plants, their roots, and the water filtration system will scrub air of unwanted toxins and volatile organic compounds before it recirculates throughout the building.

**ABSORPTION**

3. Stormwater Collection and Reuse
Rainwater will be captured from the roof and PV array and collected in a large cistern also located in the building’s garage. After filtration and treatment this greywater will be reused for all flushing fixtures and the irrigation of the green roof and hydroponic phytoremediation wall. The cistern’s capacity is 11,300 gallons.

9. Municipal Sewer Heat Exchange System
This system will tap into a combined sewer line in front of the building, which was built in the 1890s, to maximize the efficiency of the building’s mechanical systems. It will essentially function the same way a geothermal system does—as a heat sink/source—but it will be the first of its kind in the United States. The system operates by:

• Diverting wastewater to a settling tank located just outside of the building.
• Circulating the then debris-less water into a sewer heat exchanger in the underground garage.
• While in the garage, separately piped in radiant fluid will be pre-heated or cooled before being circulated throughout the building.

Fear not, it is a closed loop system, no sewage contamination will take place.
**4. Enhanced Dynamic Glazing System**
The existing windows at AGU were removed and replaced with dynamic glass. The curtainwall glazing is now made up of triple-pane, air-filled, 1-3/4 inch thick windows. The added third pane gives the windows a lower U-value and solar heat gain coefficient to help reduce the transmission of heat and cold. This glazing will also utilize an electrochromic film to tint the windows on-demand. The tint will take the place of traditional blinds as well as reduce glare and heat transmission while still allowing natural light in and views out.

**5. Radiant Ceiling Cooling System**
In a radiant ceiling system temperature is controlled by radiation, a more efficient way to condition space than forced-air. Decoupling the building conditioning system from the DOAS provides the opportunity to reduce the overall energy needed to move air through the building since it’s now only needed for ventilation, not for space cooling.

**7. DC Powered Workspace and Lighting**
The electrical grid in the United States is wired for alternating current, or AC, power distribution. However, direct current, or DC, power is used by computers, appliances, and LED lighting. Conveniently, DC power is also what will be produced by the large PV array on AGU’s roof. Creating an energy distribution microgrid which relies on direct DC to DC power will reduce the energy efficiency loss caused by power conversion.

**Enhanced Envelope Insulation**
The existing building envelope is brick on a CMU backup wall separated by an air gap. The exterior walls do not currently contain insulation or an air/weather barrier. Six inch studs have been added along the interior of the perimeter wall which will provide space to:

- Install 8 inches of closed-cell spray-applied insulation to achieve an R-value of 53. The new insulation will also act as an air barrier.

- Anchor new windows which will now be in-line with the insulation, creating a continuous thermal barrier.
KEY STATISTICS

90% of construction waste was recycled.

77% reduction in water demand because of efficient water fixtures and captured rainwater.

96 points At 96 points AGU will be in the top 5% of the 110,000+ LEED projects in the world.
AGU IS ON TRACK TO EARN ALL LEED POINTS in the Water Efficiency, Energy & Atmosphere, Innovation in Design, and Regional Priority credit categories.

96% of existing building materials were reused. For example, the terrazzo on the first floor is comprised of recycled stone, glass and porcelain from the building’s old toilets.
REVIEW PROCESS

HISTORIC PRESERVATION REVIEW BOARD

The AGU building sits at the northern edge of the Dupont Circle Historic District in Washington, DC.

While the building itself is historic, the addition of the PV array constituted an “alteration to a non-contributing building” and had to be deemed “compatible with the character of the affected district.” Thus, the success of getting to Net Zero Energy rested firmly on obtaining approval for the PV array from the Historic Preservation Office staff and the Historic Preservation Review Board (HPRB).

At the initial meeting to discuss the array, the staff made it clear that design of the array had to be extremely refined and well-executed. Their review went through a series of back and forth exchanges about the articulation of the array. Simultaneously, the design team and AGU leadership sought to communicate the goals of the project and to explain the design of the alterations to the neighborhood. Ultimately, the needed approvals from HPRB were obtained.

1 https://planning.dc.gov/page/minor-work-qualifying-hpo-review
BOARD OF ZONING ADJUSTMENT

Just prior to the schematic design phase for AGU, the Board of Zoning’s (BZA) new zoning regulations came online. For this once-in-a-generation re-write of the zoning laws, the BZA did not address how PV arrays should be reviewed. Lacking any separate set of guidelines, the PV array fell under the rules for penthouses. As such, a 1:1 ratio of height to distance back from the building face was required. This constraint would have ended any effort to get to Net Zero Energy as the project could not afford to lose so much of PV array area. This led to the application for zoning relief from this requirement. In Washington, DC there are strict limits for height of buildings; fortunately AGU was below this limit making the argument for the PV array less problematic to the BZA which was concerned about setting a precedent. After going in front of the BZA twice, unanimous approval was received.
HEALTHY WORKPLACE

At the outset, AGU set creating a 21st century workplace as a goal on behalf of their hardworking staff. To answer this challenge, Hickok Cole developed a series of architectural strategies that result in a workplace that is healthier than their current one. These strategies include the following:

- Inserting a two-story, sculptural stair to connect the three staff floors
- Bringing daylight deep into the floor plan by eliminating opaque, perimeter rooms
- Placing a hydroponic phytoremediation plant wall along the main corridor
- Creating alternate spaces which provide a variety of places conducive for getting work done; these include the roof top, the member’s lounge on the ground floor, the pantry, glassy and open conference rooms as well as small, private “quiet cars”

One of the most entertaining examples of reuse are the white chips found in the lobby terrazzo—fragments of the building’s toilets floating alongside granite from the lobby walls. The same terrazzo is being used for the main conference room table top.

Even at this later stage of construction, the team is soliciting stories of reuse from the subcontractors working in the field.

REUSE

One of the most out of the ordinary project successes is the persistence around trying to reuse—in creative and unusual ways—the existing building materials.

This effort required cataloging all of the interior elements: door, chairs, tables, wall panels, a piece of petrified wood, cabinetry, and even toilets were tagged and photographed. All of these elements were either reused in the building or connected to a new owner.

COMMUNITY ENGAGEMENT

The Dupont Circle neighborhood has multiple active groups of citizens who take pride in their area and like to participate in decisions on building projects. They are committed to maintaining the character of the neighborhood and this renovation represented a dramatic change in the streetscape.

When the design and attorney teams realized that the building would need variances from the current building code, there was concerted effort to get neighbor buy-in. In order to tackle this head-on a plan was made to communicate with the neighbors regularly and openly. An open house was organized to let everyone know about the plans AGU had for the building. Additionally, a website was created as a means to share updates and announcements of major milestones.
**High-performance building** means a building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

**Net Zero Energy** means the total amount of energy used yearly by a building is equal to or less than the amount of energy created on-site through the use of innovative technologies and renewable power generation. Achieving this goal will allow for the reduction of energy, waste, and water consumption to almost zero and greatly reduce the carbon footprint, with the intent of putting excess power back on the grid.