Renewables and Energy Storage

EPRI's 21st Energy and Climate Research Seminar
May 17, 2018 | Washington, D.C.

Cara Marcy
Renewable Electricity Analyst

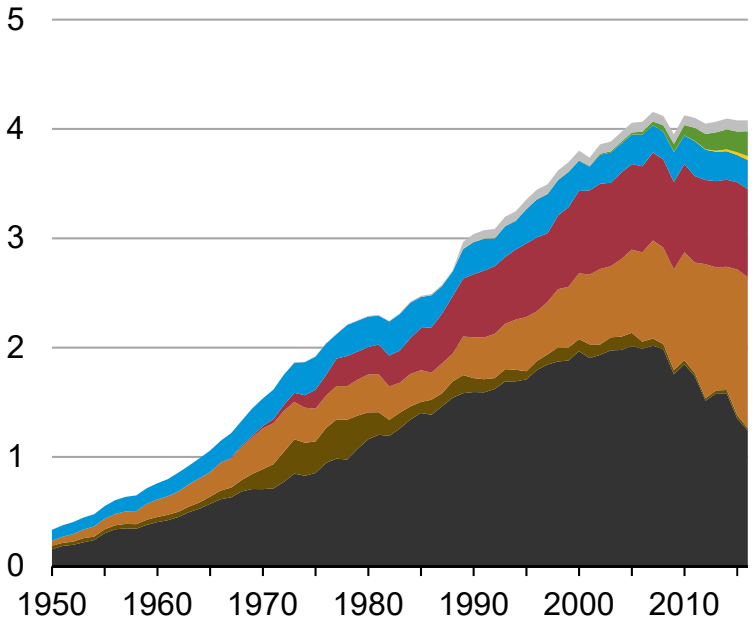
Wind, solar, and battery storage will continue to grow

- Electricity system and markets were not originally designed with non-dispatchable generators (i.e. wind and solar) and batteries in mind
  - The operation of these technologies is inherently different than conventional generators
- The future of the electric power sector will continue to see the deployment of wind, solar, and battery storage
  - The amount of growth is subject to some uncertainty
- Although battery storage is built for both capacity needs and energy needs, energy needs are the primary indicator for longer duration battery growth
  - For batteries to be competitive, they generally need both energy and capacity revenue

U.S. Electricity Generation and Capacity, 1950-2016

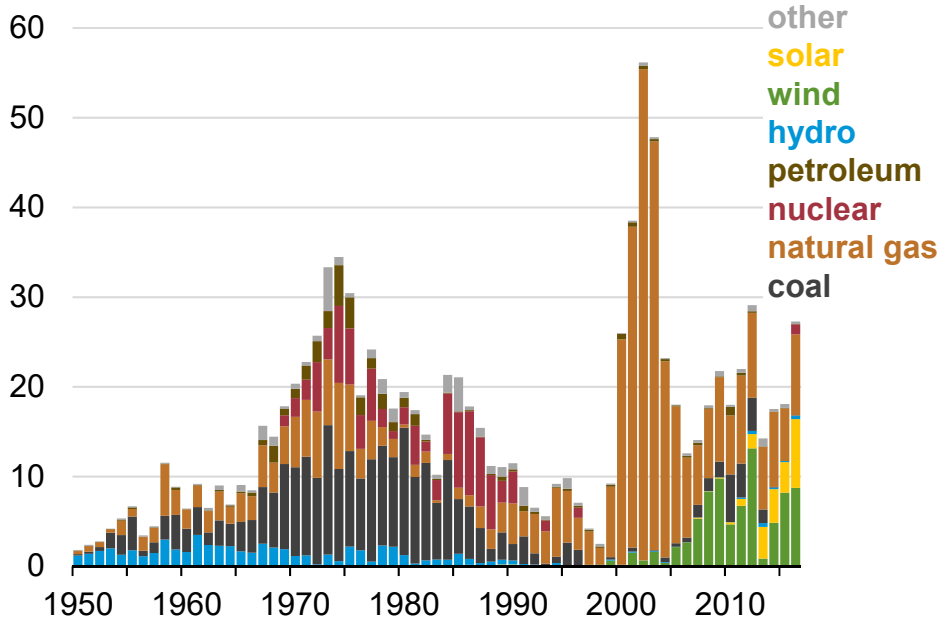
U.S. electricity generation, all sectors

trillion megawatthours



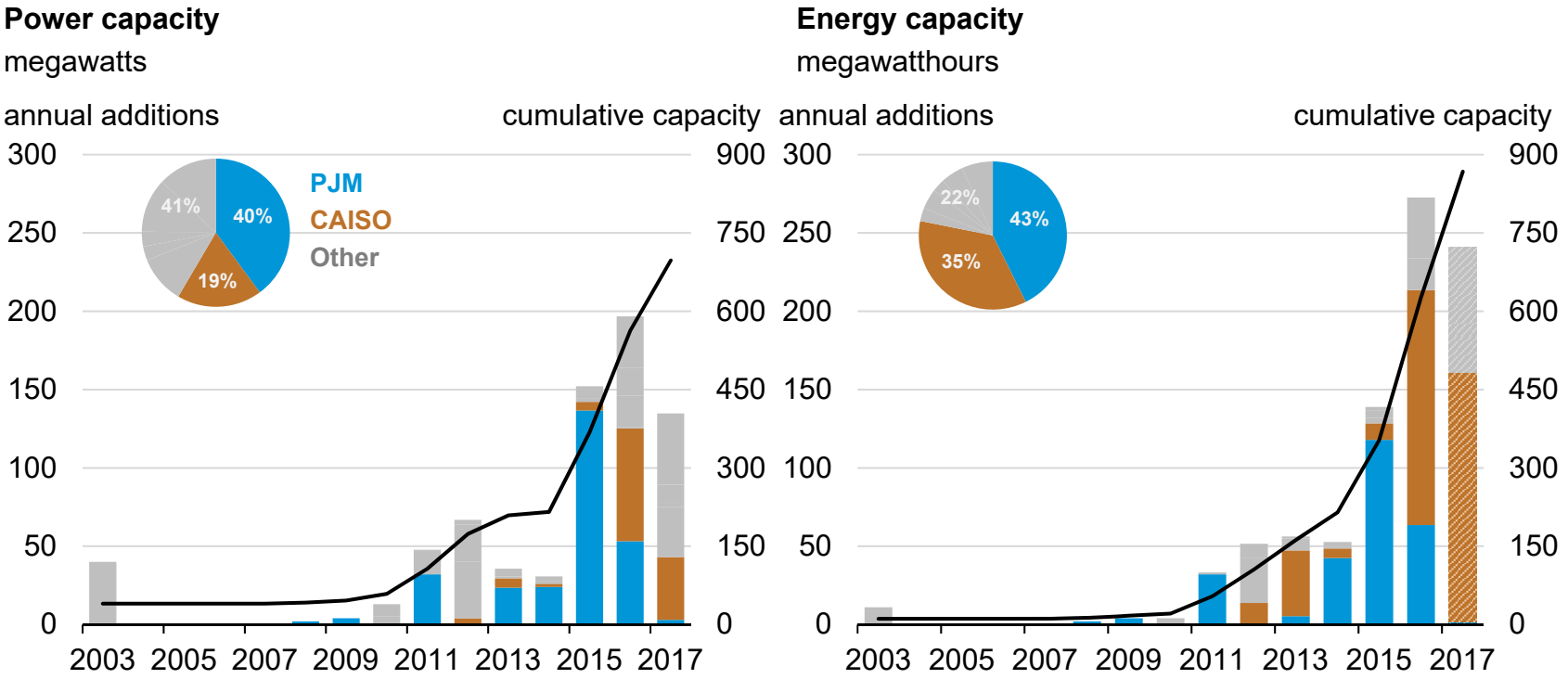
U.S. utility-scale electric generating capacity additions

thousand megawatts



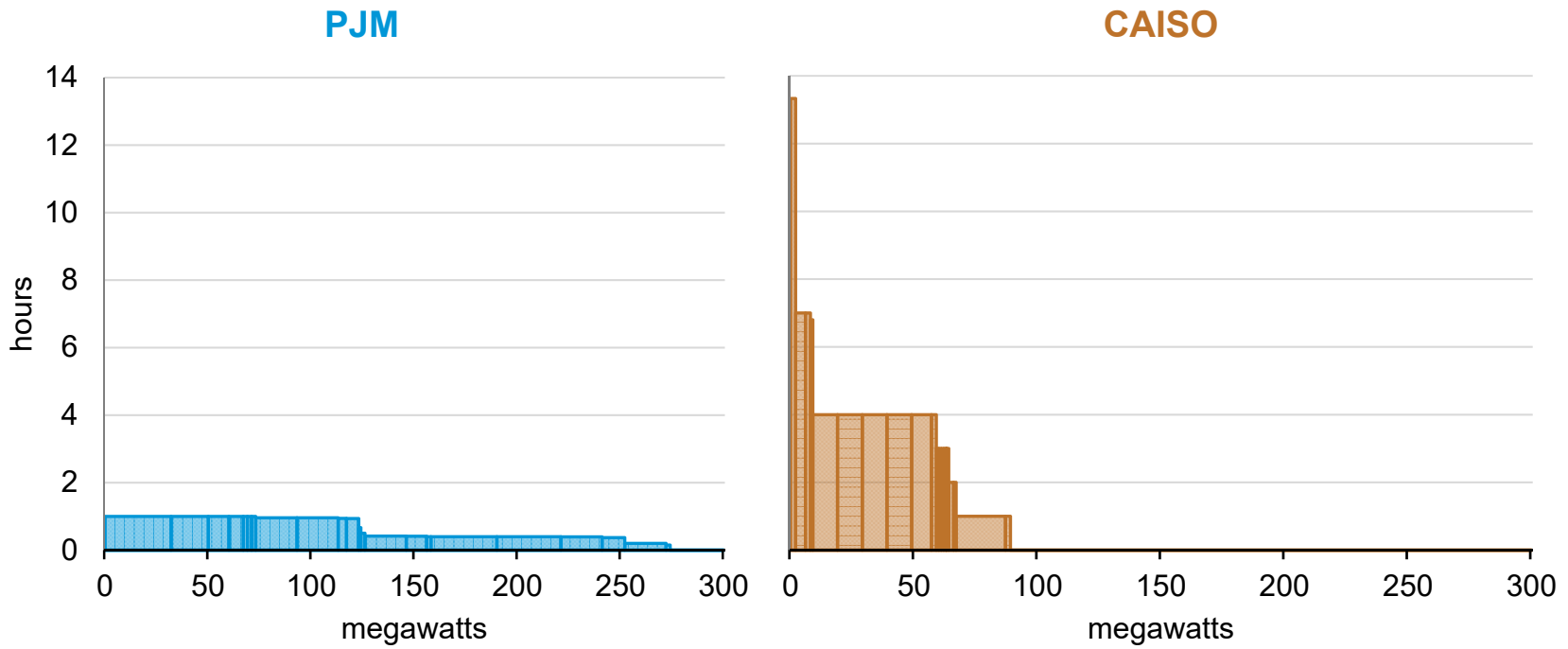
Source: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report

U.S. Large-Scale Battery Storage Capacity, 2003-2017



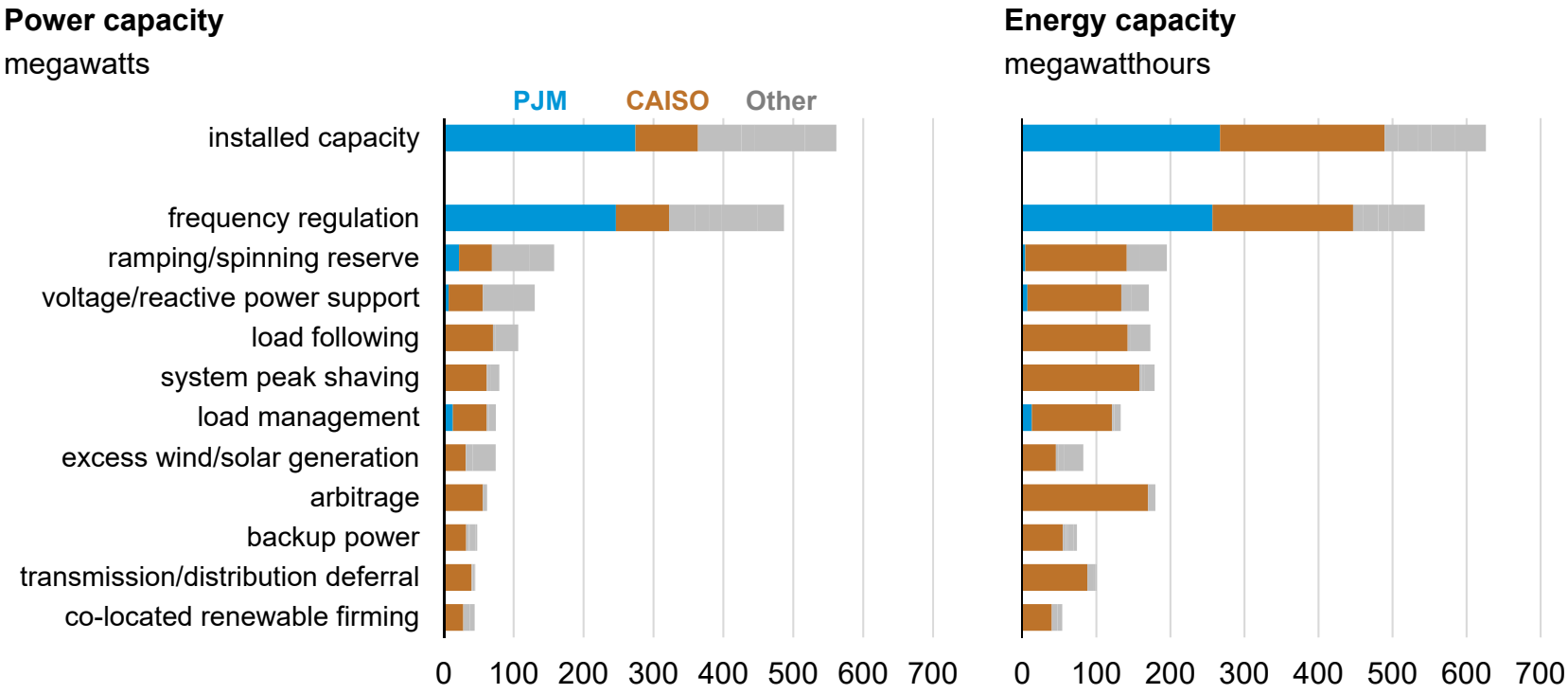
Sources: U.S. Energy Information Administration, Form EIA-860M, Preliminary Monthly Electric Generator Inventory; U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report

Capacity and Duration of U.S. Large-Scale Battery Storage, 2016



Source: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report

Applications Served by U.S. Large-Scale Battery Storage, 2016



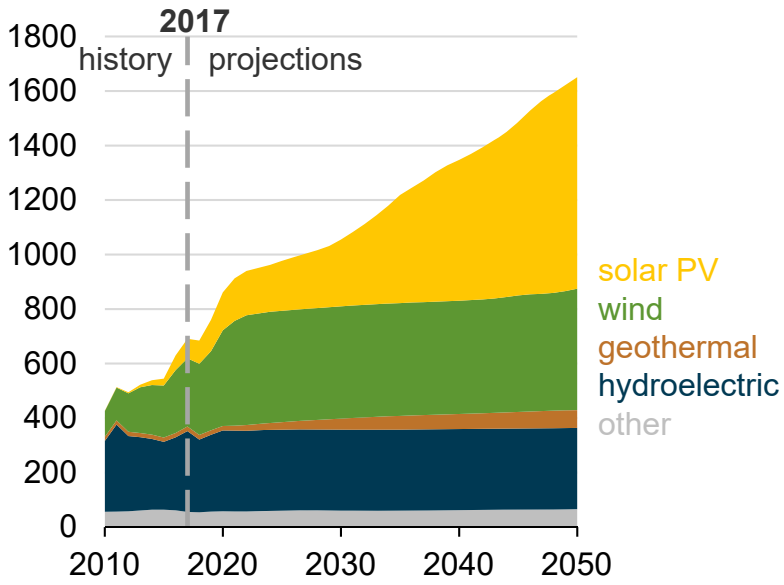
Source: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report

In the electricity sector, decisions to build different technologies are based on requirements determined by demand

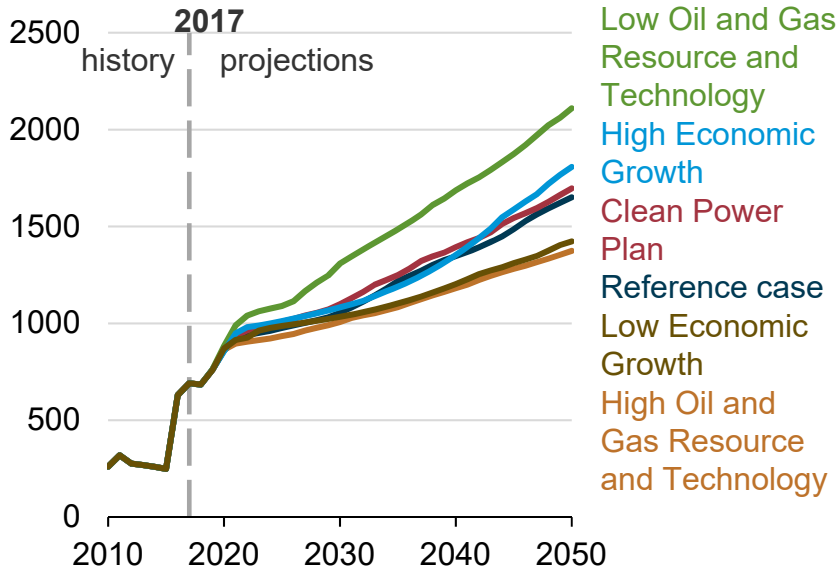
- **Capacity requirements**
  - Ensure that planning decisions which increase supply by adding new capacity are sufficient to satisfy regional reliability requirements.
- **Energy requirements**
  - Ensure that there is sufficient energy available in order to satisfy regional demand throughout the year.
- **Ancillary services (e.g. frequency regulation, spinning reserves, etc.)**
  - Services that maintain the reliable operation of the grid.
- **Externalities (e.g. policies like RPS, carbon regulation, etc.)**

The Annual Energy Outlook provides projections for future energy supply and demand through 2050

Renewable electricity generation, including end-use generation (Reference case)
billion kilowatthours

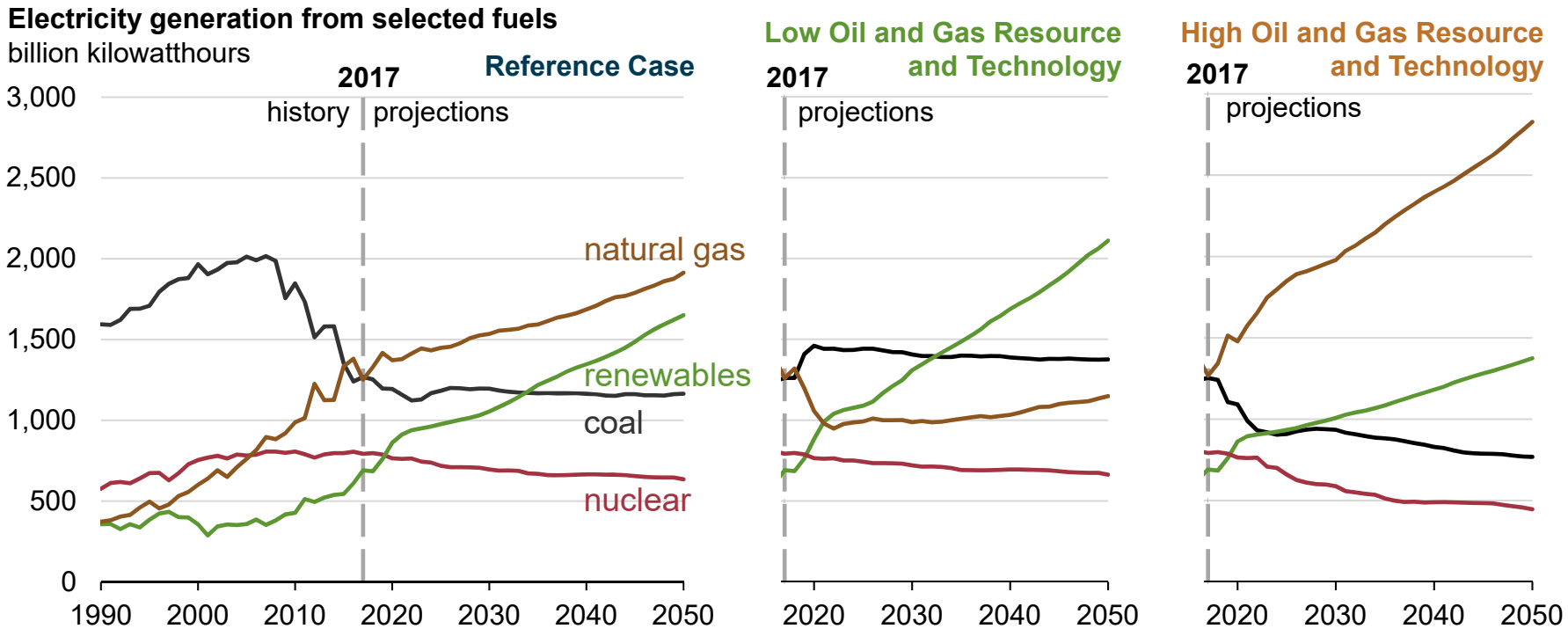


Total renewables generation, including end-use generation
billion kilowatthours



Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

U.S. Electricity generation, 1990-2050

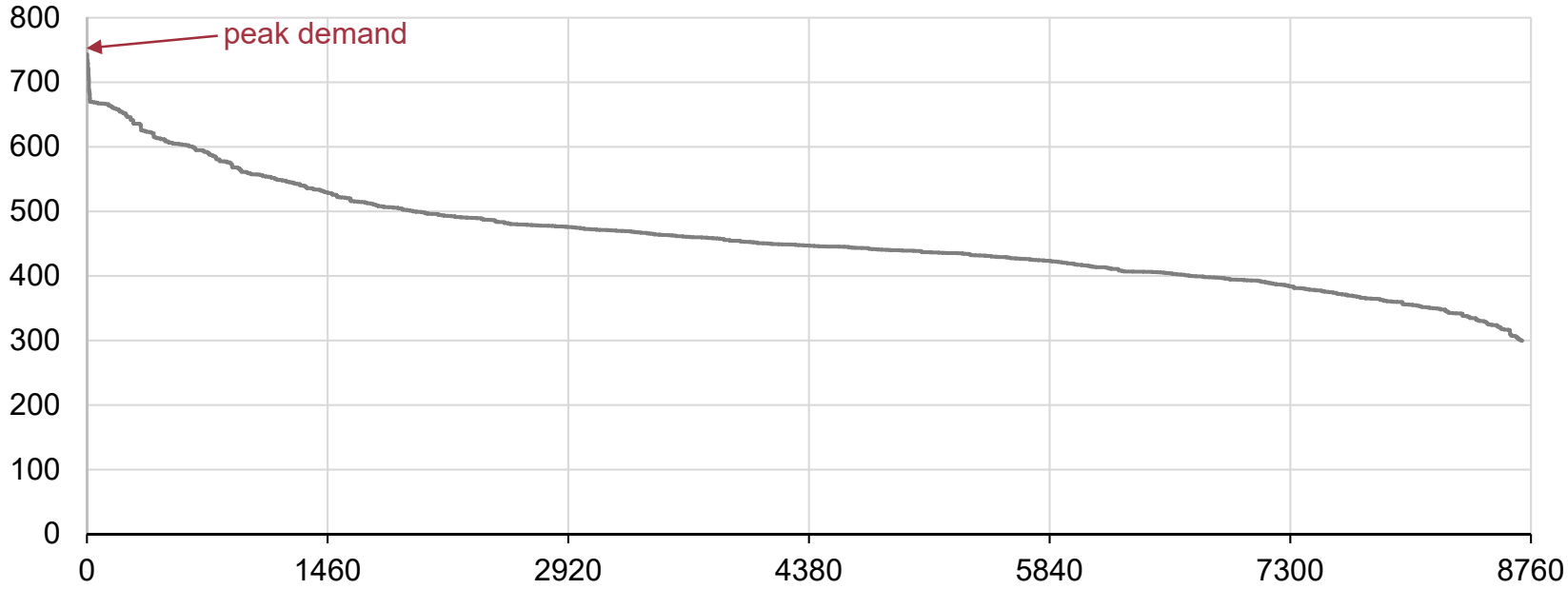


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Battery storage can also participate in capacity markets by contributing to reserve margin requirements

Example load duration curve

gigawatts

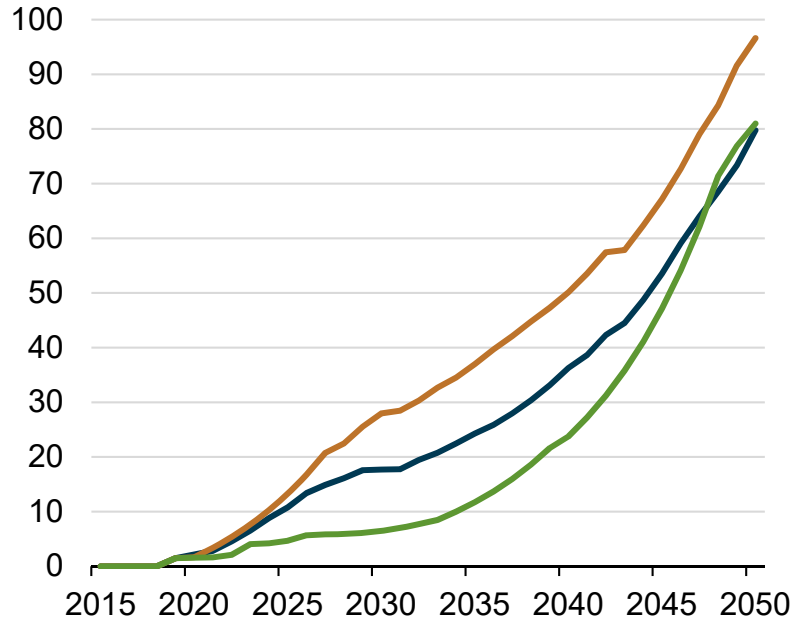


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Although combustion turbines are generally built to aid in meeting capacity requirements, battery storage can also be used

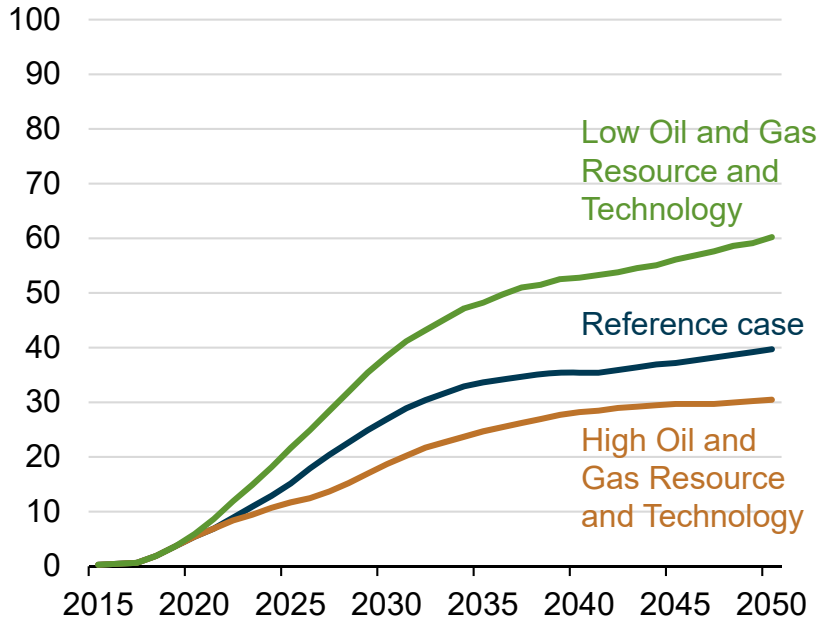
Advanced combustion turbine capacity

gigawatts



Battery capacity

gigawatts

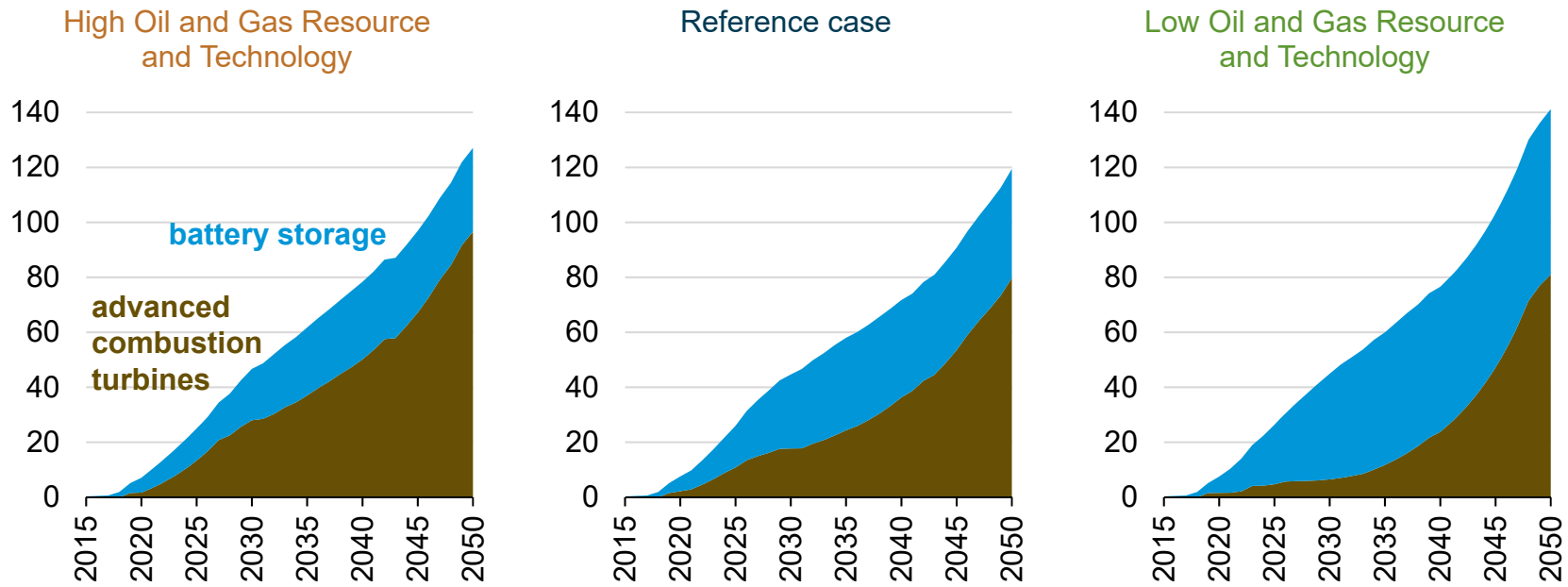


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

In fact, combustion turbine capacity and battery storage capacity compliment each other in each of the natural gas scenarios

Advanced combustion turbine and battery storage capacity

gigawatts

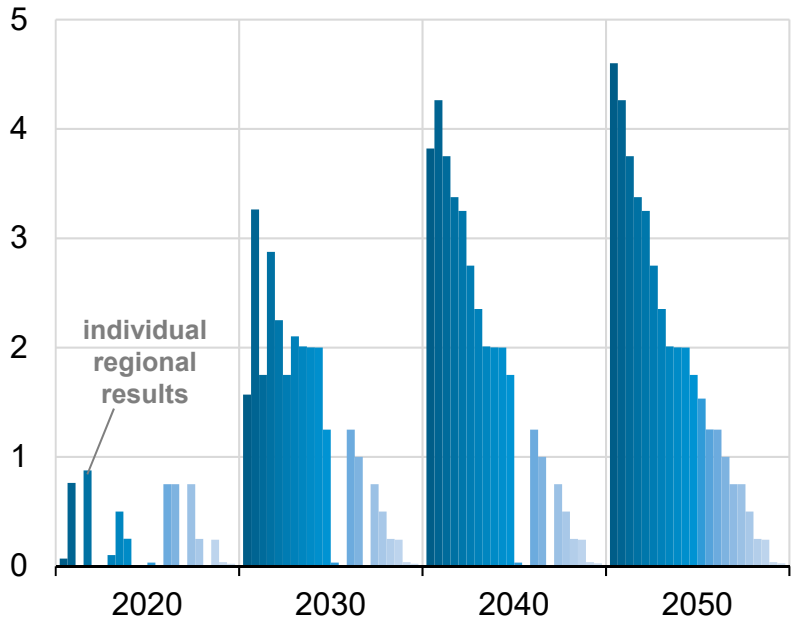


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Many of the regions where the reserve margin requirements are largest are also where the battery deployment is highest

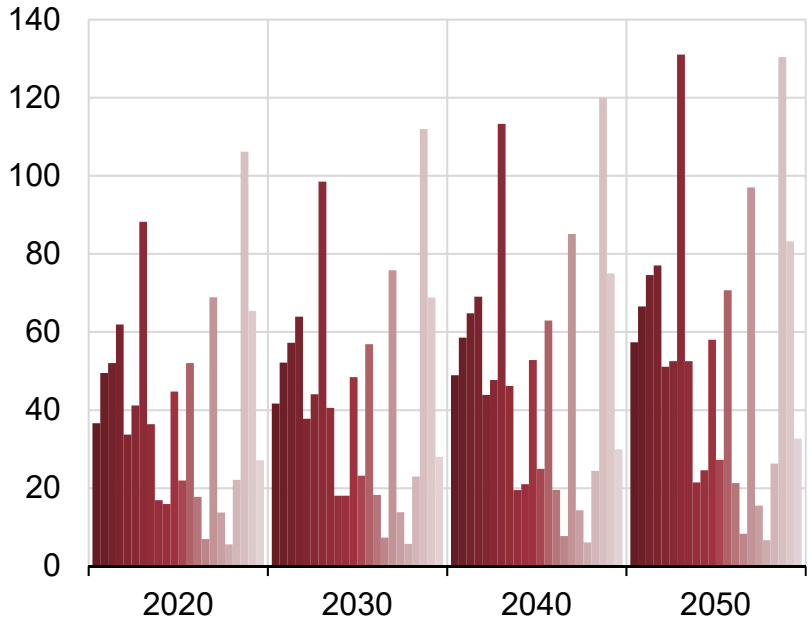
Battery capacity

gigawatts



Reserve margin requirement

gigawatts

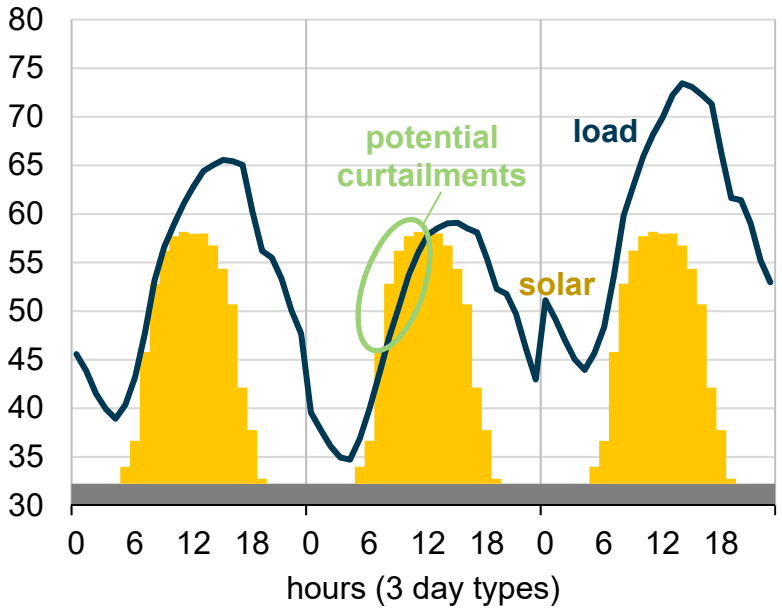


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

When solar and wind generation exceeds load, that energy is curtailed unless energy storage can shift it to when its needed

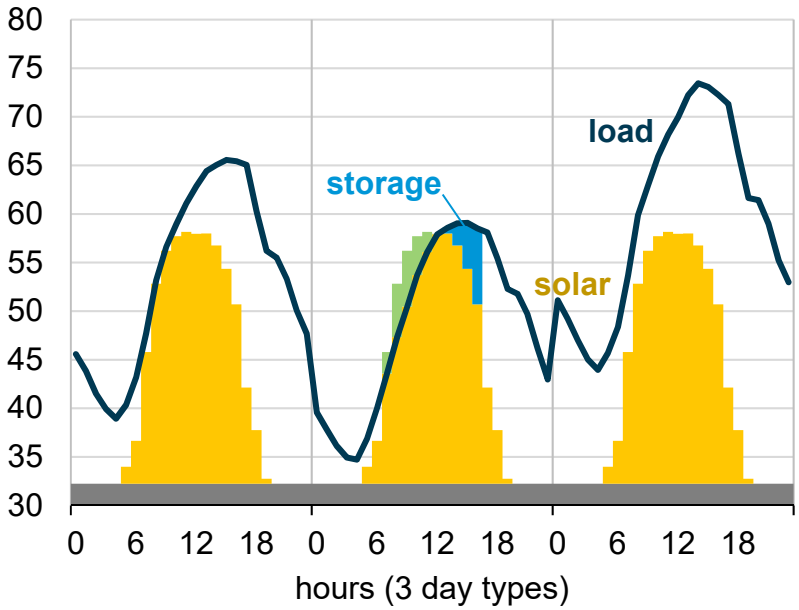
Demand and output from specific technologies

gigawatthours



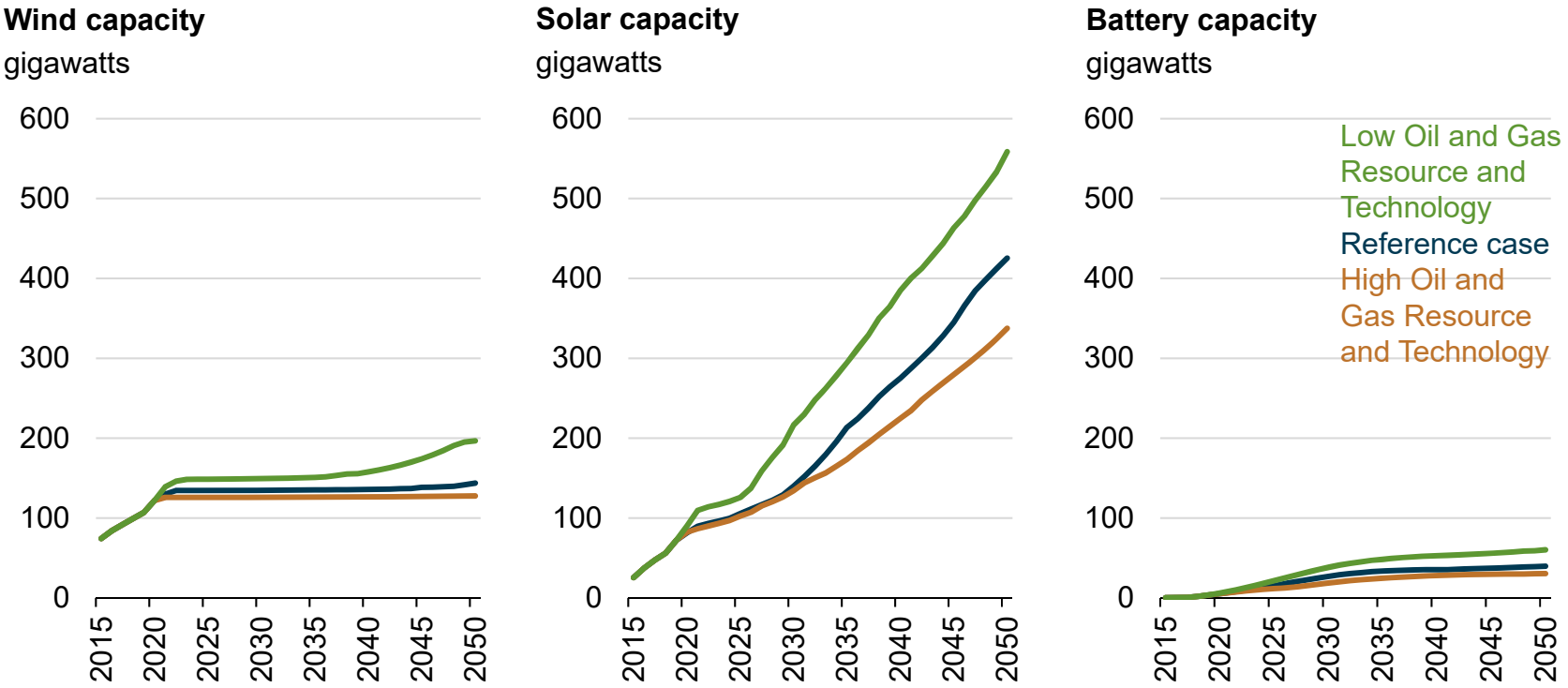
Demand and output from specific technologies

gigawatthours



Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

As wind and solar capacity increases, the need for battery storage capacity also increases

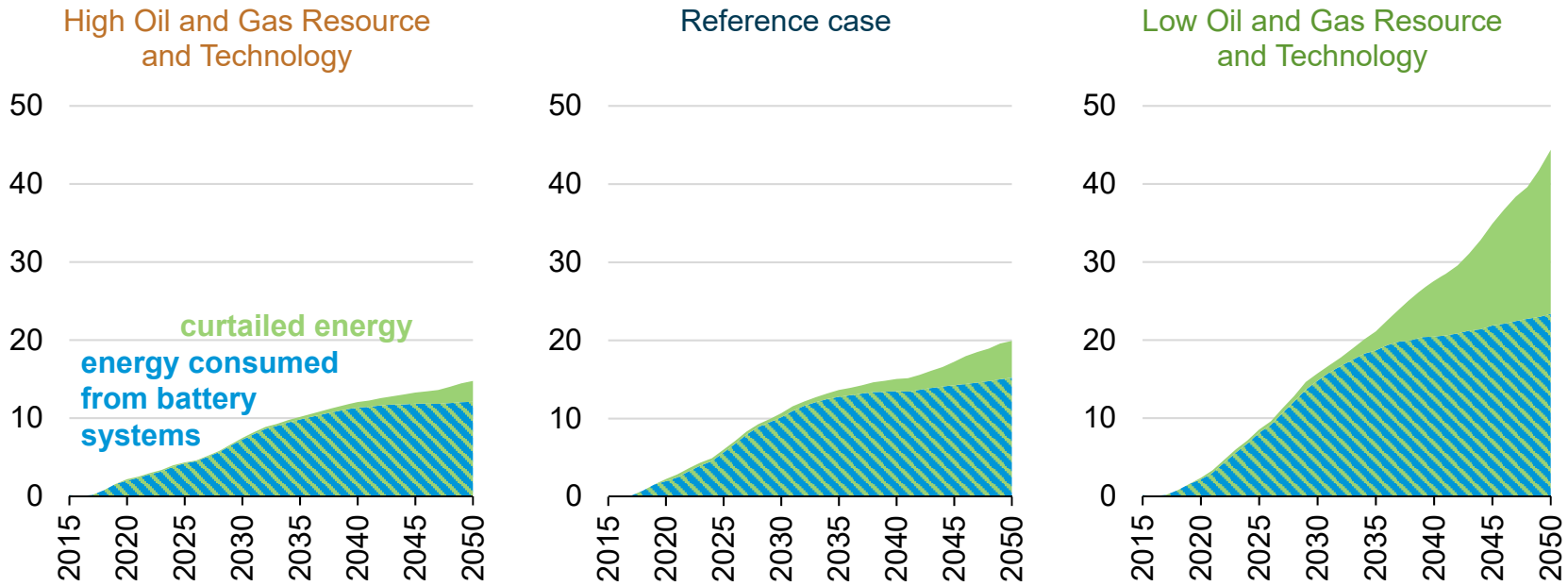


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Battery storage consumes the majority of the surplus wind and solar energy that would otherwise be curtailed

Surplus wind and solar energy

gigawatthours

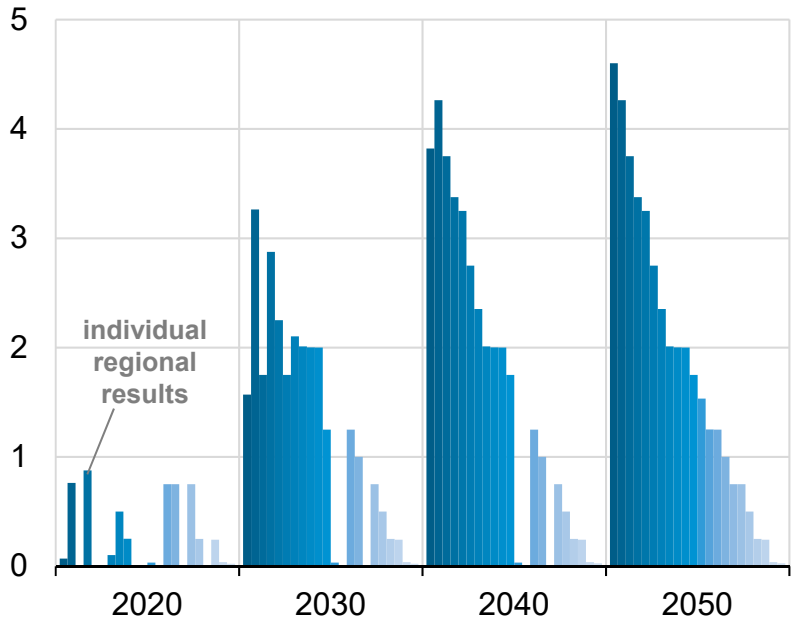


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Regional battery installations typically correlate with available surplus wind and solar generation

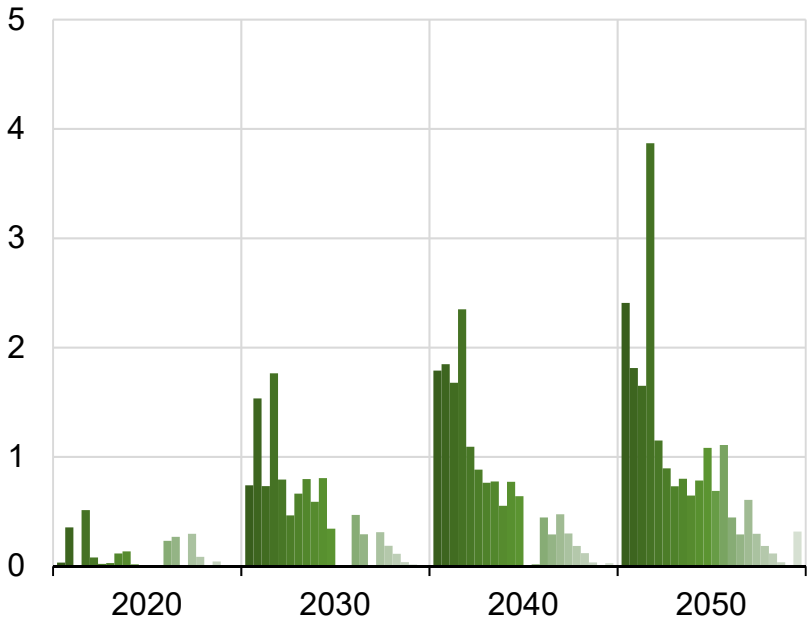
Battery capacity

gigawatts



Surplus wind and solar energy

gigawatthours

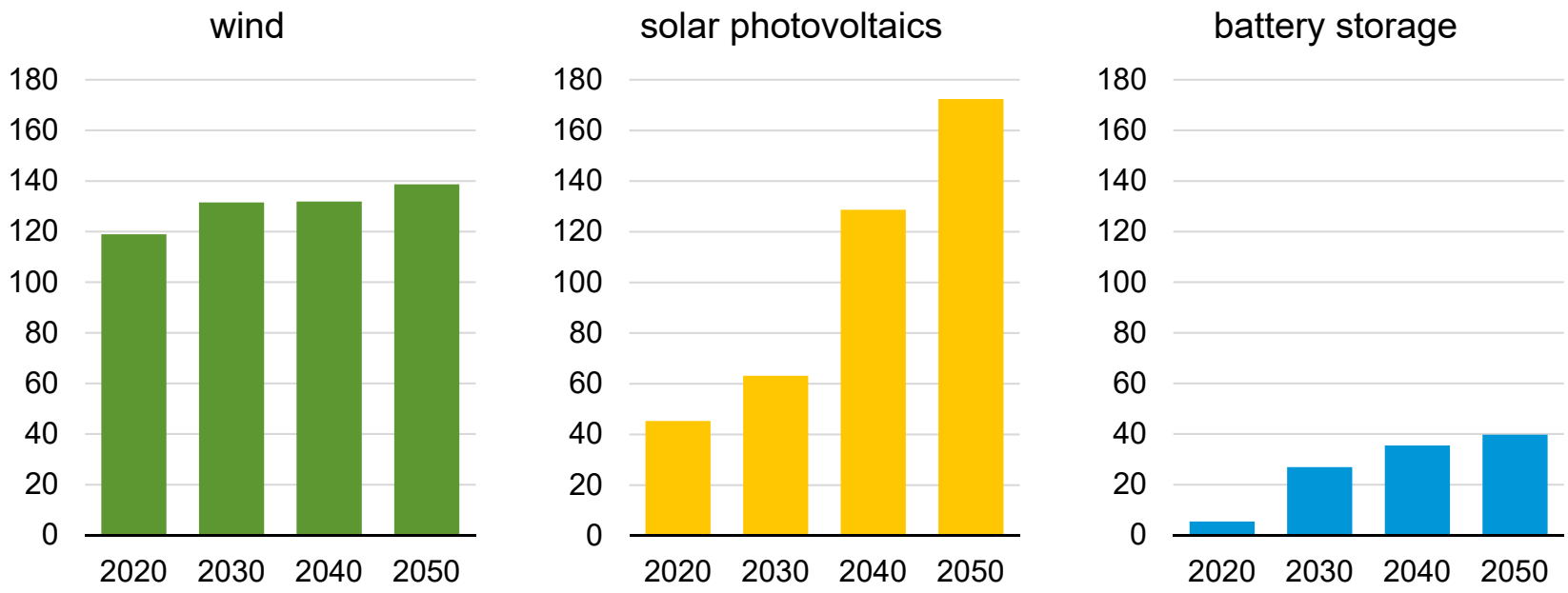


Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

U.S. Wind, Solar, and Battery Storage Capacity, 2020-2050

Utility-scale (power) capacity

gigawatts



Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

For more information

Cara Marcy
Renewable Electricity Analyst
cara.marcy@eia.gov
(202) 586-9224

U.S. Energy Information Administration home page | *www.eia.gov*

Annual Energy Outlook | *www.eia.gov/outlooks/aeo*

Assumptions Document | *http://www.eia.gov/forecasts/aeo/assumptions/*

Model Documentation | *http://www.eia.gov/outlooks/aeo/nems/documentation/*