



SHOWCASE PROJECT: ARLINGTON PUBLIC SCHOOLS: DISCOVERY ELEMENTARY SCHOOL

SOLUTION OVERVIEW

Discovery Elementary School opened in 2015 as one of the first Zero Energy schools on the East Coast of the United States. As one of 23 Elementary Schools at Arlington Public Schools (APS), Discovery serves 650 students from Early Childhood through Fifth Grade. As the first newly constructed district elementary school in 11 years, the 97,588 square foot facility incorporated local community feedback and accommodated a growing district while operating at a 66% lower energy use intensity (EUI) compared to the district's average.

To drive energy saving measures, the design team set an ambitious energy goal, adopting an absolute energy consumption metric of source EUI of 72.5 kBtu per square foot. To reach that goal, the school included energy saving solutions such as distributed on-demand pumps for the geothermal system, daylighting supplemented with 100% LED lighting, high thermal mass exterior walls, and solar-thermal water pre-heating for the kitchen. The school plans to achieve Zero Energy through the 1,700 photovoltaic panels installed on the roof, totaling nearly 500 kW of on-site renewable energy generation. In total, the project cost \$32.83 million for Discovery Elementary. The district will reinvest the cost savings achieved from the cumulative energy reduction strategies for educational needs.

SECTOR TYPE

Education

LOCATION

Arlington, Virginia

PROJECT SIZE

97,588 square feet

SOLUTIONS

At the start of the design process, the project team established Zero Energy as the energy goal for the school and targeted several integrated efficiency solutions to significantly reduce energy consumption. The project team adopted passive solar design by orienting the building with its longest facades facing north and south, took advantage of shading opportunities to reduce summer cooling loads, selected construction materials with high thermal mass, incorporated staged equipment starts and utilized occupancy sensors for temperature settings.

The following are a list of energy reduction solutions which enable the school's source EUI of 72.5 kBtu per square foot:

- Building orientation
 - The building is elongated towards the east and west, with large north and south facades, allowing for better daylighting and solar heat gain in the winter.
 - By taking advantage of overhangs over critical windows and a large canopy extending from the roof of the building there is a significant reduction in demand for cooling loads during warmer months.
- Building envelope
 - The building's exterior walls were constructed with Insulated Concrete Forms (ICF), a highly insulative (high R-value) and high thermal mass material, allowing better thermal regulation of the indoor environment.
- Lighting and controls
 - Large windows allow for a generous amount daylight to enter the building.
 - Electric lighting is 100% LED. Manual controls allow for occupants to brighten the indoor lights if daylighting provides an insufficient level of illumination.
 - Occupancy sensors in classrooms automatically turn off lights when rooms are vacant.
 - Tubular daylighting devices provide natural light to spaces that are further away from windows.
- Plug load strategies and controls
 - The project incorporates a high-level of submetering of plug loads, lighting, IT and equipment energy use which helps the facilities team pinpoint underperforming equipment and fix the problem.
 - The team designed a building dashboard, accessible through the school's internet-connected devices, which tracks energy consumption and production, giving teachers the ability to integrate real-time data into their curriculum.
- HVAC
 - The school is equipped with geothermal wells and a ground source heat pump with a distributed on-demand pumping system to heat and cool the building. This is an efficient alternative to boilers and vapor-compression chillers, which are not present at the school.
 - A dedicated outdoor air system with a heat pump chiller utilizes demand control ventilation to meet a constant CO₂ level on a space by space basis.
- Hot water heating
 - The kitchen's hot water is pre-heated with solar thermal and supplemented by geothermal heat.
 - Distributed, instantaneous hot water heaters are used for the rest of the building's hot water needs.
- Solar array
 - 1,700 PV panels are installed on the roof of Discovery Elementary, totaling nearly 500 kW of peak power production that helps offset all of the school's electricity use. The initial return on investment cost is seven years and estimated to earn a 6.3% annualized return over 20 years.
 - The panels are expected to produce 616,194 kWh annually.

- Discovery retains the renewable energy certificates (RECs) for the array and unused power is returned back to the utility through net metering and credited towards the school's account.

OTHER BENEFITS

In addition to the energy saving measures contained in the building, the project team implemented several water conservation strategies which contribute to a healthy design and result in additional cost savings. Located throughout the landscape are bioretention treatment areas to filter contaminants and mitigate the flow of storm water runoff. Inside the building, the team installed low-flow plumbing fixtures, resulting in an estimated savings of 288,700 gallons per year. Furthermore, rainwater catchment systems integrated on the roof can hold 260 gallons of water and are used to maintain the school's garden.

Discovery Elementary's zero energy building design promotes learning, creativity, and scientific inquiry. Creativity is fostered through playscapes and student spaces. The building design and Zero Energy features offer learning opportunities on energy efficiency and sustainability. The building contains a custom-built energy dashboard that reports energy use recorded by sub-meters, which are leveraged as a teaching tool for energy use and conservation. Additionally, there is a rooftop solar lab that serves as an educational tool to teach about renewable energy technology.

*Baseline represents an average across Arlington Elementary Schools

Annual Energy Use

Baseline(2013)



152 kBtu/sq. ft.*

Expected(2016)



72.5 kBtu/sq. ft.

Energy Savings

52%

Annual Energy Cost

Cost Savings



Aerial view; credit: AirPhotosLIVE



School exterior; credit: Alan Karchmer



Students viewing the dashboard; credit: Lincoln Barbour