Union of Concerned Scientists

FACT SHEET

Renewables and Reliability

Grid Management Solutions to Support California's Clean Energy Future

HIGHLIGHTS

California is making important strides to bring more clean, renewable electricity to the power grid, which is critical to helping the state meet its long-term carbon reduction goals and reducing air pollution that harms public health. As more renewable electricity becomes available, grid operators face the challenge of integrating it into the grid while providing cost-effective and reliable electricity to customers. Fortunately, technologies and improved grid practices are available today that would allow California to rely on renewables to supply at least 50 percent of overall electricity needs, positioning the state to continue its clean energy leadership.

California leads the nation in the transition to clean, safe, and renewable forms of electricity. The state is well on its way to supplying 33 percent of its electricity from renewable sources by 2020 and is now considering a policy to get to 50 percent by 2030—the most ambitious clean energy effort in the nation.

Satisfying half of California's electricity needs with renewable energy is not only visionary, but also necessary to reduce our reliance on fossil fuels that contribute to global warming and air pollution. Fortunately, this goal is also achievable. As the state plans for this clean electricity future, grid operators should deploy new methods, tools, and infrastructure that allow them to integrate more renewable energy and rely less on fossil fuels to maintain reliability on the grid. Doing so will make renewable energy integration more cost effective and result in less global warming pollution. Enhancing coordination with neighboring grid operators and diversifying the technological mix and geographic placement of its renewable energy resources will also lower costs and make grid operations more efficient. These improvements must be made today to ensure the state can meet its long-term carbon reduction goals.

Renewable energy generation like this large-scale photovoltaic project in San Luis Obispo County, CA, will be critical to reducing the state's reliance on fossil fuels.

Maintaining a Reliable Electricity Grid

A reliable electricity system is one that maintains a balance between electricity supply and demand at all times. This balance must be sustained every second, responding to fluctuations in electricity demand throughout the day, and must be quickly restored when there is a grid disturbance (such as the loss of a transmission line or major power plant). If the balance on the grid cannot be restored quickly, large-scale power outages may occur.

Grid operators are constantly adjusting the output of power plants to meet electricity demand. The operators also need resources on hand that can quickly respond (from within a second up to an hour after an operator's signal) to restore reliability should an imbalance occur. Resources required to maintain grid reliability are called "ancillary services" because they provide electrical capabilities that are in addition to the power generated to meet demand. The subset of ancillary services that are used to balance supply and demand are largely met by natural gas and hydropower plants today; unless grid operations change, incremental needs will be met by natural gas. For natural gas plants to provide most of these services in the timescale required, they must be online, which means they are generating global warming emissions and air pollution even when the electricity they generate is not needed to meet demand.

Modest levels of renewable generation can be absorbed into the electricity grid with only minor adjustments to operations. But since wind and solar generation vary over the course of the day and season, using significant quantities of these renewable resources makes grid management more challenging. Other renewable resources such as biogas, biomass, and geothermal have fairly constant generation profiles. To ensure that renewables can displace significant amounts of natural gas generation while maintaining reliability, grid operators must ensure there are enough resources available to maintain the supply/demand balance, including resources that can be called upon at a moment's notice.

Making Room for Renewables

As California brings more renewable energy online, it makes environmental and economic sense to turn down generation from other resources as much as possible to make room for this clean generation. The cost to operate a wind or solar plant is much lower than a natural gas plant because once the facility is built, the fuel is virtually free.

Therefore, a central challenge to integrating large quantities of renewables is making adequate room for this clean electricity on the grid. The California Independent System Operator (CAISO), the state's largest grid operator, is concerned that periods of high renewable generation will cause electricity supplies to exceed demand. This is referred to as "overgeneration."

As renewable generation increases in the middle of the day, primarily due to more available solar energy, the net

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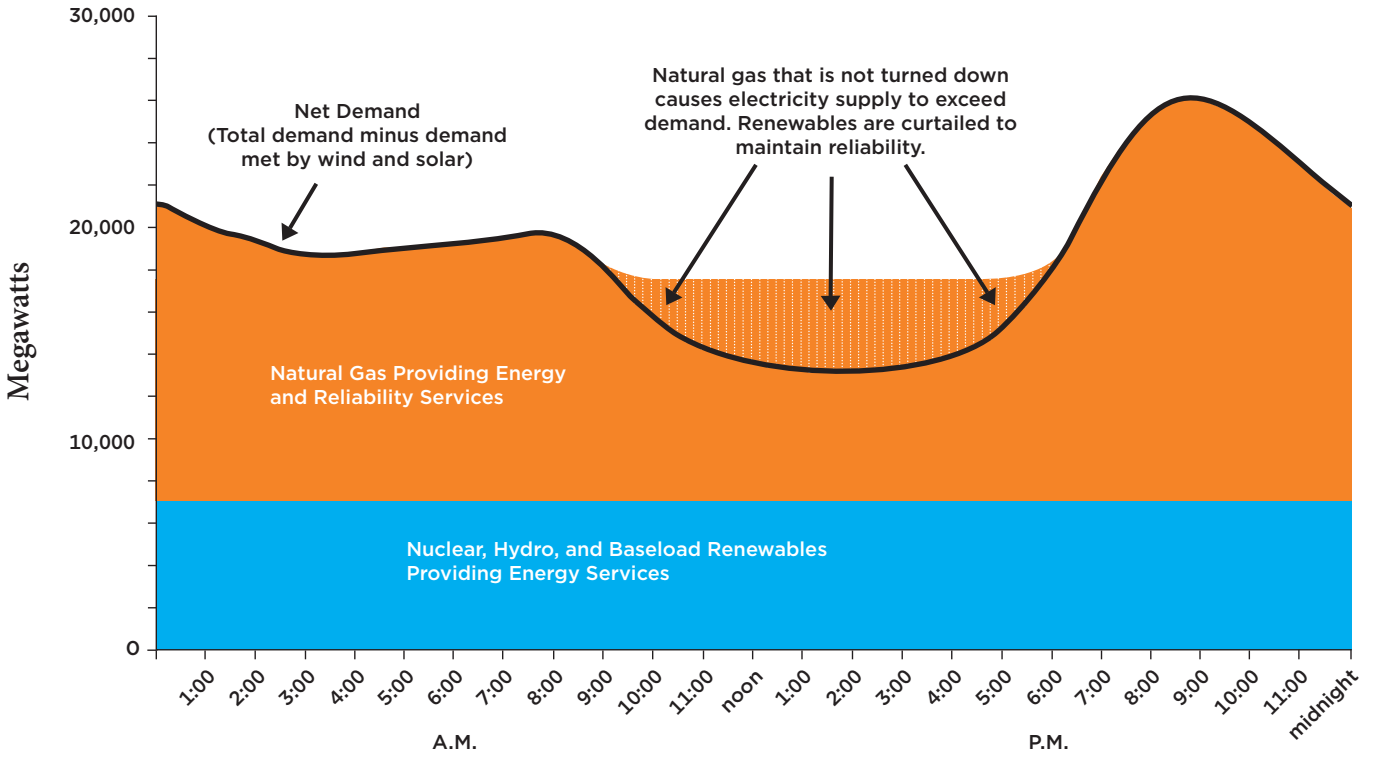
At the California Independent System Operator (CAISO) grid operation control center, electricity supply and demand are constantly balanced to maintain reliability.

Potential Renewable Energy Curtailment Scenario



Investments in flexible, low-carbon technologies will allow grid operators to rely less on natural gas plants for reliability services. Doing so will help avoid renewable curtailment.

Note: This figure illustrates a day in the future with higher levels of renewable energy penetration. The figure is conceptual and not based on actual generation data.

demand (the residual electricity demand not met by wind and solar) is dramatically reduced. Meanwhile, natural gas plants are also online to provide both energy and ancillary services; if adequate amounts of natural gas generation are not turned down or turned off, overgeneration could occur (see the figure).

The CAISO currently handles overgeneration situations by reducing or "curtailing" the generation from renewable energy facilities. This is a missed opportunity because it wastes electricity from clean sources while natural gas plants are kept online. Primarily relying on natural gas plants to meet energy needs and grid reliability services will prevent California from achieving its long-term emission reduction goals.

Since energy investments made today will be used for decades to come, the state should be wary of relying on natural gas as part of its long-term carbon reduction strategy. Instead, California should invest in low-carbon technologies to prevent overgeneration and provide grid reliability services. These investments will be critical to the state's success in bringing more renewable energy online. Fortunately, many of the low-carbon generation and load-shifting technologies that exist today are capable of offering these services; some are able to respond even faster than a natural gas plant.

Grid Integration Solutions for California

- **Target energy efficiency in evening hours.** Implementing energy-saving policies to minimize demand spikes when solar generation is not available will reduce the amount of generation required to quickly ramp up electricity supplies to meet evening needs. This will help lower overall integration costs and reduce the potential for renewable curtailment.

- **Smooth renewable generation profiles through a more diverse fleet.** California should invest in a variety of renewable energy resources with diverse production patterns—including wind, solar, bioenergy, and geothermal—to help spread out renewable generation

more evenly during the day and season. Doing so reduces the amount of flexibility required by other resources to balance electricity supply and demand, which lowers overall integration costs.

- **Increase coordination between regional grid operators.** Grid operators can pool generation across a larger area, making it easier to obtain flexible generation reserves, which lowers costs and reduces renewable curtailment. Curtailment can also be avoided if excess renewable generation can be exported to another region that can use the electricity.
- **Deploy energy storage to capture excess renewable generation and provide grid reliability.** Storage devices like pumped hydropower, compressed air, and batteries can be used to "charge" or absorb electricity from renewable facilities when they are operating and "discharge" the electricity when it is needed. Unlike natural gas plants, many storage devices do not have to be generating a minimum amount of electricity in order to respond at a moment's notice to a call from the grid operator. Therefore, their capacity to provide grid reliability services would not crowd out renewable energy generation or cause renewable curtailment.
- **Shift electricity demand to align with peak renewable output.** Demand response technologies, which enable electricity users to shift consumption toward times of the day when renewable generation is high, will help take advantage of clean electricity that would otherwise be considered "excess" and reduce the need for ramping up gas plants during other periods of the day. Load shifting can happen manually, or automatic signals can be sent to industrial equipment, home appliances, and electric vehicles so that the usage shifts happen imperceptibly (without affecting usability), avoiding the need for electricity users to make decisions. Demand response technologies can also be used to provide ancillary services that balance the grid, by adjusting levels of electricity demanded in smaller segments for shorter periods of time.

Satisfying half of the state's electricity needs with renewables by 2030 is a critical strategy in the broader effort to make meaningful reductions in global warming pollution.

- **Enable renewables to quickly adjust their generation and provide grid balancing services.** As the state moves to a grid where the majority of the generation units are renewables, these facilities should have the option of providing some of the grid-balancing ancillary services that will be required to maintain reliability. Providing some of these services with renewables will reduce the need to rely upon other forms of generation that may otherwise cause renewable curtailment.

California is making important strides to demonstrate the feasibility of operating a power grid that relies on large quantities of renewable energy to provide clean, safe, and reliable electric service. Satisfying half of the state's electricity needs with renewables by 2030 is a critical strategy in the state's broader effort to make meaningful reductions in global warming pollution. By investing in low-carbon technologies that provide grid flexibility and reliability services, California will ensure that its renewable energy integration efforts minimize costs and maximize pollution reduction.

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