Institute for Energy Economics and Financial Analysis

Briefing Note

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A Transformative Summer for U.S. Electricity

- *Even with heat waves pummeling California and Texas this summer, renewables are reliably and economically transitioning the grid from fossil fuels.*
- *Solar generated 16 million MWh of electricity from June 1 to August 31 in Texas, accounting for 11.6% of ERCOT's total summer demand—a 40% increase from just a year ago.*
- *The transformation in California has been equally pronounced, and again points to the reliability enhancing combination of solar and storage.*
- *Four years ago, there was essentially zero battery storage capacity installed across the U.S., but now there are more than 20,000 MW and that figure increases monthly.*

Solar, Battery Storage Shine, Demonstrate Reliability of Renewable Transition

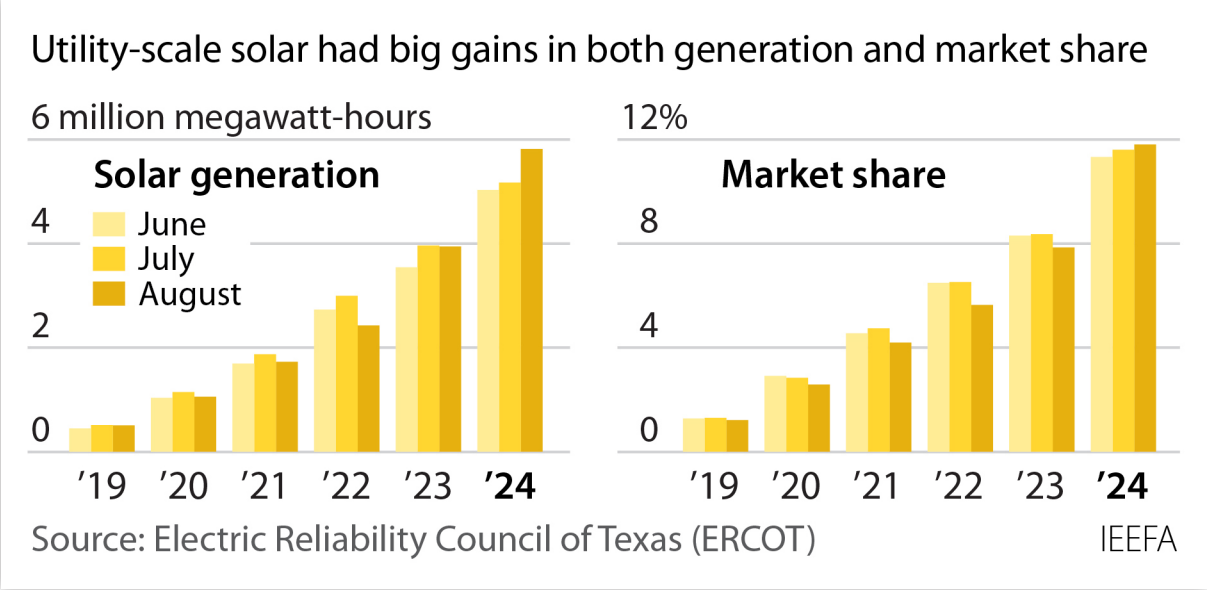
The evidence from this summer's sizzling heat is in, and the verdict is clear: Renewables are reliably and economically transitioning the grid from fossil fuels. Heat waves pummeled California (in July and again in early September) and Texas (in August), but grid operators in both states had little trouble meeting demand, in large part due to the rapid growth of renewable energy generation (particularly utility-scale solar) and the installation of thousands of megawatts (MW) of battery storage capacity. For two of the largest power markets in the country, and for the U.S. as a whole, these are the hallmarks of a transformative shift.

Texas

Solar's performance during the Texas summer was nothing short of spectacular. From June 1 to August 31, solar generated 16 million megawatt-hours (MWh) of electricity, accounting for 11.6% of the Electric Reliability Council of Texas' (ERCOT) total summer demand. This is a 40% increase from just a year ago, when solar produced 11.4 million MWh during the summer.

More telling is the reliability of solar's output during the critical peak demand time each day, a point IEEFA first analyzed last summer. These key hours, especially during heat waves, are when the grid is most tested, power prices can skyrocket, and customers' concerns about brownouts and blackouts soar. This summer, though, a vast increase in solar generation, and its consistent reliability, helped allay those issues. On average, solar met 20.4% of ERCOT demand during the peak hour during this 92-day period, with only a narrow band up or down in daily output. In August, for example, when the average peak demand was more than 80,500 MW, solar generated an average 20.7% of that demand, ranging from 17.2% to 24.2%. Importantly, on Aug. 20 when ERCOT set its latest all-time record of 85,544 MW, solar sent 17,568 MW onto the grid during the peak, accounting for 20.5% of the needed supply.

Figure 1: Summer Solar Generation in ERCOT Jumps Again

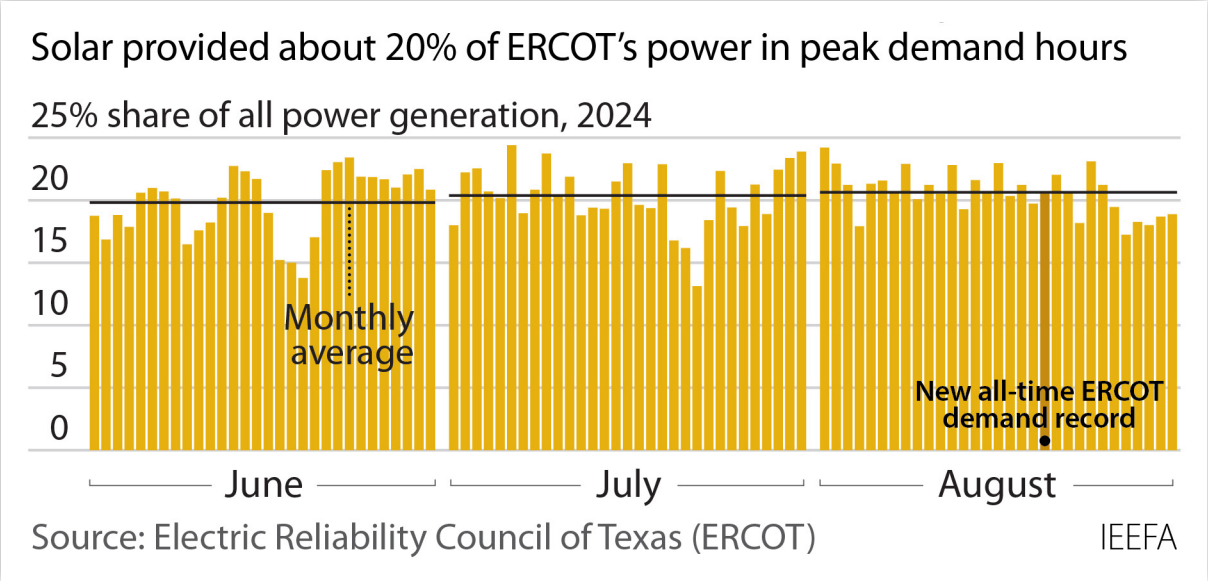


Like our findings last year, solar's summer-long reliability undercuts concerns by fossil fuel advocates that renewables aren't dependable. The data proves that they are dependable.

Here, it is worth noting that while solar was reliably available Aug. 20, several gas- and coal-fired generation resources tripped offline just as ERCOT was nearing its peak demand for the day. Between 2 p.m. and 4 p.m., the 391MW San Miguel coal plant near San Antonio dropped offline, and then in the early evening, just as the peak neared, roughly 1,200 MW of gas-fired capacity went out of service. A day earlier, the 785MW Unit 2 at the J.K. Spruce coal plant, also near San Antonio, had gone offline due to a tube leak, leaving system operators short of almost 2,500 MW of supposedly reliable fossil fuel generation on very short notice.

The summer-long growth in solar generation has continued into early fall, with solar setting back-to-back output records on Sept. 7 and Sept. 8, hitting 20,990 MW the first day and jumping to 21,667 MW the second day. As important, solar's contribution to peak hour demand rose as well, with solar sending a record 19,964 MW to the grid the first day and accounting for more than 31% of peak demand both days.

Figure 2: Peak Hour Market Share for Utility-Scale Solar, ERCOT



The growth in solar generation, coupled with the system's existing wind capacity, is reshaping the ERCOT grid, which supplies 90% of the load in Texas, even as it continues to grow. ERCOT generation in 2024 has increased by almost 11 million MWh through August, a 3.6% rise, but renewables have accounted for all the increase (and a bit more). This has pushed wind and solar's share of the market up to 34.9% and the carbon-free share including ERCOT's two nuclear plants to 43.2%.

Continued growth in solar capacity is almost certain to push renewables' share even higher over the next two years. According to ERCOT data, 26,087 MW of solar capacity is currently installed on the system. By June 2025, ERCOT expects an additional 6,380 MW of solar capacity will be on the grid, and by the end of the year, twice that—13,000 MW—is expected to be online.

In addition to solar's growth, the rapid addition of battery storage capacity within ERCOT has added greatly to system reliability, with this new resource playing an increasingly important role in the evening as solar ramps down while demand is still relatively high. Peak demand during ERCOT's Aug. 20 record occurred at 6 p.m., but demand was still high at 7 p.m. as solar generation began to fall quickly and essentially hit zero by 8 p.m. During that period, batteries across ERCOT began sending electricity back into the grid, reducing the need for additional gas and/or coal-fired generation. From 7 p.m. to 8:30 p.m., battery power accounted for at least 3% of the system's power needs, climbing to a peak of 3,930 MW at 7:35 p.m., when it met 4.9% of demand.

This battery output is particularly important because of the timing. It occurred when the system was hitting its net demand peak, which is the term system operators use to discuss the time of highest demand after removing solar and wind from the calculation; net peak demand generally occurs after the sun sets, when solar generation has ended. In the Aug. 20 example, net peak demand topped out at just under 71,000 MW at 7:45 p.m. Without the 3,790 MW of battery power flowing back to the grid at that time, additional thermal generation (likely gas in ERCOT)

would have been required. By 8:30 p.m., net demand had fallen below 70,000 MW and gas generation started to decline.

Unlike years past, ERCOT powered through the Aug. 20 peak—and the entire summer, in fact—without having to issue any calls for consumer conservation. This stands in sharp contrast to 2023, when the system issued 12 calls for conservation from June through September.

Clearly, renewables and storage are having a positive influence, a fact that was acknowledged by Pablo Vegas, ERCOT's CEO, at a board meeting on Aug. 24, just after the new peak record was set.

"We've had a very different experience operating the ERCOT grid this summer," Vegas said. "Over the last year, we've seen significant additions of energy storage resources, solar resources and wind resources, with a few additions also on the thermal side, the gas side. All of that has helped to contribute to ... less scarcity conditions during the peak periods of summer, like we experienced last year."

California

The transformation in California has been equally pronounced, and again points to the reliability enhancing combination of solar and storage. This analysis focuses on the region served by the California Independent System Operator (CAISO), which manages roughly 80% of the state's daily demand, but the lessons are similar across the state.

Demand in CAISO's territory during an early July heatwave peaked at 43,969 MW at 7 p.m. on July 11. In the past, that could have been a problem, since solar generation is rapidly declining that late in the day. In fact, on that day solar had dropped from 11,040 MW at 6 p.m. to 4,370 MW at 7 p.m., according to data from GridStatus.io. But by that point, battery storage injections had ramped up to 4,210 MW and would remain above 4,000 MW until 9:30 p.m., enabling system operators to throttle back on gas generation across the state.

Significant new clean energy generating capacity, a rapid increase in battery storage resources and better cooperation across the Western Interconnection all helped CAISO and other state power suppliers meet the demands of the two-week-long July heatwave, according to Dede Subakti, CAISO's vice president of system operations. "[This] has been a success story for the state's power system," he wrote.

The CAISO system performed similarly well in late July, hitting another summer peak of 45,426 MW on July 24. A few weeks later, on September 5, when temperatures climbed into the 100s, an even higher peak of 47,753 MW was set. On both days, solar and battery storage recorded strong performance numbers.

The symbiotic relationship between solar and storage is clearly evident drilling down into the daily generation numbers.

On Sept. 5, solar output in CAISO climbed above 40% of total demand at 8:15 a.m. and remained there until 2:45 p.m., with generation averaging more than 17,000 MW during that period. In turn, that solar generation, particularly the early morning output before demand rose later in the day, allowed the system's 9,309 MW of battery capacity to charge up. By 8:00

a.m., battery charging (effectively the same as system load) had risen above 3,000 MW and it remained there for almost four hours. This stored power was returned to the system that evening, with batteries injecting an average of more than 5,100 MW into the grid for 3.5 hours beginning at 6 p.m. During that period, batteries frequently supplied more than 10% of CAISO demand and were often the second-largest system resource during that period.

The details matter, but the transition can also be explained relatively simply, as PG&E CEO Patti Poppe did in a recent interview: "We can leverage that stored energy and dispatch it when we need it."

As in Texas, the amount of solar and battery storage capacity has risen sharply in the past couple years and is set to continue climbing in the future. CAISO's monthly key statistics report shows that the system's utility-scale solar capacity has risen 37% in two years, from 15,608 MW to 21,411 MW. Battery storage capacity has increased even faster, more than doubling from 3,913 MW in August 2022 to the current 9,309 MW. And many more megawatts of both resources are in the system's generation queue. In the next two years, CAISO anticipates 4,378 MW of new solar and 9,189 MW of battery storage will begin commercial operation.

Those new resources clearly played a role in the September event. As in Texas, CAISO system operators were able to meet the peak 2024 demand without having to issue any system alerts or conservation warnings like they were forced to do in 2020 and 2022. It is also likely that the additional battery storage capacity played a key role in keeping real time prices in check in 2024, when they never topped $100/MWh, compared to 2022 when they soared to almost $2,000/MWh on two occasions (pricing information is courtesy of GridStatus.io).

Given the experience this summer, the capacity expected over the next two years will further boost CAISO reliability, help meet new demand and continue pushing gas generation off the grid.

Other Evidence

Texas and California are clearly setting the pace in the energy transition, but evidence of the shift is increasingly evident elsewhere.

Renewable growth has been slow in PJM, the nation's largest organized power market serving 13 states and the District of Columbia in the eastern U.S. But even here, solar capacity is climbing quickly. On July 1, the system's solar generation hit a record 7,952 MW, a 52% increase from just a year ago and pushing solar to 7.5% of system demand. With the backlog of largely renewable projects in the PJM queue, significant additional solar growth is likely in the years ahead.

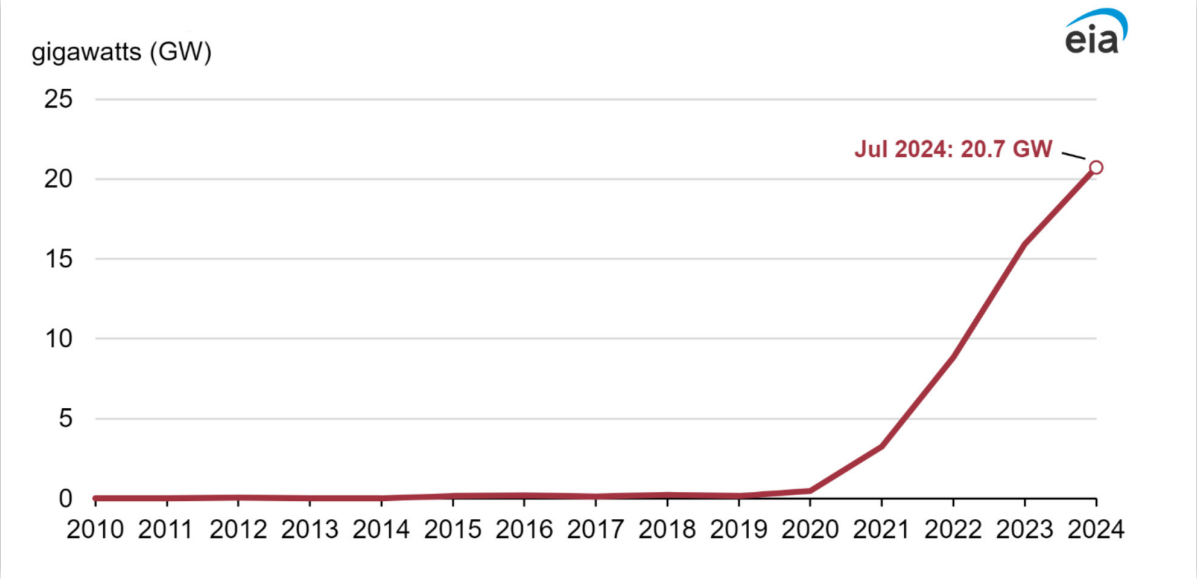
Turning to individual companies, Florida Power and Light, the nation's largest utility with 5.9 million customer accounts, shows that quick growth is possible, even in a market where overall demand is increasing. In the first eight months of 2022, the utility generated 5.5% of its demand from solar; in the comparable period this year, that percentage jumped to 8.8% even as overall demand in the utility's service territory also grew. Solar has not yet stopped gas generation growth at the Florida utility, but that is likely to happen soon if the company follows through on its aggressive solar growth plans. It projects that by 2033, 38% of its generation

will be solar, pushing gas's share down from the current 73% to 42%. To ensure the reliability and dispatchability of that solar capacity, the company also plans to build 4,000 MW of battery storage capacity in the next 10 years.

Conclusion

The speed of the ongoing transition is often hard to comprehend; the battery storage graphic below illustrates that perfectly. Four years ago there was essentially zero battery storage capacity installed across the U.S., but now there are more than 20,000 MW and that figure increases monthly: That is impressive growth.

Figure 3: Cumulative U.S. Utility-Scale Battery Power Capacity (2010–July 2024)



The speed of that growth, and solar's as well, has changed how grid operators run the power systems across the U.S. But that does not mean those systems are less reliable. Indeed, the experiences from the summer of 2024 demonstrate clearly that renewable energy and storage can reliably run power systems transitioning away from fossil fuels.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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