April 2022

ELECTRICITY MARKETS & POLICY

Record amounts of zero-carbon electricity generation and storage now seeking grid interconnection

1,300 gigawatts of wind, solar, and storage indicate a major transition underway, even if most projects will not be built

The amount of new power generation and energy storage in the transmission interconnection queues across the U.S. continues to rise dramatically, with over 1,400 gigawatts (GW) of total generation and storage capacity now seeking interconnection. The queues indicate particularly strong interest in solar, battery storage, and wind energy, which account for 93% of all proposed capacity. Altogether, this potential investment of over $2 trillion represents more capacity than the current U.S. power fleet. But most of these proposed projects will ultimately be withdrawn, and those that are built are taking longer on average to complete interconnection studies and become operational.

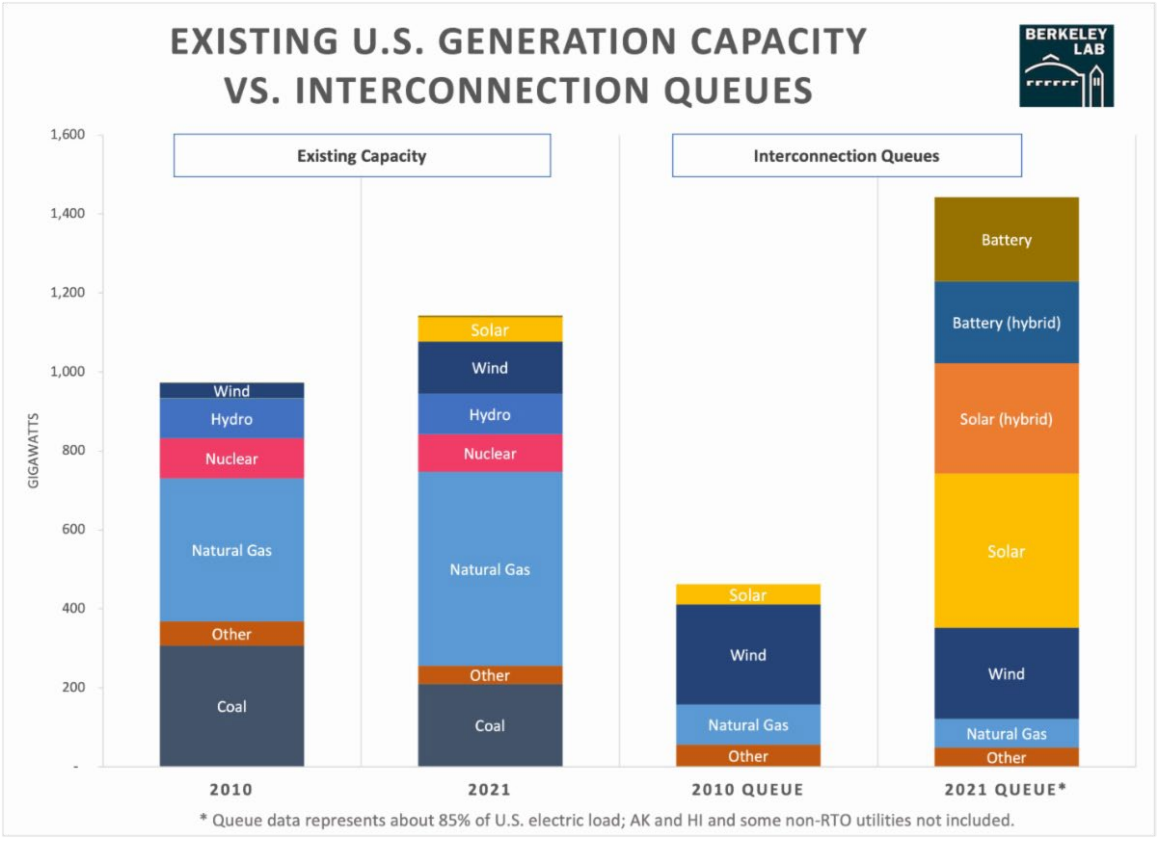

Figure 1: Existing U.S. capacity (2010 and 2021) compared to interconnection queue capacity (2010 and 2021).

A new slide deck, data file, and interactive visualization from Lawrence Berkeley National Laboratory synthesize data from transmission interconnection queues throughout the United States to illustrate trends in proposed power plants across time, technologies, and regions. In addition to the strong interest in solar, battery storage, and wind, the data demonstrate growing interest in hybrid plants that combine multiple generation types and/or storage at the point of interconnection. Berkeley Lab's data and analysis are also highlighted in a new paper from the U.S. Department of Energy's Office of Policy focused on opportunities to improve interconnection and transmission policies.

Proposed large-scale electric generation and storage projects must apply for interconnection to the bulk power system via interconnection queues. Many projects that apply for interconnection will not ultimately be built, since entering an interconnection queue is only one of many steps in the development process. Projects must also have agreements with landowners and communities, power purchasers, equipment suppliers, and financiers, and may face transmission upgrade requirements. Data from these queues nonetheless provide a general indicator for mid-term trends in developer interest. Berkeley Lab compiled and analyzed data from the seven organized electricity markets in the US and additional 35 utilities outside of those regions, which collectively represent over 85% of all U.S. electricity load.

Solar (676 GW) accounts for a large – and growing – share of generation capacity in the queues. Substantial wind (247 GW) capacity has also applied for interconnection, 31% of which is for offshore projects (77 GW). In total, about 930 GW of zero-carbon generation capacity are currently seeking transmission access, along with an estimated 427 GW of storage capacity. This is roughly the same amount of clean capacity needed to hit an 80% clean electricity share in 2030.

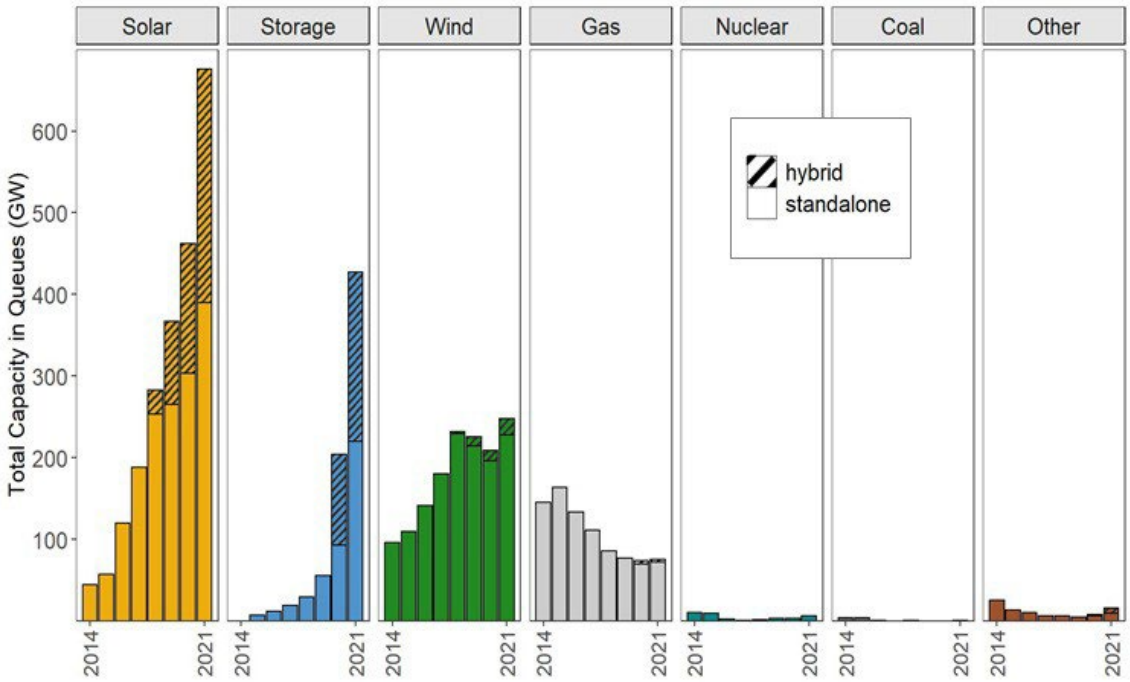

Figure 2: Total capacity in interconnection queues over time. *Hybrid storage capacity was estimated for some projects using known generator:storage ratios, and was not estimated for years prior to 2020.

As shown on the map, solar capacity in the queues is distributed across most U.S. regions, including most notably in PJM (147 GW), the non-ISO West (139 GW), and MISO (112 GW). Wind capacity in the queues is highest in the non-ISO West (49

GW), SPP (43 GW), and NYISO (41 GW, mainly offshore). Although proposed wind capacity has shrunk in some historically dominant wind regions like ERCOT and SPP, it has grown in others – particularly those with proposed offshore wind projects like NYISO, PJM, CAISO, and ISO-NE. Proposed storage is highest in CAISO (136 GW), the non-ISO West (122 GW), PJM (54 GW), and ERCOT (43 GW). Natural gas proposals center on the Southeast (24 GW) and PJM (17 GW), with less than 10 GW in all other regions.

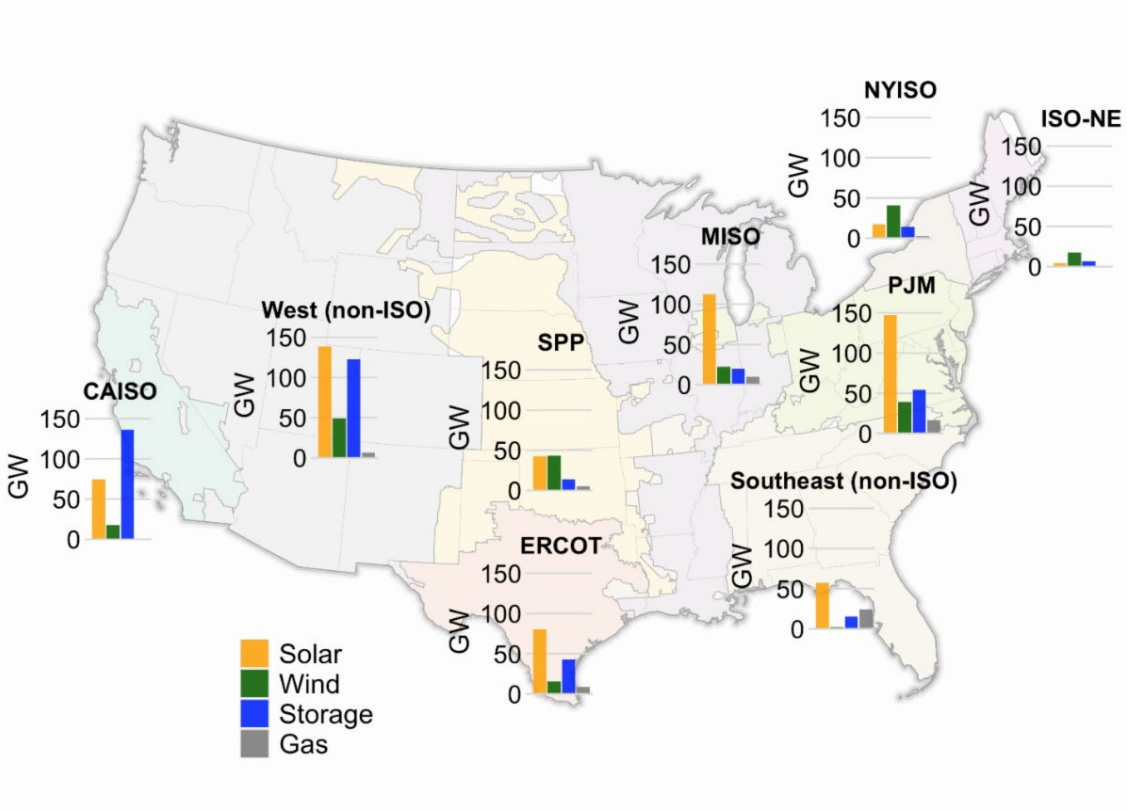

Figure 3: Regional distribution of proposed solar, wind, storage, and gas capacity.

Hybrid power plants are of growing interest, especially solar paired with storage. At least 285 GW of solar capacity in the queues is proposed as a hybrid plant (42% of all solar in the queues), as is 19 GW of wind (8% of all wind in the queues). An estimated 208 GW of battery capacity is proposed in hybrid configurations with generation, representing 49% of all storage capacity in the queues. Interest in hybrids projects is especially acute in CAISO and the non-ISO West, where 95% and 75% of the cumulative proposed solar is in a hybrid configuration, respectively. In CAISO, 99% of the solar capacity that entered the queue in 2021 was paired with storage.

But much of the proposed capacity in the queues will not ultimately be built since projects may not come to fruition for a variety of reasons. Looking back at a subset of queues for which data are available, only 23% of the projects seeking connection from 2000 to 2016 subsequently reached commercial operations. Completion percentages appear to be declining in recent years and are lower for wind and solar than for other resources. Additionally, wait times are on the rise: within the subset of regions with available data, the typical duration from connection request to commercial operation increased from ~2.1 years for projects built in 2000-2010 to ~3.7 years for those built in 2011-2021.

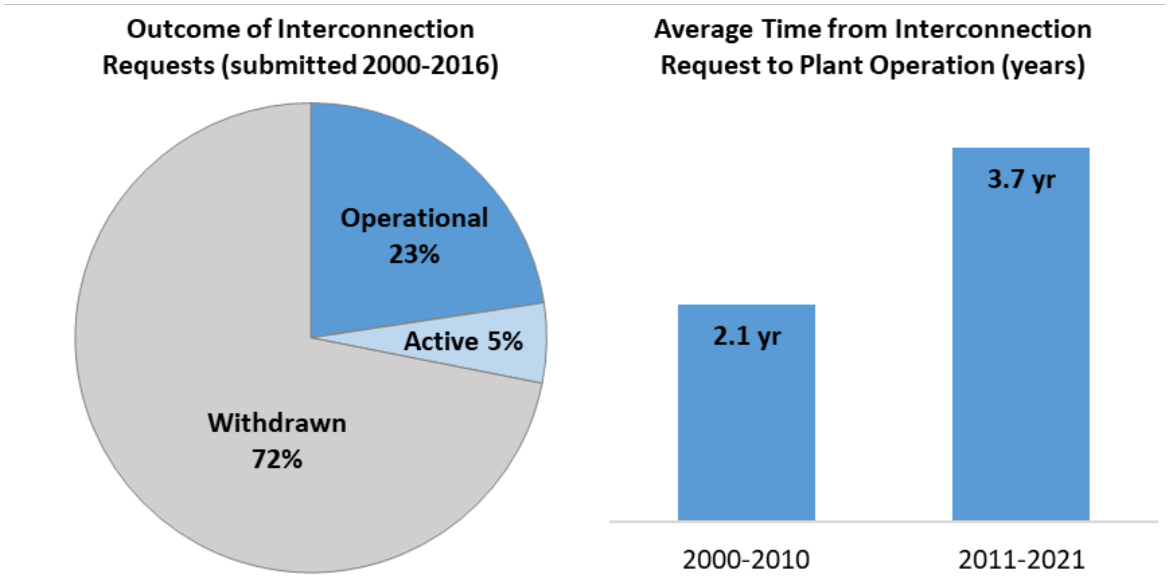

Figure 4: Completion rate and typical duration to reach commercial operations for projects in the queues.

Withdrawal rates and wait times in the queues suggest growing interconnection and transmission challenges and highlight the need to improve institutional processes. The Federal Energy Regulatory Commission has initiated an Advanced Notice of Proposed Rulemaking to study and address many of these issues. Several regional grid operators have already made substantial reforms to their interconnection processes, or have announced plans to do so. New research released today by the Department of Energy's Office of Policy leverages Berkeley Lab's queue data amongst a broader synthesis of research to highlight the importance of improved planning and policies for transmission and interconnection to enable clean power growth.

More information, including a slide deck, complete data file, and an interactive data visualization, is available here: emp.lbl.gov/queues.

Electricity Markets & Policy
Lawrence Berkeley National Laboratory
emp.lbl.gov