E3 RECOST

Q3 2025 Update

July 2025

Energy+Environmental Economics

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This is an excerpted summary of E3's full RECOST market report, available at shop.ethree.com

Executive Summary

Q3 2025

Trade Policy Pandemonium

Starting in Q1, the U.S. has imposed tariffs under various names on all U.S. trading partners to some degree. While some of these tariffs are currently paused, E3 updates our cost forecasts to assume that pre-pause levels apply through 2029 based on historical precedent. BESS costs are impacted most by current tariffs due to current supply chain dependence on imports from China.

Budget Reconciliation: Beauty in the Eye of the Beholder?

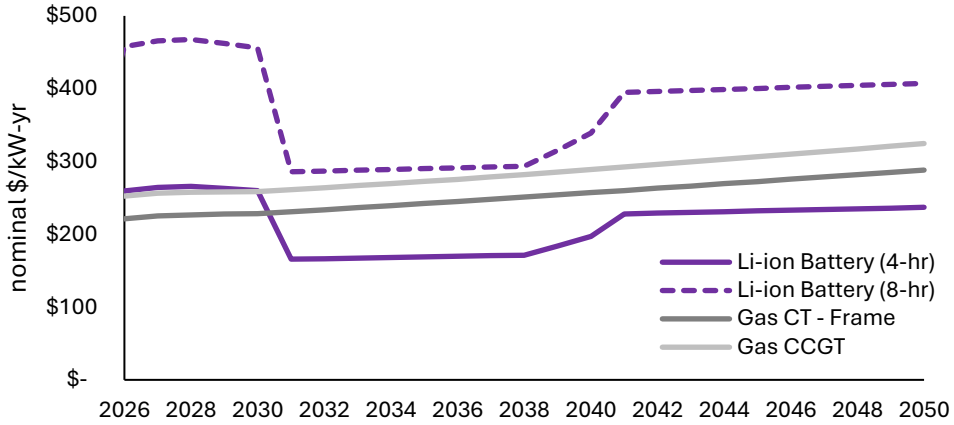
On July 4, 2025, the FY2025 Congressional Reconciliation Bill was signed into law, materially curbing the outlook for tax credits for clean energy technologies and foreign sourcing options for U.S. clean energy and energy storage projects. Implementation of the Bill is ongoing but is reflected here based on E3's current understanding of the legislation, inclusive of resource-specific safe harbor and credit phase-out timelines. Wind and solar are most impacted with an earlier expiration of tax credit availability, even with safe harbor, while BESS, geothermal, and other clean energy technologies benefit in terms of relative competitiveness.

Gas Continues to Pressurize, But for How Long?

While policy changes are the focus of this RECOST update, the cost to build new gas plants continues to increase and is expected to remain elevated at least through the rest of this decade. E3 continues to update our gas plant data and assumptions for the latest information, showing that cost abatement is not on the near-term horizon.

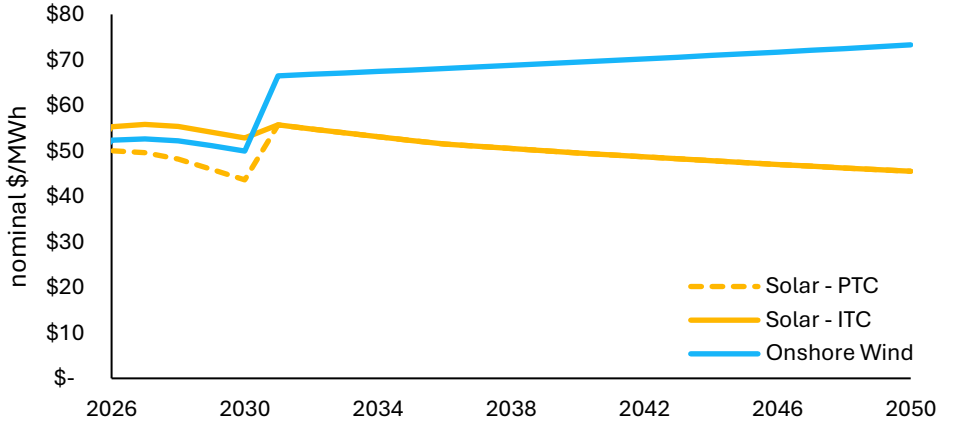
RECOST LFC Estimates for Selected Resources

Q3 2025, Mid Cost Trajectory, Generic U.S. Location



RECOST LCOE Estimates for Selected Resources

Q3 2025, Mid Cost Trajectory, Generic U.S. Location



In a complicated policy environment, E3's RECOST forecasts aim to provide transparency and rigor

Resource Cost Assumptions

RECOST: Q3 2025 Update

Energy+Environmental Economics

E3 Perspective on Resource Costs

Recost Assumptions: Q3 2025

Before levelizing over energy or capacity, resource costs can be divided into four categories:

1) Materials (e.g., commodities, equipment)
2) Labor
3) Land
4) Financing

All RECOST updates ultimately trace back to one of these four categories

Forecasts of resource costs will differ between sources based on expectations across these four categories, and E3 assumes the following:

- Cost of materials will be pressured downward by long-term commodity price declines, but equipment bottlenecks may spark temporary increases as technologies evolve, and policy-driven demand for materials will support higher costs
- Labor costs in the U.S. will decline in real terms, consistent with productivity-pay gap observed over time [(1)] but labor shortages during transition periods may create temporary spikes in wages[(2)]
- Cost of land may not spike upward in the same way it did during Covid, but the "new normal" level appears to be entrenched[(3)]
- Financing costs were expected to be a medium-term tailwind but persistent inflation and trade policy pressure on electricity sector inputs has applied continued upward pressure on the cost of capital

(1) https://www.epi.org/productivity-pay-gap/
(2) For example: https://www.reuters.com/business/energy/us-solar-storage-growth-clipped-by-labor-shortages-2024-10-17/ and https://www.spglobal.com/commodity-insights/en/news-research/latest-news/electric-power/031025-ceraweek-renewables-ready-to-go-labor-and-parts-delays-gas-plants-nextera-ceo
(3) https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/farmland-value

Summary of Q3 2025 Updates

E3's Resource Cost (RECOST) forecasts now reflect material shifts in the policy environment and continuing secular market trends:

+ Policy trajectories shifted materially in Q2, leading to the following updates:

- The FY2025 Congressional Reconciliation Bill was passed on July 3 and signed on July 4, substantially impacting multiple technologies as reflected here
  - Assumptions used here reflect E3's understanding of the Act as of July 7, 2025; many details of the final legislation are still being reviewed and interpreted, and may be subject to change in near-term RECOST updates, including but not limited to safe harbor
  - E3 is continuing to monitor developments in the interpretation and implementation of the legislation, and will update RECOST as more information, guidance, and evidence becomes available
- Wide-ranging tariffs were announced and applied across U.S. trading partners, impacting every technology but which are especially impactful for technologies dependent upon imports from China
  - The 90-day pause of new U.S. tariffs was scheduled to end on July 9, 2025 but was extended to August 1, 2025; it is not clear if further extensions are forthcoming for some or all countries; E3 assumes here that pre-pause tariff conditions apply, given the temporary nature of the current policy

+ Parallel to policy shifts, market data on resource costs continues to evolve rapidly, leading to the following updates:

- Natural gas new build costs continue to experience upward pressure, with upfront capital costs elevated relative to Q1 2025 RECOST but with longer-term expectations moderated as market pressure builds to incentivize increases in manufacturing and labor supply

Key Energy Elements of the FY2025 Congressional Reconciliation Bill

Everything Matters, But What Matters Most is Different for Each Technology

Tax Credits

- Technology-neutral tax credits (45Y PTC and 48E ITC) modified for all resources: solar and wind tax credit availability is much more limited, and no resource can claim tax credits if they begin construction after 2032
- The timing for when solar and wind projects may claim tax credits is now more complicated (see later slide)
- Projects may still claim bonus credits for meeting wage and apprenticeship requirements and siting within energy communities
- Sales of tax credits (transferability) is still allowed
- Hydrogen production projects must begin construction by the end of 2027 to claim the 45V production tax credit

Depreciation

- Projects claiming technology-neutral tax credits remain classified automatically as 5-year MACRS property
- 100% depreciation bonus option is restored

Foreign Entity of Concern (FEOC) Requirements

- Technology-neutral tax credits may be denied or recaptured for any new resource that fails to comply with FEOC rules
- FEOC requirements apply at the level of the project and taxpayer (e.g., under transfer sales)
- In general, compliance with FEOC requires demonstrating that a project did not receive "material assistance" from a "prohibited foreign entity" during construction, or that a "foreign-influenced entity" is not proposing to claim or sell tax credits

Key drivers of project costs and expected contract prices will be impacted by the Reconciliation Bill (tax credit availability, safe harbor allowances, and sourcing requirements): which matters most will depend on technology-specific supply chains and costs

Sources: https://www.projectfinance.law/publications/2025/july/effects-of-one-big-beautiful-bill-on-projects/ and https://www.whitecase.com/insight-alert/amendments-ira-tax-credits-senate-budget-bill

Diverging Policy Impacts Among Technologies

Expected Impacts on Resource Costs, by Technology and Driver

▲: Positive Impact
▼: Negative Impact
⇆: Impact Unclear / No Change

Impacted by FY25 Reconciliation Bill (7/4/25)

	Solar PV	Wind	Li-ion Batteries	Geothermal	Nuclear	Thermal / CCS
Tax Credits	▼ Final qualification year now 5 years earlier than previous minimum, and >10 years earlier than prior policy target year		▲ Qualification preserved through 2032			▲ 45Q preserved, and 45X revision supports coal
Safe Harbor Provisions	▼ Significant uncertainty present around ability of wind and solar to claim safe harbor, increasing risk of projects with 2029-2030 COD; Treasury guidance expected Q3/Q4 2025		▲ Safe harbor timeline preserved and is incremental to tax credit phase-out timeline after 2032; Treasury guidance expected Q3/Q4 2025			⇆ No change
FEOC Impact	▼ Compliance will look different across technologies and technologies more dependent on imports (solar, wind, li-ion batteries) are more exposed to FEOC risk, but novelty and severity of FEOC guidelines imposes near-term risk on all new projects seeking to claim tax credits					▲ 45Q risk is elevated but underlying technology is derisked
Depreciation	▲ 5-year MACRS preserved and 100% bonus depreciation restored			⇆ Bonus restored but heat pumps excluded from 5-year MACRS (legacy credits only)	▲ 5-year MACRS preserved and 100% bonus depreciation restored	⇆ 45Q dynamics preserved but underlying technology unchanged
Tariffs	▼ Significant risk, large impacts from multiple overlapping tariff policies	▼ Difficult to de-risk but impacts likely to be small than for solar	▼ Highest expected impact for any technology (high impact and high certainty)	⇆ Commodity risk during construction is minor, may depend on drilling equipment sources	▲ Nuclear fuel (commodity risk) currently exempted	▲ Little to no commodity risk during construction, and domestic supply chain is ramping up

Recent policy changes have increased resource costs relative to 2024 expectations, especially with regards to IRA incentives, but relative impacts are not the same for every technology, with implications for the competitiveness of different resources moving forward

Tariff Impacts

U.S. trade policy changed rapidly, significantly, and repeatedly in H1 2025; E3 incorporates detailed tariff assumptions for key technologies and conservative tariff assumptions across all technologies into this RECOST update

E3 Methodology for Estimating Tariff Impacts:

1) Identify imported components for a given technology
2) Calculate the percentage of total capital expenditures (CAPEX) that each component represents
3) Determine share of total demand for each component represented by imports
4) Identify tariff rate for each CAPEX component, for each major import country
5) Apply country-specific tariff rate to each component
6) Calculate the impact on total CAPEX from tariffs as a weighted average of component- and country-specific tariff policies
7) Calculate levelized costs and PPA prices using new, elevated CAPEX assumption
8) Identify year of potential tariff phase-out, based on historical precedent and policy context

Tariff Impacts for Key Technologies in RECOST, Q3 2025

Technology	**Key Imports** (Countries)	**Capex at Risk** (% Total)	**Weighted Average Tariff** (% Rate Applied to Capex at Risk)
Wind (Onshore)	Nacelle, rotors, towers (Mexico, Germany)	55%	29%
Solar (Utility PV)	Module and BOS (Vietnam, China)	44%	70%
BESS (Standalone, Li-ion)	Cabinets and BOS (China)	73%	121%

E3 assumes solar developers have been adapting, and will continue to adapt, their supply chains to avoid AD/CVD penalties; however, BESS supply is uniquely dependent on imports from China, which is subject to some of the highest tariffs applied under current U.S. policy

E3 assumes 2029 is the last year of current tariffs, based on review of historical data and analysis of U.S. trade policy[1]

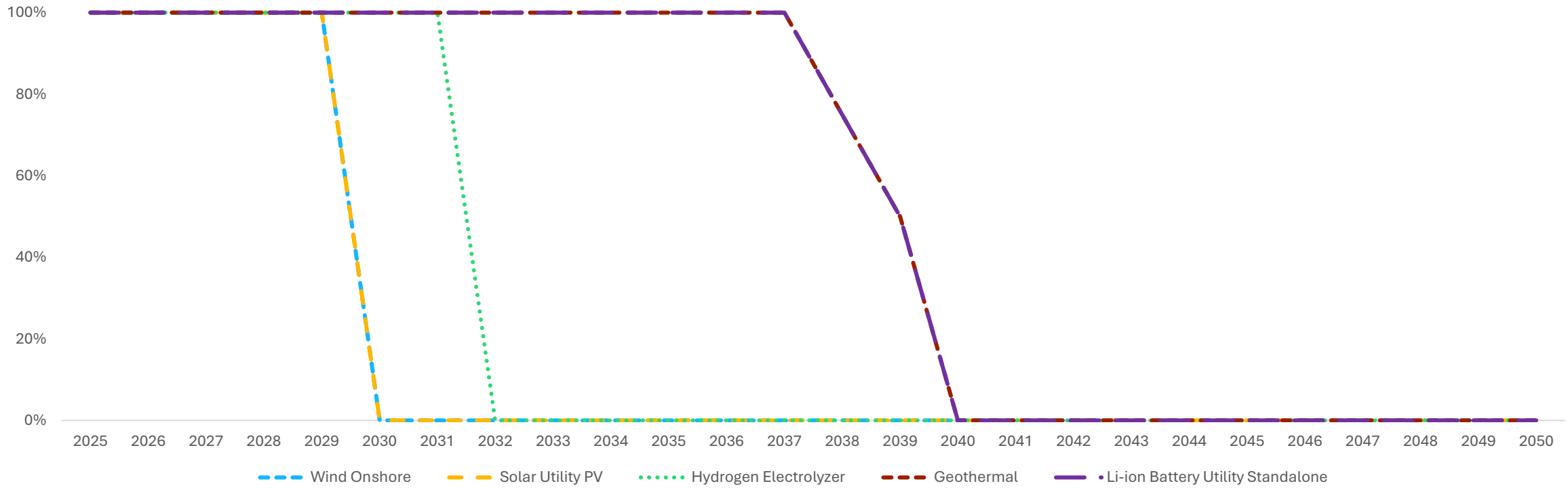
(1) https://www.historians.org/resource/history-of-tariffs/ , https://www.cato.org/blog/high-protective-tariffs-have-been-short-lived-american-history , https://www.nber.org/reporter/winter-1998/9/historical-perspectives-us-trade-policy

Tax Credit Schedules Under the Inflation Reduction Act

Recost Assumptions: Q3 2025

Technology-Neutral Tax Credits (ITC or PTC)[1, 2]

% of Full Credit Value Claimed by Utility-Scale Resources in RECOST, by Resource COD Year (Not Year of Construction Commencement)



Timing of decline reflects E3 interpretation of the "One Big Beautiful Bill Act" as of July 2, 2025; this includes assumptions regarding safe harbor and potential phase-out of tax credits for non-wind and non-solar resources, which are subject to revision.

(1) Eligibility for the "Bonus" IRA incentives (assumed for all technologies) is subject to meeting certain prevailing wage requirements; additional 10% adders available for meeting additional domestic content and energy community criteria. In RECOST's cash flow estimates, tax credits are assumed to be monetized at 90% of their effective value.
(2) For projects electing the ITC, the cost basis eligible for the tax credit is assumed to be equal to 95% of project capital costs.

Resource Cost Forecasts

RECOST: Q3 2025 Update

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Levelized Fixed Costs (LFC)

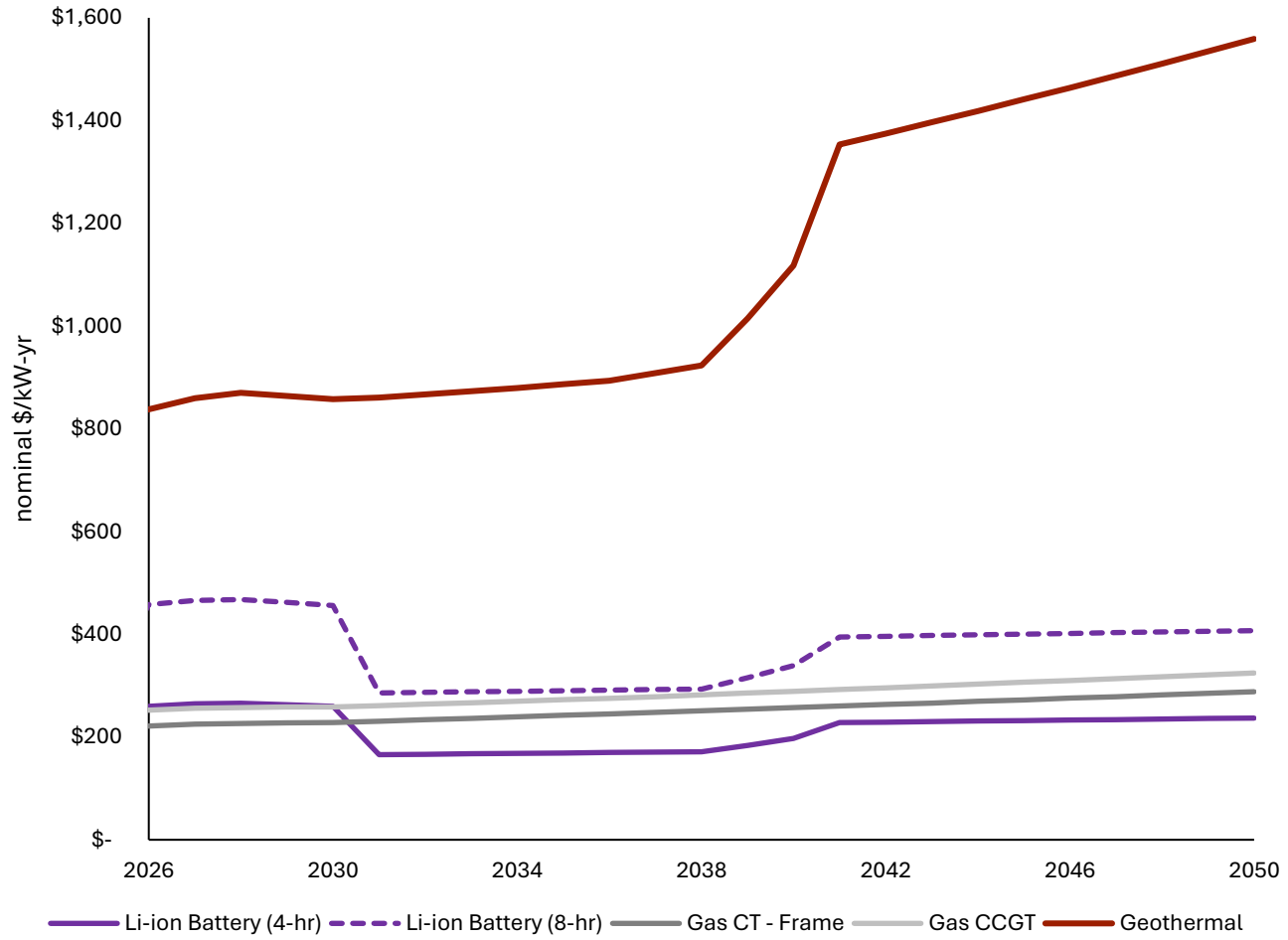
Recost Forecasts: Q3 2025

- LFC remains the **default metric for many utility resource planning processes**, making it one of the core outputs analyzed in RECOST
- IRA tax credits for BESS and geothermal are assumed to begin extend through 2032, with phase-out and safe-harbor assumptions extending eligibility through the 2030s
- Tariff impact is assumed through 2029
- Capacity costs for mature, non-firm technologies (i.e., onshore wind and solar) are persistently competitive, but this advantage is degraded by capacity accreditation mechanisms in various markets

Note: All projections shown in this analysis are an estimate of future resource costs. Results for LFC or LCOE do not constitute market price forecasts for a given technology or region.

E3 LFC Forecast

Nominal $/kW-yr



Levelized Cost of Electricity (LCOE)

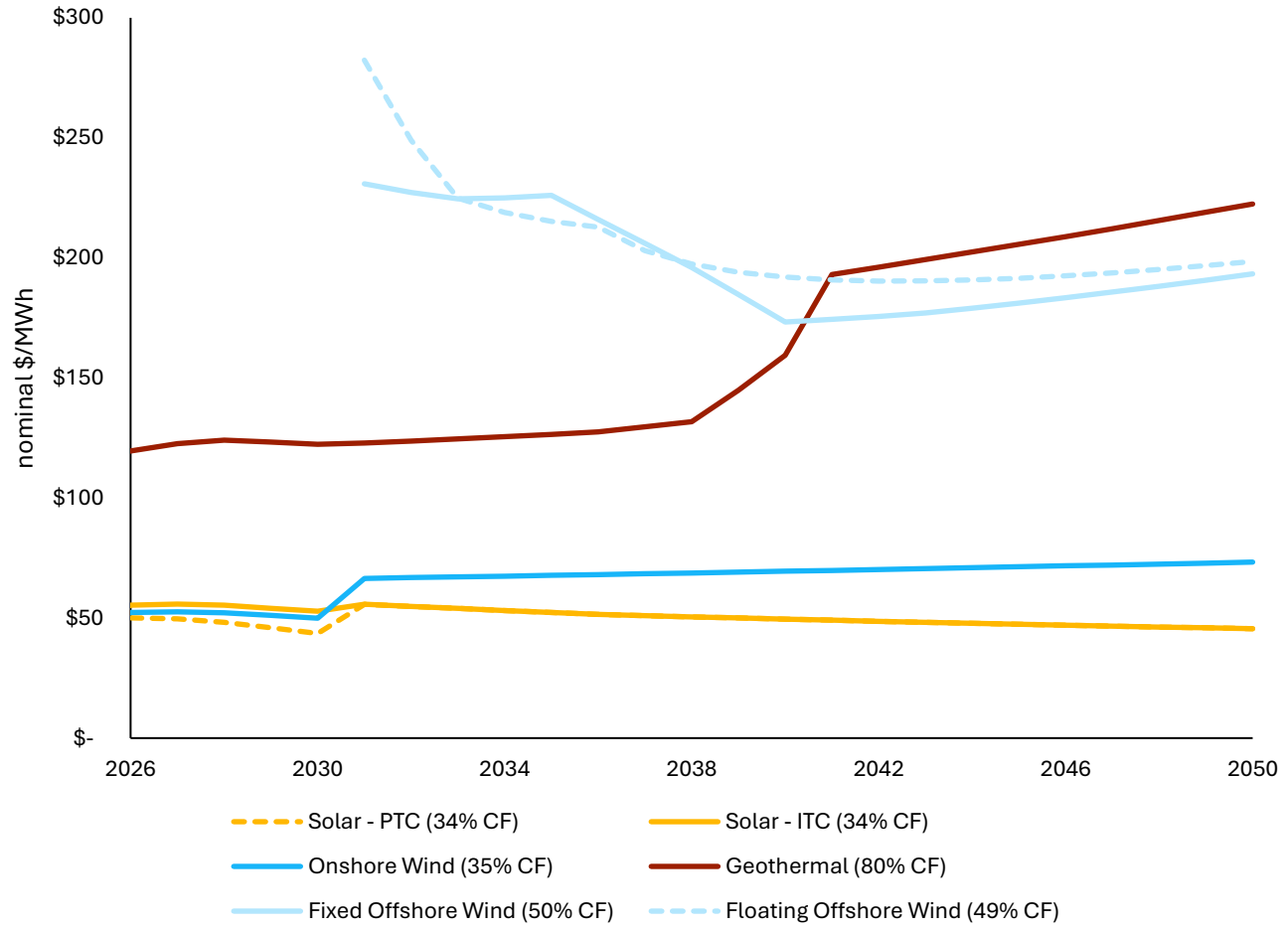
Recost Forecasts: Q3 2025

- IRA tax credits for solar and wind are assumed to end by 2030, and phase out after 2032 for geothermal
- Tariff impact is assumed through 2029
- Offshore wind, especially fixed-bottom installations, can out-compete geothermal by 2041, but **long-run development decisions will be contingent on project location**
  - In California, for example, all offshore wind must be floating, so geothermal is expected to remain competitive in CAISO

Note: All projections shown in this analysis are an estimate of future resource costs. Results for LFC or LCOE do not constitute market price forecasts for a given technology or region.

E3 LCOE Forecast

Nominal $/MWh



Levelized Cost of Storage (LCOS)

Recost Forecasts: Q3 2025

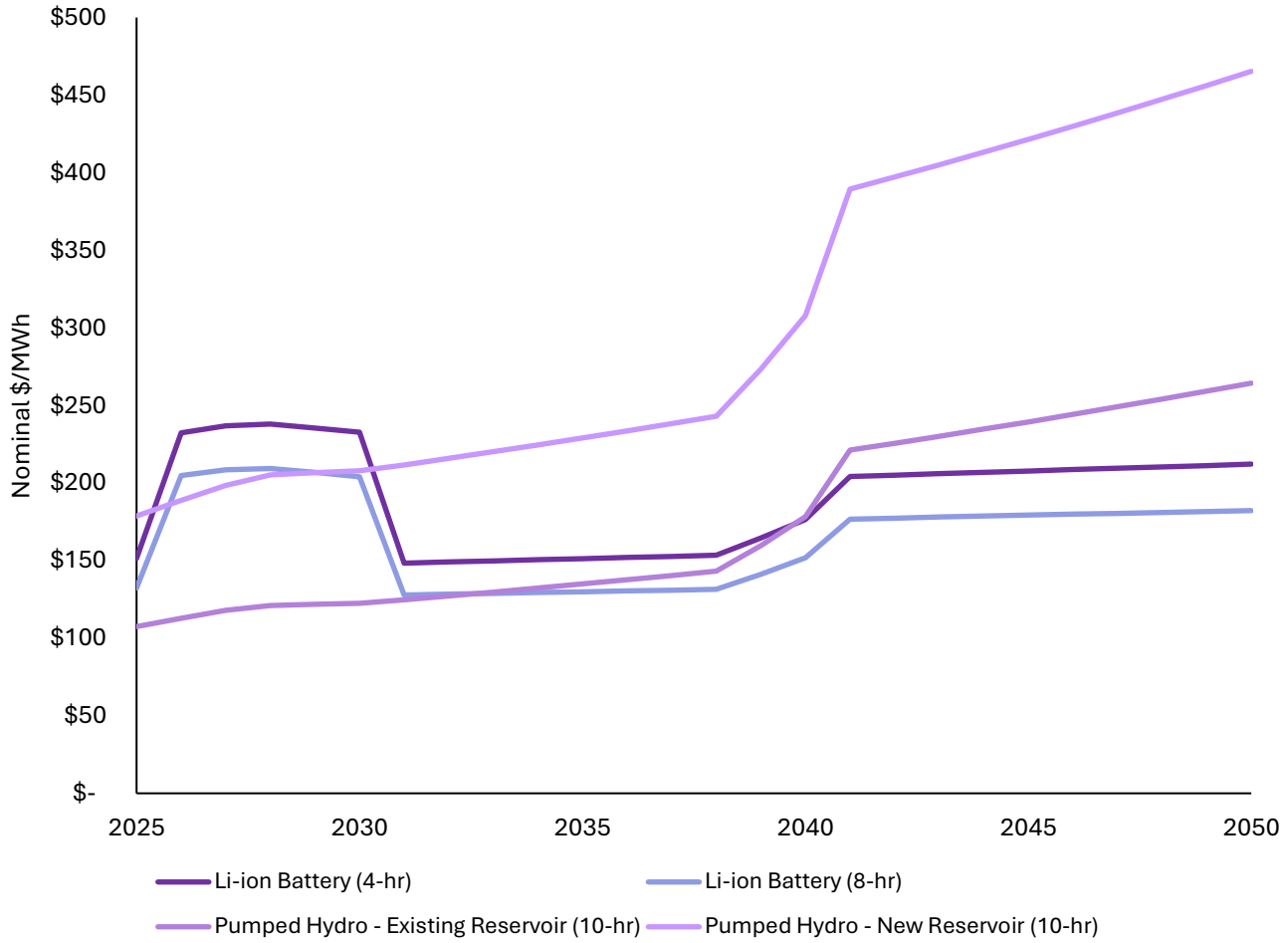
- **Pumped Hydro retains a cost advantage relative to 4-hour lithium-ion battery storage into the 2030s; the technology is also insulated from tariffs and volatility in rare-earth metal commodity markets**
- **Battery storage costs moving forward will be shaped by multiple factors, most notably:**
  1) Commodity input costs, and
  2) Supply chain dynamics
- **ITC value for energy storage in percentage terms will likely be higher in the near term for PSH, given domestic content requirement (DCR) bonus requirements, but long-term manufacturing on-shoring may erode this advantage**
- **Battery development activity began to migrate towards Energy Community jurisdictions after passage of the IRA, taking advantage of siting flexibility; it remains to be seen if this will change under the FY2025 Congressional Reconciliation Bill[2]**

[1] Levelized Cost of Storage is LFC normalized by the annual storage discharge (hours): assumes 250 cycles per year, 100% depth of discharge, and 80% round-trip efficiency for pumped hydro; and 365 cycles per year, 90% depth of discharge, and 85% round-trip efficiency for Li-ion battery; excludes charging cost

[2] https://www.ethree.com/energy-community-adder/

E3 LCOS Forecast

Nominal $/MWh[1]

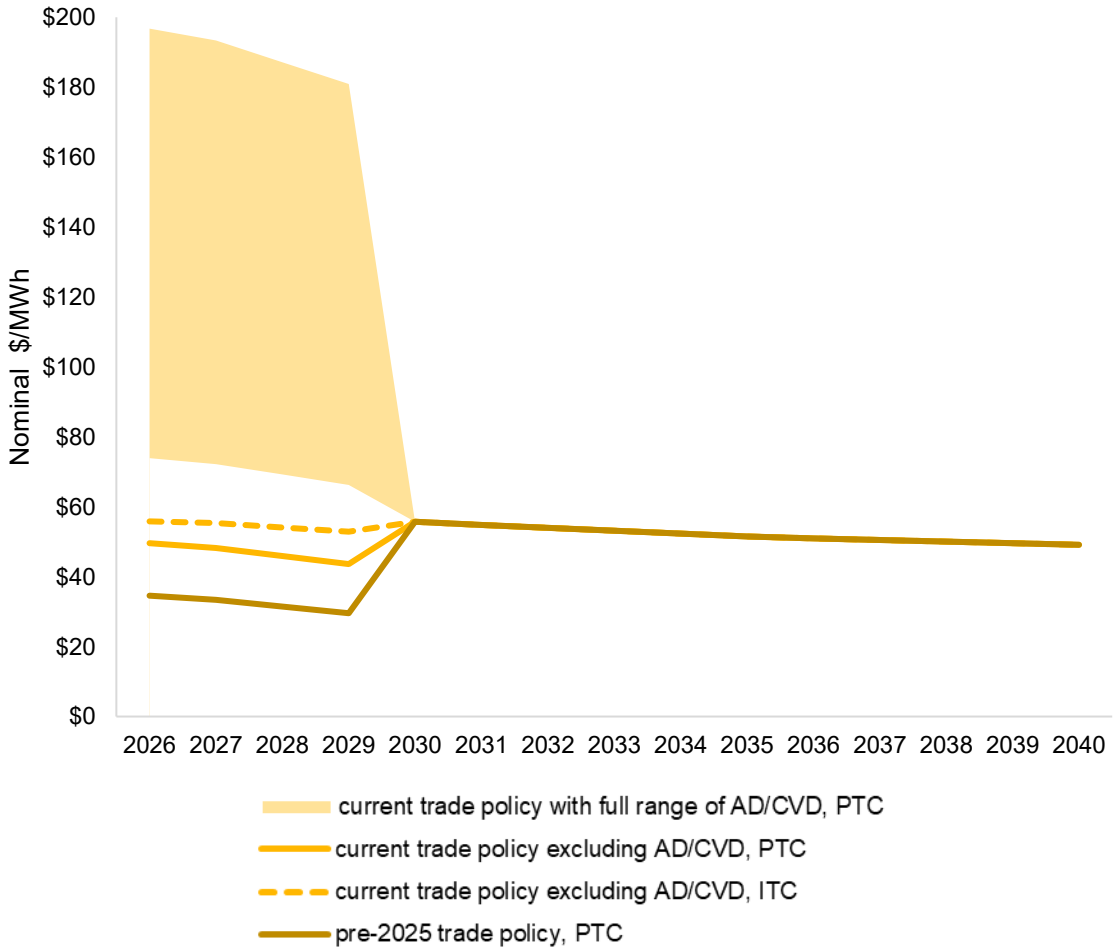


Solar Tariff Impact Details

- While the percentage of capex at risk for solar (70%) is less than that for BESS (121%), the range of potential tariff costs for solar is currently wider
- Total solar capex could increase by 30%, 79%, 221%, or 326% under current tariffs with minimum, average, or high Anti Dumping / Countervailing Duty (AD/CVD) rates imposed by the U.S. Commerce Department
- The levelized cost of solar energy could increase by 44% - 470% under current tariffs without and with minimum, average, or high AD/CVD tariff rates

E3 Solar LCOE Forecast under Tariffs Impact

Nominal $/MWh, 34% Capacity Factor



System Planning Using RECOST: LCOE and LCOC

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Effective Load Carrying Capability: RECOST Impacts

+ **RECOST forecasts the fundamental economic costs of a given resource, anywhere in North America**
  - These forecasts are agnostic to ELCC, and may be thought of as the price of 'perfect capacity' described earlier
+ **The capacity value of a resource as reflected under a capacity contract (e.g., Resource Adequacy in California) will be different for every system in North America**
  - ELCC reflects the capacity mix of the system to which the new resource is added as well as the load characteristics of the system, both of which will vary from market to market
+ **Therefore, E3 recommends calculating expected capacity payments for a given resource by applying an ELCC adjustment to the Levelized Fixed Costs shown in these materials**
  - Conversely, calculating the capacity cost in effective capacity term requires dividing the nameplate capacity by the ELCC input for comparability to other resources with higher and lower ELCC

For an energy storage resource where:
Nameplate Capacity = 100MW
State-Specific Levelized Fixed Cost (Recost Output) = 150 $/kW-yr
Resource- and Market-Specific ELCC = 80%

Expected Annual Capacity Payment = 100MW * 150$/kW-yr * 80% * 1000MW-per-kW = **$11.25mm, or 112.50 $/kW-yr**

and Levelized Cost of Capacity = 150$/kW-yr ÷ 80% = **187.50$/kW-yr**

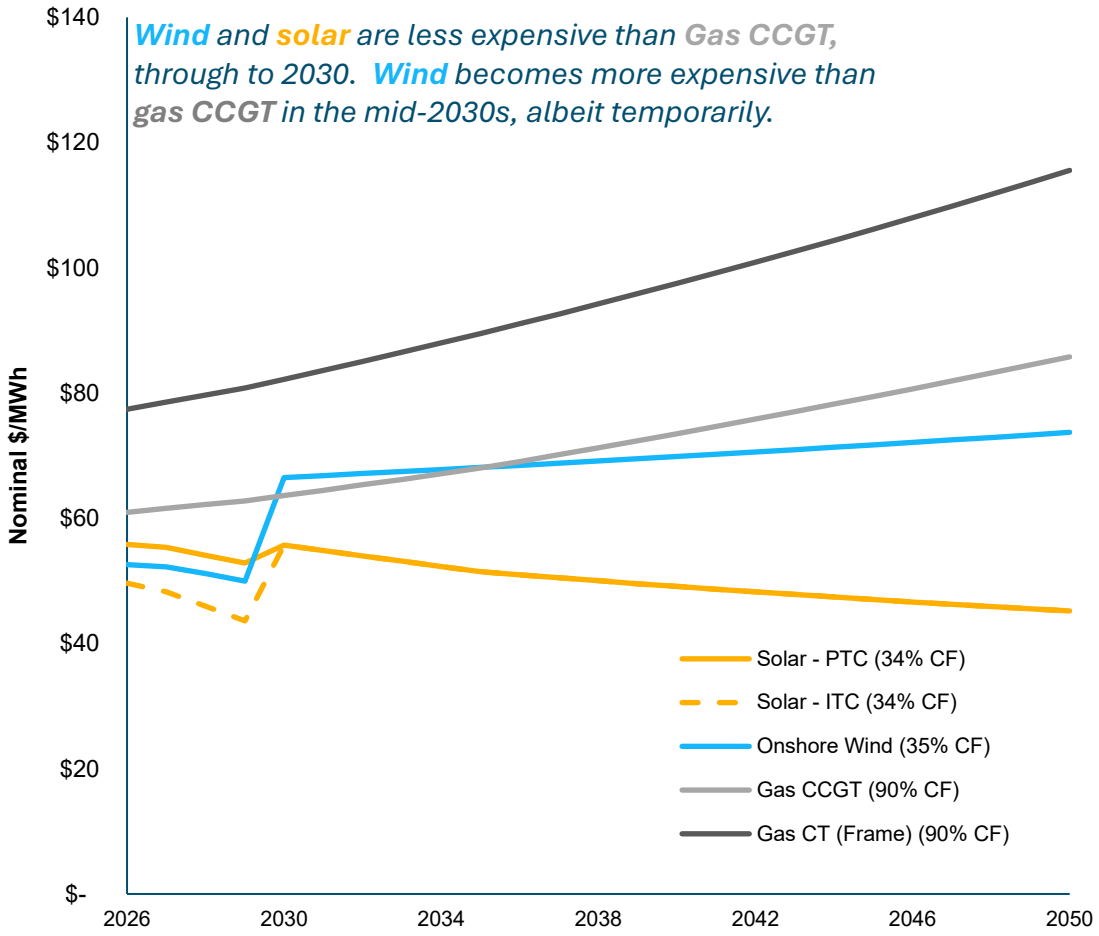
Note: Calculation above is simplified and excludes adjustments for additional contract terms (e.g., round-trip efficiency, operating deviation factors).

Resource Comparison: LCOE for Available Energy and LCOC

RECOST Forecasts: Q3 2025

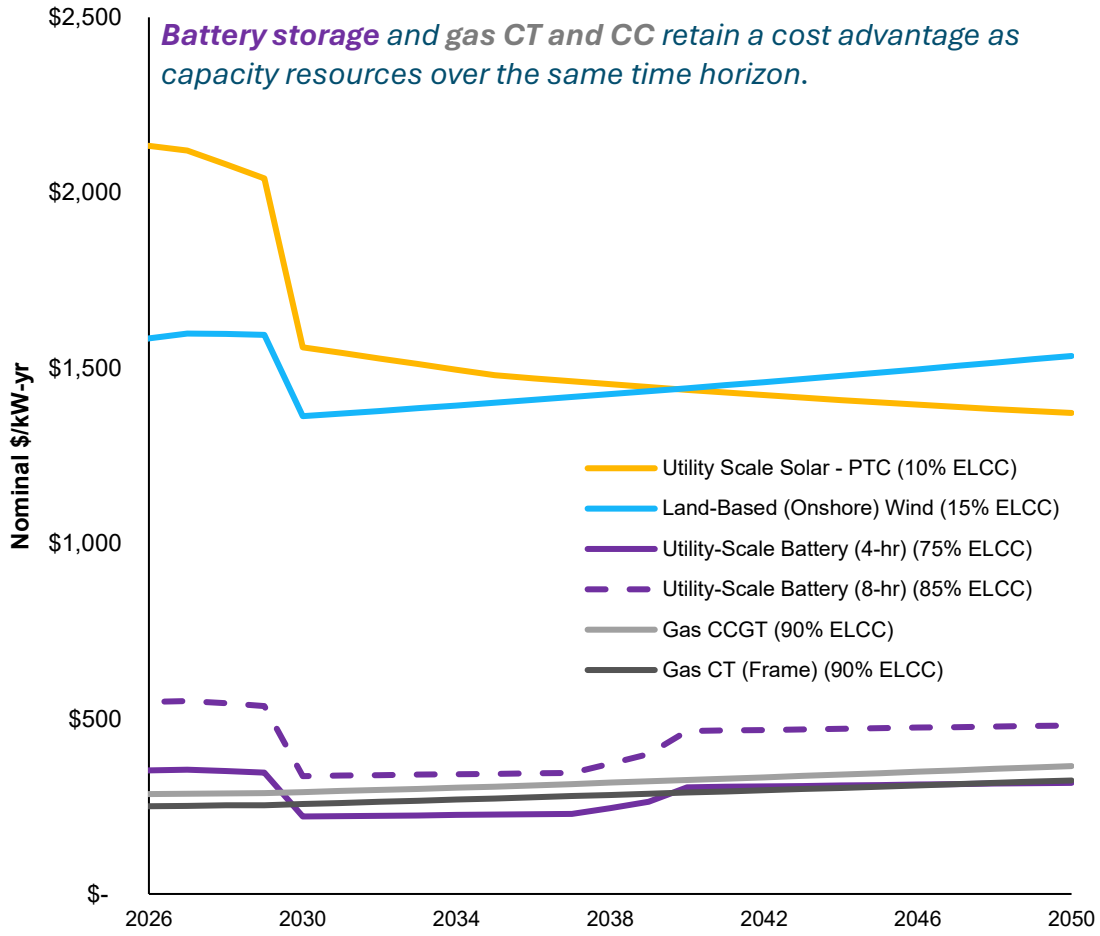
E3 LCOE Forecast

Nominal $/MWh of Available* Energy, Mid Cost Forecast



E3 LCOC Forecast

Nominal $/kW-yr of Effective Capacity, Mid Cost Forecast



* Available energy denotes the technical potential output of a project, without adjusting for congestion or curtailment (physical or economic). LCOC excludes energy revenues.

Stepping Back: What's in a Contract?

Levelized Costs Versus PPAs

+ **RECOST calculates the recovery of all project costs over the technical life of the project, discounted by a specified cost of capital and levelized over total project output (or capacity, for LFC)**
  - By default, IPP financing assumptions are used to calculate the cost of capital
  - Term (years) used for debt is always matched to PPA term, even though costs post-PPA are still captured in the final LCOE or LFC output
+ **It may not always be appropriate to compare levelized costs to PPA price offers, for a variety of reasons:**
  1) Market evidence is overwhelming that PPA term tends to fall below operating life over which levelized costs are calculated; LevelTen Energy estimates the average term length for solar and wind PPA offers in Q3 2024 at ~14 years
  2) PPAs typically recover less than 100% of project costs; the term for debt used to finance the project will not exceed the PPA term
  3) PPAs may be priced as an initial value that escalates over time, or as a flat nominal price for the contract term
  4) In any given year, for any given technology, a PPA will reflect the degree to which buyers versus sellers have greater pricing power, which are shaped in large part by factors exogenous to this analysis
     1) Supply chain cost shocks or improvements are typically not foreseeable in terms of exact timing
     2) Macroeconomic shocks such as inflation, and ensuing changes in the Federal Funds rate can lift or depress pricing dynamics
     3) Credit rating upgrades or downgrades can impact leverage potential and associated PPA pricing for reasons specific to the developer
+ **Even if we were to assume that economic life is equal to technical life, and the PPA will recover 100% of project costs, this does not mean that LCOE or LFC are equivalent to a PPA price: the quantity of energy or capacity guaranteed by a PPA does not need to be equal to technical (available) generation or capacity**
  - PPAs are often signed for a portion of plant output, either to facilitate multi-party contracting arrangements or because a developer is being conservative in their guarantees (or is forced into being conservative), inclusive of potential curtailment adjustments or risk that may be shared between the buyer and seller of power

About E3 and RECOST

Energy+Environmental Economics

Who is E3?

Thought Leadership, Fact Based, Trusted.

130+ full-time consultants

30+ years of deep expertise

Engineering, Economics, Mathematics, and Public Policy Degrees


San Francisco


New York

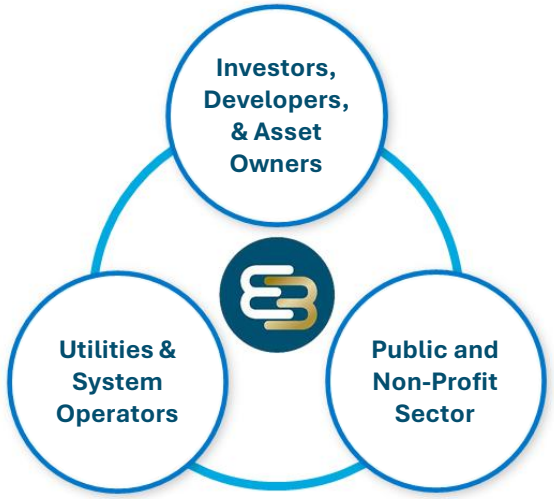

Boston


Calgary


Denver

E3 Clients

300+ projects per year across our diverse client base



Asset Classes Supported by E3

- Utilities
- Thermal Resources
- Transmission
- New and Emerging Technologies
- Electric Vehicles and Infrastructure
- Software and IoT
- Decarbonized Fuels
- Energy Storage
- On/Off-Shore Renewables
- Distributed Generation and Flexible Loads

Who is E3?

Our Practice Areas

+ **E3 is the largest consulting firm focused on the clean energy transition in North America**
+ **E3 is a recognized thought leader on decarbonization and clean energy transition topics**
+ **E3 has three major practice areas covering energy systems from bulk grid to behind the meter**

Climate Pathways & Electrification

- Long-term energy & climate scenarios
- Electrification and low-carbon fuels analysis
- Future of gas

Asset Valuation & Markets

- Energy market price forecasting
- Strategic advisory
- Due diligence
- Market design
- Transmission planning

Integrated System Planning

- Electric system planning: reliability and resource analysis
- Planning for utility and state RPS + GHG targets
- Utility planning and procurement decisions

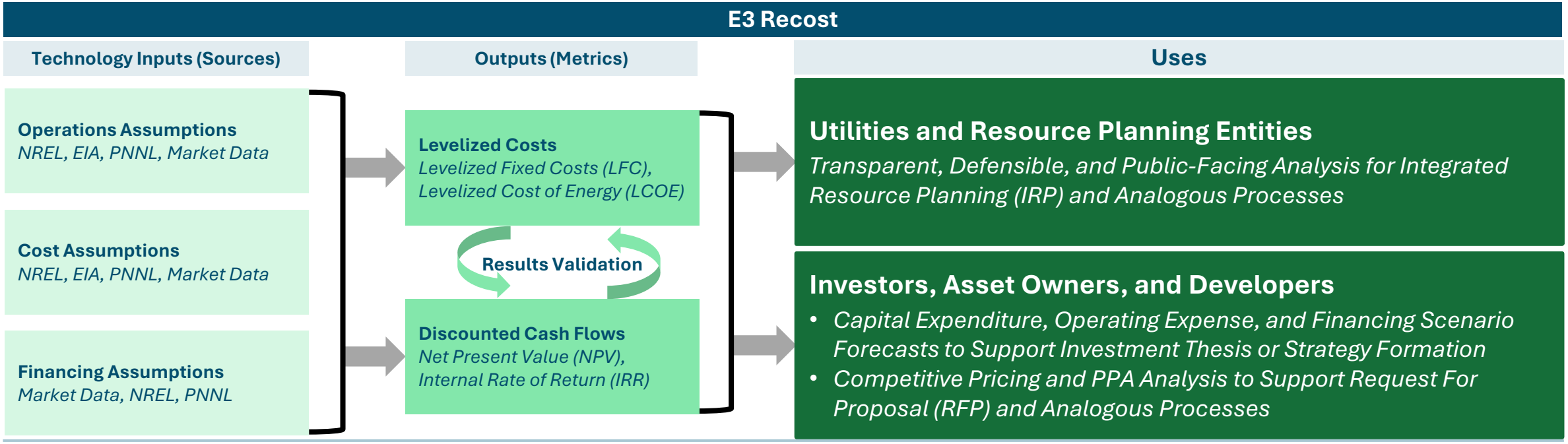
Economy-Wide Energy Systems — Bulk Grid Power Systems — Grid Edge / Behind-The-Meter

What is E3 RECOST?

Overview of Model and Use(s)

- **Recost** is E3's in-house discounted cash flow model used to calculate levelized fixed costs and levelized cost of electricity for mature and emerging technology resources, inclusive of financing costs
- **Recost** is optimized for two goals:
  1) Evaluate the fundamental economic costs of building new resources to inform energy system modeling, validate investment theses, and shape resource strategy for public and private sector stakeholders
  2) Estimate the expected cost to contract these resources under Power Purchase Agreements (PPAs), and support the calculation of Levelized Cost of Capacity (LCOC) using each resource's Effective Load Carrying Capability (ELCC)

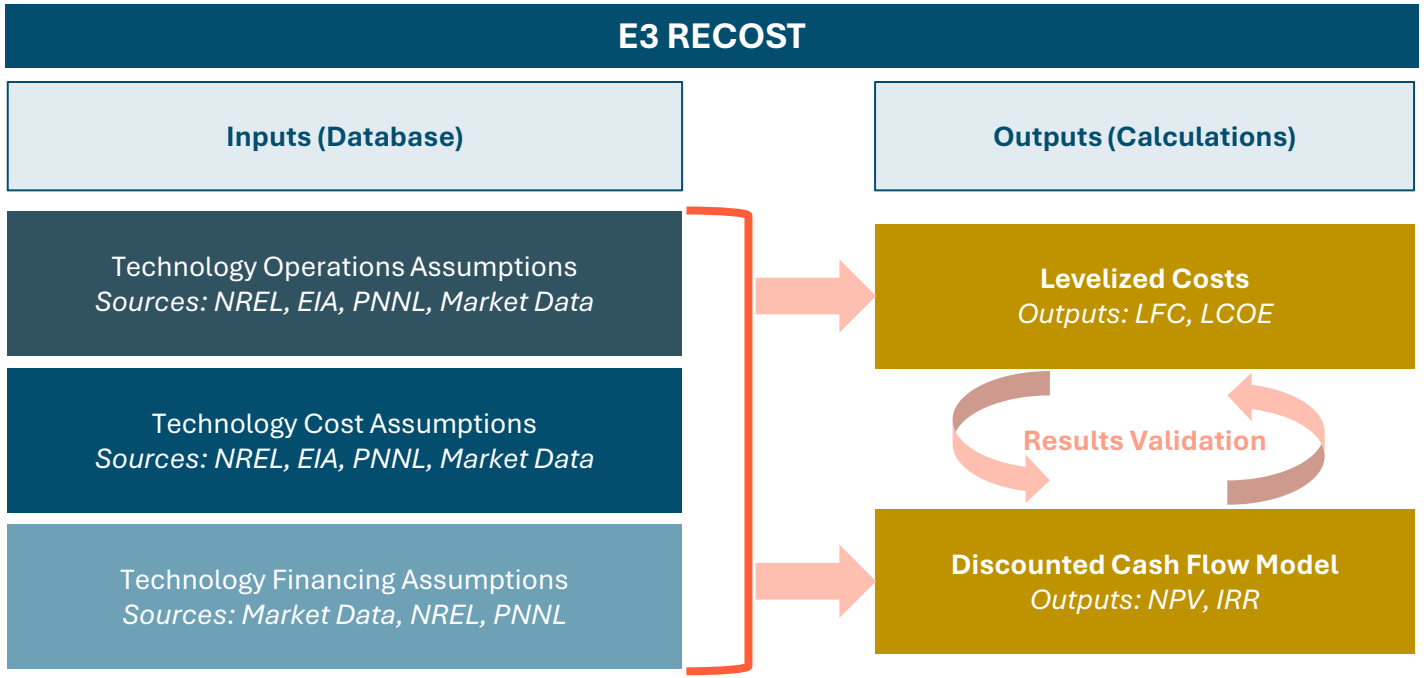
Recost is built to inform the ongoing debate around how to finance and build the resources necessary for the energy transition by leveraging E3's expertise on this topic



E3 Resource Cost Estimates

RECOST Model Overview

+ **E3's RECOST model calculates levelized fixed costs (LFC) and the levelized cost of electricity (LCOE) for a range of conventional and emerging technologies**
  - LFC is reported in $/kW-yr, and LCOE is reported in $/MWh
+ **LFC and LCOE are calculated by initial commercial operations date (COD), from 2025 through 2050**
+ **RECOST estimates are calculated using inputs from various sources:**



Calculation of Levelized Costs

RECOST Model Overview

+ **Levelized Fixed Cost (LFC) ($/kW-yr):** the levelized ***capacity*** payment that a system would need every operating year over its useful life to cover fixed costs, including amortized capital costs (capex), fixed operations and maintenance (O&M) costs, property taxes, and investment tax credits (if applicable)
  - This output is used to calculate Levelized Cost of Capacity (LCOC) by adjusting for Effective Load Carrying Capability
+ **Levelized Cost of Electricity (LCOE) ($/MWh):** the levelized ***energy*** payments that a system would need for every operating hour over its useful life to cover all costs, including fixed cost components as well as fuel costs, variable O&M, and the federal production tax credit (if applicable)
  - An electricity generator that collects revenue over its useful life at the LCOE will have an NPV of $0

$$\mathbf{LFC} = \frac{\mathrm{NPV}(\text{Fixed Costs}, \$)}{\mathrm{NPV}(\text{Capacity}, \mathrm{kW})}$$

Fixed Costs =
+ Capital Expenditures and Interconnection Costs
+ Investment Tax Credit
+ Fixed O&M
+ Property Taxes
+ Warranty
+ Repowering & Augmentation

$$\mathbf{LCOE} = \frac{\mathrm{NPV}(\text{Total Costs}, \$)}{\mathrm{NPV}(\text{Energy}, \mathrm{MWh})}$$

Total Costs =
+ LFC
+ Variable O&M
+ Fuel
+ Production Tax Credit

What is E3 RECOST?

Technologies Evaluated in RECOST

***RECOST** currently evaluates the following technologies, with the ability to modify any cost or operating parameter as appropriate:*

Biomass	Dedicated Biopower
Energy Storage*	1) Utility-scale lithium-ion battery storage 2) BTM lithium-ion battery storage 3) Pumped storage hydro (PSH) 4) Long-duration energy storage (LDES) technologies*
Geothermal	1) Hydrothermal (Flash, Binary) 2) Enhanced (Flash, Binary)*
Hydropower	1) New Non-Powered Dams (NPD) 2) Existing Non-Powered Dams
Hydrogen*	1) Production (electrolysis) 2) Storage 3) Transport 4) Conversion and combustion, including CCGTs, CTs, and fuel cells*
Natural Gas*	1) Natural gas combustion turbines (CT) 2) Combined cycle gas turbines (CCGT) 3) Reciprocating internal combustion engines (RICE) 4) CCGT new build and retrofit units equipped with carbon capture and storage (CCS)*
Nuclear*	1) Small modular reactor (SMR) units 2) Pressurized water reactor (PWR) units
Solar	1) Utility-scale solar photovoltaic (PV) systems 2) Commercial behind-the-meter (BTM) solar PV 3) Residential behind-the-meter (BTM) solar PV 4) Solar thermal systems
Wind*	1) Onshore wind 2) Offshore wind (fixed-bottom) 3) Offshore wind (floating)

** Includes emerging technologies evaluated by E3.*

Thank You

marketprices@ethree.com

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