Levelized Costs of New Generation Resources in the Annual Energy Outlook 2025

U.S. Energy Information Administration

#AEO2025

April 2025
www.eia.gov/aeo

Introduction

- This paper presents average values of levelized costs for new generation resources as represented in the National Energy Modeling System (NEMS) for our *Annual Energy Outlook 2025* (AEO2025) Reference case. The estimates include only resources owned by the electric power sector, not those owned in the residential or commercial sector.
- Levelized cost of electricity (LCOE) and levelized cost of storage (LCOS) represent the estimated costs required to build and operate a generator and diurnal storage, respectively, over a specified cost recovery period.
- Levelized avoided cost of electricity (LACE) is an estimate of the revenue available to that generator during the same period.
- Although LCOE, LCOS, and LACE do not fully capture all factors contributing to the capacity expansion decisions as modeled, when used together as a value-cost ratio (the ratio of LACE-to-LCOE or LACE-to-LCOS), they provide a reasonable comparison of first-order economic competitiveness among a wider variety of technologies than is possible using LCOE, LCOS, or LACE individually.
- We included both a capacity-weighted average reflecting as-built regional cost variation and a simple average (unweighted) of the regional values across the 25 U.S. supply regions[1] of the Electricity Market Module (EMM).
- We included only laws and regulations effective as of December 2024.

[1] *U.S. supply regions of Electricity Market Module, https://www.eia.gov/outlooks/aeo/pdf/nerc_map.pdf*

Technology-specific assumption of tax incentives

The provisions of the Inflation Reduction Act (IRA) of 2022 qualify eligible technologies for either the PTC or the ITC. We choose the credit that is most economically beneficial to the technology.

Technology	Credit type	Prevailing wage	Apprenticeship	Domestic content	Tax value[a] (percentage or 1992 cents/kWh)	Advanced manufacturing	Energy communities
Battery storage	ITC	✓	✓		30%		
Geothermal	ITC	✓	✓		30%		
Hydroelectric	ITC	✓	✓		30%		
Wind, offshore	ITC	✓	✓	✓	30% through 2031 40% 2032 forward		
Advanced nuclear	PTC	✓	✓	✓	16.5 cents/kWh		
Biomass	PTC	✓	✓	✓	16.5 cents/kWh		
PV-battery hybrid	PTC	✓	✓		15.0 cents/kWh		✓
Solar PV	PTC	✓	✓		15.0 cents/kWh		✓
Wind, onshore	PTC	✓	✓	✓	16.5 cents/kWh	✓	✓

[a]Tax value represents the total value of the production tax credit (PTC) or investment tax credit (ITC) as represented in the Levelized Tax Credit component of the LCOE. Tax value consists of the base credit as well as the prevailing wage, apprenticeship, and domestic content bonus credits. Advanced manufacturing and energy communities bonus credits are converted into cost multipliers and applied to the overall capital cost, and they are not estimated as a part of the Levelized Tax Credit component of the LCOE.

Note: kWh=kilowatthour

Carbon capture and sequestration

Starting in AEO2025, we estimate the levelized captured carbon credit that represents the revenue (negative cost) at a power plant with a carbon capture and sequestration (CCS) system.

The price of CO_2 is determined in NEMS, and it includes the cost to transport CO_2 for either saline formation storage or enhanced oil recovery (EOR) for oil wells, net policy revenue, and revenue from selling CO_2 to EOR sites.

The 45Q tax credits are under the IRA of 2022 and available for the first 12 years of plant's operation with construction start date before 2033. In addition, we assume the prevailing wage and apprenticeship requirements are met for the additional bonus credit.

In April 2024, the U.S. Environmental Protection Agency (EPA) finalized its rule for Section 111 of the Clean Air Act regulating CO_2 emissions from existing coal, oil, and natural gas-fired steam generating units and new natural gas-fired combustion turbines.[1]

Part of the ruling requires that new natural gas-fired combustion turbines intended to run as base load (greater than 40% capacity factor) must operate with at least a 90% CO_2 removal rate CCS system by 2032. In AEO2025, we represent this operating restriction on any new natural gas-fired combined-cycle plants that are built without CCS.

We consider combustion turbines operating at or below a 40% capacity factor to be consistent with current efficient designs and the use of low-emitting fuel.

[1] *U.S. Environmental Protection Agency, Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants, April 25, 2024*

General assumptions

The costs presented in the report are for generation facilities entering service in 2030, which is the first feasible online year for all technologies given the long construction lead time for some technologies. For AEO2025, ultra-supercritical coal technology is not represented in this report, and we added natural gas-fired combined-cycle with a 95% CO_2 removal rate CCS system in its place.

The levelized costs are calculated based on a 30-year cost recovery period, using an after-tax weighted average cost of capital (WACC) of 6.65% for the 2030 online year.

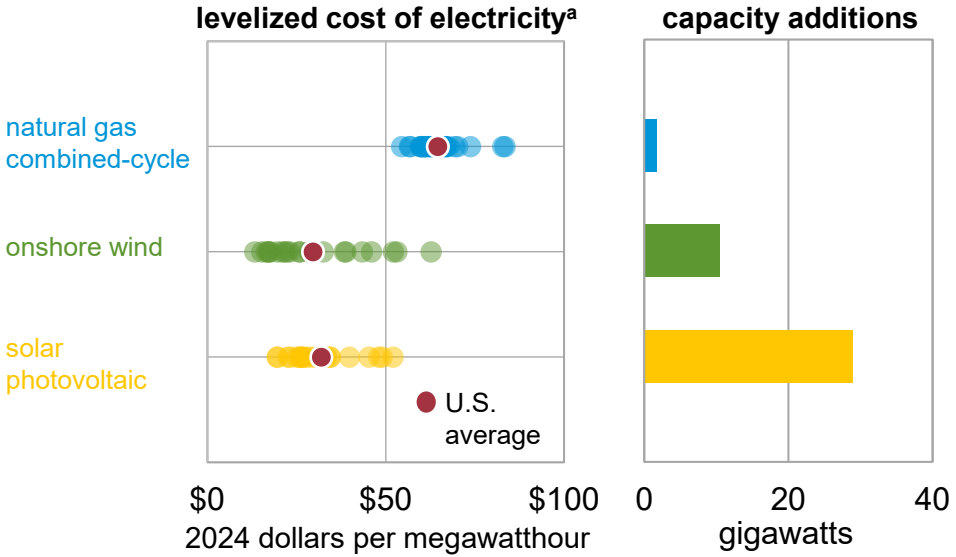
The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region in 2030, excluding planned capacity additions. Technologies for which no capacity additions are projected do not have a capacity-weighted average.

We assume the solar technology is photovoltaic (PV) with single-axis tracking. A solar PV-battery (PV-battery) hybrid system is a single-axis PV system coupled with a four-hour battery storage system. Costs are expressed in terms of net AC (alternating current) power available to the grid for the installed capacity.

As modeled, we assume that hydroelectric generating assets are seasonal because generation is a function of seasonal rainfall. Similarly, PV-battery hybrid generating assets are used at specific times of the day, depending on the number of daylight hours.

Direct comparisons of LCOE or LCOS across technologies are misleading as a method to assess the economic competitiveness

Regional and U.S. average levelized cost of electricity and capacity additions in AEO2025 Reference case



LCOE does not capture all factors that contribute to investment decisions. The inherent uncertainty about future fuel prices, changing policies, or local considerations to ensure system reliability can place a value on portfolio diversification or other risk-related concerns.

In AEO2025, we project higher solar PV capacity additions compared with that of onshore wind in 2030, even though the LCOE, on average, is higher. In this case, adding solar PV capacity to the grid provides value in certain regions that LCOE may not fully capture.

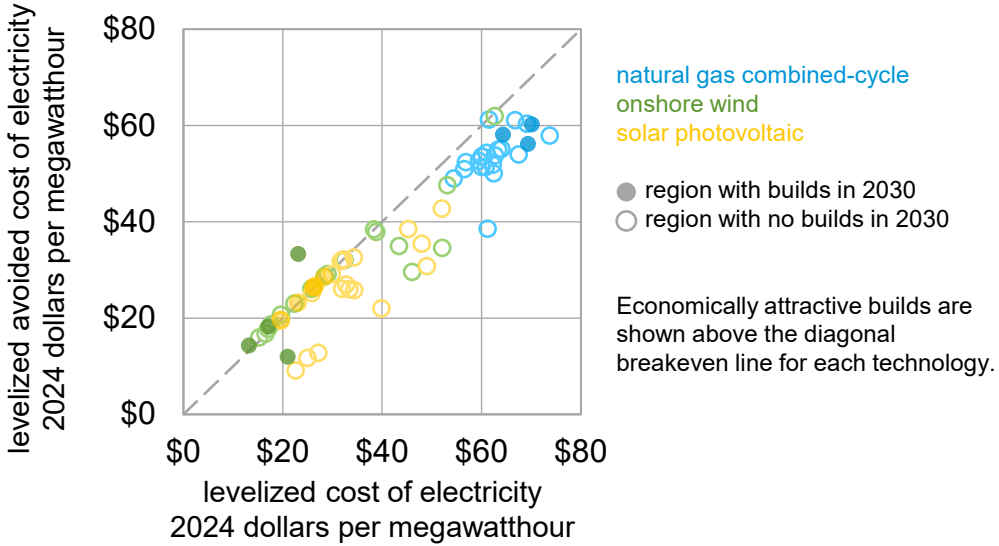
Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

Note: Each solid circle on the figure represents an electricity market region as modeled.

[a]Levelized cost includes tax credits available for plants entering service during the projection period.

LCOE is limited because it only reflects the *cost* to build and operate a plant, not the *value* of the plant to the grid

Levelized cost of electricity[a] and levelized avoided cost of electricity by region for online year 2030, AEO2025 Reference case



We use LACE as a companion metric to LCOE. This method improves comparisons of different generation technologies by providing the value of the plant serving the electric grid.

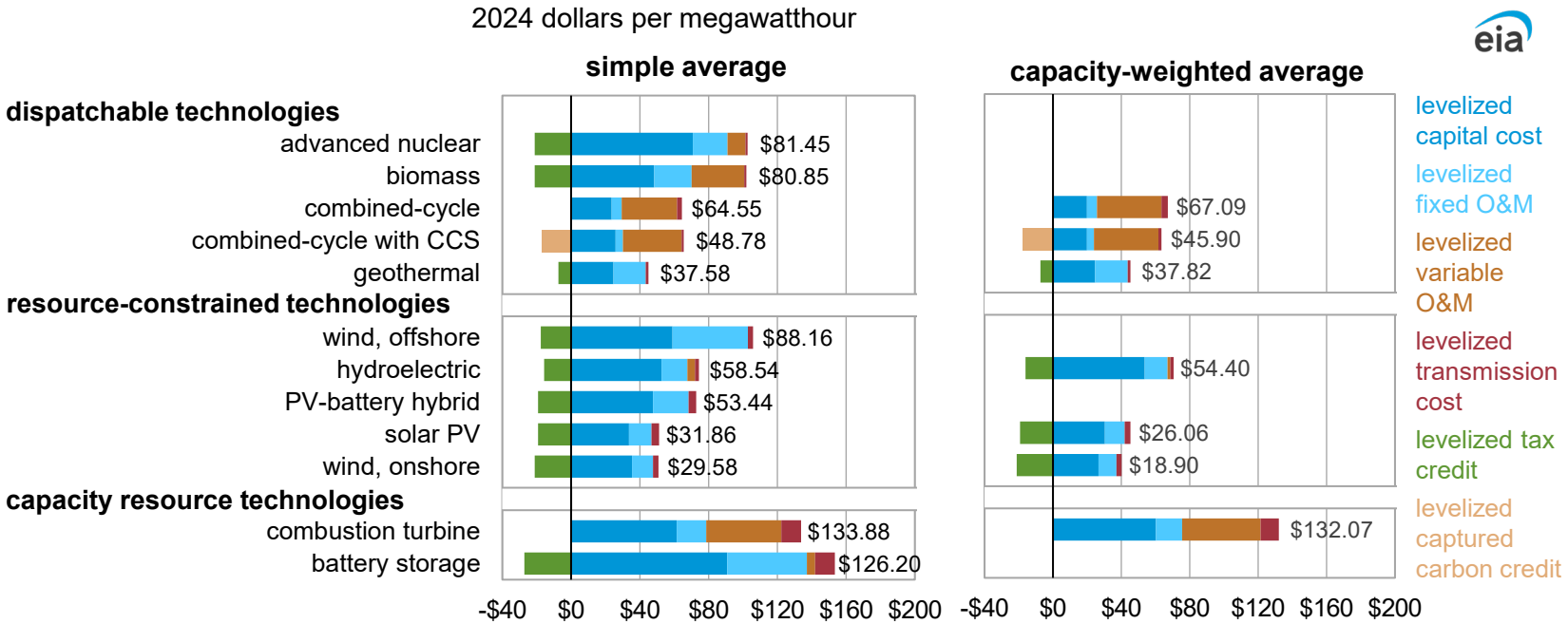
The LACE (value) provides a proxy measure for potential revenues (or avoided costs) from the sales of electricity or other ancillary services produced from a candidate project displacing another marginal asset.

Projects with LACE (value) greater than LCOE or LCOS (cost) are more economically attractive to build than those with a value-cost ratio less than one (that is, LACE is less than LCOE or LCOS).

Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

[a]Levelized cost includes tax credits available for plants entering service during the projection period.

Estimated levelized cost of electricity (LCOE) and levelized cost of storage (LCOS) for new resources entering service in 2030

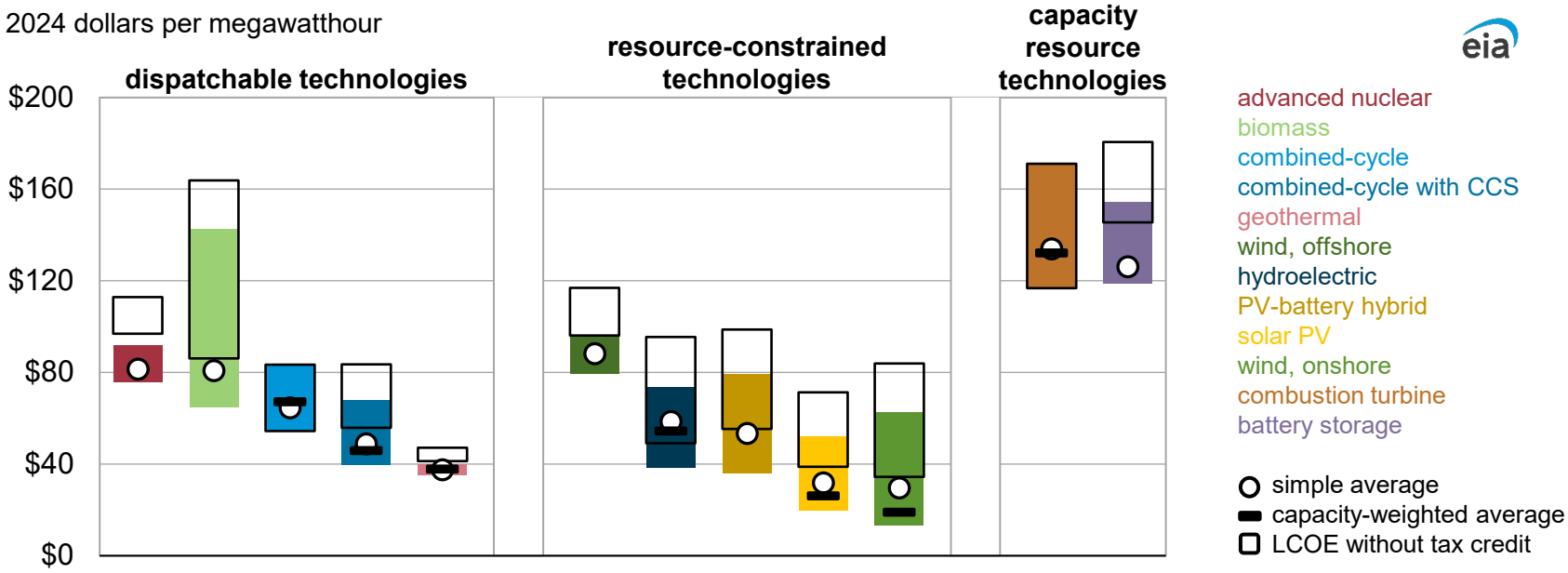


Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

Note: Technologies with no additions in 2030 do not have a capacity-weighted average. The stated LCOE values include the levelized tax credit component for eligible technologies. CCS=carbon capture & sequestration, PV=photovoltaic, O&M=operations and maintenance

Solar PV LCOE is lower than natural gas combined-cycle LCOE on average and, in most regions, even without the tax credit

Regional variation in levelized cost of electricity (LCOE) and levelized cost of storage (LCOS) for new resources entering service in 2030 by technology, AEO2025 Reference case

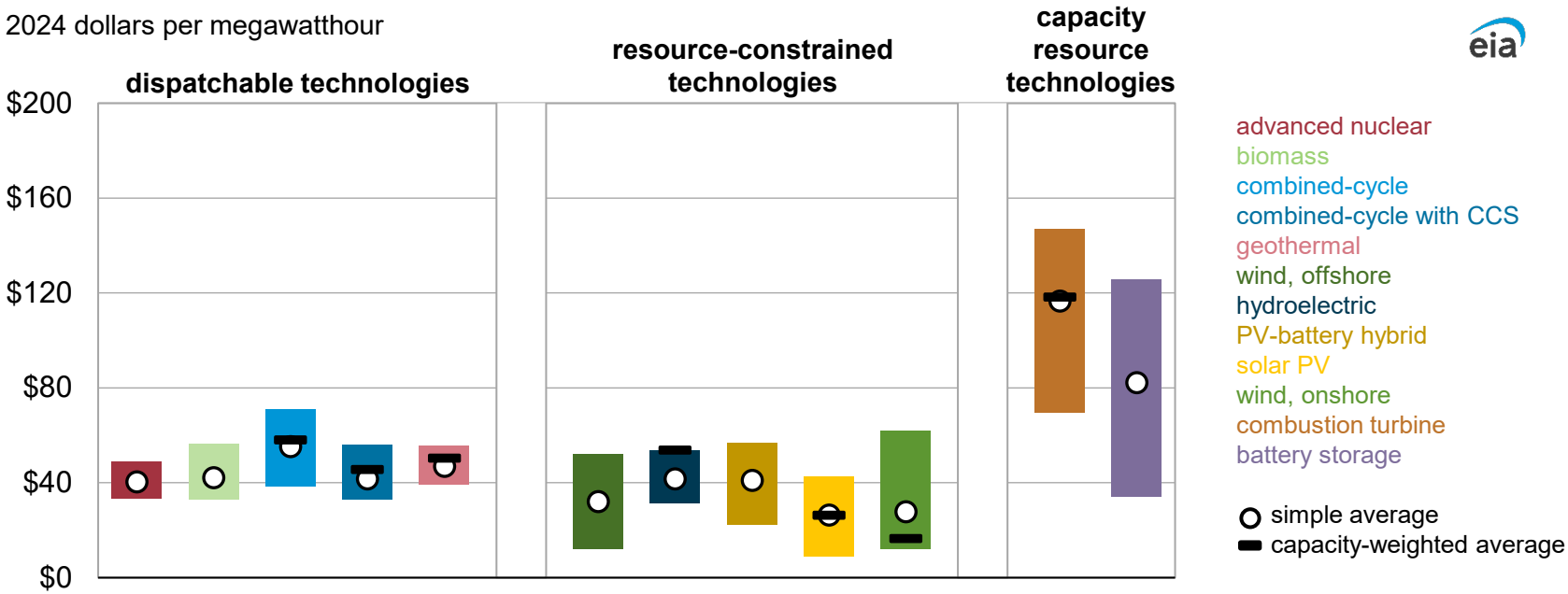


Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

Note: Technologies with no additions in 2030 do not have a capacity-weighted average. CCS=carbon capture & sequestration, PV=photovoltaic

LACE for resource-constrained technologies is generally lower because of their lower contribution for energy, capacity, and spinning reserve to the grid

Regional variation in levelized avoided cost of electricity (LACE) for new resources entering service in 2030 by technology, AEO2025 Reference case

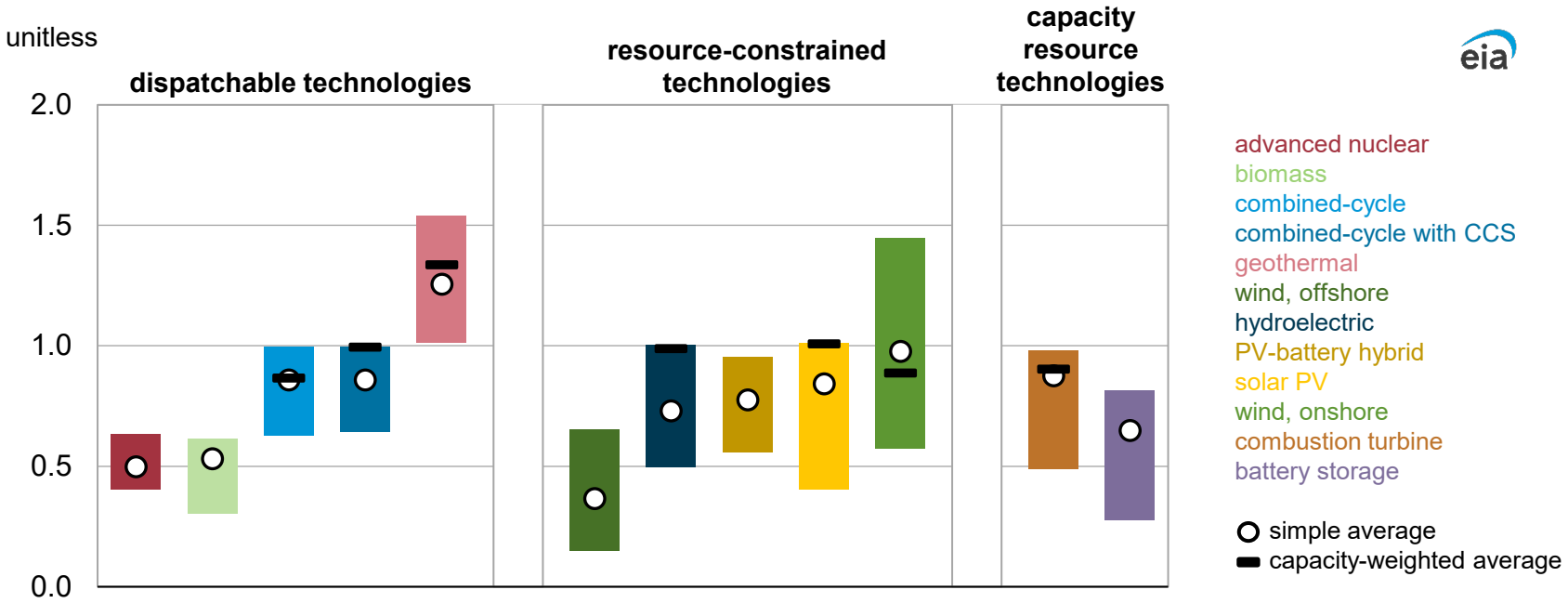


Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

Note: Technologies with no additions in 2030 do not have a capacity-weighted average. CCS=carbon capture & sequestration, PV=photovoltaic

Capacity-weighted value-cost ratio stays above simple average value-cost ratio, indicating capacity is added in regions where it is most economical

Regional variation in value-cost ratio (VCR) for new resources entering service in 2030 by technology, AEO2025 Reference case

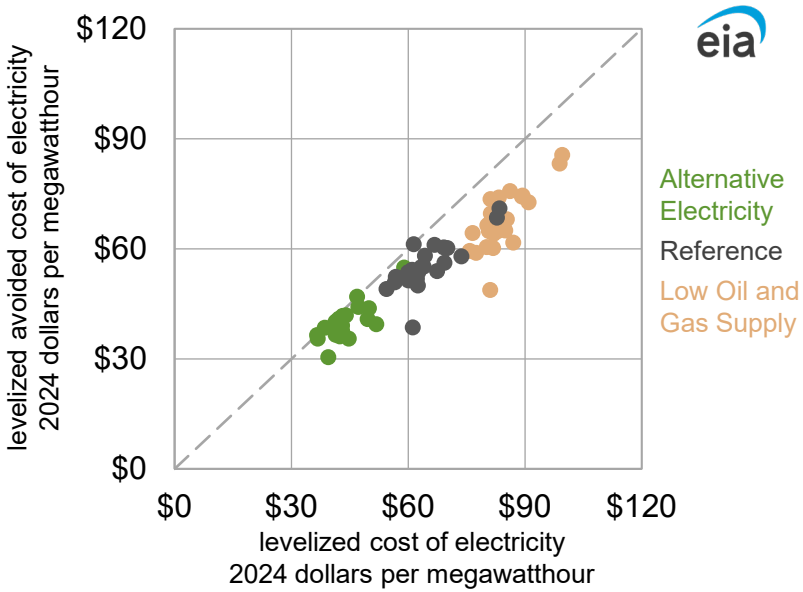


Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

Note: Technologies with no additions in 2030 do not have a capacity-weighted average. CCS=carbon capture & sequestration, PV=photovoltaic

Multiple factors affect LCOE, LACE, and value-cost ratio differently at regional level, making the context of projection scenarios important

Levelized cost of electricity and levelized avoided cost of electricity for combined-cycle plants entering service in 2030, AEO2025 select cases



In the Alternative Electricity case, we assume the final Clean Air Act's Section 111 rule is not implemented. The LCOE is lower because the combined-cycle plants without CCS are assumed to operate at an 87% capacity factor and are not limited at 40%, like in the Reference case, distributing the same costs over higher generation. LACE is also lower because less hours are available to contribute toward spinning reserves. Although capacity revenue is the same in both cases, the Alternative Electricity case has higher expected annual generation, which leads to lower capacity payment per megawatthour compared with the Reference case.

Higher natural gas prices assumed in the Low Oil and Gas Supply case lead to higher fuel cost and higher LCOE compared with the Reference case. Higher natural gas prices, however, also lead to higher realized electricity prices and subsequently higher revenue that also increase LACE when compared with the Reference case.

Data source: U.S. Energy Information Administration, Annual Energy Outlook 2025

For more information

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Annual Energy Outlook | www.eia.gov/aeo

Levelized Cost of New Generation Resources Methodology | https://www.eia.gov/outlooks/electricity_generation.php