EIA's Annual Energy Outlook 2021: Projections for Battery Storage in the United States

For

2021 EIA Energy Storage Workshop

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By

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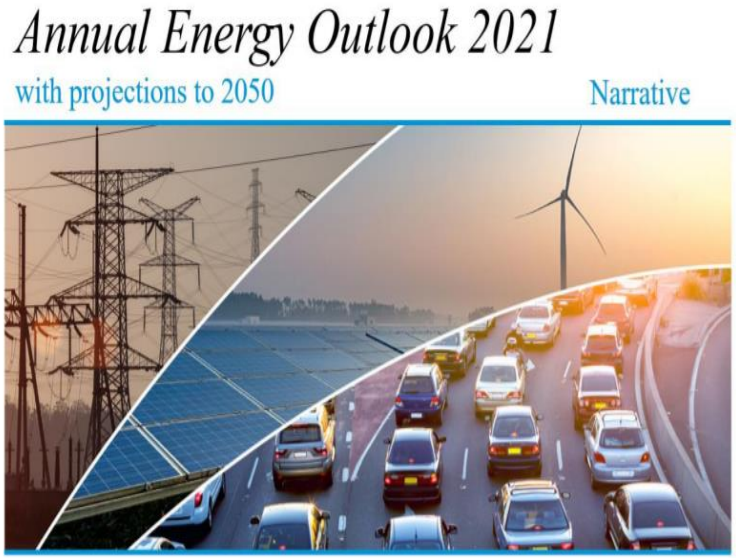
Overview

- Annual Energy Outlook (AEO) and NEMS Intro
- AEO2021 Battery Storage Costs and Assumptions
- AEO2021 Battery Storage Results
- Conclusions

Independent Statistics & Analysis
U.S. Energy Information Administration

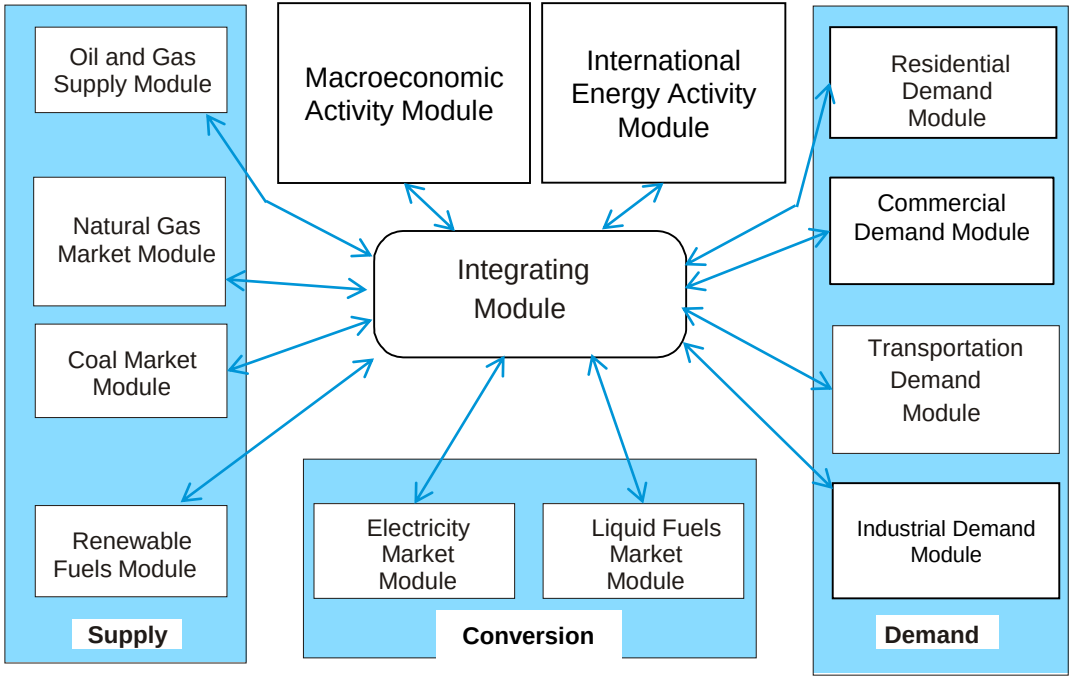
Annual Energy Outlook (AEO) Overview

- Produces annual projections to 2050:
  - Energy consumption by sector, fuel type, region
  - Production by fuel
  - Energy imports/exports
  - Energy prices
  - Technology trends
  - Carbon dioxide emissions; environmental policy indicators
  - Macroeconomic measures and energy market drivers
- National Energy Modeling System (NEMS): Regional energy-economy model of the United States



NEMS Modular Structure

- A key aspect of the NEMS is its coverage of all sectors of the energy economy.
- Where appropriate and significant information exists, each sector is represented by a detailed structural model of the market.

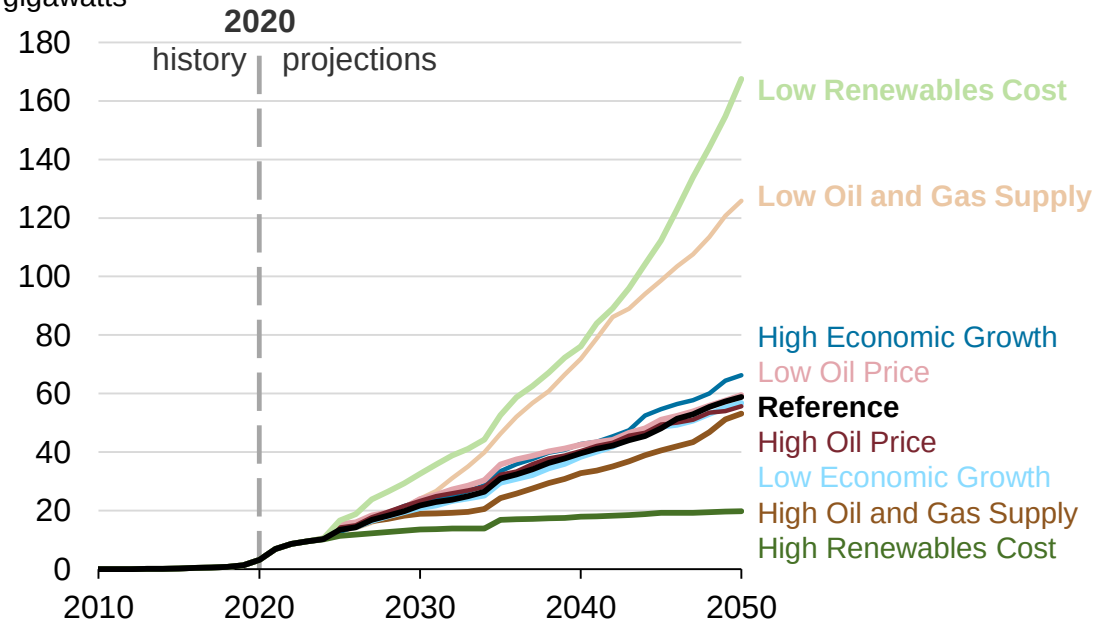


AEO 2021 Battery Storage Capacity by Case

9 standard annual cases:

- **Reference**
  - baseline w/ only current policy, not proposed
- **Low/High Renewables Cost**
  - low: 2050 renewables cost is 40% of Reference
  - high: no renewables cost decline in projection
  - battery storage included as “renewable”
- **Low/High Oil and Gas Supply**
  - Varying production costs and resource availability for oil and natural gas
- **Low/High Economic Growth**
  - GDP growth = 1.6 – 2.6%
- **Low/High Oil Price**
  - 2050 Oil price = $48/b – $173/b

U.S. battery storage power capacity
AEO2021 side cases



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

Primary assumptions for Battery Storage in AEO2021

- Two technology options
  - Standalone battery energy storage system
    - 4 hours to charge and discharge
    - Round trip efficiency (discharge / charge) = 0.85
  - PV plus battery hybrid
    - 150 MW PV installed for every 50 MW of 4 hour battery
    - Inverter limited to PV capacity (150 MW inverter for 150 MW PV + 50 MW battery)
    - Hybrid battery only charges from hybrid PV, not from power grid
- Two applications
  - **Arbitrage**: shift energy from high supply/low demand hours to low supply/high demand hours
  - **Reserve Margin**: provide capacity to meet regional reserve requirements

Primary assumptions for Battery Storage in AEO2021

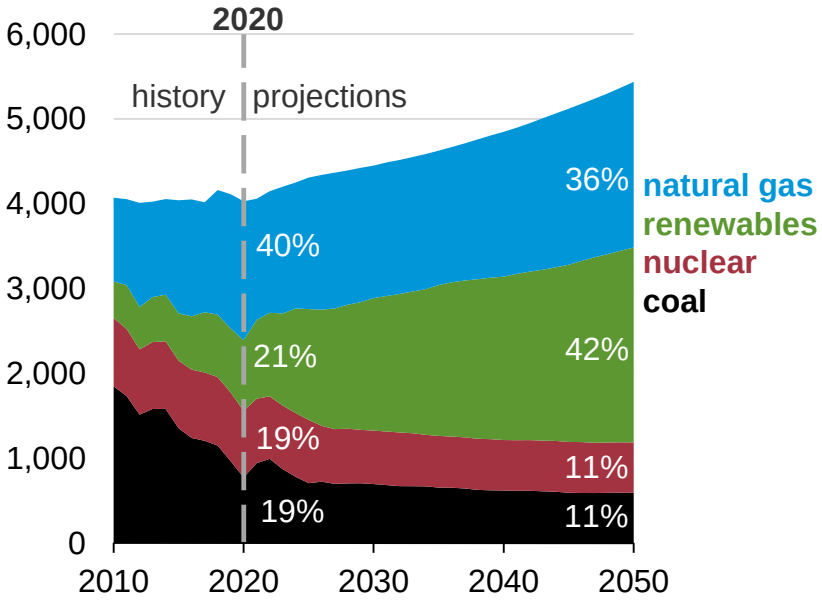
	$/kW	$/kWh	Power Capacity (MW)	Duration (Hours)
AEO 2021 (Sargent & Lundy 2019)				
50 MW x 4 hour	1391	348	50	4
PV-Hybrid (PV 150 MW, Battery 50 MW)	1783	-	150*	4
2019 Form EIA-860				
>2 hour (n=45)	2575	575	4.7	4.6

** The inverter capacity for the PV plus Battery hybrid technology in NEMS is set to the PV capacity*

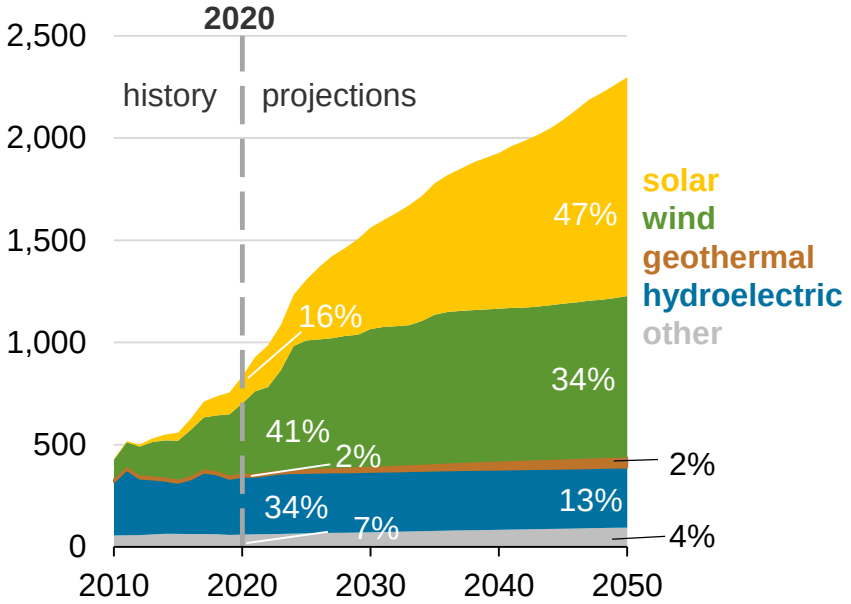
Source: *U.S. Energy Information Administration, Annual Energy Outlook 2021*
U.S. Energy Information Administration, 2019 Form EIA-860

U.S. electricity generation and share from selected fuels and renewable sources

U.S. electricity generation from selected fuels
AEO2021 Reference case
billion kilowatthours



U.S. renewable electricity generation, including end use
AEO2021 Reference case
billion kilowatthours

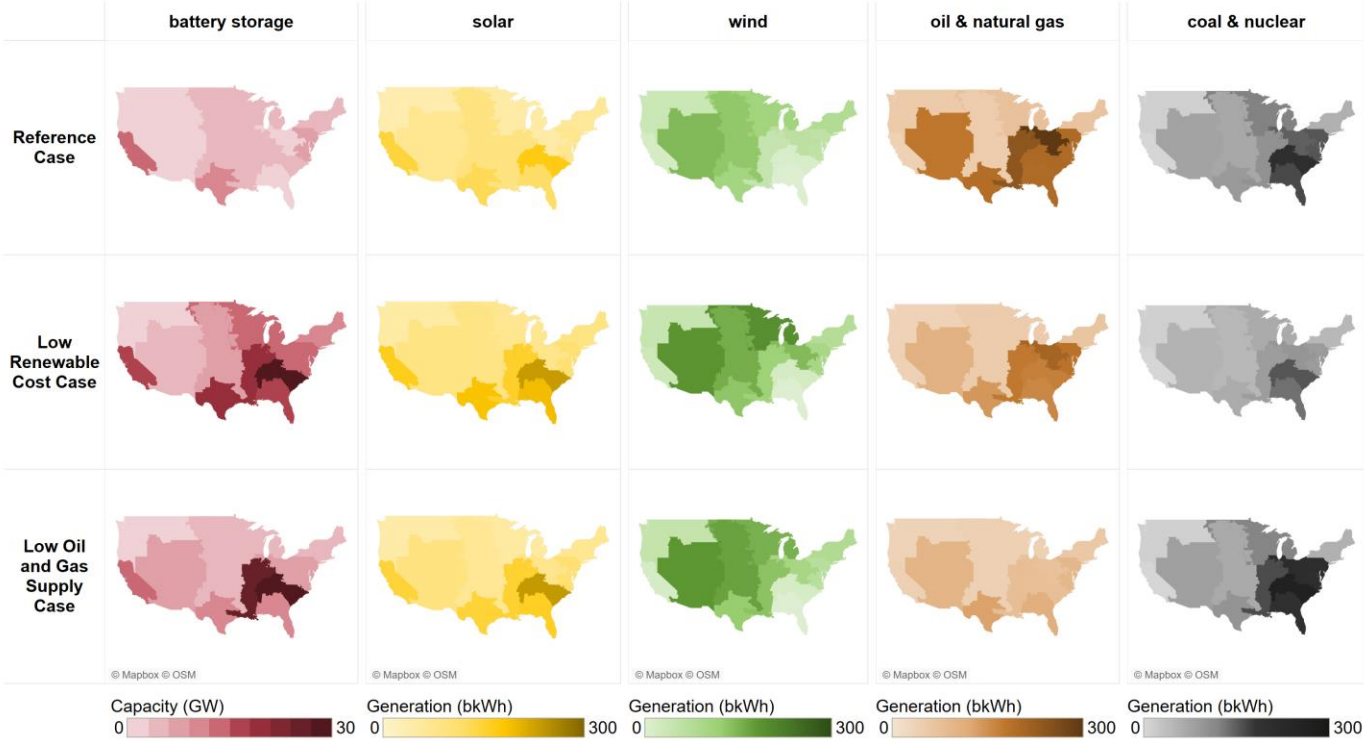


Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

Battery storage deployment depends on regional characteristics

- Strong correlation with PV builds
- Outside of Texas and California, strong growth in Southeast MISO and SERC regions
- West region has strong wind and natural gas growth

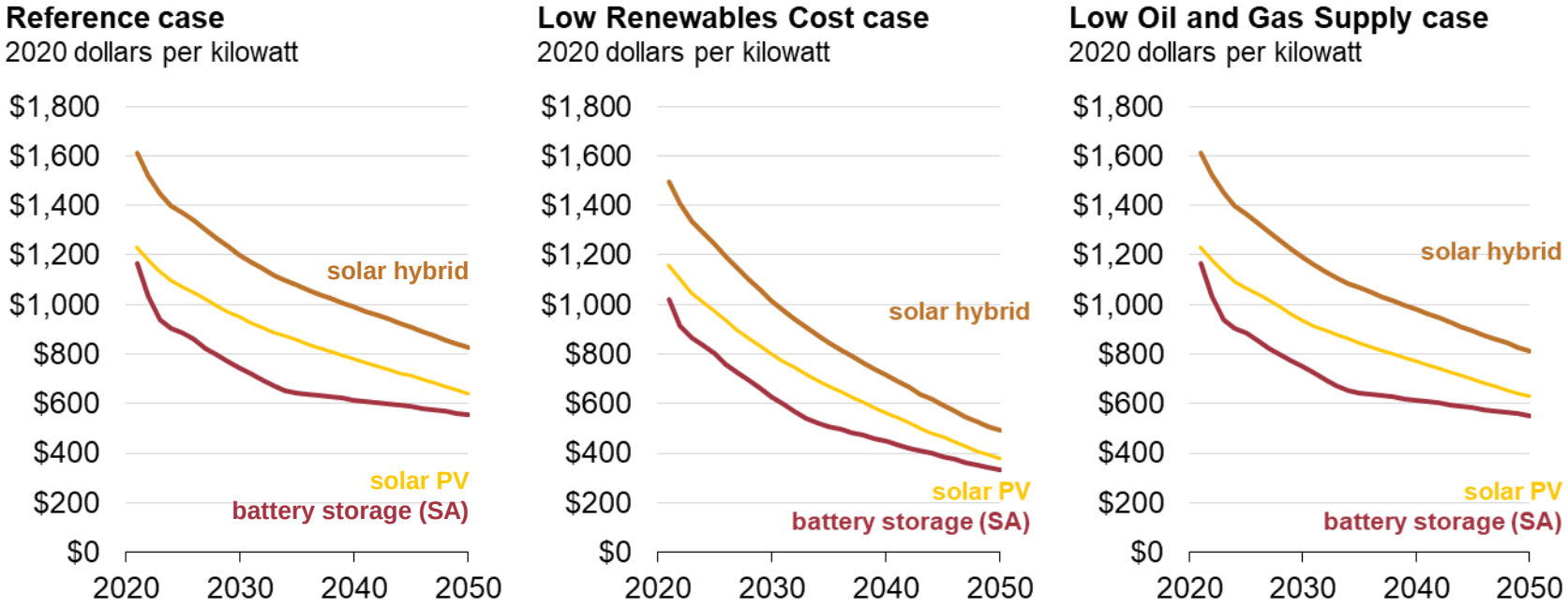
AEO2021 regional battery storage capacity and generation from selected technologies by case (2050)



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

Projected installation costs for solar PV and battery storage

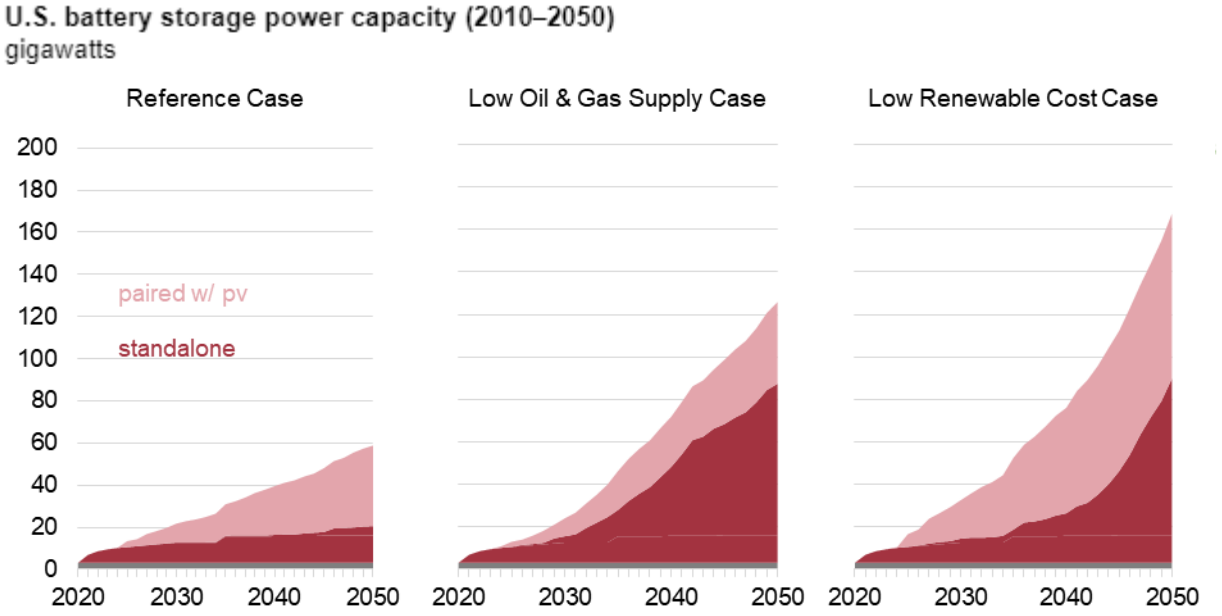
Overnight installation cost, selected AEO2021 side cases



Note: Series begin in 2021

Standalone vs. PV hybrid battery storage deployment

- Reference case: nearly all future builds from PV plus storage hybrid
  - Investment tax credit only applied to battery storage when paired with PV
- Low Oil and Gas Supply Case: standalone battery systems built to replace reserve gas units
  - More competitive in the capacity market

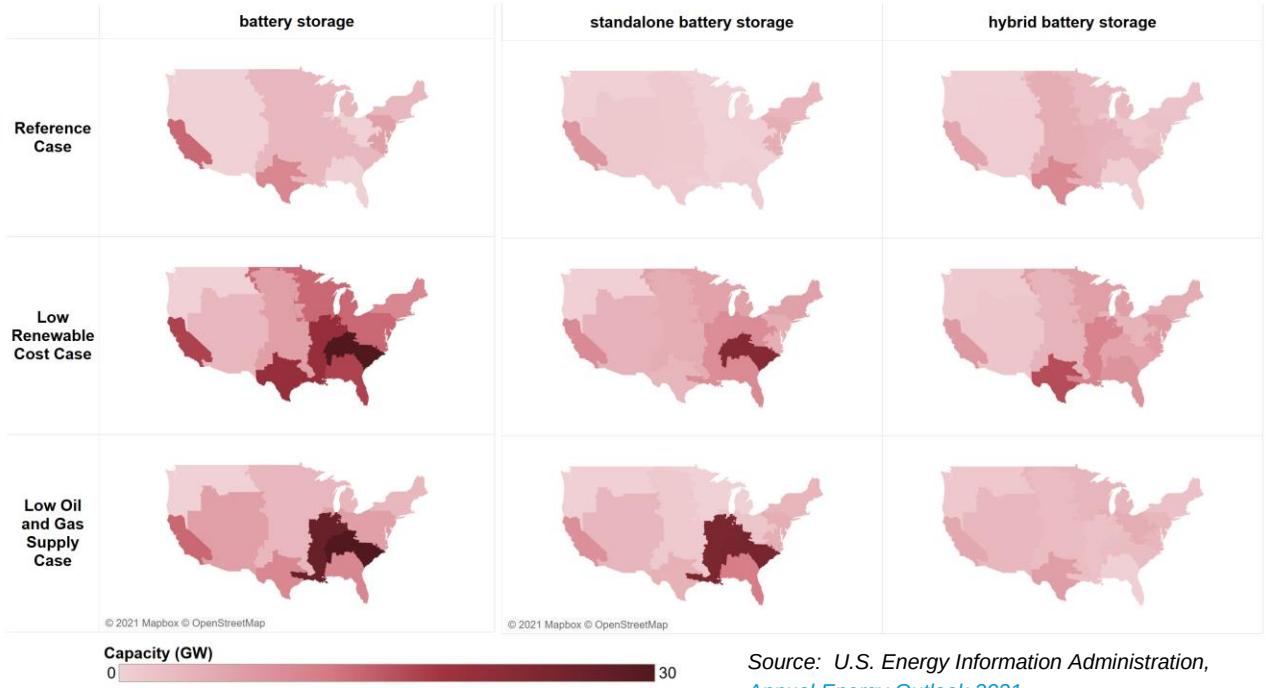


Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

Standalone vs. PV hybrid battery storage deployment

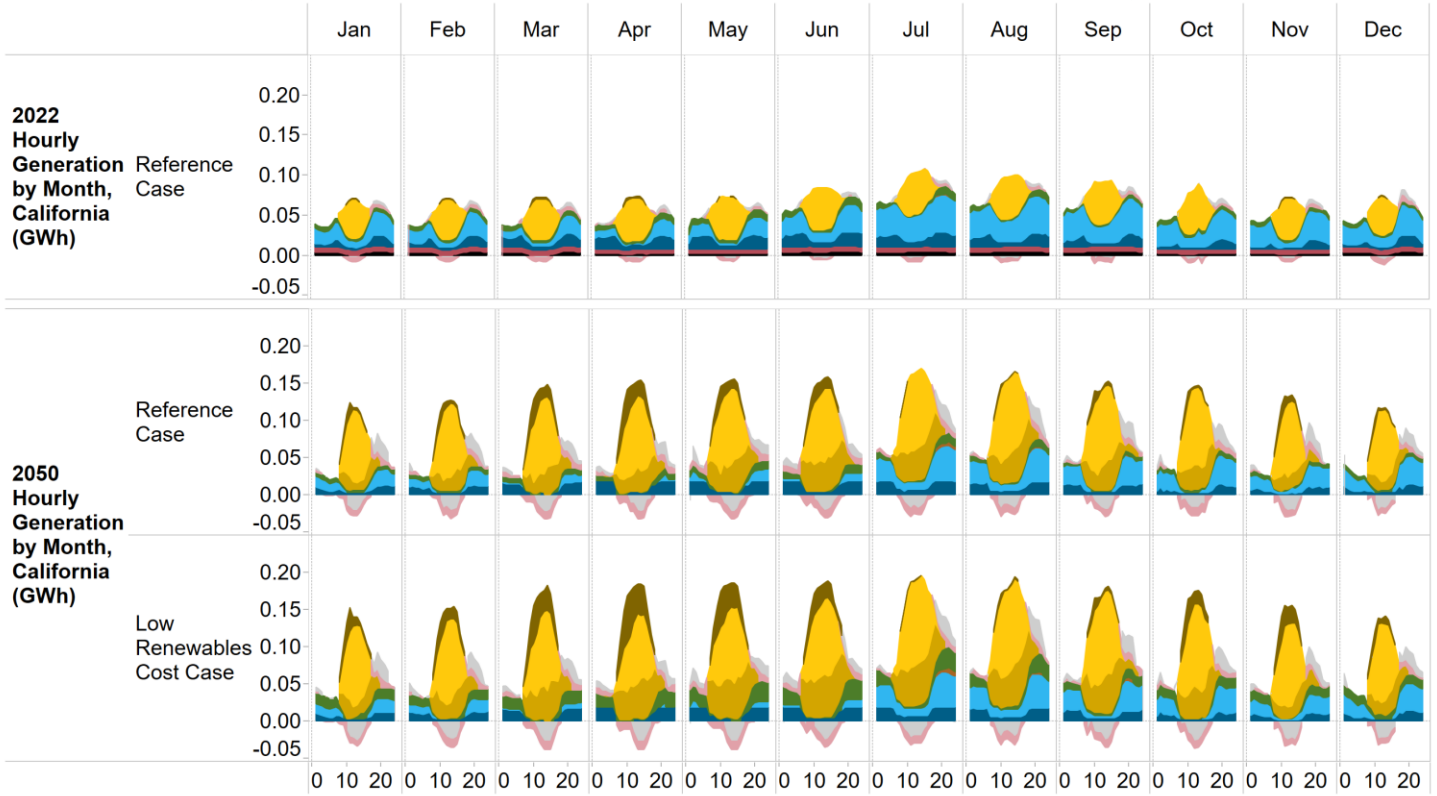
- Low renewables costs drive hybrid builds, high gas prices drive standalone builds
- Strong growth for southeast region mostly standalone
- Strong growth in Texas mostly standalone

AEO2021 standalone and hybrid regional battery storage capacity by case (2050)



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

Use of batteries varies by season and region, but is generally shifting solar production to the evening hours



curtailment
storage
pumped storage
solar
solar hybrid
wind
oil and gas peakers
gas combined-cycle
hydroelectric
nuclear
coal

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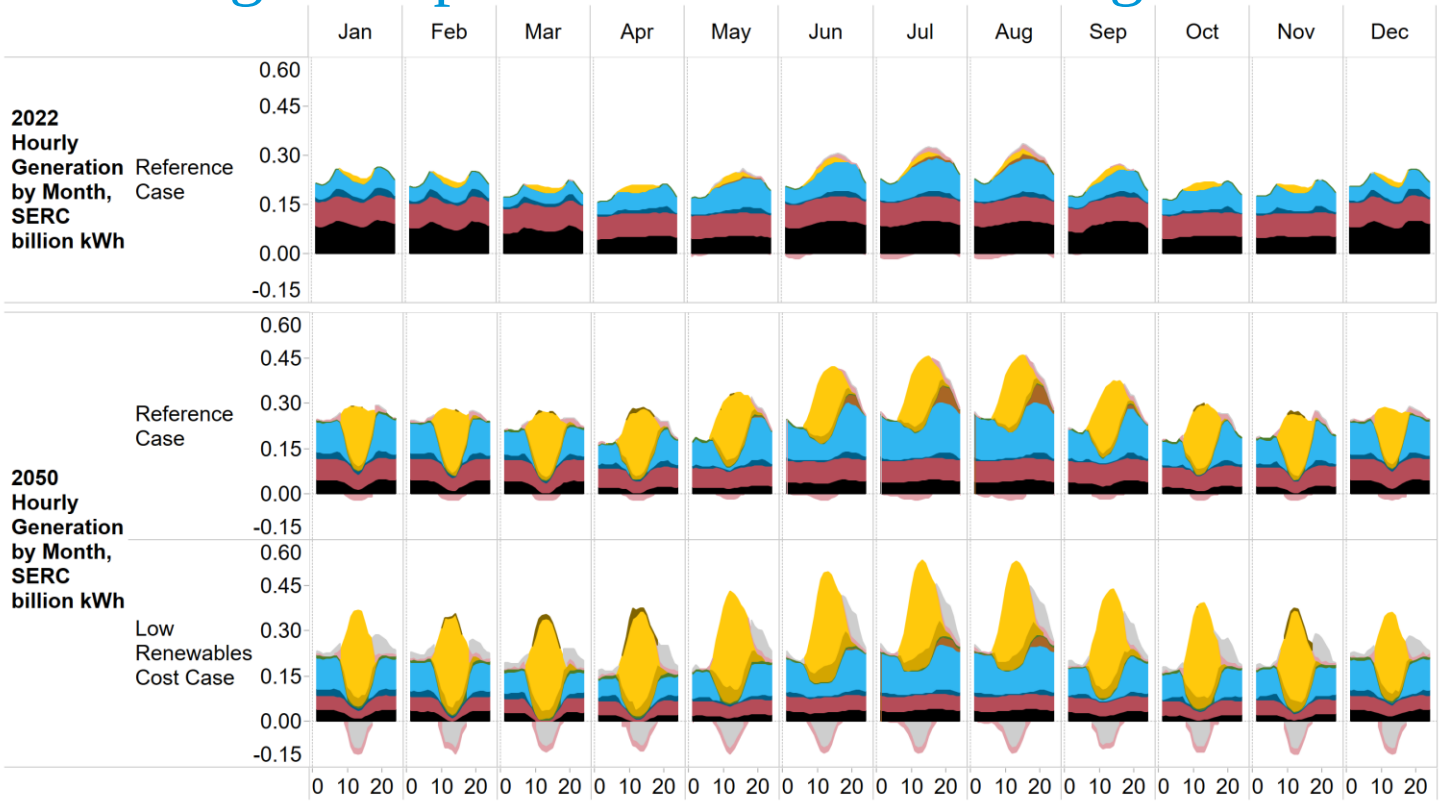

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Conclusions

- In all scenarios of EIA's Annual Energy Outlook 2021, we project that utility scale battery storage capacity in the United States will grow dramatically from today's levels over the next 30 years

- California and Texas look to continue their ongoing investments into energy storage. In some scenarios, parts of the MISO & SERC regions could have relatively favorable environments for deployment of battery storage as well.

- Lowering technology costs results in increased deployment of battery storage across the USA, while increasing gas prices results in more focused deployment in certain regions via standalone systems

- Opportunities to improve NEMS modeling

Contact information

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For more information

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

U.S. Battery Storage Market Trends | www.eia.gov/analysis/studies/electricity/batterystorage/

Electric Power Monthly | www.eia.gov/electricity/monthly/

Electric Monthly Update | www.eia.gov/electricity/monthly/update/

EIA-860 Data Files | www.eia.gov/electricity/data/eia860/

EIA-860M Data Files | www.eia.gov/electricity/data/eia860m/

Today in Energy | www.eia.gov/todayinenergy

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

Questions?

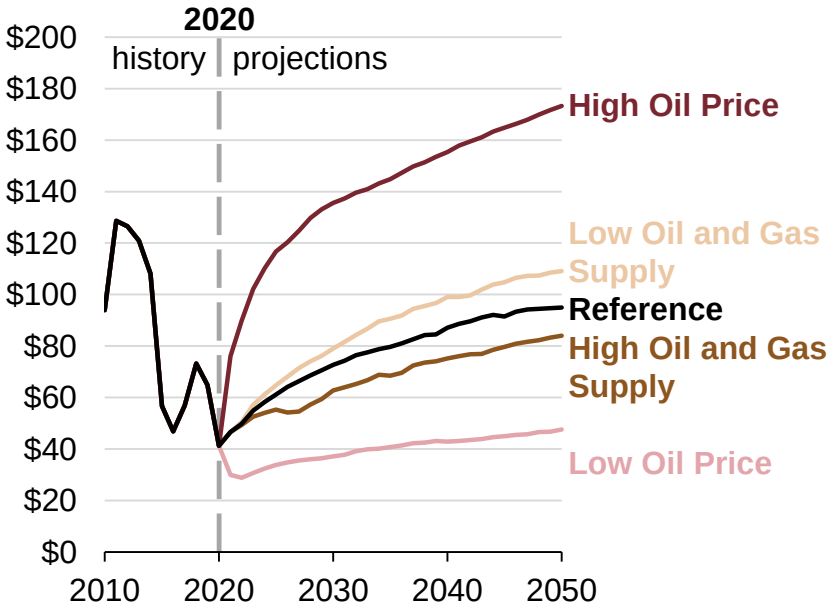
Supplemental slides

Potential model development to improve AEO's representation of energy storage

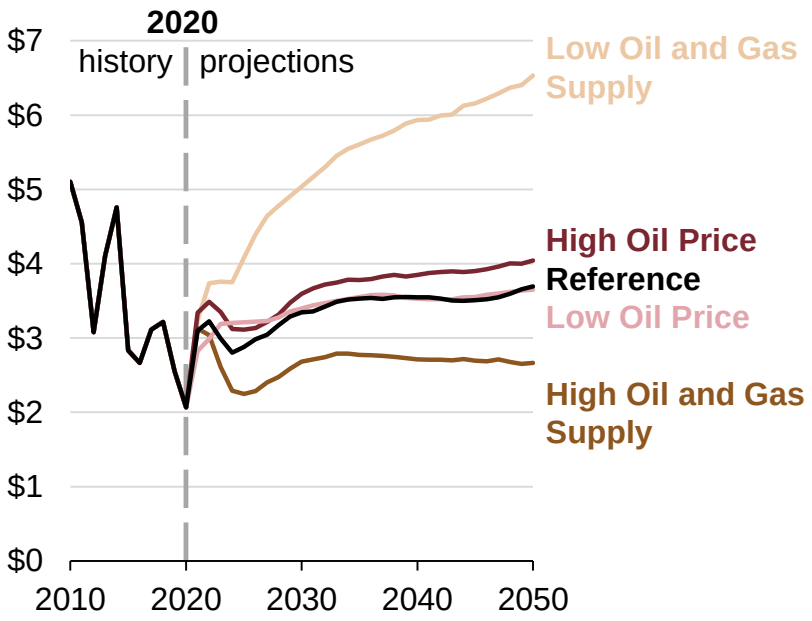
- What is worth modeling in detail, when are simplifications justified?
  - Adding some features to the model may have a negative impact on run time and EIA resources without having an impact on run results. Other features could improve the model
    - 9 vs 864 vs 8760 model time slices/year
    - Currently 25 regions, are more needed? (transmission constraints)
    - Hybrid battery storage
      - Dynamic dispatch
      - Should generators other than PV be able to pair with batteries? (wind, fossil, etc)
      - Should hybrid batteries be able to charge from the grid in the model?
      - Different options for how to size the inverter?
  - Capture value of ancillary services such as spinning reserves
  - Intraday or seasonal storage needed to model strict carbon scenarios

Crude oil price assumptions and natural gas price projections

North Sea Brent crude oil price
AEO2021 side cases
2020 dollars per barrel

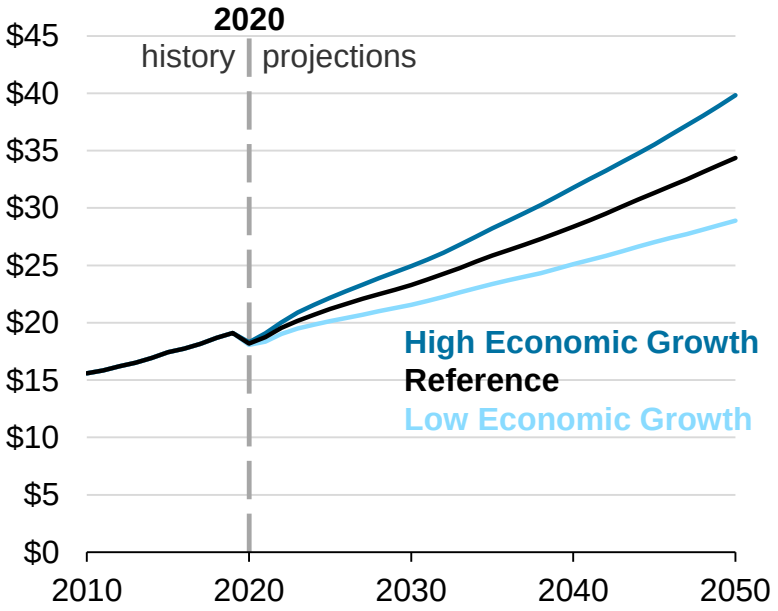


Natural gas price at Henry Hub
AEO2021 side cases
2020 dollars per million British thermal units

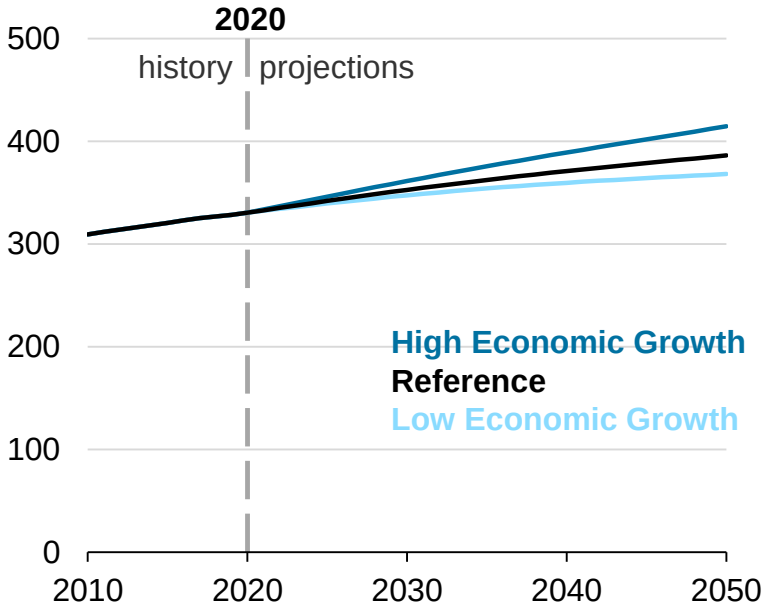


Gross domestic product and population growth assumptions

U.S. gross domestic product assumptions
AEO2021 economic growth cases
trillion 2012 dollars

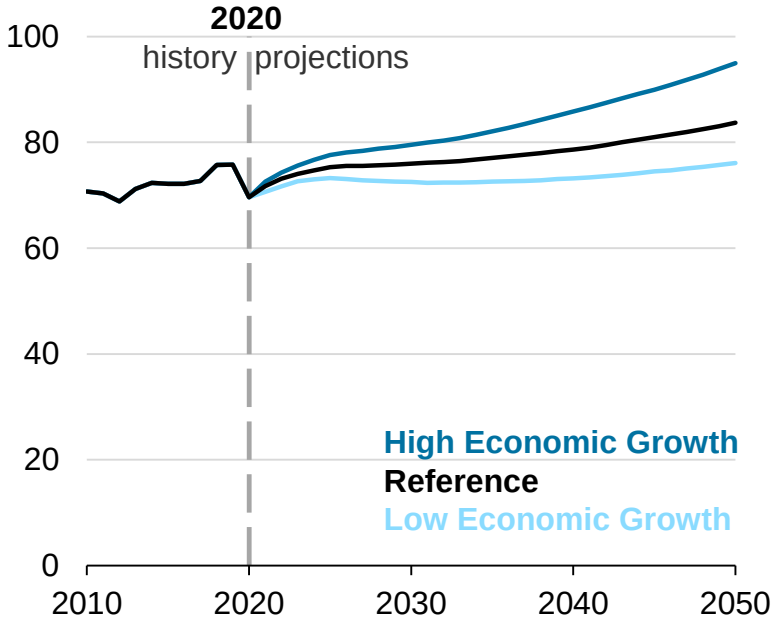


U.S. population assumptions
AEO2021 economic growth cases
millions



Delivered energy

Delivered energy across end-use sectors
AEO2021 economic growth cases
quadrillion British thermal units



Indexed delivered energy across end-use sectors
AEO2021 economic growth cases
2019 = 1.0