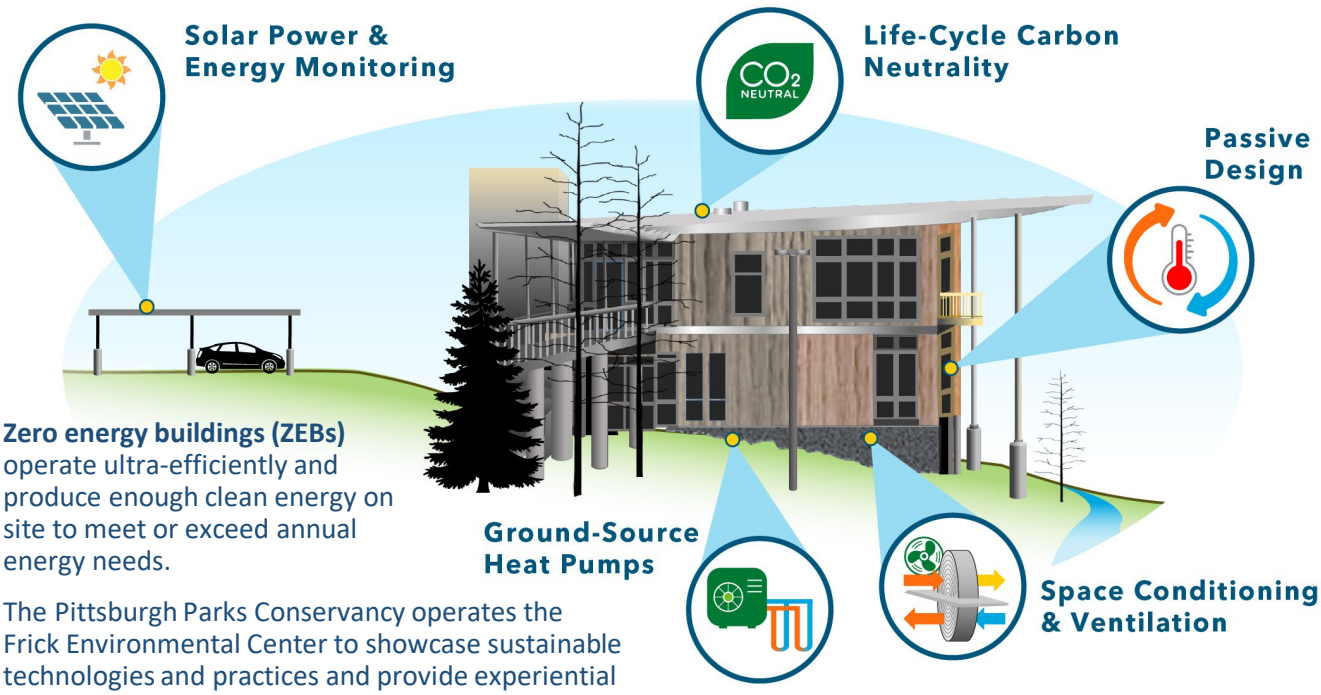
Zero Energy Building Highlight

Frick Environmental Center (FEC)



Zero energy buildings (ZEBs) operate ultra-efficiently and produce enough clean energy on site to meet or exceed annual energy needs.

The Pittsburgh Parks Conservancy operates the Frick Environmental Center to showcase sustainable technologies and practices and provide experiential environmental education to the public.

Building design by Bohlin Cywinski Jackson

See the full **report** by the Lawrence Berkeley National Laboratory

Solar Power & Energy Monitoring

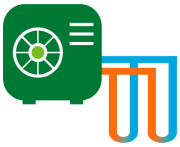
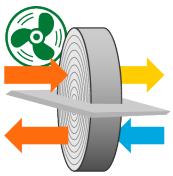
The Center's nearly 162-kW photovoltaic (PV) system is grid-connected and net-metered. When it generates more solar electricity than needed, the surplus is fed to the local utility grid.

- **PV panels:** The 600 275-Watt solar panels and supporting racking system provide shade for the parking area.
- **Micro-inverters:** Eight of these plug-and-play devices efficiently convert the direct current generated by the solar panels into alternating current for use in the building.
- **Enterprise electrical monitoring system:** The custom system enables detailed subsystem monitoring in real time with web access to data and dashboards.

Life-Cycle Carbon Neutrality

Careful planning from building design through operation minimizes the net carbon balance. The net energy use intensity translates to CO_2 emissions of -0.18 pounds per square foot per year.

- **Life-cycle analysis:** Designers developed pioneering methods to estimate the embodied carbon and operational carbon impacts of candidate materials.
- **Sourcing:** A cap on the distance from which construction materials could be transported limited emissions.
- **Scheduling:** A four-day work week was enforced during construction to further limit transportation emissions.
- **Carbon offsets:** All construction-related CO_2 emissions were quantified and offset by purchased credits.

Passive Design 	The building's tightly insulated envelope and use of multiple passive design principles reduce the need for mechanical space conditioning—except in the hottest or coldest weather.	• **Envelope:** The FEC features a well-insulated slab (R-10), walls (R-19 to 22), and continuously insulated roof (R-48). • **Window-to-wall (WWR) ratio:** The relatively modest WWR of 0.37 helps provide better overall insulation. • **Window overhangs:** Overhangs are positioned to block peak summer rays but admit winter sun (at lower angle). • **Natural ventilation:** Mechanized windows open and close automatically, and a light notification system guides occupants in the efficient operation of manual windows.
Ground-Source Heat Pumps 	The constant under-ground temperature of ~55° F in the region provides a stable heat source in winter and heat sink in summer. Seven ground-source heat pumps (GSHPs) and 18 closed-loop vertical wells provide efficient space conditioning.	• **Well field:** Eighteen vertical ground heat exchange loops (1¼" poly-ethylene pipe) circulate water to 520-ft. depth. • **Ground-source heat pumps:** Five 8-ton water-to-water ground source heat pumps (GSHPs) and two 1.5-ton water-to-air GSHPs provide space conditioning. The water-to-water GSHPs have a rated coefficient of performance (COP) of 4.3 for heating and an energy efficiency ratio (EER) of 17.8 for cooling. The water-to-air GSHPs have a rated EER of 17.9. The reversible expansion valve enables heat absorption or heat rejection according to the season. • **Hydronic piping:** The in-floor, zoned, hydronic piping system circulates heated water to warm interior spaces.
Space Conditioning & Ventilation 	High-efficiency systems, passive design strategies, and active participation by the building occupants keep the air inside the Center clean, safe, and comfortable with minimal energy usage.	• **Dedicated outside air handler:** The 3,500 cubic ft. per minute (CFM) unit with energy recovery enthalpy wheel and 12 variable-air-volume (VAV) boxes transfer sensible and latent energy and regulate the volume of air flow. • **Indoor air quality:** Zone-level CO_2 sensors activate the mechanical air handler when needed to maintain adequate ventilation. • **Natural ventilation:** Operable and mechanized windows and operable interior transoms harness natural ventilation. Six zone sensors alert occupants to adjust windows based on temperature and humidity.

See the full **report** by the Lawrence Berkeley National Laboratory or the DOE Zero Energy Buildings **webpage**.

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