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Last week, the city of Los Angeles inked a deal for a solar-plus-storage system at a record-low price. The 400-MW Eland solar power project will be capable of storing 1,200 megawatt-hours of energy in lithium-ion batteries to meet demand at night. The project is a part of the city's climate commitment to reach 100 percent renewable energy by 2045.

Electricity and heat production are the largest sources of greenhouse gas emissions in the world. Carbon-free electricity will be critical for keeping the average global temperature rise to within the United Nations" target of 1.5 degrees Celsius and avoid the worst effects of climate change. As world leaders meet at the United Nations Climate Action Summit next week, boosting renewable energy and energy storage will be major priorities.

Wind and solar skeptics are quick to point out that such systems are expensive and can"t keep the lights on 24/7. The first argument is wilting as renewables become cost-competitive with fossil fuels. The second one also boils down to cost: that of energy storage, which will be essential for sending large amounts of renewable energy to the grid when needed.

"Low-cost storage is the key to enabling renewable electricity to compete with fossil fuel generated electricity on a cost basis," says Yet-Ming Chiang, a materials science and engineering professor at MIT.

But exactly how low? Chiang, professor of energy studies Jessika Trancik, and others have determined that energy storage would have to cost roughly US $20 per kilowatt-hour (kWh) for the grid to be 100 percent powered by a wind-solar mix. Their analysis is published in Joule.

That"s an intimidating stretch for lithium-ion batteries, which dipped to $175/kWh in 2018. But things look up if you loosen the constraints on renewable energy, the researchers say. Then, storage technologies that meet the cost target are within reach.

Energy storage would have to cost $10 to $20/kWh for a wind-solar mix with storage to be competitive with a nuclear power plant providing baseload electricity. And competing with a natural gas peaker plant would require energy storage costs to fall to $5/kWh.

But those figures are only for scenarios in which solar and wind meet power demand 100 percent of the time. If other sources meet demand just 5 percent of the time, storage could work at a price tag of $150/kWh. Which technologies could hit that target?

Lithium-ion batteries are within reach of the $150/kWh target, and their share in the utility-scale energy storage is growing. Yet they face materials scarcity challenges exacerbated by a rising electric car market. But, says Chiang, the technology is "unlikely to meet the cost requirements for long-duration storage, so for deep decarbonization, there is a critical need to develop low-cost, long duration storage technologies."

Pumped hydro and compressed air, which use extra power to pump water uphill or to pressurize air, both of which can be used to turn a turbine and generate electricity when needed, already have a low energy cost of $20/kWh, the researchers say. But these systems need a large amount of space and special geological features such as mountains or underground caverns, so cannot be used everywhere.

Another viable technology is flow batteries that would use abundant, low-cost chemicals to store energy in large tanks. But not all flow battery chemistries are inexpensive. One of the main types, vanadium redox flow batteries, have an estimated cost of $100/kWh, the researchers say, but more development could bring down costs.

Chiang is betting on sulfur batteries. He has recently developed an aqueous sulfur flow battery that could cost as little as $10/kWh. The technology has what it takes for long-duration, low-cost storage, and is now being developed by Form Energy, a company he co-founded in 2017 and that has recently gotten extensive financial backing.