DESIGN GUIDANCE FACTSHEET

GRIDOPTIMAL®
BUILDINGS INITIATIVE

Optimizing Building-Grid Integration in Warehouses

This factsheet recommends selected high-impact building design and operational strategies for warehouses.

As we transition to a clean energy future, building equipment will need to optimize opportunities for grid integration and demand flexibility. Through three years of study, the GridOptimal Initiative has developed recommendations for selected high-impact building design and operational strategies for homes and buildings. They are based on a wide variety of research, including building-scale and grid-scale simulation modeling and on-the-ground GridOptimal pilot project experience.

Factsheets are available for other building types and for specific regions across the U.S. Warehouses 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.

While the recommendations outlined in this factsheet are specifically tailored for warehouses, factsheets are available for other building types and for specific regions. Visit **newbuildings.org/resource/gridoptimal-design-guidance**

Top 5 GridOptimal Building Design and Operation Strategies:

Warehouses

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.

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.

Cool roofs. Buildings with low floor area ratios tend to have expansive roofs. Cool roofs that reflect direct sunlight can greatly reduce heat gain and therefore HVAC cooling load. This mitigated cooling load peaks in the late afternoon: often high-cost, high-carbon hours.

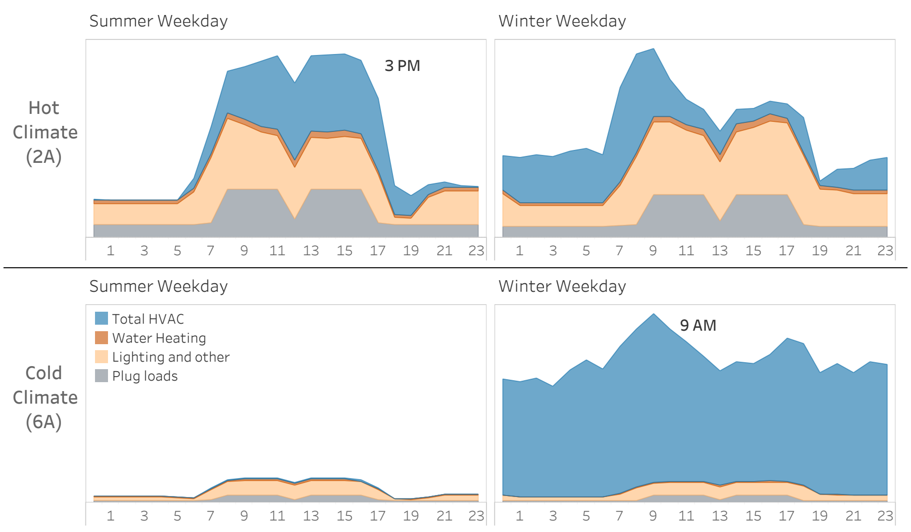
Smart HVAC controls. Temperature setpoint and schedule adjustments such as setbacks, precooling, and preheating can deliver peak demand savings and shift load toward low-cost, low-carbon hours. Communications standards such as OpenADR 2.0b enable current and future participation in demand response and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

Equipment and process loads. Buildings with substantial process loads or equipment loads may be able to modify their typical daily energy demand profiles with simple scheduling and planning. Charging batteries, pumping fluids, pressurizing tanks, and other processes can often be shifted by several hours away from high-cost and high-carbon hours with no operational cost.

Where the Energy Goes: Typical Warehouse 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.

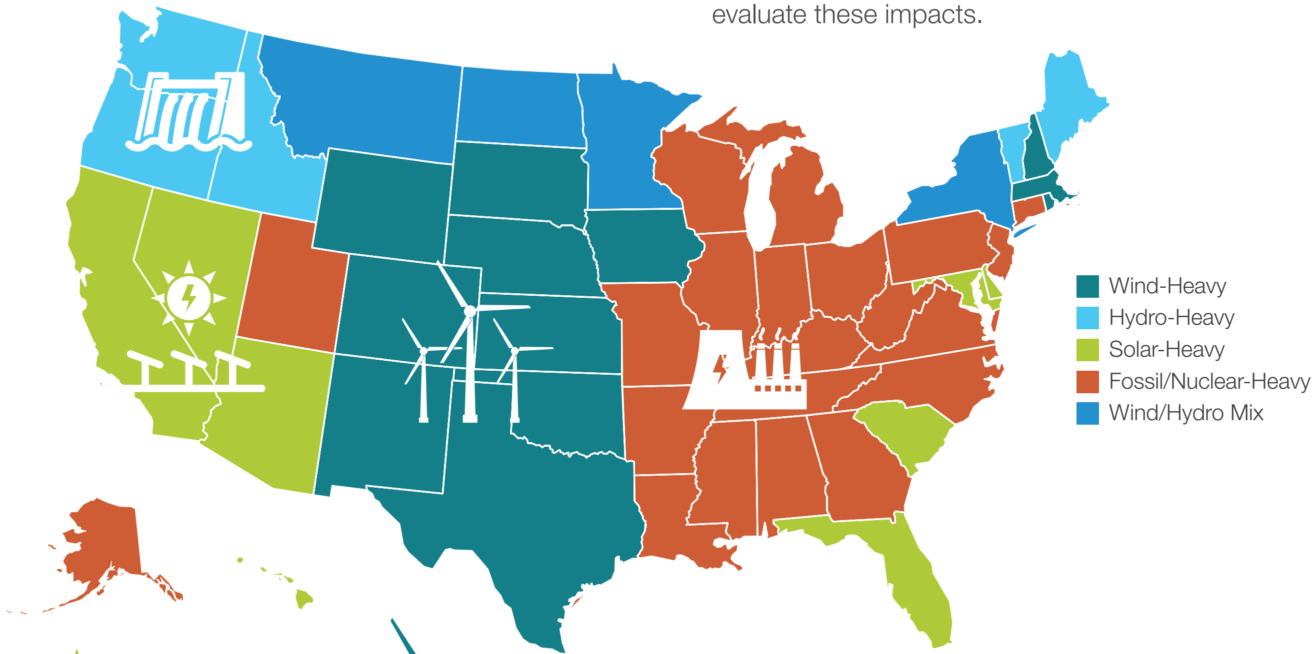
These charts show typical summer and winter demand profiles for a warehouse in a hot climate (zone 2A) and a cold climate (zone 6A).

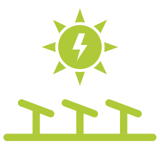


Designing for the Local Grid

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).

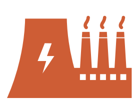
In general, buildings should seek to **minimize demand during the highest net load hours** on the grid and **shift load toward periods of low net demand.** High net load occurs when less renewable energy is on the grid—often evenings in summer. The times of low net load vary depending on the local grid 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: Warehouses

Building Envelope

Managing building energy demand starts at the building envelope. An air-tight, well insulated envelope with thermal-bridge-free construction dramatically reduces building energy demand, particularly during common high-priority hours for the grid—winter mornings and summer evenings. High-performance envelopes also importantly contribute to both demand flexibility and resiliency by prolonging the building's passive survivability, which is a measure of how long a space remains comfortable and habitable after a partial or complete power outage.

Efficient Lighting and Daylighting

Modern LEDs offer dramatic energy efficiency improvements over legacy technologies. Networked lighting controls can dim specific fixtures to reduce demand throughout the building and reduce total power demand. Daylighting offers multiple benefits, including energy savings and occupant wellbeing. Spaces with high illuminance requirements can reduce their reliance on artificial lighting by supplementing or even fully meeting needs with daylight. Proper diffusion and distribution of daylighting is critical to avoid glare and manage heat gain with the use of shades, tinting, or other treatment to gain the benefits of daylighting while avoiding unwanted effects.

Refrigeration

Buildings with high refrigeration loads should employ an efficiency-first approach for refrigeration, but significant demand flexibility is also achievable. Investing in higher efficiency systems reduces peak building demand throughout the year. Efficiency strategies like variable frequency drive motors, compressor staging, and centralized controls offer savings year-round and during high-cost, high-carbon hours. Thermal energy storage can enable cold storage warehouses to shift demand, reducing carbon emissions and earning incentives through demand response programs.

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 Research & Development, American Public Power Association · Efficiency Vermont · Energy Trust of Oregon · PG&E · SMUD · Southern California Edison, Energy for What's Ahead