DESIGN GUIDANCE FACTSHEET

GRIDOPTIMAL®
BUILDINGS INITIATIVE

Discovery Elementary School | Arlington, VA
Credit: Alan Karchmer

Optimizing Building-Grid Integration in Education Buildings

This factsheet recommends selected high-impact building design and operational strategies for education buildings, including K-12 schools and higher education.

Factsheets are available for other building types and for specific regions across the US. K-12 schools and higher education buildings can save costs, reduce carbon emissions, and help advance energy system decarbonization through time-of-use energy efficiency, smart devices, connected controls, and distributed energy resources such as onsite/community solar and energy storage. The recommendations in this factsheet are based on a wide variety of research, including building-scale and grid-scale simulation modeling and on-the-ground GridOptimal pilot project experience.

Top 5 GridOptimal Building Design and Operation Strategies:

Education Buildings

Efficiency and demand flexibility strategies have widely varying impacts across multiple building types, climates, and grid paradigms. High-impact strategies like these can deliver time of-use energy efficiency and demand flexibility while minimizing or avoiding occupant disruption.

Energy efficiency. Envelope measures like insulation, air-sealing, high-performance windows, and mechanical systems (HVAC and water heating) offer both year-round savings and peak demand reduction during times of high grid demand and carbon emissions. Energy efficiency is an enabler and often an impact multiplier for demand flexibility.

Plug load management. Plug loads can account for more than half of all energy consumption in high-performance schools. Because plug load schedules overlap with times of high grid load and emissions, efficient appliances, devices, and plug load controls can have benefits in terms of reducing peak demand on the grid as well as avoiding carbon emissions.

Windows & shading. Carefully planned shading and window treatments can reduce afternoon and evening cooling loads that lead to increased energy demand during system peak. West-facing shading, exterior louvers, and electrochromic glass in conjunction with high-performance glazing are effective solutions to increase a building's grid-friendliness.

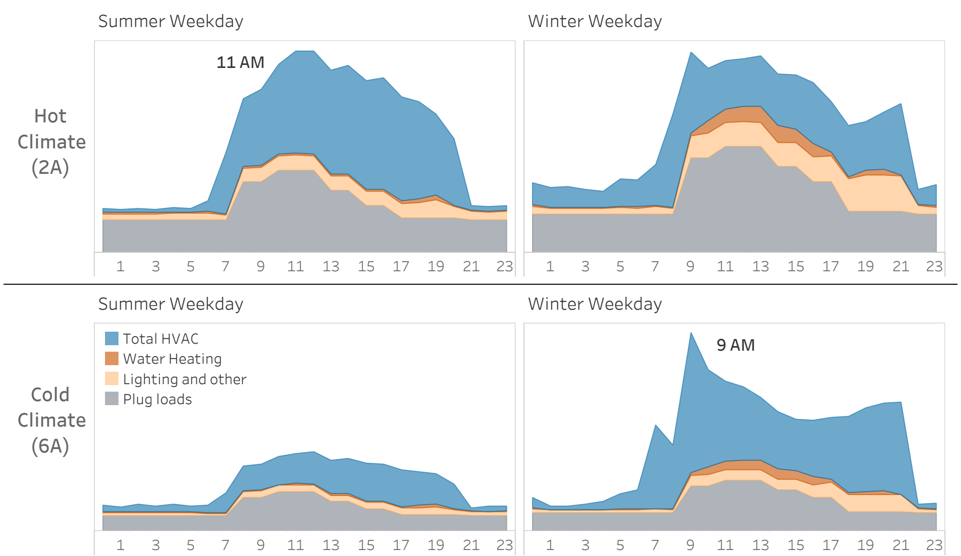
Smart HVAC controls. Temperature setpoint and schedule adjustments such as setbacks, precooling, and preheating can deliver peak demand savings and shift load toward low-cost, low-carbon hours. Communications standards such as OpenADR 2.0b enable current and future participation in demand response and similar programs.

Energy storage. Both battery electric and thermal (e.g., ice, hot water) storage systems can enable load shifting away from high-cost, high-carbon hours. Key benefits include energy cost savings, emissions reductions, and resilient operations. Co-optimize schedules to achieve cost, emissions, and resiliency benefits, and specify grid-integrated communications.

Where the Energy Goes: Typical Education End-Use Demand Profiles

To find the highest-impact opportunities for time-of-use energy efficiency and demand flexibility, identify key hours in terms of energy cost, carbon, and/or overall grid net load, then search for opportunities when those times overlap with high building demand.

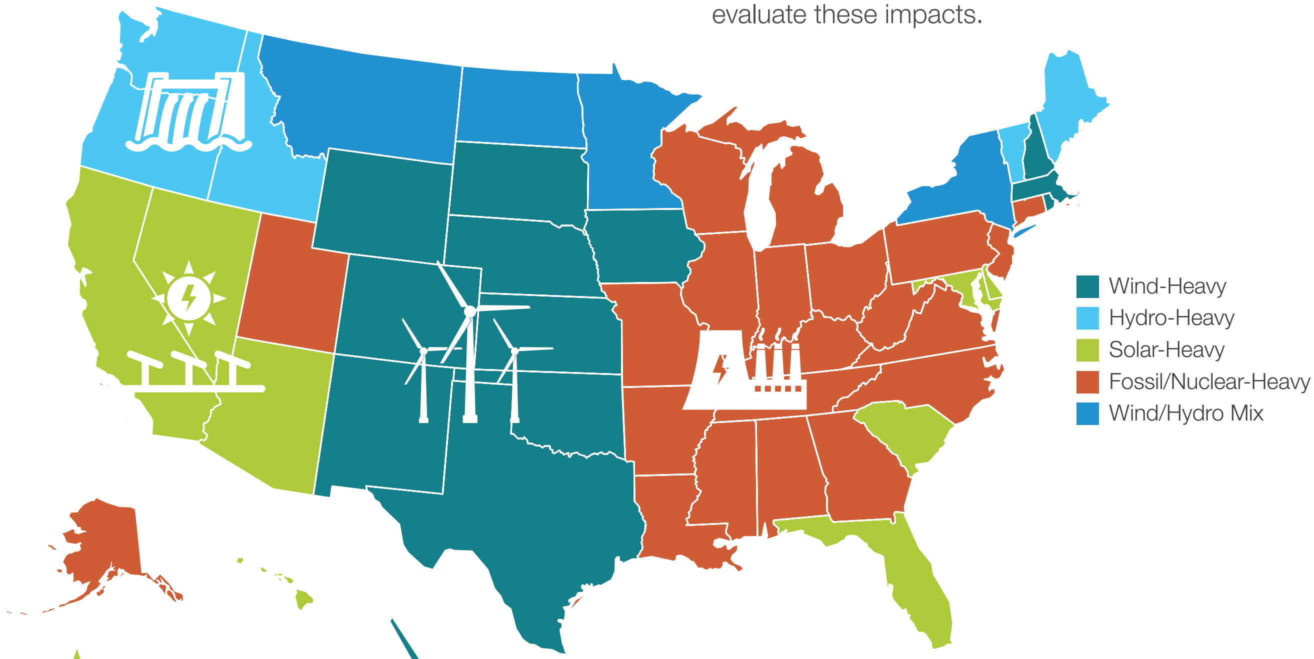
These charts show typical summer and winter demand profiles for a K-12 school in a hot climate (zone 2A) and a cold climate (zone 6A).

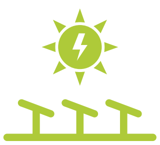


Designing for the Local Grid

Across the nation and the world, electricity grids are changing fast, and variable wind and solar are the fastest-growing resources. There are many pathways to decarbonization, and which resources are dominant at the regional level impacts both rate structures and carbon emissions patterns. Broadly, most regions can be considered either solar, wind, hydro, or fossil-heavy (in reality, all grids use a unique mix of resources; this framework is intended mainly for at-a-glance comparisons).

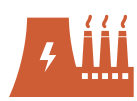
In general, buildings should seek to **minimize demand during the highest net load hours** on the grid and **shift load toward periods of low net demand.** High net load occurs when less renewable energy is on the grid—often evenings in summer. The times of low net load vary depending on the local grid conditions. Buildings can co-optimize targeted energy efficiency and flexibility strategies to achieve both cost savings and carbon emissions reductions by considering both their cost and carbon implications; the GridOptimal Buildings LEED Credit calculator spreadsheet can help designers evaluate these impacts.



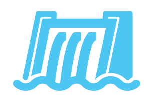


Solar-Heavy: PV panels produce more energy during mid-day hours, but grid peak demand often comes later in the day, especially in summer. Consider strategies that enable the building to shift energy away from morning and evening and toward 10am-2pm, such as grid-integrated heat pump water heaters and batteries. Target energy storage duration of 2-8 hours.

Wind-Heavy: Onshore wind in many locations tends to be stronger at night; offshore wind tends to be stronger during the day. Day to day variability can be high: prioritize demand flexibility. Consider strategies to leverage abundant, clean daytime and/or overnight energy for use during afternoons and evenings, with energy storage durations in the 8-16 hour range.



Fossil/Nuclear-Heavy: Emissions are typically highest during grid system peak demand hours but often remain relatively high during off-peak hours. Overnight and baseload hours may be very carbon-intensive (coal) or lower-carbon (nuclear). Focus on deep energy efficiency and target demand flexibility during grid peak hours, typically during summer afternoons and evenings.



Hydro-Heavy: Abundant clean energy is available during spring and early summer months as snow melts and rivers run high but limited during summer and fall. Large dams offer grid balancing and buffering ability to minimize electricity demand and supply variability. Electrification offers high carbon savings impacts. Target energy efficiency and demand reduction during summer afternoons.

Key Considerations: Education Buildings

Plug Loads

K-12 schools and higher education facilities of all sizes have substantial plug loads: computers, monitors, servers, printers, lab equipment, etc. ENERGY STAR certified, network-connected devices deliver 24/7 energy savings, and savings are often highest during peak hours. Smart devices can often be configured to facilitate load shifting or shedding. Plug load controls can be deployed at the device, the outlet, or the circuit, and can use timers, occupancy sensors, or signals from broader systems such as a building automation system. Consider shutting off power to specific devices or circuits after-hours or when spaces are unoccupied, particularly in computer rooms, libraries, labs, and kitchens.

West Elementary School | Washington DC
Credit: Perkins Eastman

Ventilation and Indoor Air Quality

To reduce the risk of disease spread in the wake of the COVID-19 pandemic, and to improve indoor air quality in general, building designers and operators are focusing on ventilation and air filtration. These strategies are important for student and staff health and safety, but if not implemented carefully they can add substantially to energy demands, especially during high-cost, high-carbon hours. Good HVAC controls are critical and building controls installation or upgrades offer a prime opportunity to integrate HVAC, lighting, and shading systems as well as to include grid-connected communications equipment.

Exploratorium Observatory

Occupant Engagement

Educating and engaging with students and staff is an important aspect of shaping a school's energy demand profile and a learning opportunity. Public dashboards, incentives, competitions, and other engagement strategies can drive occupant engagement while integrating with science learning and other curriculum components. Schools have a critical role in teaching students to be mindful of energy. This includes efficiency habits (e.g., turning off lights when leaving the room) and real-time engagement (e.g., opening or closing windows assisted by red/green indicator lights).

Program Information

The GridOptimal Buildings Initiative aims to improve building-grid interactions across the built environment by empowering building owners, designers, utilities, and other key players with dedicated metrics, tools, and guidance.

Up to three LEED points are available for buildings that improve their building-grid integration outcomes through the GridOptimal Buildings Pilot Alternative Compliance Path. See: usgbc.org/credits/gridoptimal-152-v4.1

For more information, contact alexi@newbuildings.org

Read more: newbuildings.org/gridoptimal

nbi new buildings institute

New Buildings Institute (NBI) is a nonprofit organization driving better energy performance in buildings. We work collaboratively with industry market players—governments, utilities, energy efficiency advocates and building professionals—to promote advanced design practices, innovative technologies, public policies and programs that improve energy efficiency and reduce carbon emissions. We also develop and offer guidance and tools to support the design and construction of energy efficient buildings. Learn more at newbuildings.org

NBI developed this GridOptimal design guidance factsheet.

The GridOptimal Buildings Initiative is supported by these organizations:

Austin Energy | DEED Public Power (American Public Power Association) | Efficiency Vermont | Energy Trust of Oregon | PG&E | SMUD | Southern California Edison