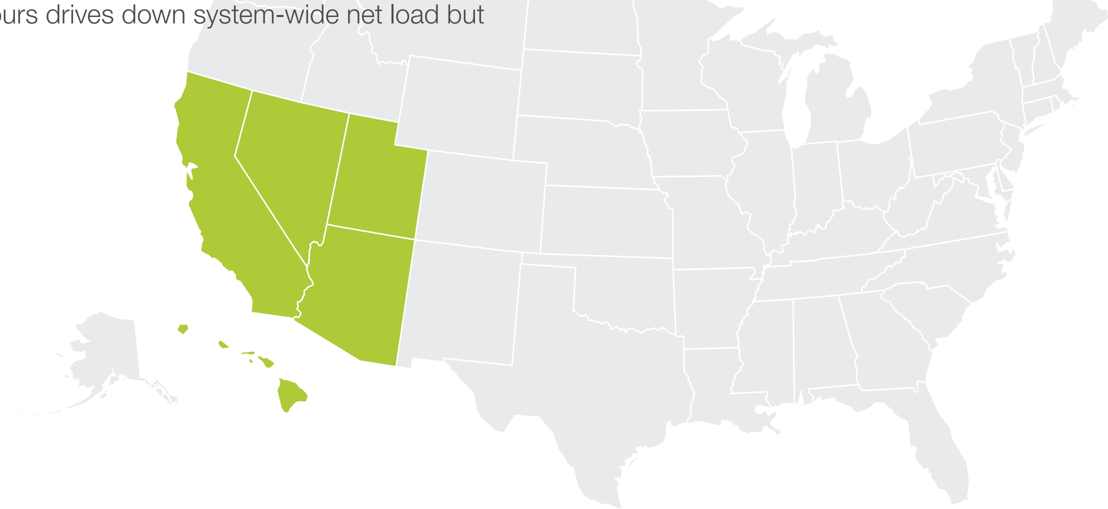
DESIGN GUIDANCE FACTSHEET

GRIDOPTIMAL®
BUILDINGS INITIATIVE

Palomar Community College | San Marcos, CA
Credit: Nick Merrick © Hall+Merrick 2019

Optimizing Building-Grid Integration in the Southwest US

This factsheet recommends selected high-impact building design and operational strategies for homes and buildings specifically tailored for the Southwestern US. Factsheets are available for other regions and for specific building types. The bountiful sun and moderate climate in many locations across the Southwest, along with policy and market factors, have driven high distributed and utility-scale solar photovoltaic (PV) deployment. This has produced the "duck curve" phenomenon: high solar penetration during mid-day hours drives down system-wide net load but has less impact during peak hours in the evening. Buildings across the region 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:

Southwest 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.

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.

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.

Thermal energy storage.
Thermal energy storage systems (e.g., ice, hot water) can enable load shifting away from high-cost, high-carbon hours. Key benefits include energy cost savings, emissions reductions, and resilient operations. Prioritize systems that enhance the overall energy efficiency of the cooling and heating systems to better co-optimize schedules and achieve both energy cost and carbon emissions savings, as well as resiliency.

Energy efficiency. Passive efficient envelope measures like insulation, air-sealing, high-performance windows, and cool roofs, along with active building efficiency improvements through mechanical system upgrades (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.

Solar + storage. Onsite renewables help reduce building net demand during peak grid demand hours. In solar-heavy grids like California and Hawaii, the value of solar exports during mid-day hours is limited, so the ability to charge during the day and discharge in the evening is especially valuable. Solar + storage systems can enable buildings to island from the grid, allowing key systems and circuits to remain online during a power outage. Solar + storage can offer an attractive combination of cost savings, carbon reductions, and resiliency benefits.

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) such as 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.

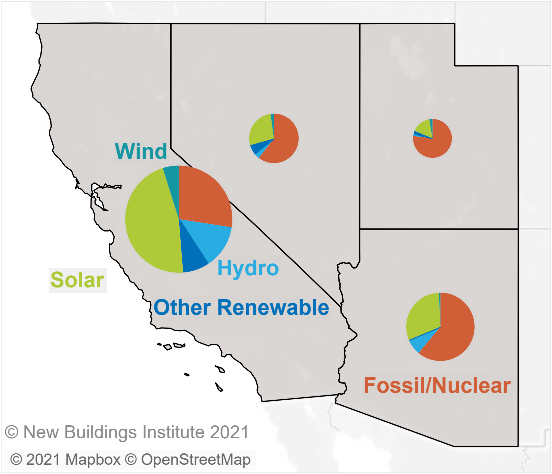
Designing and Operating Buildings in a Solar-Heavy Grid

Across the Southwest region, solar is the most common renewable energy source. This is forecast to hold over the next few decades. This solar-heavy grid paradigm means that energy is relatively abundant, low-cost, and clean during the day, with net demand rising sharply around sunset.

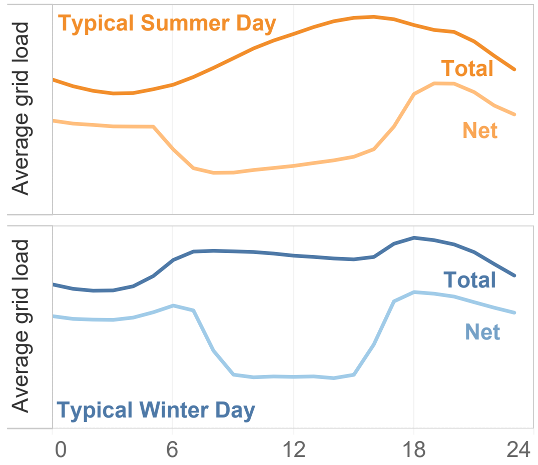
Fossil fuel burning plants provide much of the region's baseload power, which is why overnight carbon emissions factors are relatively high. Fossil generators also help meet demand during peak hours, such as summer afternoons and evenings.

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 (such as west-facing shading or electrochromic glass), diurnal demand flexibility strategies (precooling, temperature setbacks) as well as short- to medium-duration energy storage (batteries, cold/hot water tanks).

Southwest States Grid Mix



Southwest System Load Profile



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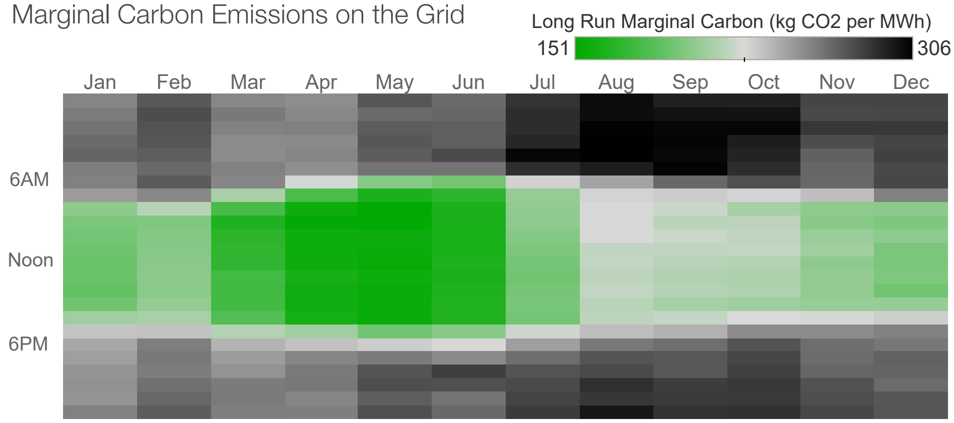
Hours with high net system load (shaded lines) tend to be more expensive and higher-carbon. Net system load equals total load minus renewable generation. Net load is estimated based on hourly regional renewable generation forecasts.

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/.

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 will greatly reduce these emissions. This represents both a great challenge and a great opportunity.

Buildings: Generally, grids in California and the rest of the Southwest are summer-peaking, but as electrification advances, winter demand will grow—and electricity rates may be impacted. Designers should consider 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 chargers are an emerging technology that can enable EV batteries to support electricity grids and buildings.

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, earthquakes, heat waves, and floods have direct impacts, like wildfire smoke, and indirect impacts, like preventative power system shutoffs, 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 · Efficiency Vermont · Energy Trust of Oregon · PG&E · SMUD · Southern California Edison