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Halfway To Zero…

But a Long Ways To Go

Progress towards a Carbon-Free U.S. Power Sector

Ryan Wiser, Lawrence Berkeley National Laboratory

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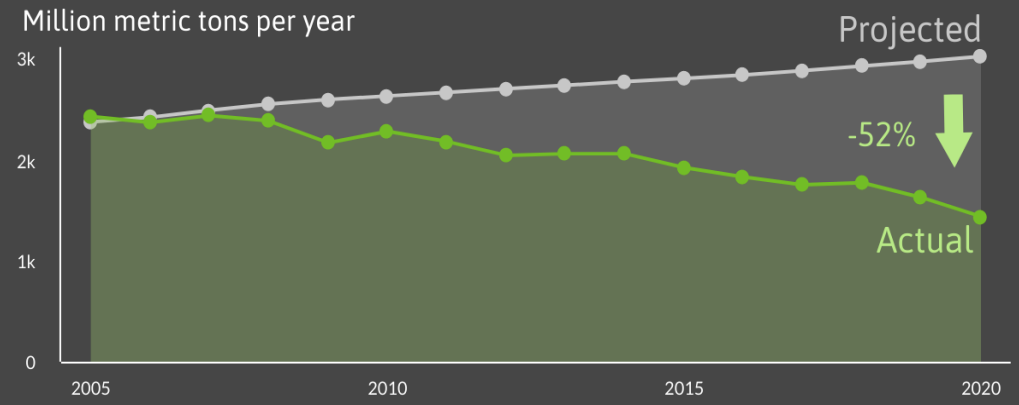
Halfway to Zero: Progress Towards a Carbon-Free Power Sector

Power-Sector Carbon Dioxide Emissions



Power-sector carbon dioxide emissions in 2020 were 52% lower than projected by the U.S. Energy Information Administration in 2005. Drivers included lower demand for electricity, growth in wind, solar and natural gas, and nuclear energy. Relative to the earlier projection, total electricity costs were lower, damages to public health and the climate were lower, and electricity-supply jobs were higher.

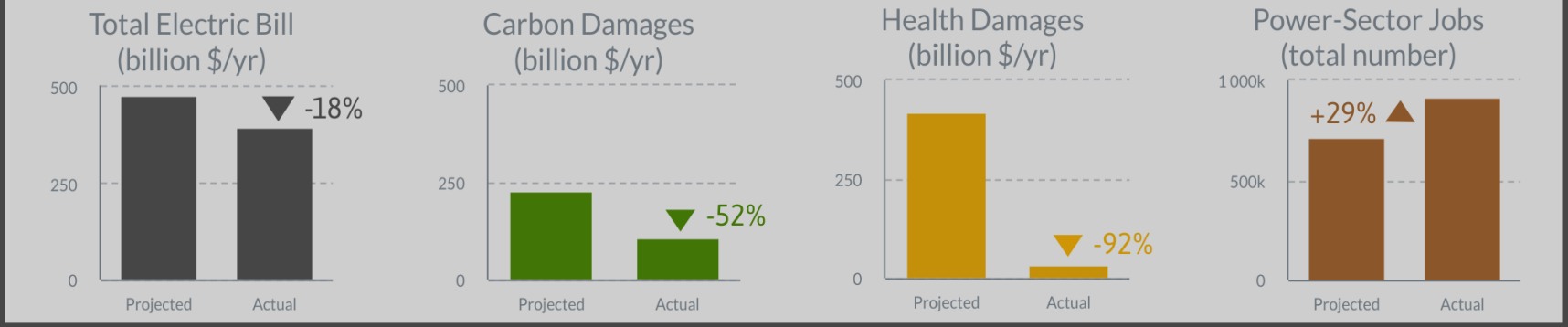
Demand
24% less than projected

Renewables
79% more than projected

Nuclear
20% of total generation

Natural Gas
112% more than 2005

Coal & Oil
70% less than projected

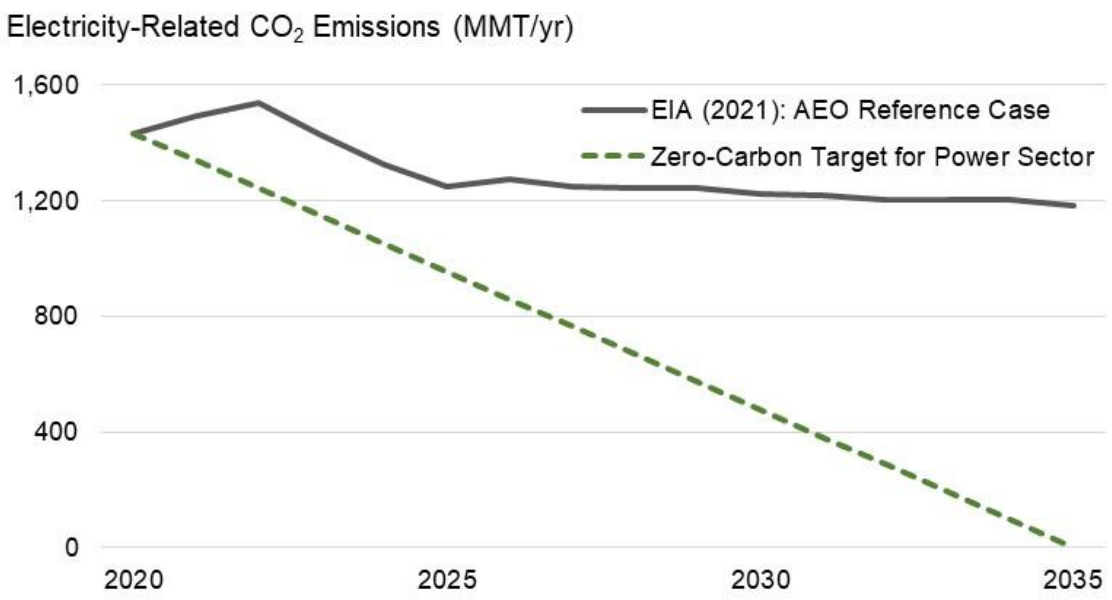


Note: Comparisons shown directly above are between EIA's AEO2005 projection for 2020 and actual 2020 outcomes.

Source: Lawrence Berkeley National Laboratory: https://emp.lbl.gov/

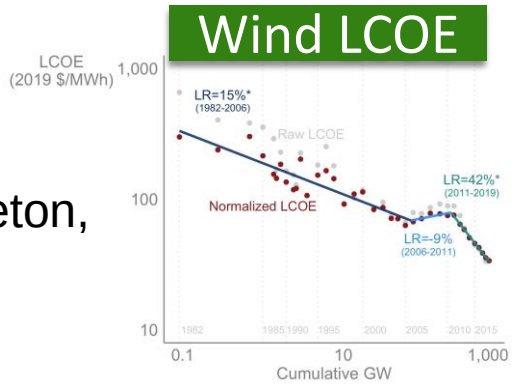
The Second Half Requires Beating Expectations, Again…

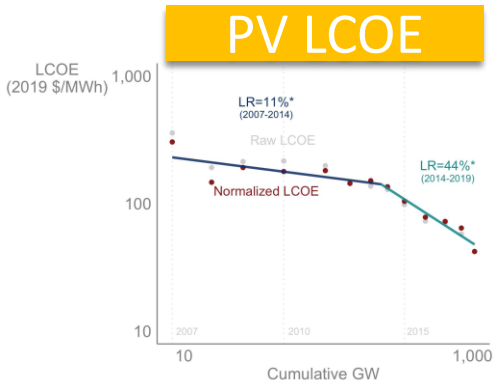
- Not the same roadmap as the first half
- Will require technology advancement and thoughtful policy
- Humility as a useful trait: human's have a poor record of predictions

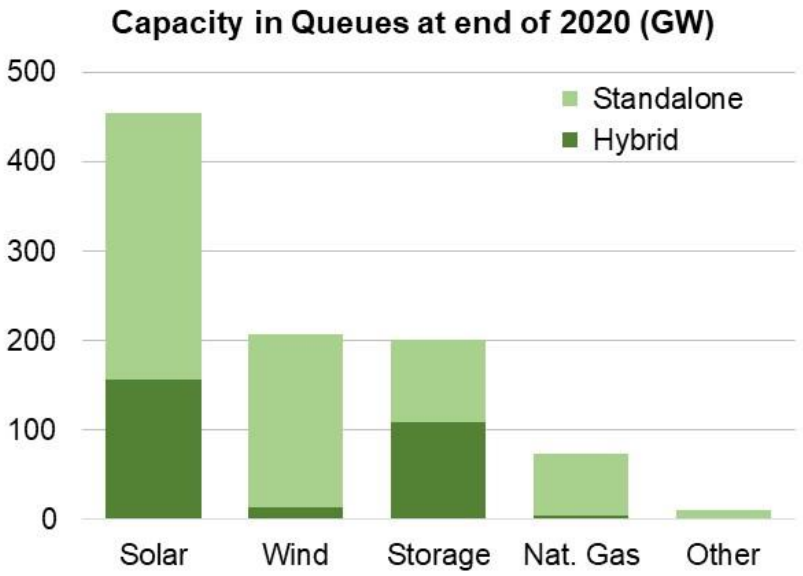


What We Think We Know about Power Sector Decarbonization?

- Go big on solar, wind, and batteries in the near team
  - National Academies, AGU, Princeton, UC Berkeley, more
- In concert with efficiency and existing low-carbon resources (hydropower, nuclear), can get to 70-90% zero-carbon shares at relatively low additional costs
- More than half of the wind, solar, and batteries needed for deep power-sector decarbonization already in the queue







- Growing agreement: electrify as much as reasonably possible

It's Not Easy Being Green

Dramatic scaling solar, wind, and batteries is not trivial

- Extensive efforts to ensure power-system stability, reliability, resilience
- Significant new transmission infrastructure, interconnection reform
- Wholesale market re-design, integrated planning and operations, standards
- Careful management of siting, permitting, human use, and ecological conflicts
- Focused attention on workforce and supply chain issues
- Heightened responsiveness to impacted communities

Aggressive energy efficiency can address some of these challenges

Technology & commercial advancement needed to fill final 10-30% gap

- Longer duration storage
- Hydrogen or synthetic fuels; biofuels
- CCUS, nuclear, geothermal
- Maximizing inter-sectoral synergies

Be ready to adapt as gain policy experience and as technologies advance
Recognize that globally not all are as well-endowed with wind and solar

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