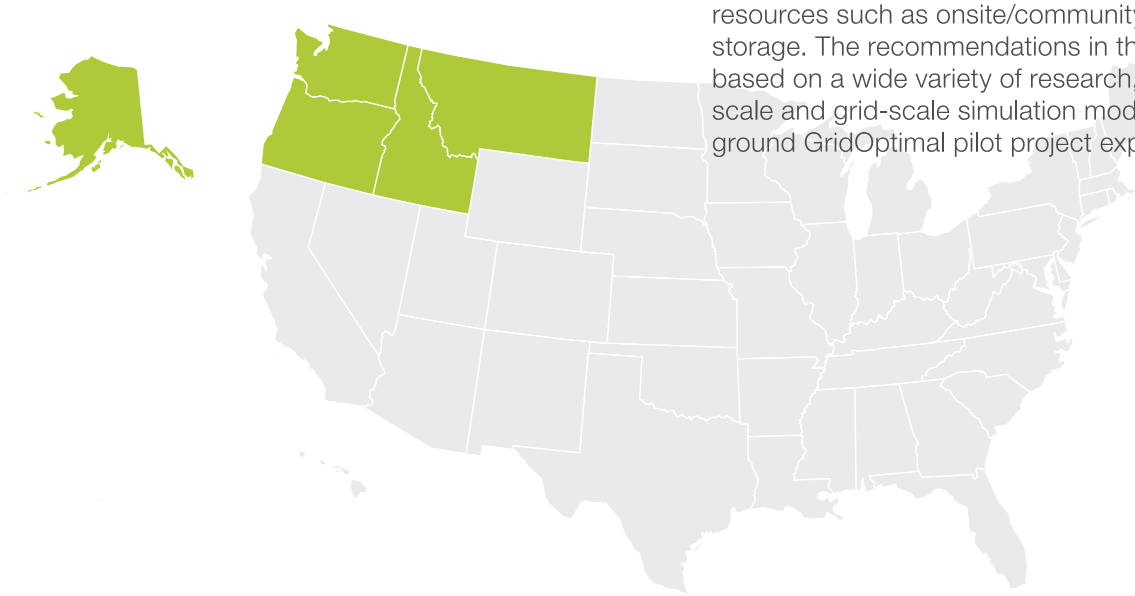
DESIGN GUIDANCE FACTSHEET

GRIDOPTIMAL®
BUILDINGS INITIATIVE

Optimizing Building-Grid Integration in the Northwest US

This factsheet recommends selected high-impact building design and operational strategies for homes and buildings specifically tailored for the Northwest US. Factsheets are available for other regions and for specific building types. The region's many hydroelectric dams provide bountiful, affordable, low-carbon electricity and help balance more variable renewables such as wind and solar, but as electricity demand grows and the region's climate changes, new solutions will be needed to meet demand throughout the year. Buildings across the region are uniquely positioned to play an important role in improving building-grid integration 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:

Northwest US

Efficiency and demand flexibility strategies have widely varying impacts across multiple building types, climates, and grid paradigms. These high-impact approaches can help improve building-grid integration outcomes on both sides of the meter in this region.

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.

Managed EV charging. Electric vehicles (EVs) are a key decarbonization solution but charging adds substantial demand. Charging during off-peak hours, and reducing or staging charging during peak hours mitigates the impact. Special rates and generous incentives are often available for smart EV chargers.

Building envelope. Buildings with well-insulated, airtight envelopes reduce winter heat loss and summer heat gain, decreasing HVAC energy needs while maintaining comfortable indoor temperatures. Additional passive measures such as west-facing shading, window treatments, and cool roofs can decrease peak cooling load needed on summer afternoons and peak winter heating demand, both of which typically occur during high-cost, high-carbon hours.

Energy storage. Both battery electric and thermal (e.g., ice or 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. Systems designed only for resiliency may not deliver cost and carbon savings: co-optimize system design and dispatch to achieve the right balance of resiliency, cost savings, and carbon reductions.

Efficient systems. Efficient mechanical systems (HVAC and water heating) meet occupant thermal comfort needs with decreased energy use. Consider variable-capacity heat pump HVAC systems and grid-connected heat pump water heaters to maximize energy savings and carbon emissions reductions. Paired with an efficient building envelope, efficient systems improve resiliency by prolonging the building's ability to remain comfortable and habitable through a partial or complete power outage. Efficient systems are an enabler and often an impact multiplier for demand flexibility.

Key Enablers: Energy Efficiency and Distributed Energy Resources

Energy efficiency is critical: more-efficient buildings have lower operating costs, carbon impacts, and power demand. Efficient buildings with high-performance envelopes remain comfortable for longer without mechanical conditioning, widening the demand response potential and load shifting window.

Passive strategies can deliver targeted time-of-use energy savings. Insulation and air-sealing save energy all the time, but especially during peak conditions. West-facing shading and electrochromic windows reduce cooling demand during costly, high-carbon summer evenings.

Active strategies offer demand response by shifting load away from peak hours toward low-cost, low-carbon hours. Automated grid-integrated controls on HVAC, water heating, lighting, and appliances facilitate reliable, consistent load shifting during occupied and unoccupied hours.

Distributed Energy Resources (DERs) including solar PV, batteries, managed EV charging, and thermal energy storage can deliver energy flexibility. Target energy storage systems that can charge during the day and reduce evening demand. Co-optimize storage systems for both cost and carbon through real-time rate and carbon signals or by adding in a time-varying synthetic carbon cost. At a minimum, be solar-ready and storage-ready: reserve space and capacity in conduits and electrical panels for future DERs and related electric infrastructure.

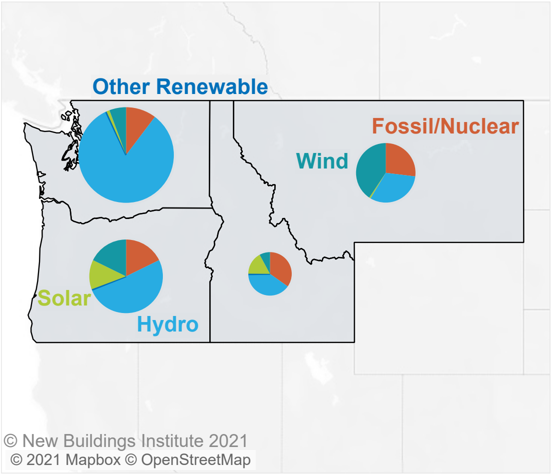
Designing and Operating Buildings in a Hydro-Heavy Grid

In the Northwest US, hydropower is the most common electricity source. The share of wind and solar will grow, but low-carbon hydropower dams will remain central to the region's grid.

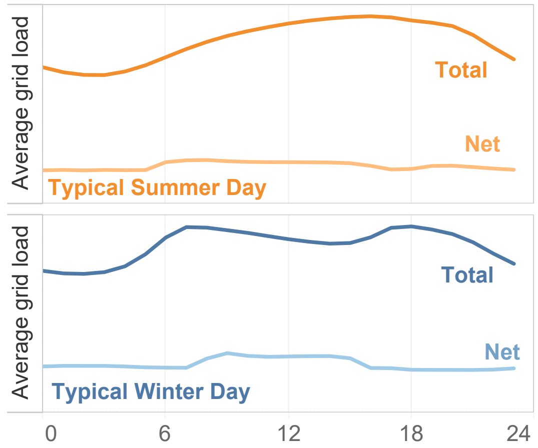
Hydropower is very flexible on a short-term basis and can compensate for variability in wind and solar generation and from the demand side. However, it is less flexible on a seasonal basis: hydropower provides abundant, low-cost, clean electricity in spring and early summer when rivers are high, but less so from late summer through mid-winter. Solar and onshore wind deliver cleaner electricity during the day, but fossil generators help meet demand during nighttime and peak-demand hours.

To minimize carbon emissions from electricity consumption, identify hours in each season when high building demand coincides with high grid carbon factors. Search for energy-saving or demand flexibility opportunities in the end-uses and equipment that are driving significant building demand during those hours. Strategies that are well-suited to this grid paradigm include passive load shaping (e.g., west-facing shading or electrochromic glass), diurnal demand flexibility strategies (e.g., precooling, temperature setbacks) as well as short- to medium-duration energy storage (e.g., batteries, cold/hot water tanks).

Northwest US Grid Mix



Northwest US System Load Profile



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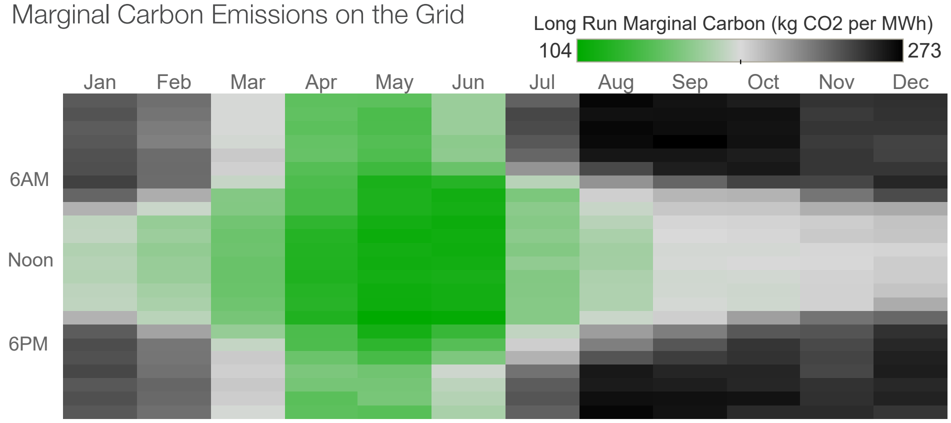
Hours with high net system load (dashed lines) tend to be more expensive and higher-carbon. Net system load equals total load minus renewable generation.

Electricity grids across the region are transforming toward zero carbon emissions. Buildings can enable this transition by focusing on time of use energy efficiency and demand flexibility.

Marginal Carbon Emissions on the Grid



All graphs and charts on this page show an average of 2036-2044 hourly data from the 2020 release of NREL's Cambium Standard Scenarios, available at https://cambium.nrel.gov/.

Lovejoy Office Building | Portland, OR
Credit: Opsis Architecture

Futureproofing: Building and Vehicle Electrification

Burning fossil fuels in buildings is responsible for about 9% of US carbon emissions, while transportation emissions make up 29%. Building and vehicle electrification can greatly reduce these emissions. This represents both a great challenge and a great opportunity.

Buildings: Unlike most regions in the US, grids in the Northwest are dual-peaking: both winter and summer have peak hours. As electrification advances, winter demand will grow—and electricity rates may be impacted. Designers should consider both cooling-season and heating-season demand flexibility and peak load reduction strategies. Improved building envelopes and high-efficiency mechanical systems help minimize winter heating demand, while battery and thermal energy storage paired with smart controls can help shift peak demand.

Vehicles: Electric vehicle (EV) charging can add substantial whole-building loads and if not managed carefully can contribute to higher energy costs and carbon emissions. Specify smart EV chargers that can communicate with the utility or a third party. Bidirectional EV chargers are an emerging technology that can enable EV batteries to support electricity grids and buildings.

VanDusen Botanical Gardens Visitor Centre | Vancouver, BC
Credit: Nic Lehoux

Futureproofing: Climate Change Adaptation and Resiliency

Resiliency is a critical consideration for building owners and occupants. Natural and climate-change-amplified disasters such as wildfires, heat waves, earthquakes, drought, and severe winter storms have direct impacts, like wildfire smoke or local grid outages, and indirect impacts, like decreased hydro capacity, across the region. Energy efficiency can help extend the building's passive survivability time window. Use hours of passive survivability as a metric for evaluating and comparing energy efficiency and demand flexibility strategies. Evaluate the resiliency and other non-energy benefits of both efficiency and flexibility strategies and prioritize strategies that improve building-grid integration benefits while saving energy and reducing carbon impacts. In many cases, resiliency benefits may be the deciding factor in deploying strategies such as energy storage; if so, ensure that day-to-day operations deliver cost, grid support, and emissions benefits.

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

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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