

Existing Power Plants Sharing Grid Access with New Resources Can Accelerate Energy Deployment and Lower Costs in Pennsylvania

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Fast-tracking 16 GW of new capacity using existing grid with \$1.4B savings





The Challenge

-  Pennsylvania has 21 GW across 694 projects in the PJM interconnection queue, with average connection timelines exceeding 5 years, over 40 months to reach interconnection agreement, plus 2+ years for construction.
-  PJM capacity market prices have surged from \$29/MW-day (2024/25) to \$333/MW-day (2027/28), an 11x increase in three years, hitting the price cap and signaling urgent need for new capacity.
-  New gas plants ordered today won't come online until 2030-2031 at earliest, with capital costs surging to \$2,200-2,800/kW for recent combined-cycle projects (GridLab, 2025).
-  Pennsylvania faces explosive data center demand. PPL alone has 25.2 GW of potential projects with signed agreements. Power availability is the primary site selection factor, but extended interconnection timelines limit competitiveness.

The Solution

-  10.5 GW of Pennsylvania's thermal capacity (31%) operates at less than 20% capacity factor. Similarly, solar plants (15.1% CF) severely underutilize their interconnections, leaving expensive grid infrastructure idle most of the time.
-  Deployment of new generation at these existing underutilized plants can provide cost-effective energy and capacity without building new transmission infrastructure, bypassing lengthy interconnection queues.
-  Pennsylvania can add up to 10 GW of clean energy capacity through surplus interconnection: 9.5 GW solar + 0.5 GW wind at thermal plants. An additional 6.6 GW is achievable at existing renewable plants through co-location of complementary resources and 2.3 GW of battery storage.
-  Surplus interconnection can save \$1.4 billion in interconnection costs, equivalent to \$256 per Pennsylvania household. Projects can be completed in 12-18 months compared to 5+ years for standard queue projects.

Policy Recommendations

-  Require the Pennsylvania Public Utility Commission and utilities to evaluate surplus interconnection potential in resource planning, identifying which existing plants offer the best opportunities for co-location of solar, wind, and storage resources.
-  Develop procurement mechanisms for surplus interconnection projects, including RFPs for specific plant sites and Purchase and Sale Agreement structures to enable third-party development at utility-owned facilities.
-  Streamline land permitting near existing thermal sites. Projects co-located at existing generation facilities have inherently lower land-use and environmental impacts and should qualify for expedited approval pathways.
-  Require evaluation of surplus interconnection opportunities before approving new greenfield generation capacity. Co-location at existing sites saves transmission costs and accelerates deployment compared to building new infrastructure.

Data Center Drive massive load growth in Pennsylvania

~60%+

Projected peak demand increase in PPL territory by 2030

🏢 Pennsylvania: The Emerging Data Center Powerhouse

Data centers are driving up to 94% of peak load growth in PJM, with Pennsylvania at the epicenter. PPL Electric Utilities alone has 25.2 GW of signed data center agreements — more than triple its current peak demand.

⚡ Data Center Mega-Investments

Amazon (\$20B+, 1.4 GW by 2028), Microsoft (\$1.6B Three Mile Island restart, 835 MW), Meta/Vistra (2,600 MW from Beaver Valley nuclear), and Google (\$3B PPA, 670 MW hydro) are collectively investing over \$90B in Pennsylvania's energy infrastructure.

📈 Unprecedented Utility Load Growth

PPL territory peak demand is expected to jump from 7,300 MW (2025) to ~12,000 MW by 2030. FirstEnergy projects a 45% system peak increase (+15 GW) by 2035. Up to 38 planned data center projects could require 19,632 MW of new capacity.

94%

PJM Load Growth from Data Centers

64%

PPL Peak Demand Growth

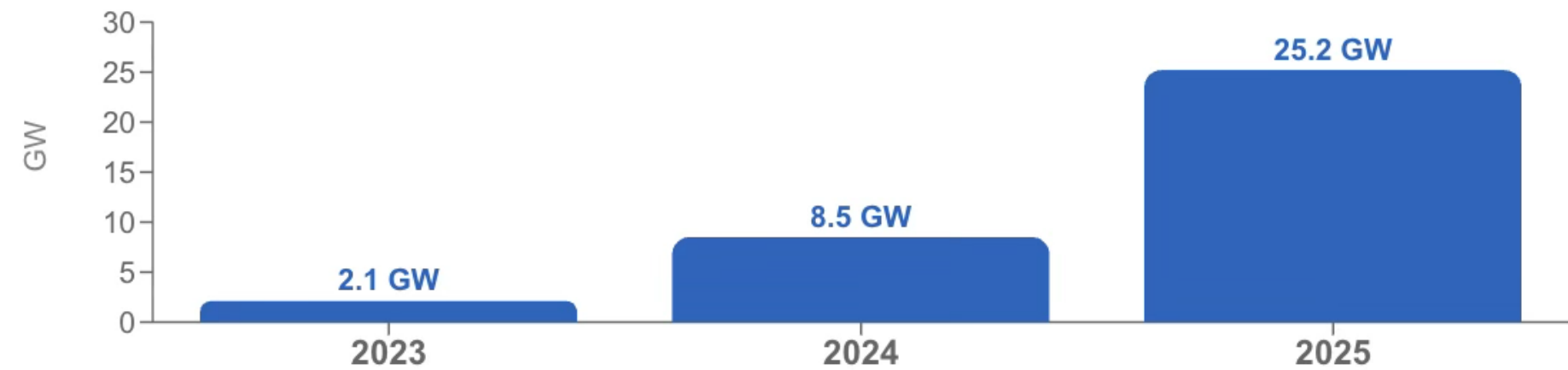
45%

FirstEnergy Peak Growth

\$92B+

Total DC Investment

⚡ PPL Data Center Agreements (GW Signed)



📈 PPL Territory Peak Demand Projection (MW)



Gas dominates the 7 GW of capacity in pipeline in Pennsylvania

Project Pipeline

Pipeline Summary:

- Total Projects: 89
- Total Capacity: 7,380 MW
- 20% increase from current capacity

Capacity by Category:

Renewables: 2,660 MW (36%)

Solar, wind, and hybrid projects

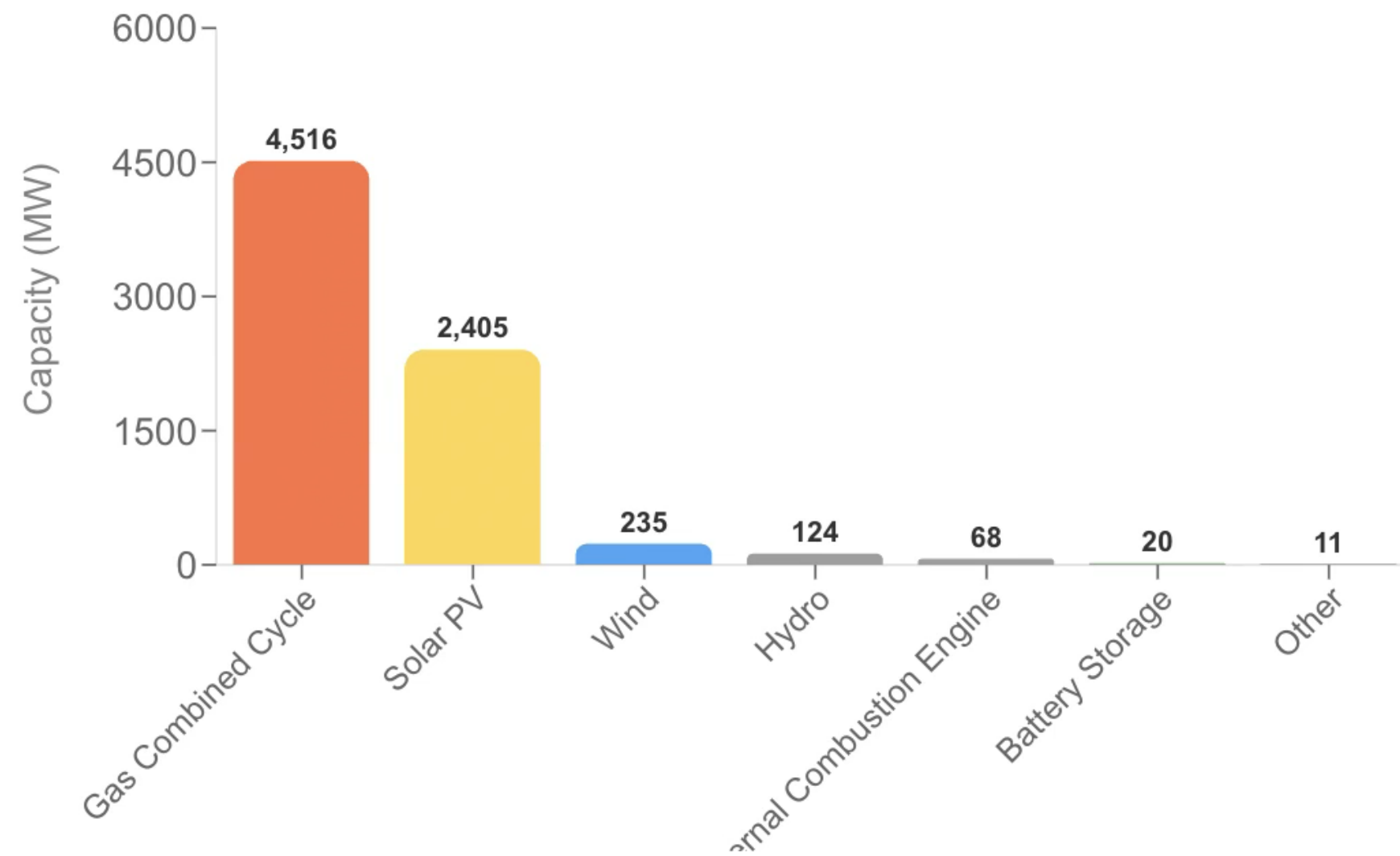
Storage: 20 MW (0%)

Battery energy storage systems

Natural Gas: 4,516 MW (61%)

CCGT and internal combustion engines

Upcoming Capacity by Technology Type (MW)



Total pipeline represents 20% of Pennsylvania's existing capacity

Projects in interconnection queue takes 5+ years

 **21.3 GW**

Total upcoming capacity in PA queue (694 projects)

 **83%**

RE+Storage share of queue (solar+battery+wind)

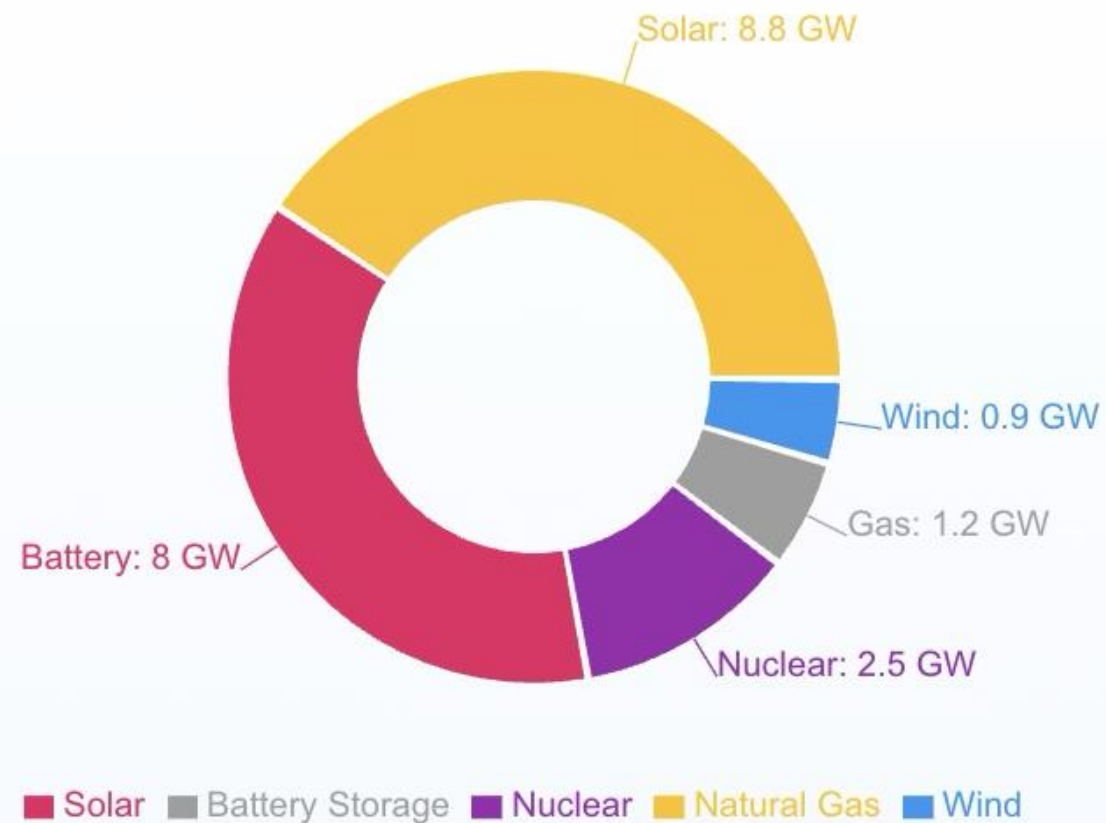
 **694**

Upcoming projects in queue

 **37.6%**

Battery storage share of queue

Technology Distribution (Active Projects)



Total Active Queue Capacity:

21.3 GW (694 projects)

Pennsylvania's Interconnection Queue Breakdown

- **Solar capacity:** 8.8 GW (492 projects) — the largest technology in Pennsylvania's queue, reflecting growing solar development momentum.
- **Battery storage:** 8 GW (156 projects) driven by high PJM capacity prices (\$333/MW-day) creating strong economics for grid flexibility.
- **Nuclear:** 2.5 GW (4 projects) including Three Mile Island Unit 1 restart (Constellation/Microsoft) and Peach Bottom uprates.
- **Wind:** 0.9 GW (29 projects) and **Natural Gas:** 1.2 GW (11 projects) round out the queue.
- **Queue scale:** 21.3 GW across 694 upcoming projects — these face 5-7 year wait times through the traditional interconnection process.

Source: PJM Interconnection Queue via GridStatus.io API (March 2026). Upcoming = Active + Engineering & Procurement + Under Construction. Excludes withdrawn and in-service projects.

PJM Reliability Emergency: First-Ever Capacity Shortfall

⚠️ For the first time in PJM history, the capacity auction failed to meet reliability requirements — falling 6,623 MW short.
 NERC has flagged PJM as "elevated risk" for energy shortfalls. PJM Board ordered emergency Reliability Backstop Procurement.

📉 Supply-Demand Gap Widening

- **~40 GW at risk of retiring by 2030** — 21% of PJM installed capacity (PJM Energy Transition Report)
- **12 GW** of announced retirements + 25 GW policy-driven + 3 GW economic
- Only **~2.5 GW** new generation entered service in 2025 (~90% solar)
- **+32 GW** peak demand growth projected by 2030 (driven by data centers)
- **Gap grows from 10 GW to 30 GW by end of decade**

⚠️ Interconnection Queue Bottleneck

- **~260 GW** total in PJM queue; ~50 GW actively processed (PJM 2026)
- Historical completion rate: **only ~15%** (IMM 2025)
- ~80% of proposed projects withdraw before reaching COD
- Standard queue timeline: **5-8 years** to commercial operation

⚡ Capacity Prices at Historic Highs

- Prices surged from **\$29/MW-day** (2024/25) to **\$333/MW-day** (2027/28)
- 2027/28 price hit FERC-approved **price cap** — unable to signal true scarcity
- **11x price increase** in just 3 delivery years
- **Signals urgent need for new capacity deployment pathways**

📈 PJM Reserve Margin Collapse vs. Reliability Target



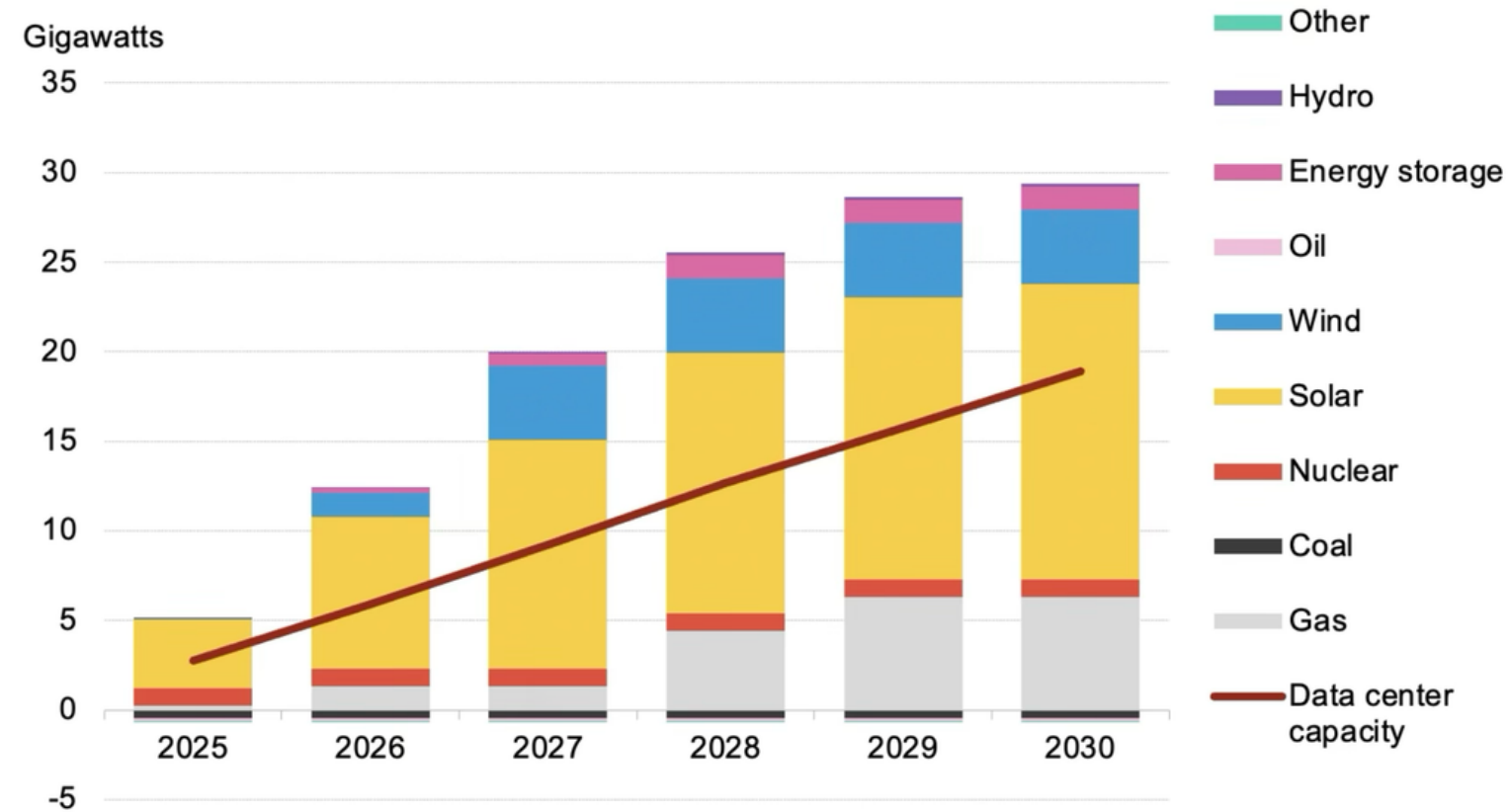
14.4% 2027/28 Reserve Margin	20.0% Target Reserve Margin	6,623 MW Capacity Shortfall	\$333/MW-day Record Capacity Price
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Sources: PJM 2027/28 BRA Report; PJM Energy Transition Report; NERC Long-Term Reliability Assessment; Monitoring Analytics State of the Market (2025)

PJM Faces a 9.5 GW Effective Capacity Shortfall by 2030 - BNEF

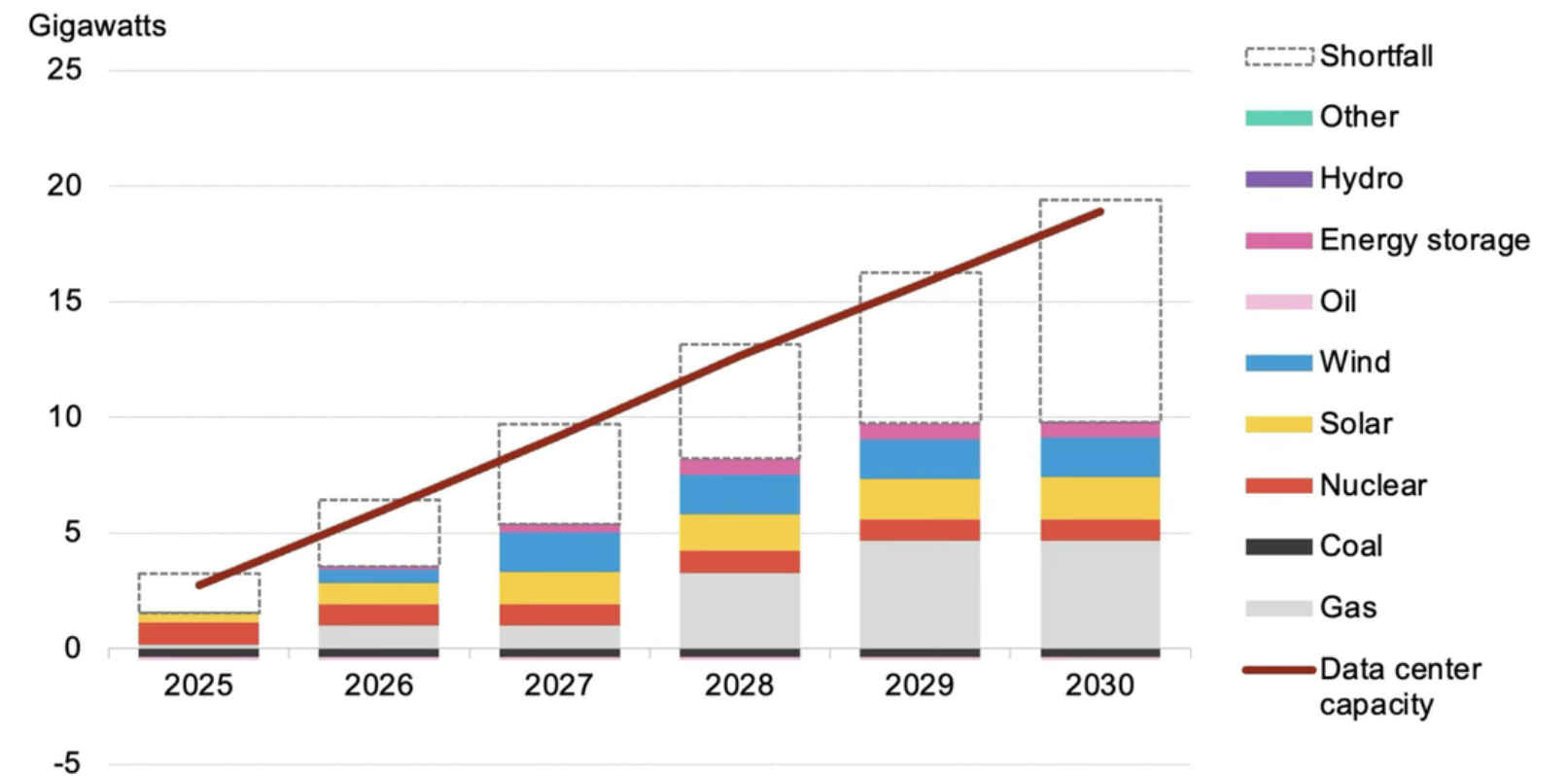
▲ Supply vs. Demand Mismatch: BNEF forecasts PJM data center load reaching **31 GW by 2030**. EIA projects **28.7 GW** of new supply additions — barely keeping pace with data center growth alone. When adjusted for effective load carrying capacity (ELCC), PJM faces a **9.5 GW shortfall** by 2030. [BNEF]

Supply by Nameplate Capacity



New supply additions (57% solar, 22% gas, 14% wind) appear sufficient on nameplate basis

Supply by Effective Load Carrying Capacity (ELCC)



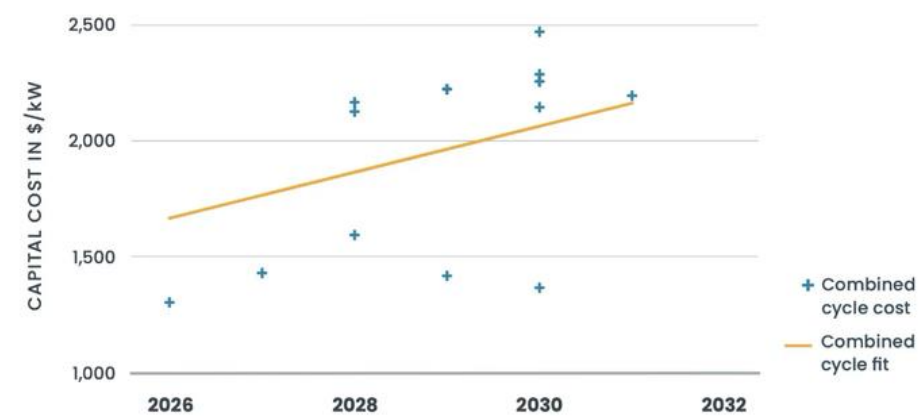
When adjusted for reliability contribution, a **9.5 GW shortfall** emerges by 2030

New Gas Would Not Come Online Before 2030 — At Double the Cost

Gas Turbine Capital Costs Have Doubled

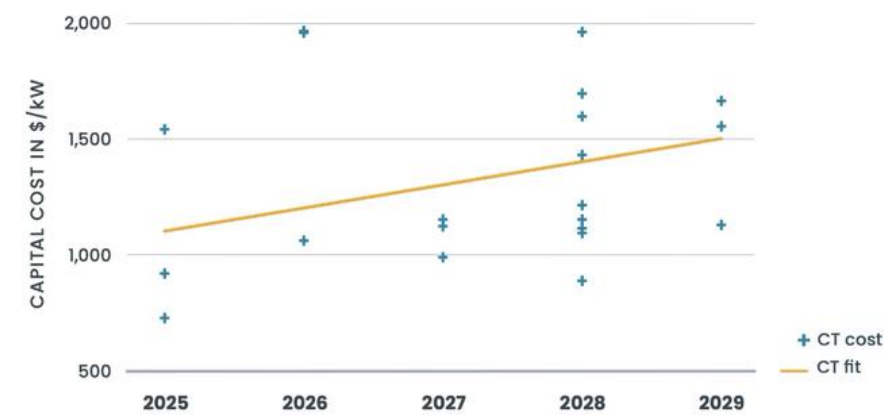
Combined Cycle (CCGT)

COMBINED CYCLE GT COST VS. OPERATING YEAR
Linear regression includes only operating year



Simple Cycle (CT)

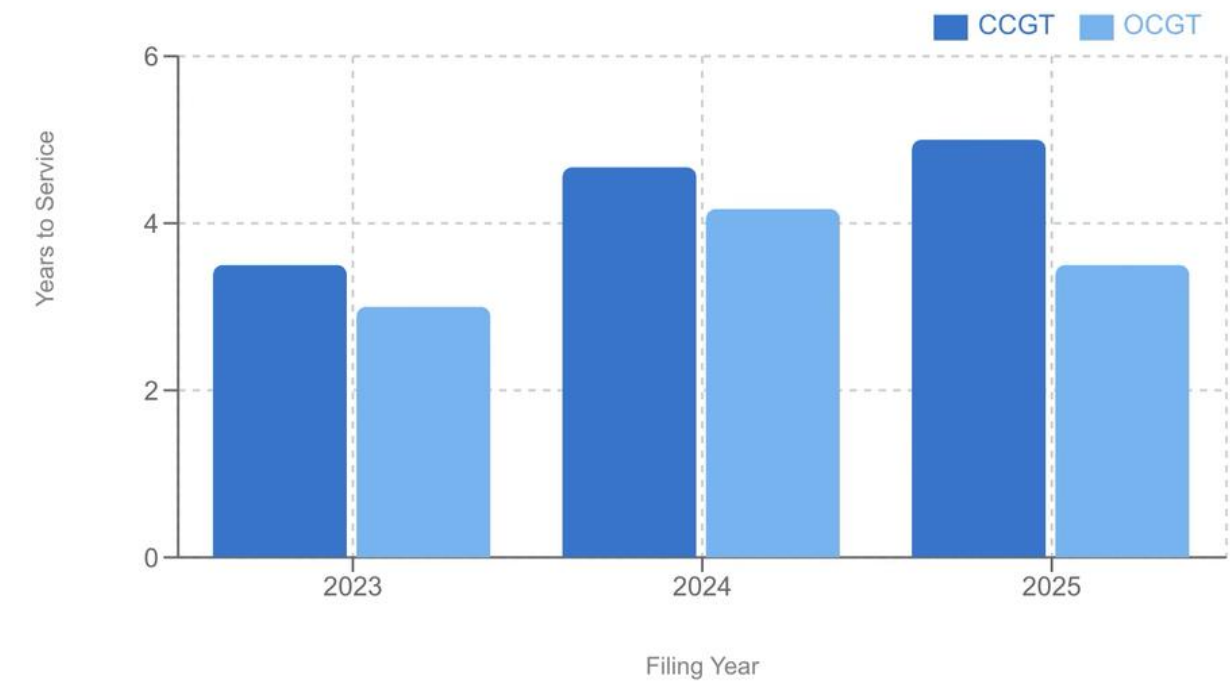
CT COST VS. OPERATING YEAR
Linear regression includes only operating year



Source: GridLab "The New Reality of Power Generation" Report, September 2025

Gas Lead Times Are Growing

Gas Project Lead Times by Filing Year



⚠️ A gas project filed today would not be operational until 2030-2032

CCGT Lead Times:

- 2023: 3.5 yrs
- 2024: 4.7 yrs
- 2025: 5.0 yrs

Why Increasing:

- Supply chain constraints
- Queue backlogs (6+ yrs)
- Permitting delays
- Labor shortages

Source: BloombergNEF Gas Plant Tracker

Thermal plants are underutilizing their interconnection capacity

🔥 Interconnection Underutilization

Thermal plants like peaker gas plants and oil/gas steamers operate at extremely low capacity factors. In Pennsylvania, peaker gas plants operate at 16% capacity factor and oil/gas steamers operate at 13% capacity factor, meaning for 84% of the time and 87% of the time, respectively, the interconnection capacity sits idle.

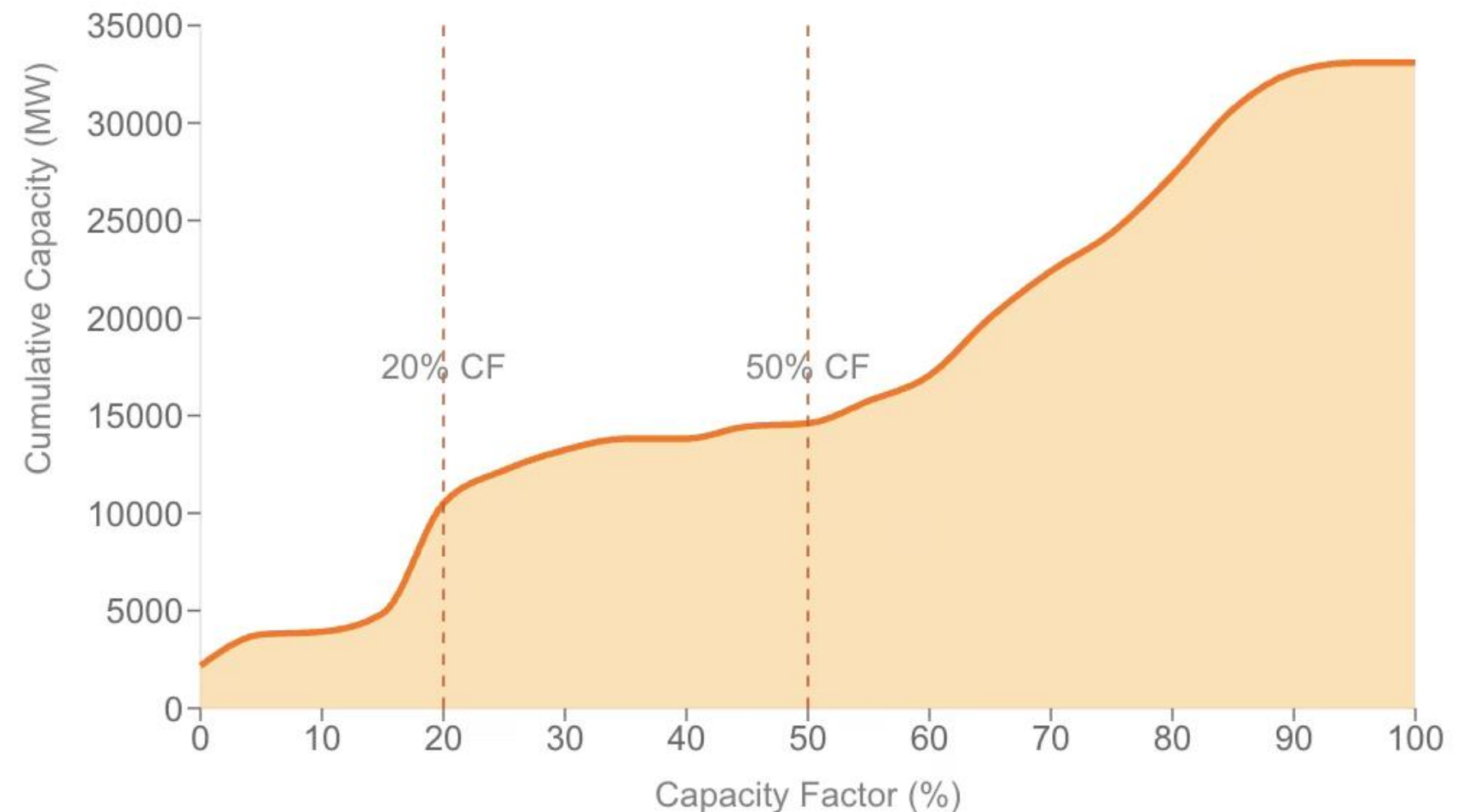
↗ 2024 Thermal Capacity Factors

- Gas CCGT: 72%
- Oil/Gas Steam: 13%
- Coal: 19%
- Gas CT: 16%

📊 Underutilized Interconnection Capacity

- **10.5 GW** operates at <20% capacity factor
- 38.8% of capacity operates below 30% CF

↗ Cumulative Thermal Capacity by Capacity Factor



Steep rise shows majority of capacity concentrated in low-utilization plants

Renewables are underutilizing their interconnection capacity

Two Dimensions of Underutilization

Pennsylvania renewables underutilizing interconnection capacity from both firm capacity and energy perspectives

⚡ RE Energy Production Gap

Solar operates at 15.1% and wind at 23.9% capacity factor, leaving 84.9% and 76.1% of interconnection capacity idle respectively

ⓘ ELCC Value Disparity

PJM assigns only 8% ELCC for tracking solar and 41% for wind (2027/28 BRA), compared to 95% for nuclear and 74% for gas combined cycle

⚠ Firm Capacity Shortfall

2.3 GW of installed renewable capacity provides only 0.7 GW of firm capacity — just 30% of nameplate capacity

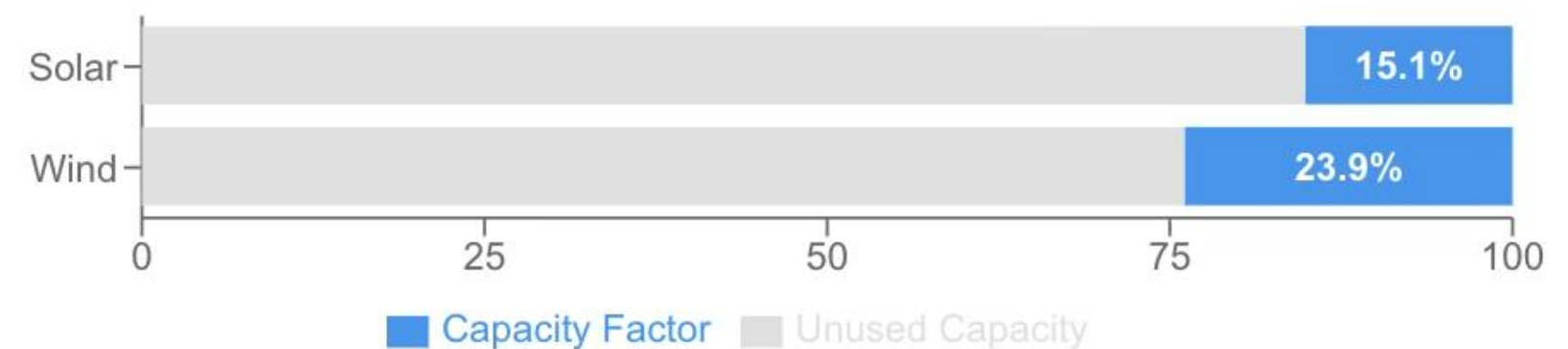
⚡ Storage as the Solution

4-hour storage receives 58% ELCC in PJM — significantly higher than standalone solar

▬ Firm Capacity vs. Installed Capacity (GW)



↗ Renewable Energy Capacity Factors (%)



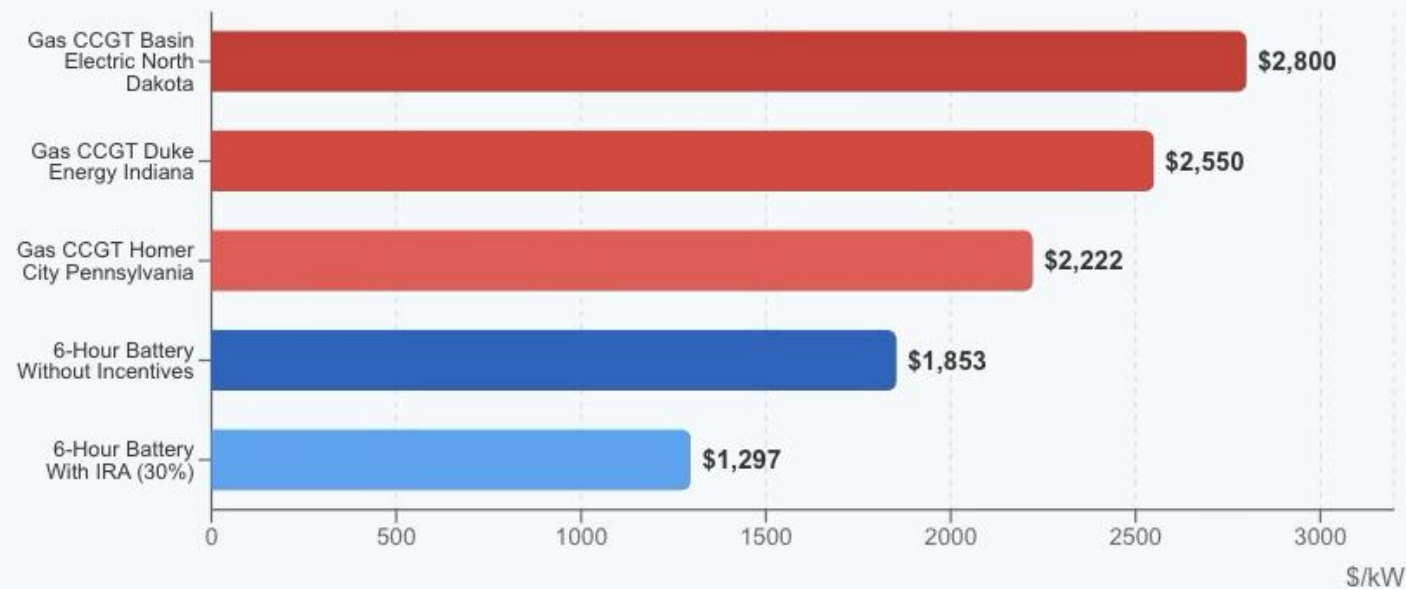
PJM 6H Storage ELCC comparable with Gas

The Cost of Firm Capacity

ELCC measures how much a resource contributes to meeting peak demand. 6-hour battery storage delivers **67% ELCC** — comparable to Gas CC at 74% — but at a fraction of the capital cost.

New gas CCGT capital costs have surged to **\$2,200-2,800/kW**, far above industry projections. Battery storage is now the lowest-cost source of firm capacity.

Capital Cost Comparison (\$/kW)



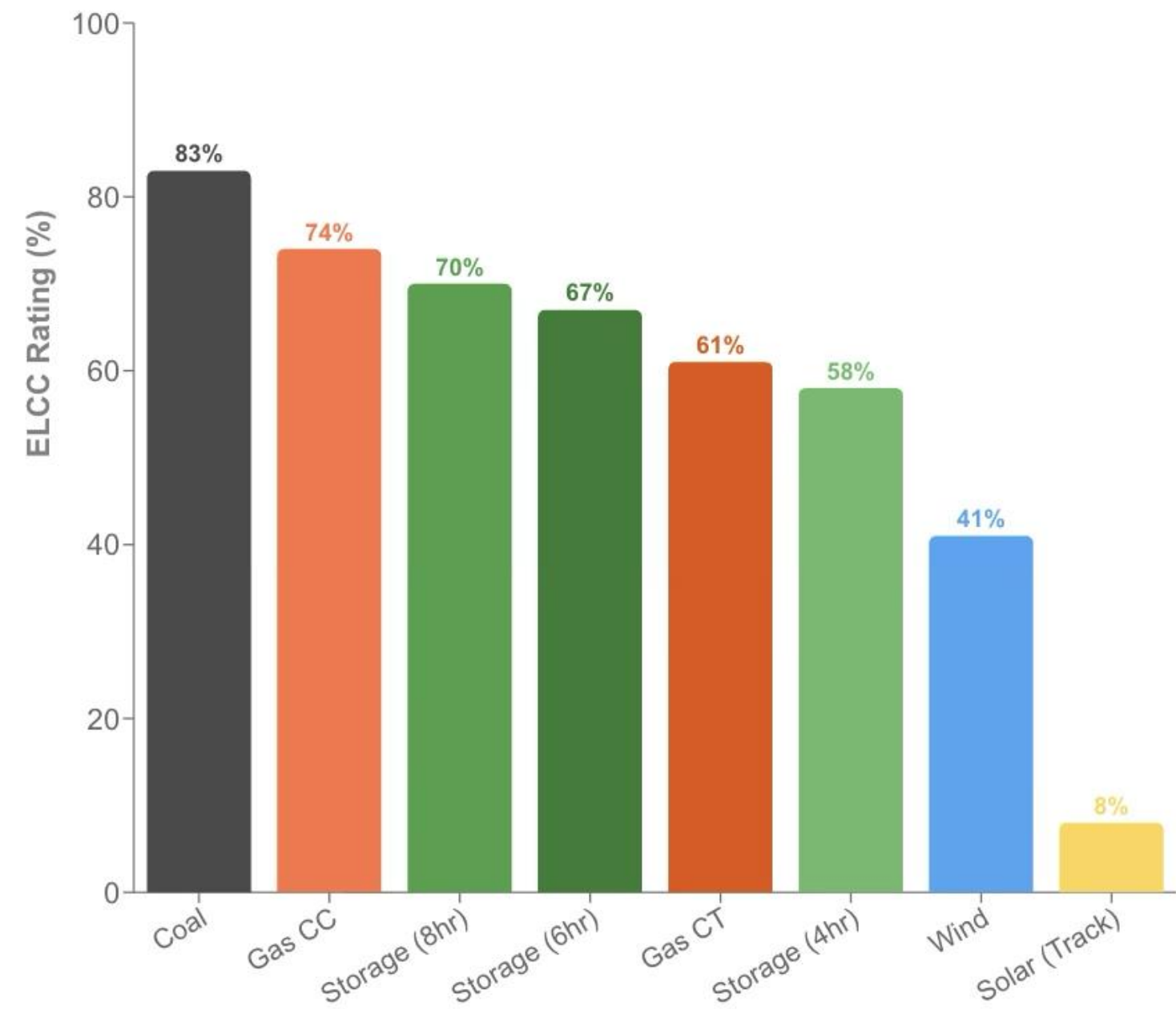
Cost per kW of Firm Capacity

- Gas CC: \$2,550 / 74% ELCC = **\$3,446/kW-firm**
- 6hr Battery: \$1,853 / 67% ELCC = **\$2,766/kW-firm**
- 6hr Battery w/ IRA: \$1,297 / 67% ELCC = **\$1,936/kW-firm**

Batteries deliver firm capacity at 44-56% lower cost than new gas

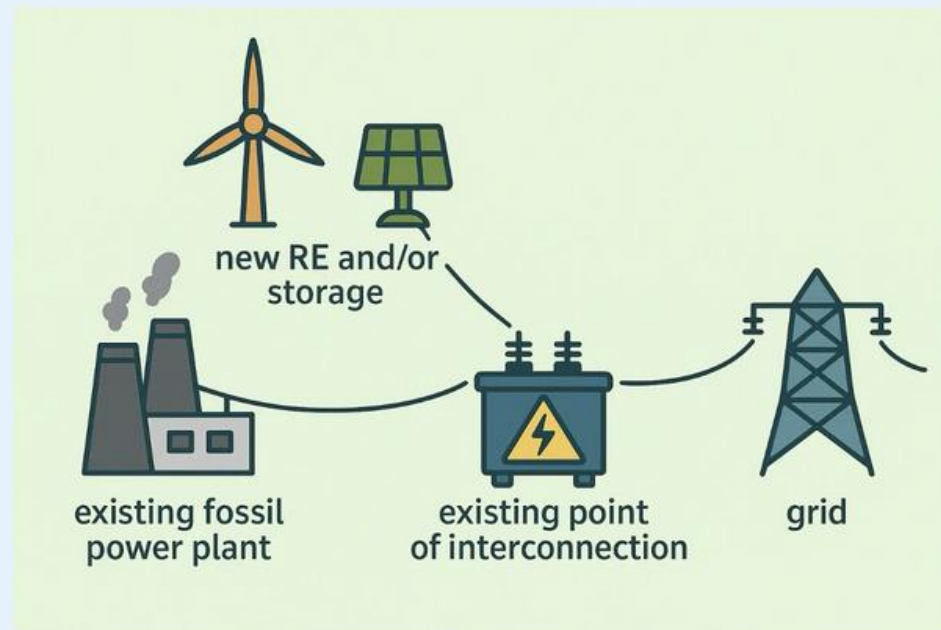
Sources: ELCC — PJM 2027/2028 BRA; Capital costs — GridLab Gas Turbine Costs Report (Sep 2025), BNEF 2025, PUC Filings

Annual Average ELCC by Technology Type



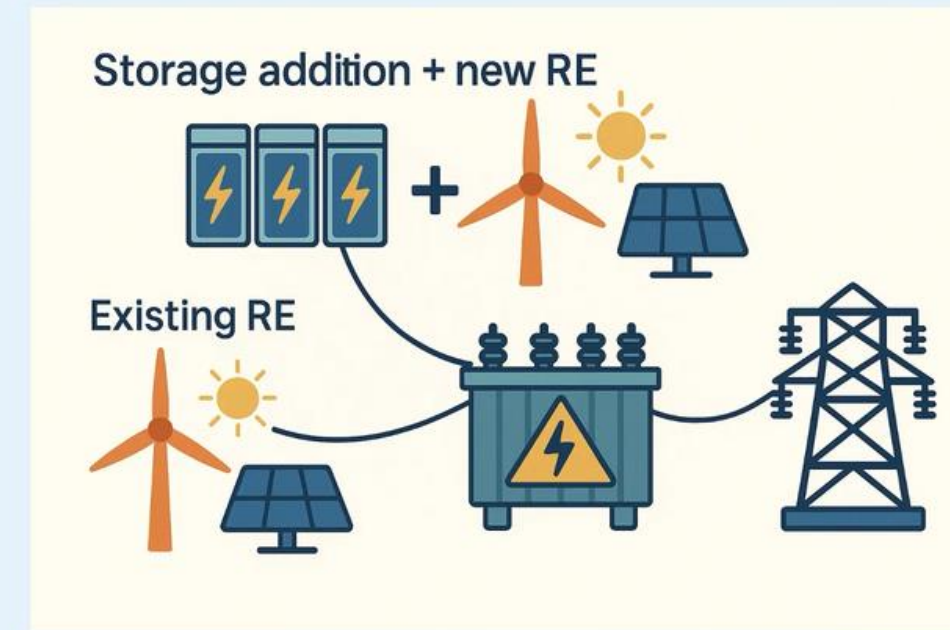
Maximizing efficiency of existing assets: Surplus Interconnection

⚡ Renewables at Thermal Plants



- ⚡ Thermal plants (especially peakers) significantly underutilize their interconnection capacity
- ☀️ Cheaper solar and wind resources can be added at underutilized thermal plants using surplus interconnection service (SIS)
- 📄 FERC Order 845 provides regulatory pathway for surplus interconnection service
- 🏃 Bypasses lengthy interconnection queues for faster deployment
- 💰 Reduced costs through shared infrastructure and site development
- 🔄 Creates transition pathway beyond fossil generation assets

☀️ Storage at Renewable Plants






- 🔋 Batteries can be added to existing renewable sites using spare grid capacity (SIS)
- ⚡ They store excess clean energy that would otherwise go to waste
- 🕒 Energy dispatched even when renewables aren't generating, smoothing output
- ⊕ Batteries enable adding more renewable capacity at the same location
- ✓ This maximizes the value and efficiency of existing grid connections
- 📄 FERC Order 845 provides the regulatory pathway for this approach

Surplus Interconnection Projects

Thermal

Crete Energy Venture



 Earthrise Energy
 Will County, IL - PJM


 Original Capacity
301MW Gas
 Online: Operating

+ Added Capacity
250MW Solar (2 projects)
 Online: In Development

Source: [Earthrise Portfolio](#)

Gibson City



 Earthrise Energy
 Ford County, IL - MISO


 Original Capacity
237MW Gas
 Online: Operating

+ Added Capacity
270MW Solar (2 projects)
 Online: In Development

Source: [Earthrise Portfolio](#)

Shelby County

 Earthrise Energy
 Shelby County, IL - MISO



 Original Capacity
352MW Gas
 Online: Operating


+ Added Capacity
360MW Solar (2 projects)
 Online: In Development

Source: [Earthrise Portfolio](#)

RE

Polaris Solar


 DTE Energy
 Michigan - MISO


 Original Capacity
168MW Wind
 Online: Operating

+ Added Capacity
100MW Solar
 Online: 2025

Source: [DTE Solar](#)

Pine River Solar



 DTE Energy
 Michigan - MISO

 Original Capacity
161.4MW Wind
 Online: Operating

+ Added Capacity
80MW Solar
 Online: April 2025

Source: [DTE Announcement](#)

Scott Solar + Storage

 Dominion Energy + RES
 Powhatan County, VA




 Original Capacity
12MW Solar
 Online: 2019

+ Added Capacity
12MW/48MWh Storage
 Online: May 2022




Source: [Scott Solar](#)

Maximizing efficiency of existing assets: Surplus Interconnection




Resource Assessment

-  Assessed RE resource availability within a 6 mile buffer zone around each thermal and renewable plant in Pennsylvania
-  Applied 50+ exclusion criteria including physical constraints (land cover, slope, etc.), environmental protections (protected areas, national parks, etc.), and local ordinances
-  Estimated local solar and wind potential using suitable area and average solar and wind generation density




Economic Analysis

-  Estimated local hourly solar and wind generation near each power plant in Pennsylvania using meteorological data from ERA5
-  Estimated local solar and wind LCOE using capital cost data from BNEF and compared with the variable costs of thermal plants to identify economic crossover points
-  Applied relevant IRA incentives including energy community bonus tax credits at power plant locations

Portfolio Optimization

-  Estimated optimal mix of solar, wind and storage which maximizes interconnection use while limiting curtailment below 5%
-  For thermal plants, estimated optimal solar and wind capacity that can be added, and for renewable plants, estimated additional solar and wind capacity that can be enabled by adding 6-hour storage.
-  Selected high-quality resources with capacity factors above 30% for wind and 20% for solar to ensure economic viability

Load Growth Analysis

-  Compared surplus interconnection potential with Pennsylvania's peak and energy load growth projections for 2030
-  Estimated interconnection utilization increase for renewable plants through battery storage and renewable additions
-  Quantified avoided interconnection and network upgrade costs based on historical cost data from Pennsylvania

Case Study: Adams Solar

Facility Information



LOCATION

Adams, Pennsylvania



INSTALLED CAPACITY

80 MW



OWNER

Energix Renewables



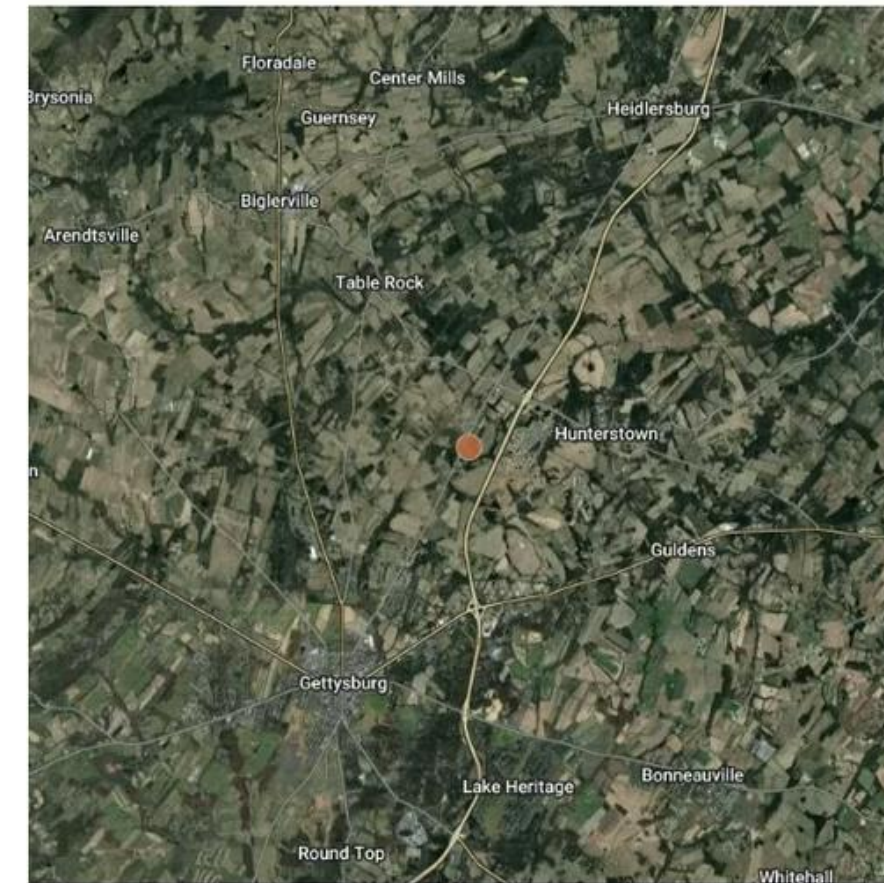
COD

2023

Satellite View

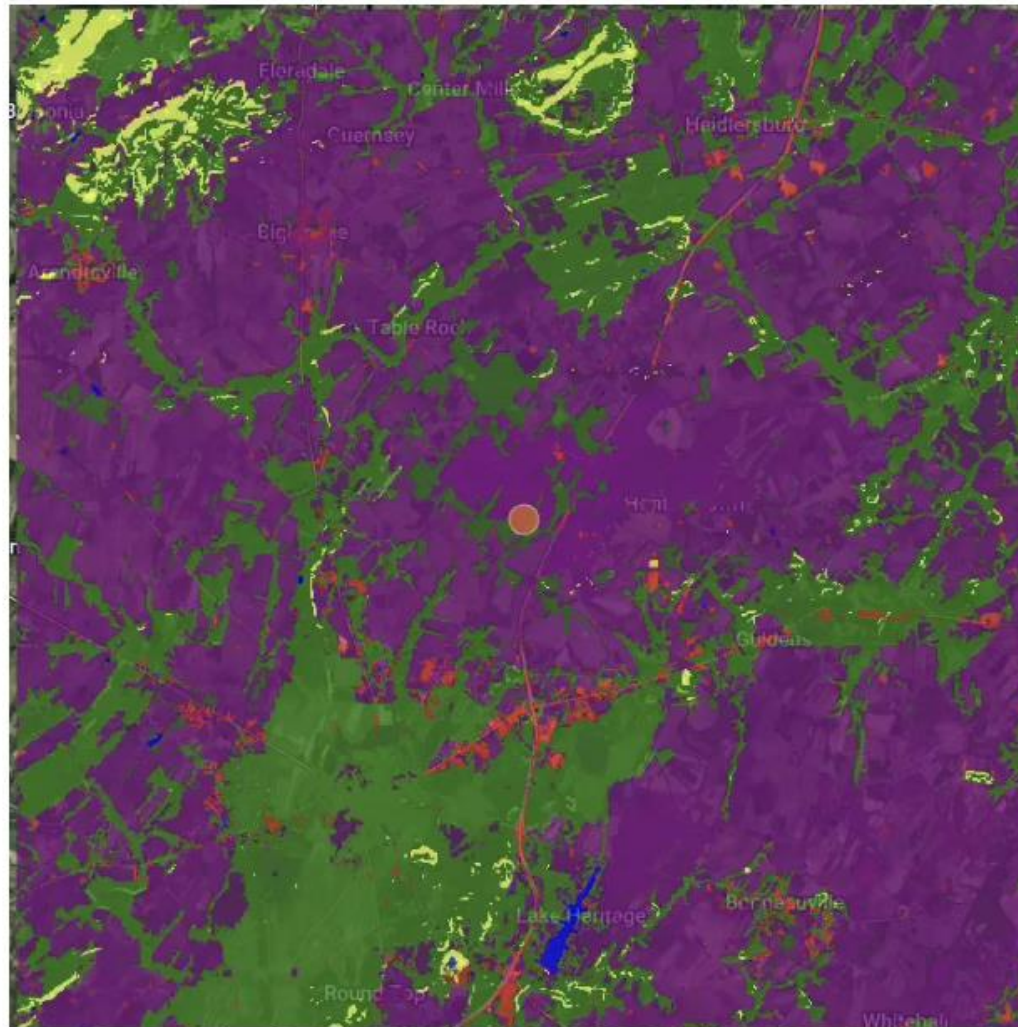


6x6-Mile Buffer Zone



Adams Solar : Local Solar and Wind Potential

Classification Map



- Sensitive Habitat
- Water/Ice Covered
- Urban Area
- Unfavorable Topography
- Buildable
- Other

RE Potential within 6 miles of Adams Solar LLC PA

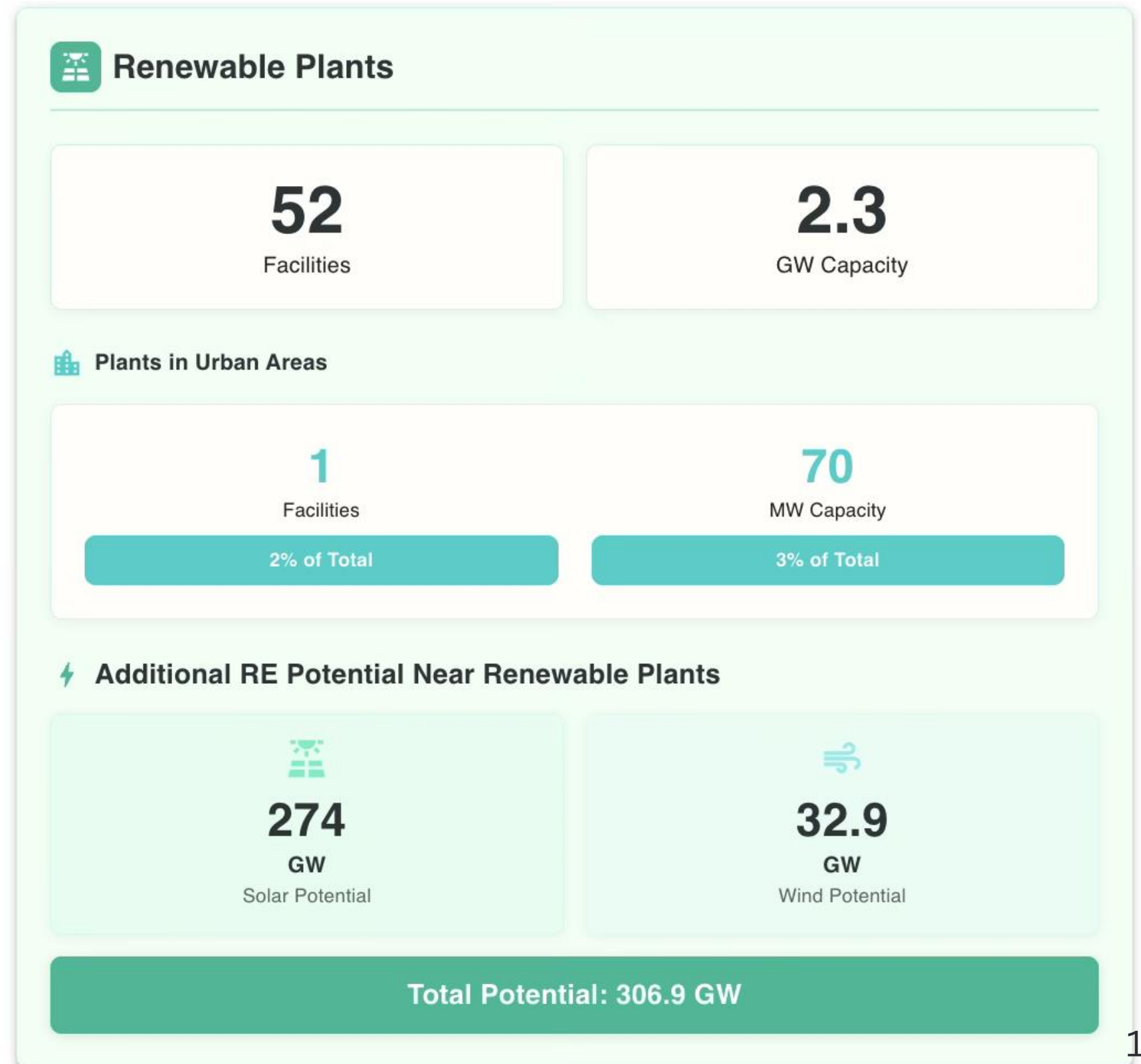
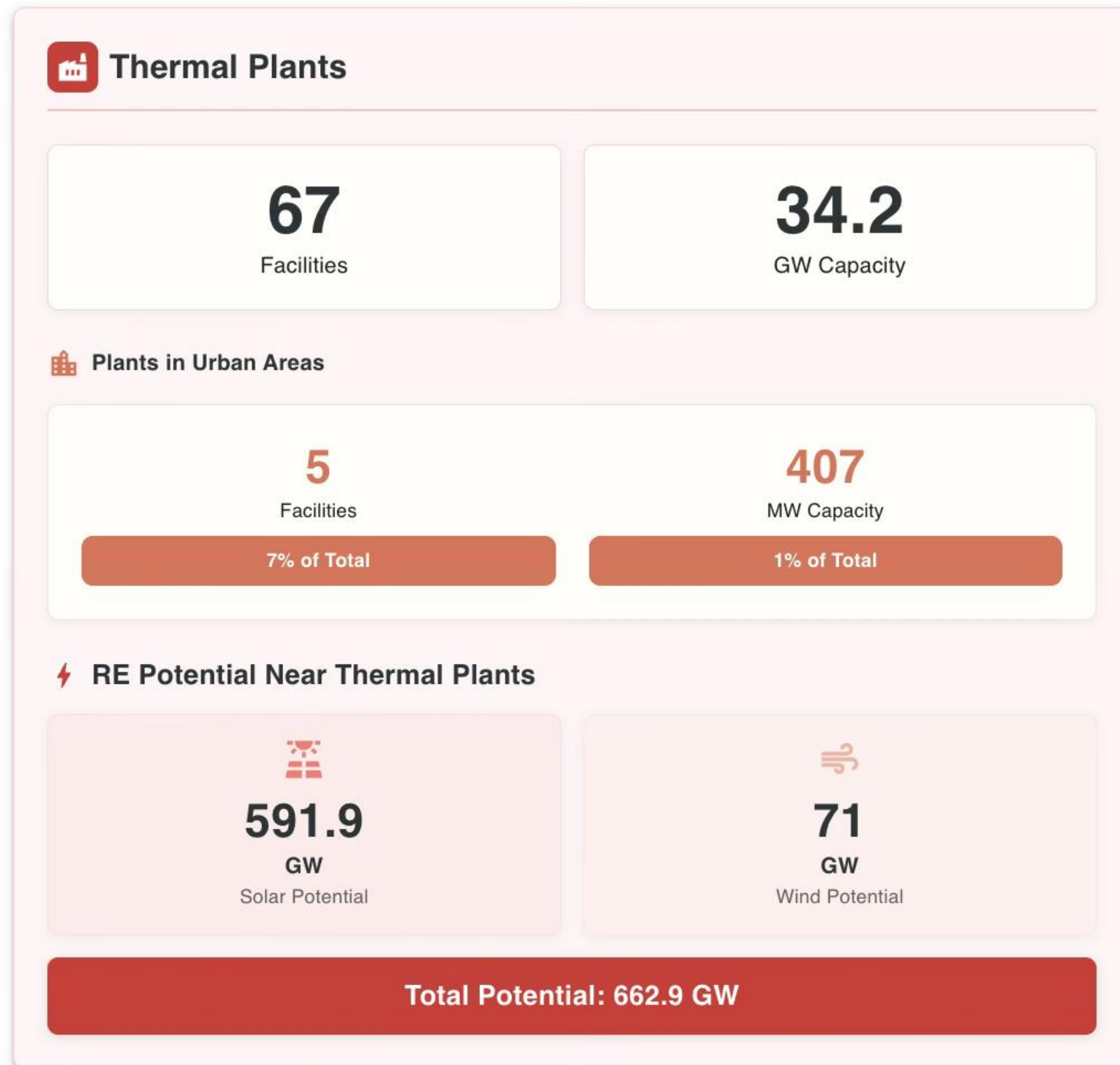
- Assessed RE resource availability within a 6x6 mile buffer zone around the Adams Solar LLC PA project
- Applied 50+ exclusion criteria including physical constraints, environmental protections, and local ordinances
- Estimated local solar and wind potential using suitable area and generation density analysis

% 99.2% of area within this 6 mile square is buildable

☀️ 17,311 MW Solar Potential

🌀 2,077 MW Wind Potential

1 TW of solar and wind potential near existing interconnection points



By 2030 10GW Thermal Capacity Expensive Compared to Local RE LCOE

↗ Economic Crossover

Crossover occurs when renewable LCOE becomes lower than thermal plant variable costs. At this point, it becomes cheaper to build new renewables than to operate existing thermal plants.

☀ Solar Crossover

GW of thermal capacity with variable costs higher than local solar LCOE

2025

With IRA: **33.3 GW**

Without: **4.6 GW**

2030

With IRA: **33.3 GW**

Without: **10.3 GW**

🌬 Wind Crossover

GW of thermal capacity with variable costs higher than local wind LCOE

2025

With IRA: **14.1 GW**

Without: **1.4 GW**

2030

With IRA: **20.9 GW**

Without: **2 GW**

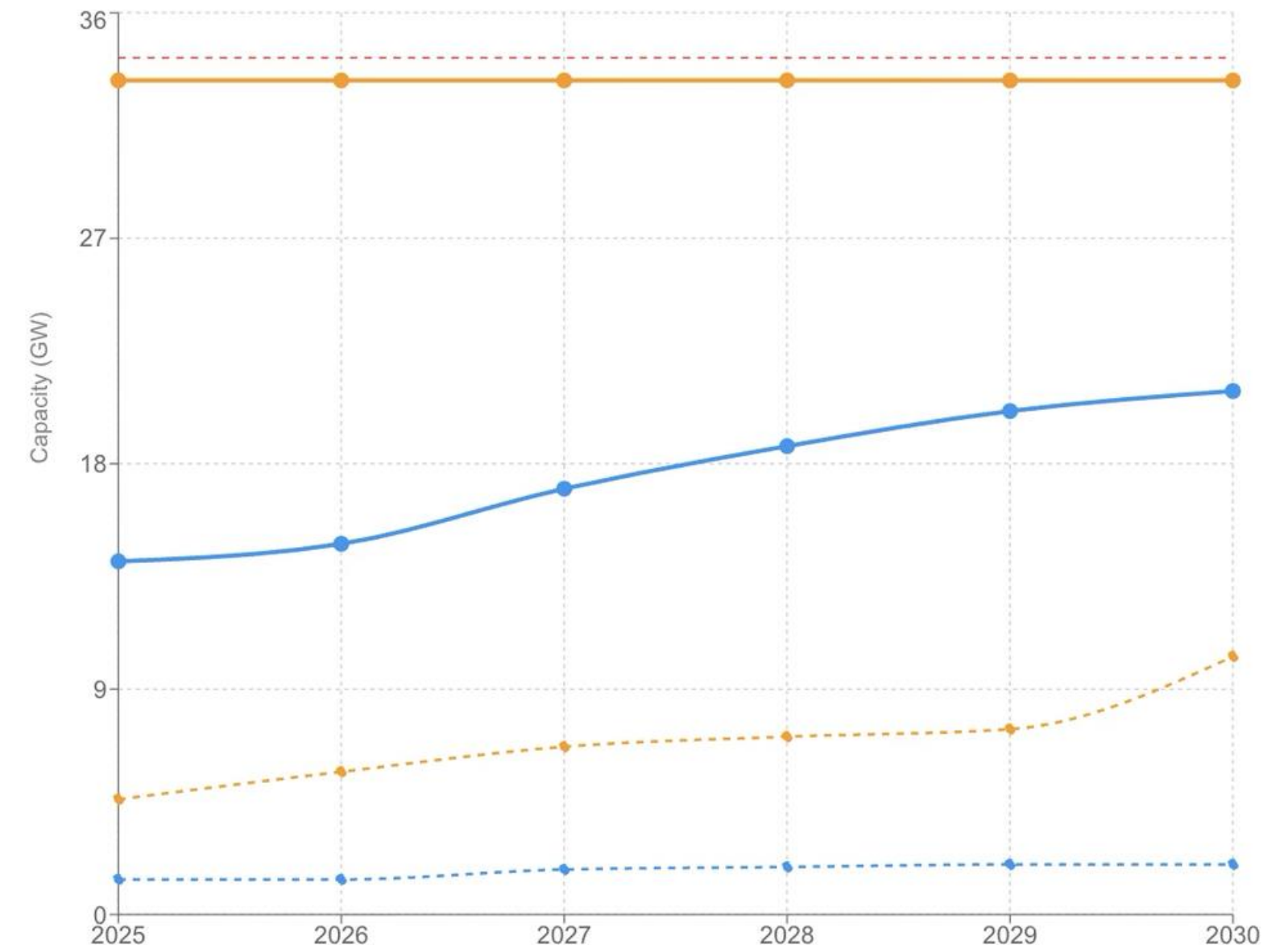
Impact of Losing IRA Tax Credits

IRA tax credits significantly scaled back under the 2025 One Big Beautiful Bill Act (OBBBA), with accelerated phase-out for wind and solar projects starting construction after July 2026. Without these credits, renewable LCOE will increase significantly.

Already in 2025, IRA tax credits enable solar to compete with 33.3 GW of thermal capacity (97% of Pennsylvania's thermal fleet), but without credits this drops to just 4.6 GW—a massive 28.7 GW reduction.

Wind shows similar dramatic impact: competing with 14.1 GW with credits versus only 1.4 GW without, a difference of 12.7 GW.

↗ Renewable Capacity Below Thermal Variable Costs

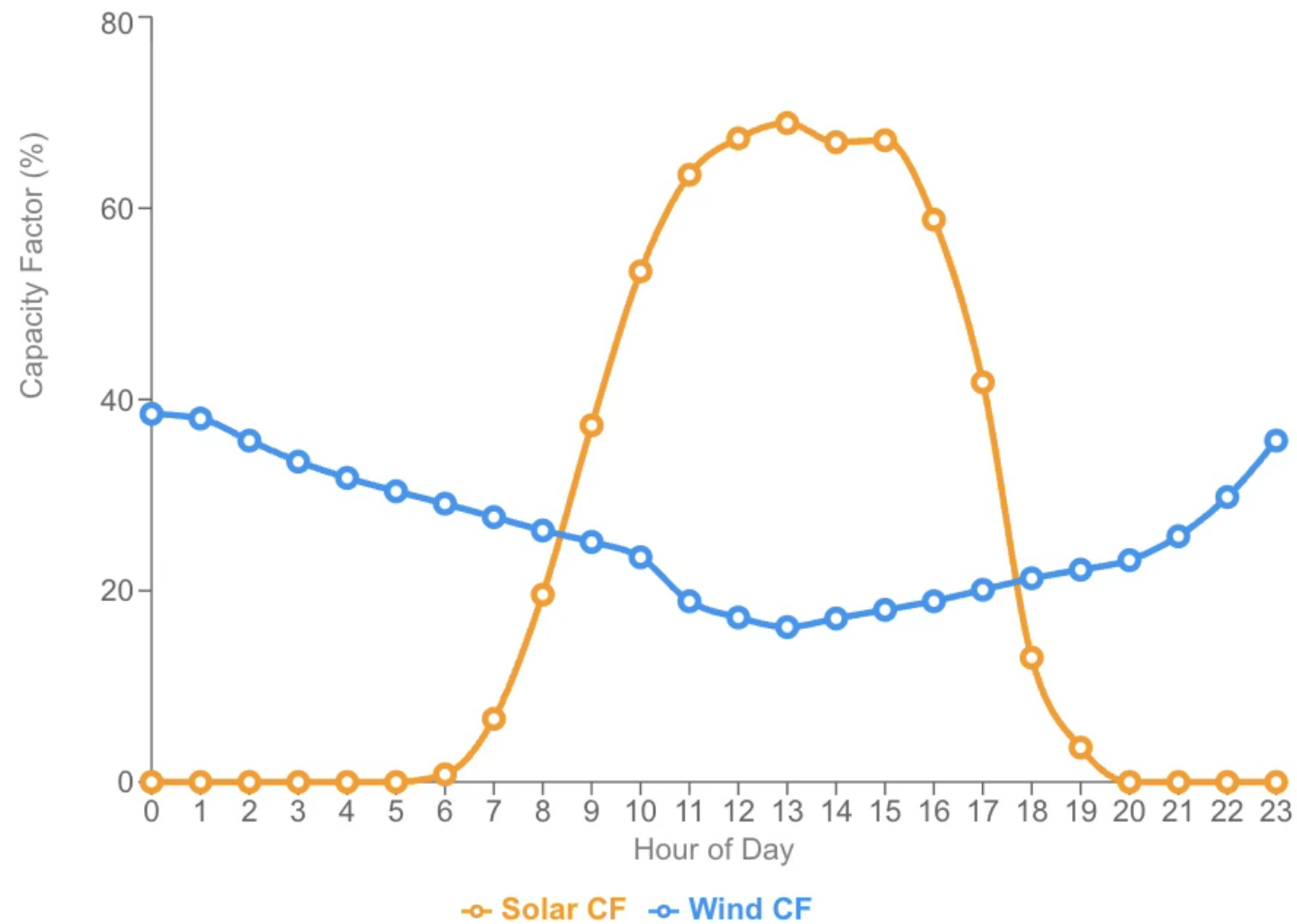


↔ Solar Capacity (w/ IRA) ↔ Solar Capacity (w/o IRA) ↔ Wind Capacity (w/ IRA)
↔ Wind Capacity (w/o IRA)

Solid lines: With IRA incentives | Dashed lines: Without IRA incentives

Adams Solar: Local Solar and Wind LCOE

Diurnal Capacity Factors at Adams Solar LLC PA



Hourly average capacity factors showing solar peaks during midday and wind's more consistent generation pattern

Capacity Factors

Solar (AC)

26.3%

Wind

30.6%

Levelized Cost of Energy

Solar

\$34.6/MWh

2025 (with IRA)



\$27.1/MWh

2030 (without IRA)

Wind

\$78.9/MWh

2025 (with IRA)



\$73.2/MWh

2030 (without IRA)

10 GW of RE can be added at Pennsylvania thermal plants

⚡ RE Integration Potential Results

10 GW of renewable energy capacity can be integrated near existing thermal plants in Pennsylvania by 2030

- Solar integration potential: 9.5 GW
- Wind integration potential: 0.5 GW

Sensitivity analysis:

We varied the cost of fuel by taking one standard deviation below and above the average fuel prices to test the economics of thermal versus local solar and wind:

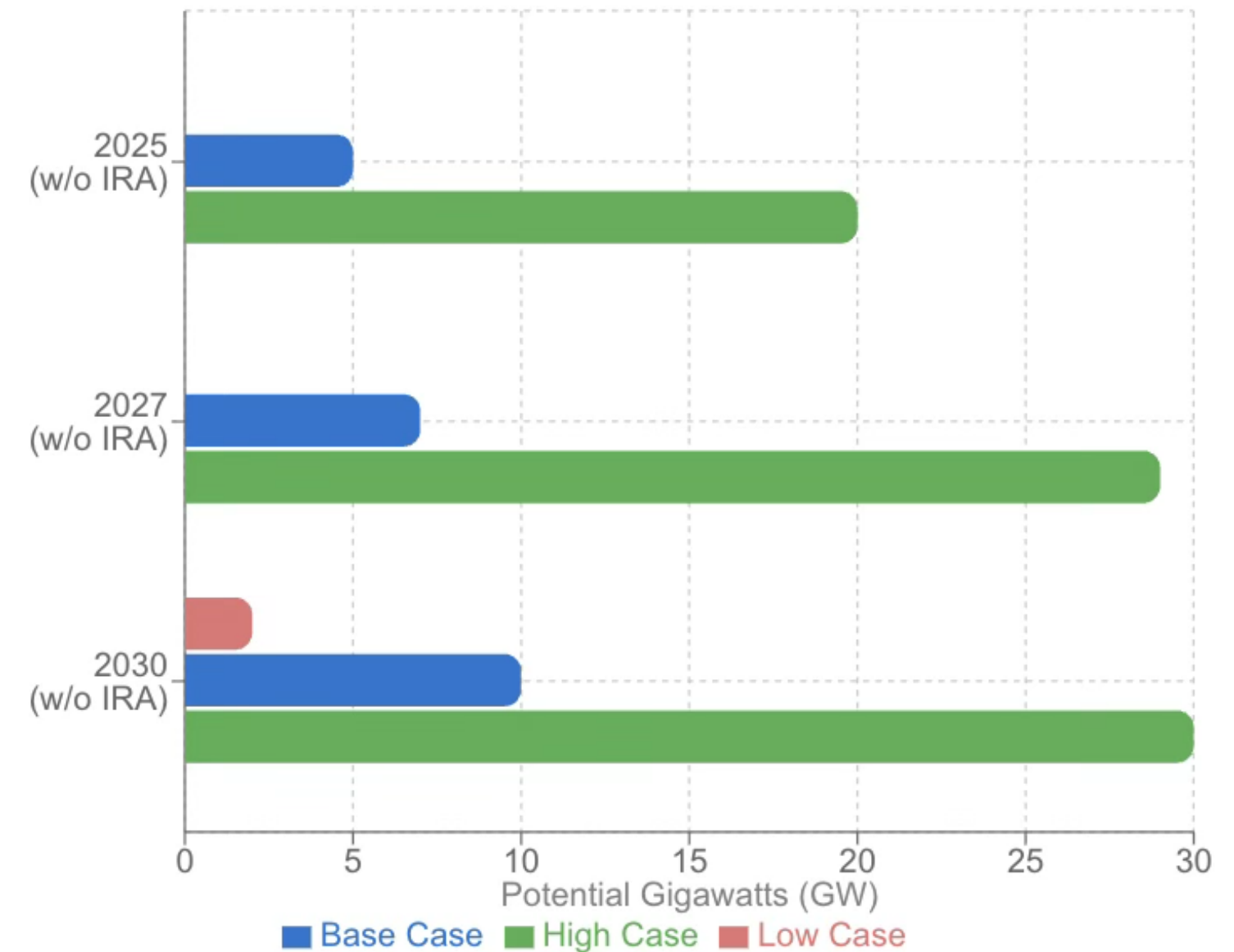
- Low fuel prices (1σ below average): 0 GW (2025) → 2 GW (2030)
- High fuel prices (1σ above average): 20 GW (2025) → 30 GW (2030)

Impact of IRA Tax Credit Removal:

Without IRA tax credits, the integration potential starts at 5 GW in 2025. By 2027, technology cost declines increase potential to 7 GW. By 2030, potential reaches 10 GW as renewable costs continue declining.

↗ Total RE Integration Potential by Year

All years without IRA Tax Credits (unsubsidized LCOE)



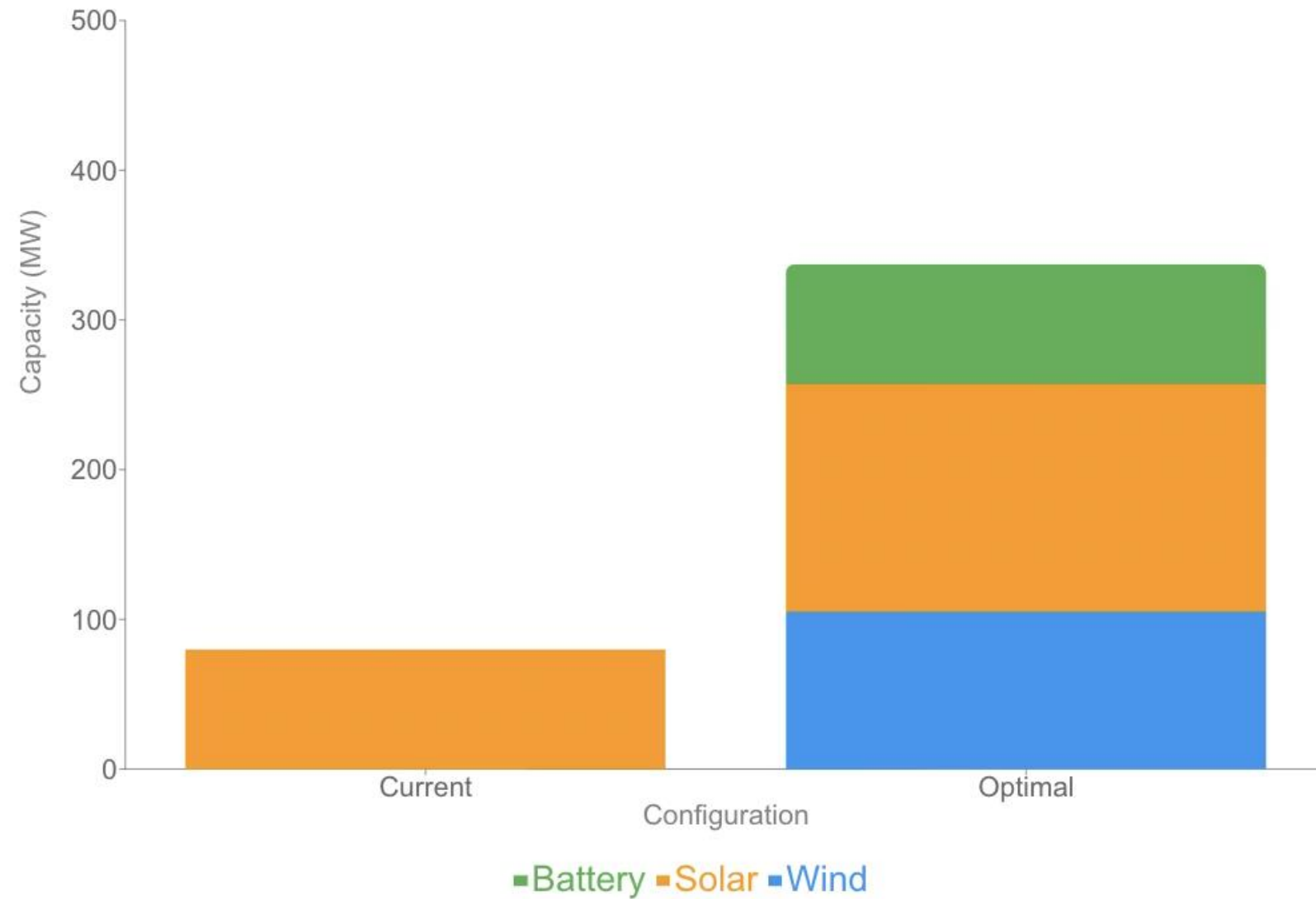
.257 MW of RE enabled by 80 MW of 6H storage

Optimal Capacity Configuration

4.2x
Capacity Increase

46.7%
CF Improvement

26.3% → 73% Capacity Factor
+327 GWh/year additional energy



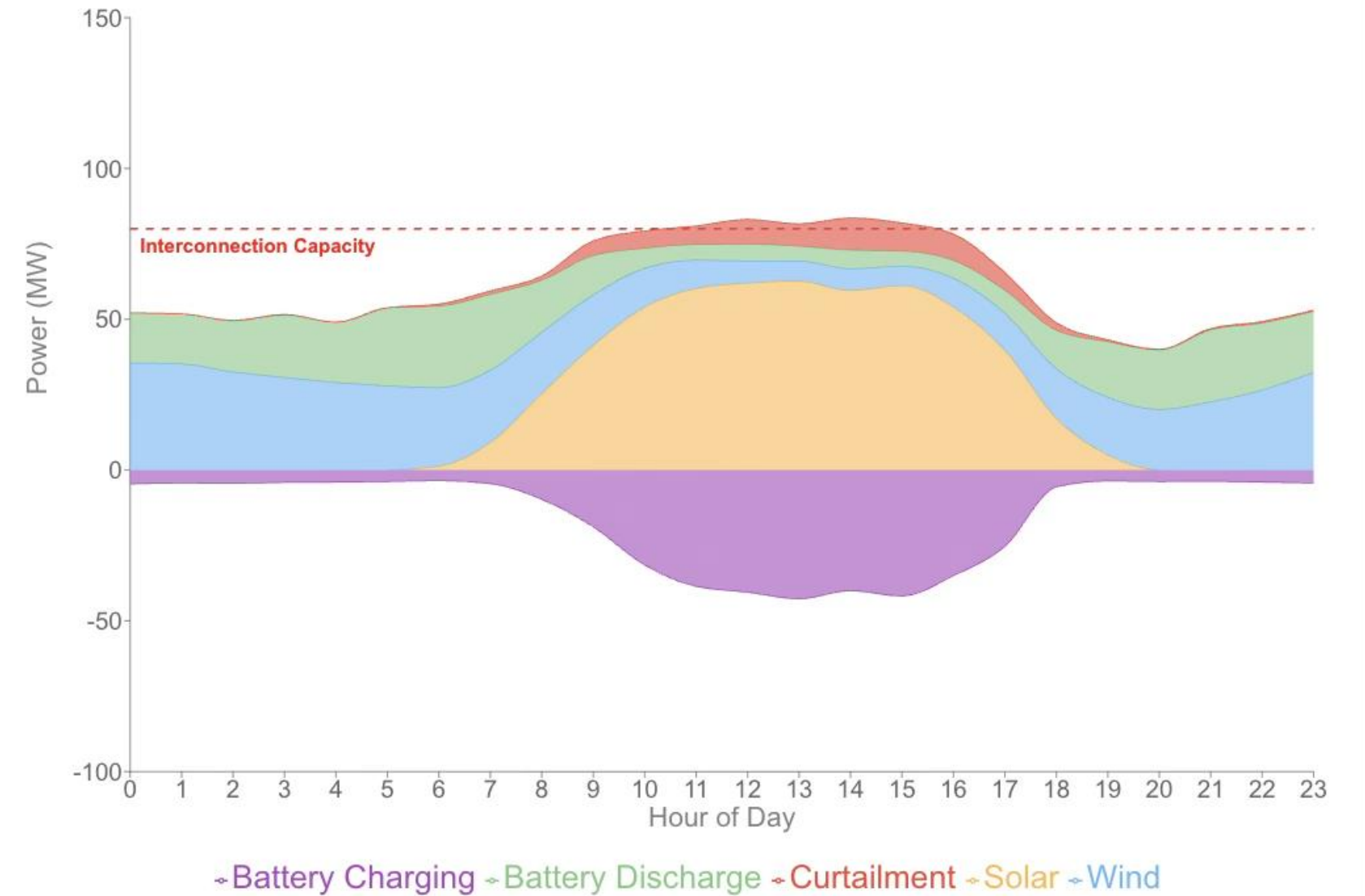
24-Hour Energy Flow Pattern (Annual Average)

System Performance Summary

58.4
MW Avg Output

6
Hour Battery

5%
Curtailment



4 GW of RE enabled by 2.3 GW of storage can be added at existing RE plants

Enhancing Pennsylvania's Existing Renewable Fleet

We analyzed optimal solar and wind capacity additions at each renewable site when paired with 6-hour battery storage. Battery storage increases interconnection utilization by capturing excess generation during peak production, enabling significantly more renewable capacity without infrastructure upgrades.

The optimization algorithm estimates the solar and wind capacity that maximizes the interconnection utilization while limiting curtailment to below 5%. We analyzed 52 renewable plants (≥ 10 MW) in Pennsylvania.

Solar Capacity
+2.6 GW

Wind Capacity
+1.6 GW

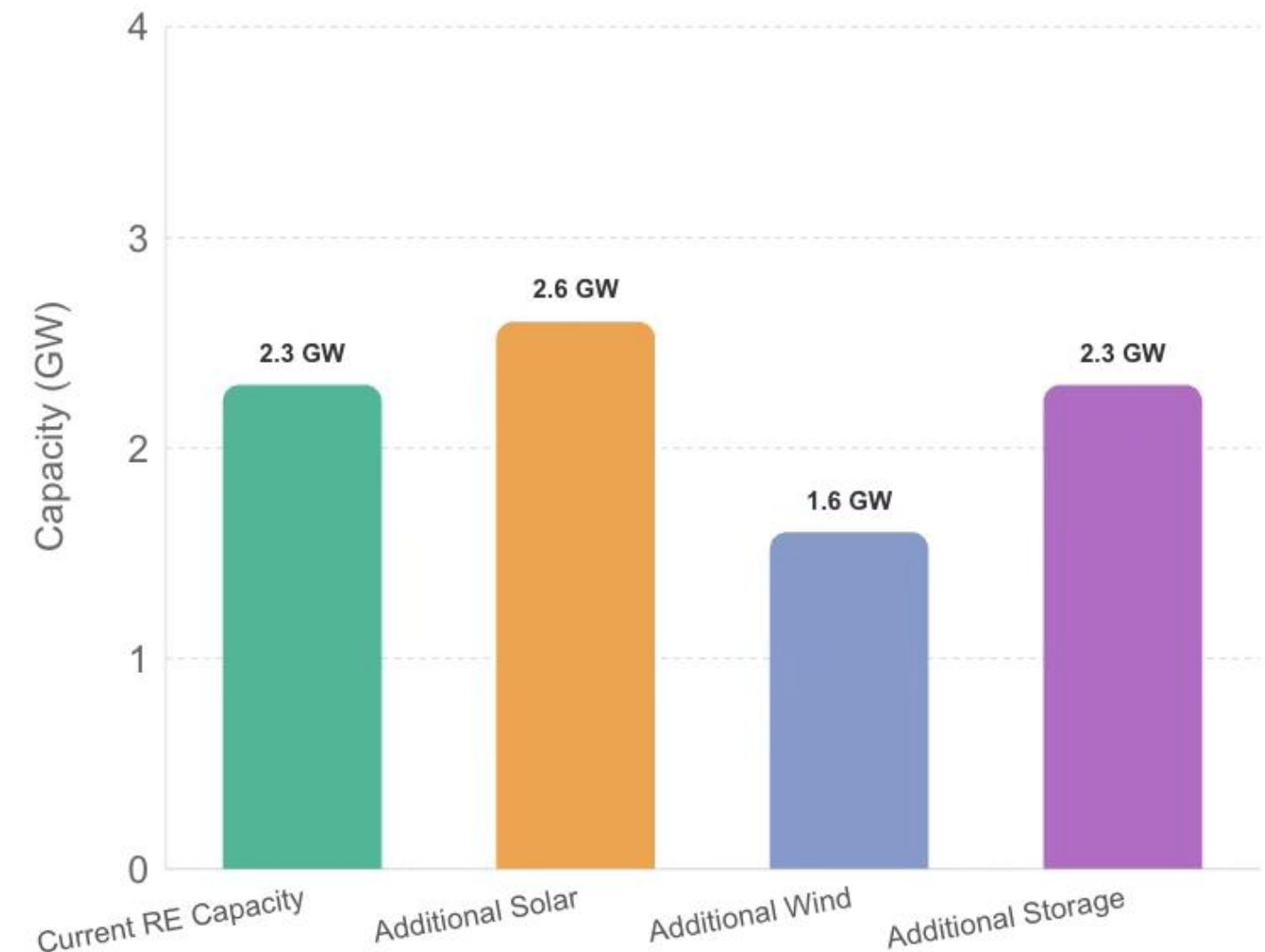
Storage Capacity
+2.3 GW

Current RE Capacity: 2.3 GW

Total After Enhancement: $2.3 + 4.3 = 6.6$ GW

182% Overall Increase

Additional Capacity at Existing RE Sites (GW)



Additional capacity potential: 2.6 GW solar + 1.6 GW wind + 2.3 GW storage

16 GW of RE + Storage can be added at existing power plants in Pennsylvania



12.1 GW of additional solar capacity near existing renewable and thermal plants



2.1 GW of additional wind capacity through interconnection sharing



2.3 GW of storage enables higher penetration of renewables

\$1.4B of savings in interconnection costs

\$ Total Potential Savings

\$1.4B

By leveraging existing infrastructure



\$256

Savings per Pennsylvania household

- ✓ Reduces interconnection costs
- ✓ Reduces new transmission infrastructure requirements
- ✓ Cost savings from faster deployment of cheaper clean energy and replacing generation from expensive thermal plants

i This \$1.4B is a conservative estimate that only accounts for interconnection cost savings for 16.5 GW of renewable capacity using an average cost of \$83/kW (Queued Up, LBNL 2025). Additional benefits from co-location of solar, wind, and batteries, and increased utilization of bulk transmission would significantly increase the total value of savings, but are not included in this figure.

👥 Shared Benefits Across Stakeholders

Surplus interconnection creates benefits for all stakeholders:

RE Developer

Tax Credit

Reduced Interconnection Costs

Faster Development

Existing Plant Owner

Additional Revenue Streams

Diverse Portfolio

Consumer

Low Cost Electricity

Tax Revenue

Less Pollution

Power System

Reliability

Higher Tx Utilization

Low Capacity Prices

Economy

Reliable Supply

Faster Supply

Low Cost Power

Finding best candidates for surplus interconnection

🔥 Thermal Plants Ranking

Weighted scoring to identify best thermal plants for surplus interconnection service

- 25%** **Economic Arbitrage**
Differential between plant variable cost and renewable LCOE
- 30%** **Renewable Resource Potential**
Combined solar and wind capacity within 6-mile radius
- 15%** **Underutilization Factor**
Inverse of capacity factor (lower utilization = higher score)
- 15%** **Technical Resource Quality**
Maximum renewable capacity factor achievable at site
- 5%** **Site Development Suitability**
Percentage of non-urbanized land area
- 10%** **Plant Interconnection Capacity**
Existing thermal plant megawatt capacity

🌱 Renewable Plants Ranking

Weighted scoring to identify best expansion candidates

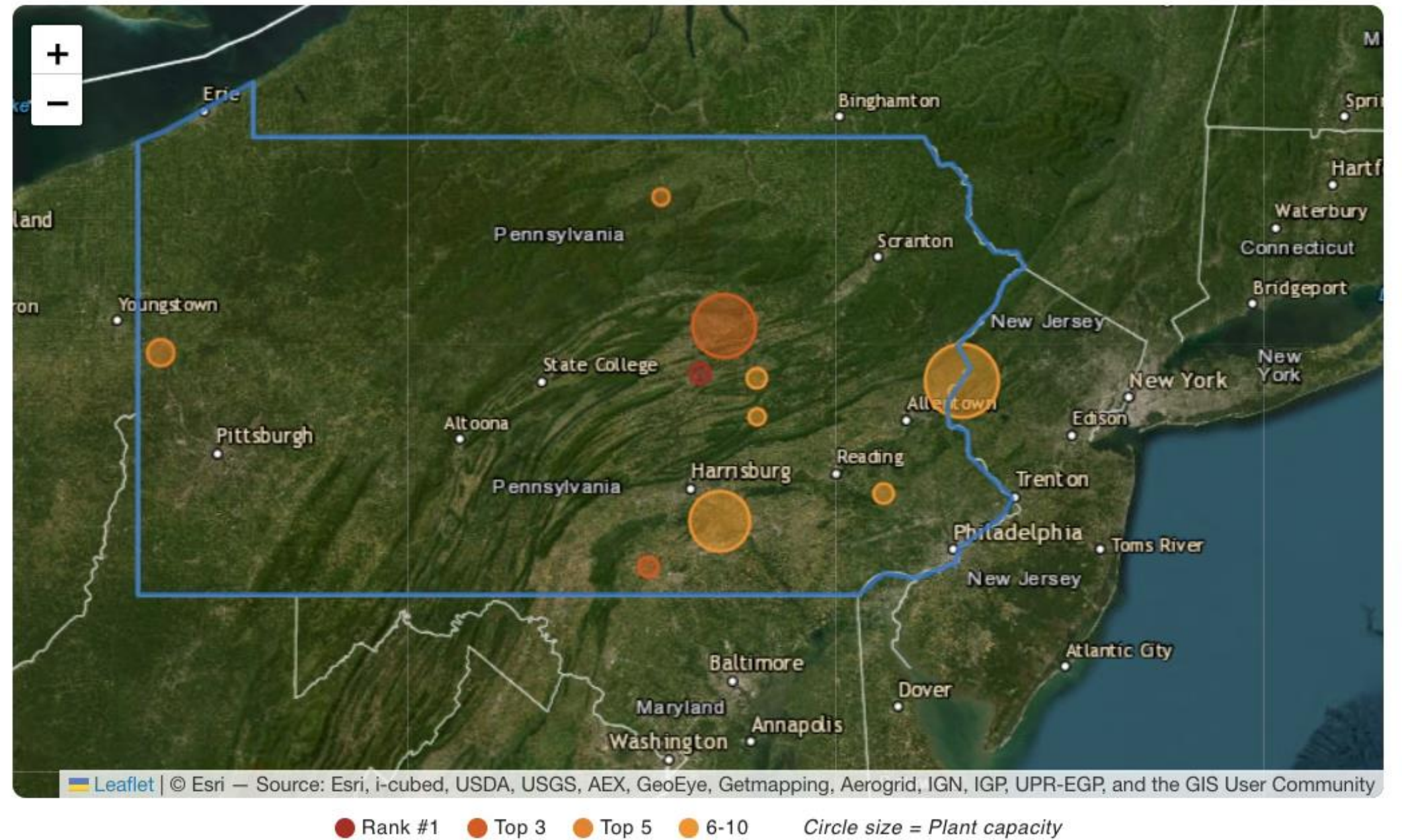
- 25%** **Resource Quality Performance**
Current operating capacity factor of renewable facility
- 25%** **Expansion Potential**
Additional renewable capacity within 6-mile radius
- 20%** **Economic Optimization**
Ratio of optimal to current capacity factor
- 10%** **Age Score**
Plant age factor — older facilities score higher for repowering potential
- 10%** **Site Development Viability**
Percentage of non-urbanized surrounding area
- 10%** **Existing Plant Scale**
Current installed capacity demonstrating viability

Top thermal plants for surplus interconnection

Top Ranked Plants

- #1 Sunbury Generation L**
Snyder County • 36 MW • ogs
SIS Solar: 21 MW, Wind: 47 MW
- #2 TalenEnergy Montour**
Montour County • 1504 MW • Coal
SIS Solar: 933 MW, Wind: 0 MW (Wind LCOE exceeds plant VC by 2030 (no IRA))
- #3 Hunterstown**
Adams County • 64 MW • Gas CT
SIS Solar: 80 MW, Wind: 0 MW (Wind CF 28% below 28% threshold)
- #4 Blossburg**
Tioga County • 21 MW • Gas CT
SIS Solar: 14 MW, Wind: 27 MW
- #5 New Castle Plant**
Lawrence County • 326 MW • ogs
SIS Solar: 407 MW, Wind: 0 MW (Wind LCOE exceeds plant VC by 2030 (no IRA))

Geographic Distribution

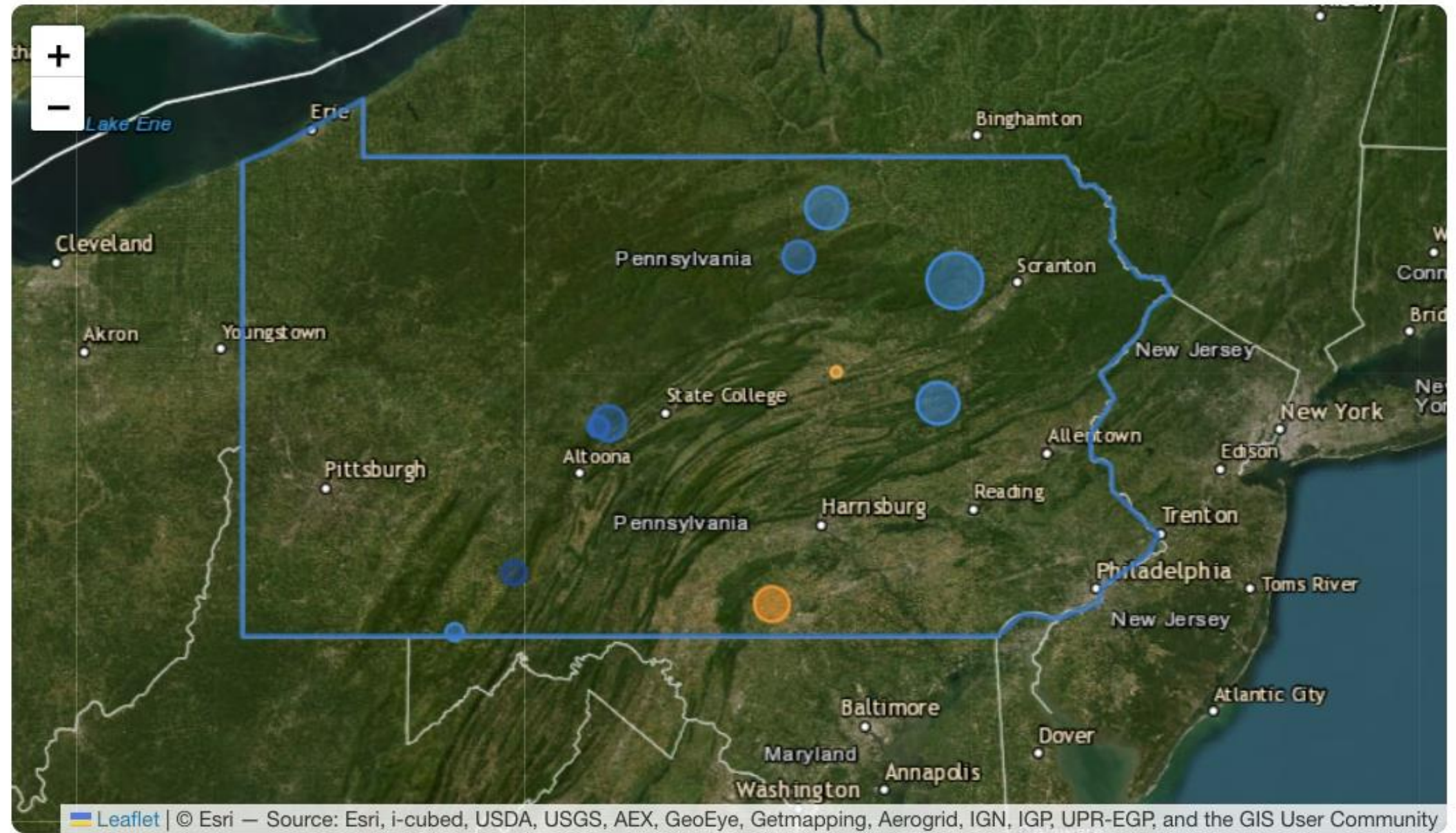


Top renewable plants for surplus interconnection

Top Ranked Plants

- #1** 🌬️ **Stony Creek Wind Farm LLC**
 Somerset County • 53 MW • Wind
 SIS Solar: 66 MW, Wind: 18 MW
- #2** 🌬️ **Sandy Ridge Wind Farm**
 Blair County • 50 MW • Wind
 SIS Solar: 66 MW, Wind: 20 MW
- #3** 🌬️ **Sandy Ridge Wind 2, LLC**
 Blair County • 88 MW • Wind
 SIS Solar: 115 MW, Wind: 34 MW
- #4** 🌬️ **Laurel Hill Wind**
 Lycoming County • 69 MW • Wind
 SIS Solar: 106 MW, Wind: 28 MW
- #5** ☀️ **Adams Solar LLC PA**
 Adams County • 80 MW • Solar
 SIS Solar: 72 MW, Wind: 105 MW

📍 Geographic Distribution



☀️ **Solar:** ● #1 ● Top 3 ● Others 🌬️ **Wind:** ● #1 ● Top 3 ● Others *Circle size = Plant capacity*

Quick deployment and incremental scaling reduce stranded asset risk

↗ Uncertain Demand Growth Drivers

- AI & Data Centers**
Explosive growth with unpredictable timing - some facilities need 1GW+
- Manufacturing Reshoring**
Policy-driven industrial expansion with uncertain location and scale
- Transportation Electrification**
EV adoption varies 10x between forecasts - massive grid impact uncertainty

Grid planners face unprecedented uncertainty in timing, location, and magnitude of new loads - traditional planning breaks down

🕒 Deployment Strategy Comparison

Traditional New Generation

- 🕒 5-7 year development timeline
- ⚠️ Large upfront commitment (500MW+)
- ↗ High stranded asset risk
- ⚠️ Requires accurate long-term forecasts

SIS + Battery Storage

- ✅ 12-18 month deployment
- 🔄 Modular additions (50-200MW blocks)
- ✅ Deploy capacity as demand materializes
- 🔌 Leverages existing interconnection

🏗️ The "Build As You Need" Advantage with SIS

Surplus Interconnection Service transforms how utilities can respond to uncertain demand growth by enabling incremental, just-in-time capacity additions:

Risk Mitigation Benefits:

- Match CAPEX deployment to actual load growth
- Avoid overbuilding in uncertain markets
- Preserve optionality as forecasts evolve
- Minimize stranded asset exposure

Operational Flexibility:

- Start with 100MW, scale to 500MW+ over time
- Respond to surprise data center announcements
- Adjust to actual EV adoption rates
- Redeploy assets if local demand shifts

SIS enables utilities to transform stranded asset risk into strategic flexibility - critical for navigating the unprecedented uncertainty of the energy transition

FERC Approves PJM Surplus Interconnection Service Reforms

Four Key Changes Approved by FERC

PJM filed tariff revisions on December 20, 2024 to remove restrictions and expand surplus interconnection service access

1. Additional Interconnection Facilities



Explicitly allows construction of new physical interconnection facilities where needed. Enables parallel operation of surplus unit with existing generator - critical for solar+storage configurations. Previously unclear if additional facilities were permitted.

2. Removes "Material Impact" Restrictions



Strikes language that terminated requests for ANY impact on queue determinations or material impacts on system limits. Now only blocked if new network upgrades required. This "materiality review" previously killed most surplus requests.

3. Earlier Access to Surplus Service



Expands eligibility to projects with executed ISA/GIA but not yet built. Previously only operational facilities could offer surplus. Allows requests during construction phase - aligns with FERC Order 2023 requirements.

4. Energy Storage Eligibility



Clarifies that resources "seeking to receive electric energy from the grid and store it for later injection" can use surplus service. Removes ambiguity about storage eligibility that existed in prior tariff language.

⚠ Previous Restrictions Removed

PJM would automatically terminate surplus requests if:

- Any impact on network upgrade determinations for queued projects
- Material impacts on short circuit capability limits
- Material impacts on steady-state thermal and voltage limits
- Material impacts on dynamic system stability

Result: "Materiality review" effectively blocked most surplus requests

↗ Expected Benefits

- Faster deployment of new capacity without queue delays
- Existing solar can add batteries using surplus service
- Better utilization of existing interconnection capacity
- May help reduce capacity prices
- Aligns PJM with MISO's more flexible approach

Behind-the-Meter Data Centers: Leveraging Surplus Interconnection

Innovative Behind-the-Meter Solution

Configuration Setup

Data center is located behind-the-meter of an existing gas peaker plant, with new oversized solar arrays + 16-hour battery storage added on-site

How It Works

95% of the time: Data center receives power from solar + battery storage.
5% of the time: When solar/battery unavailable, gas plant provides backup power

Gas Plant Dual Role

- 1) Provides electricity to grid during peak demand when needed
- 2) Acts as backup power source for data center (5% of time)

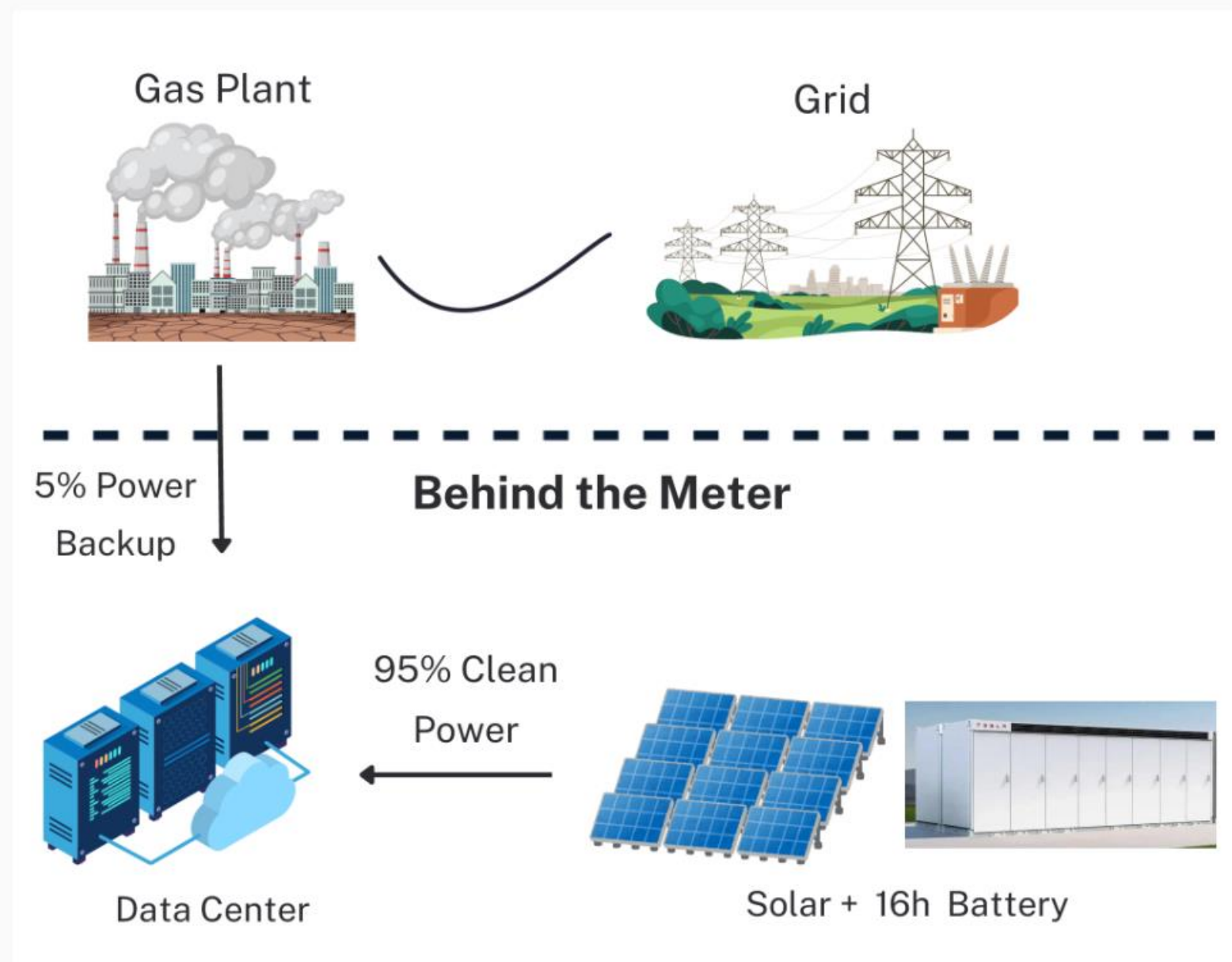
Fast Implementation

Complete build in 1-2 years (vs 5-6 years for new gas plant or grid connection)

Key Benefits

- Uses existing gas plant interconnection (no new transmission)
- 95% carbon-free operation with solar + battery
- Gas plant remains available for grid emergencies

Surplus Interconnection to Power Data Centers

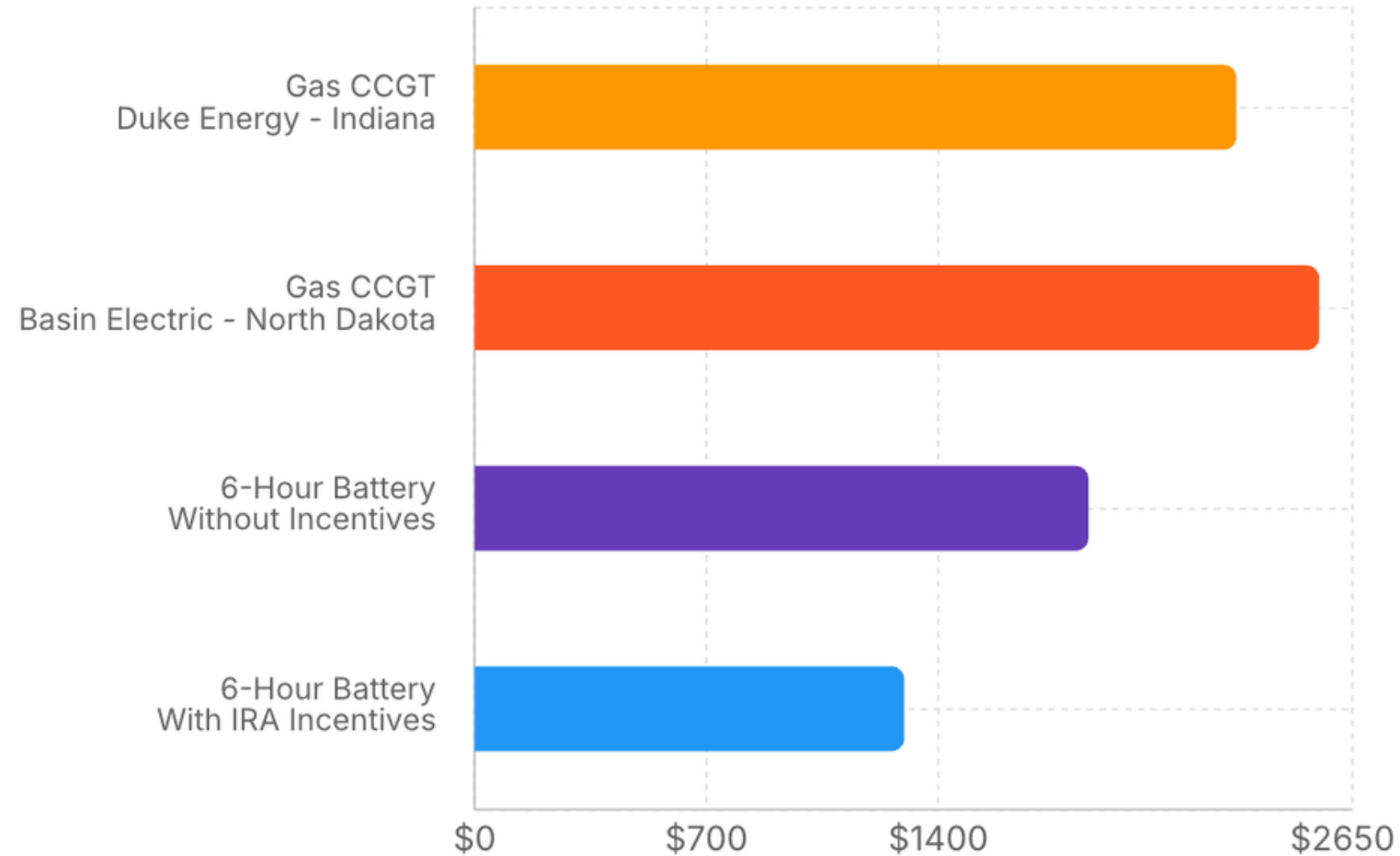


Thank you!

Storage capital costs are cheaper than gas

Capital Cost Comparison (\$/kW)

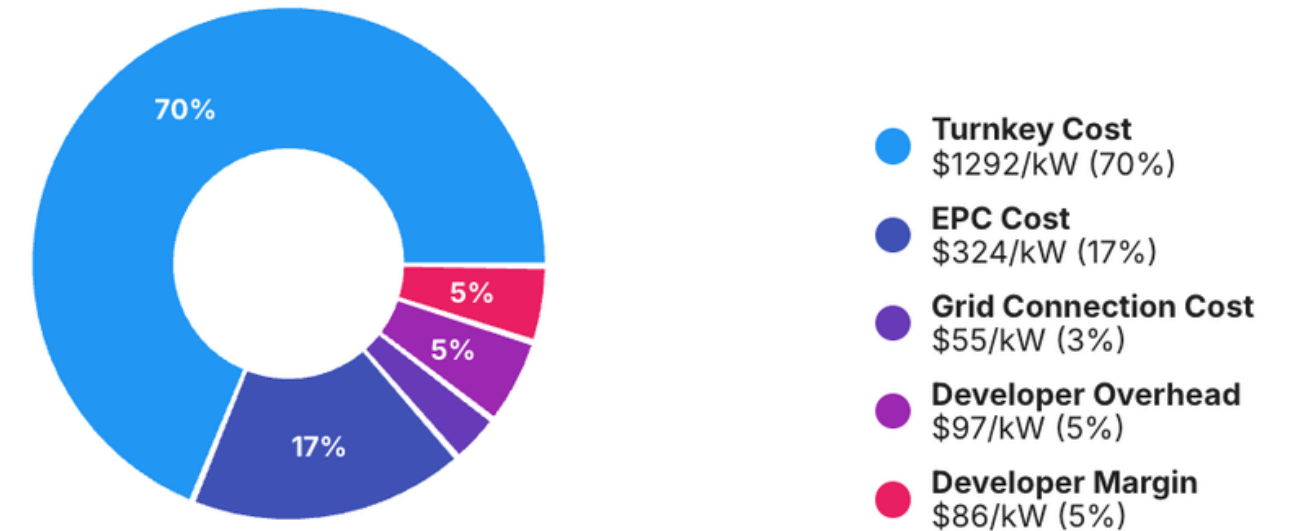
6H Battery with IRA: \$1297/kW



Source: BNEF 2025 and PUC Filings

6H Battery Cost Components (wo Incentives)

Total: \$1853/kW



Source: BNEF 2025

Battery Storage Outperforms Gas Plants

- ✓ Gas costs rising (\$2,300-2,550/kW)
- ✓ Battery costs dropping every year
- ✓ Battery supply chain advantages over gas
- 🕒 2018: 2,000 cycles (6-year life)
- 🕒 2024: 10,000-15,000 cycles (20+ years)

Renewables are underutilizing their interconnection capacity

⚡ Renewable Interconnection Underutilization

Because of the intermittency, renewables utilize their interconnection only when the sun is shining or wind is blowing. The average capacity factor in Pennsylvania for solar is 13.3%, for wind is 23.9%. This means solar plant interconnection is idle 86.7% of the time, and wind plant interconnection is idle 76.1% of the time.

↗ Technology Capacity Factors

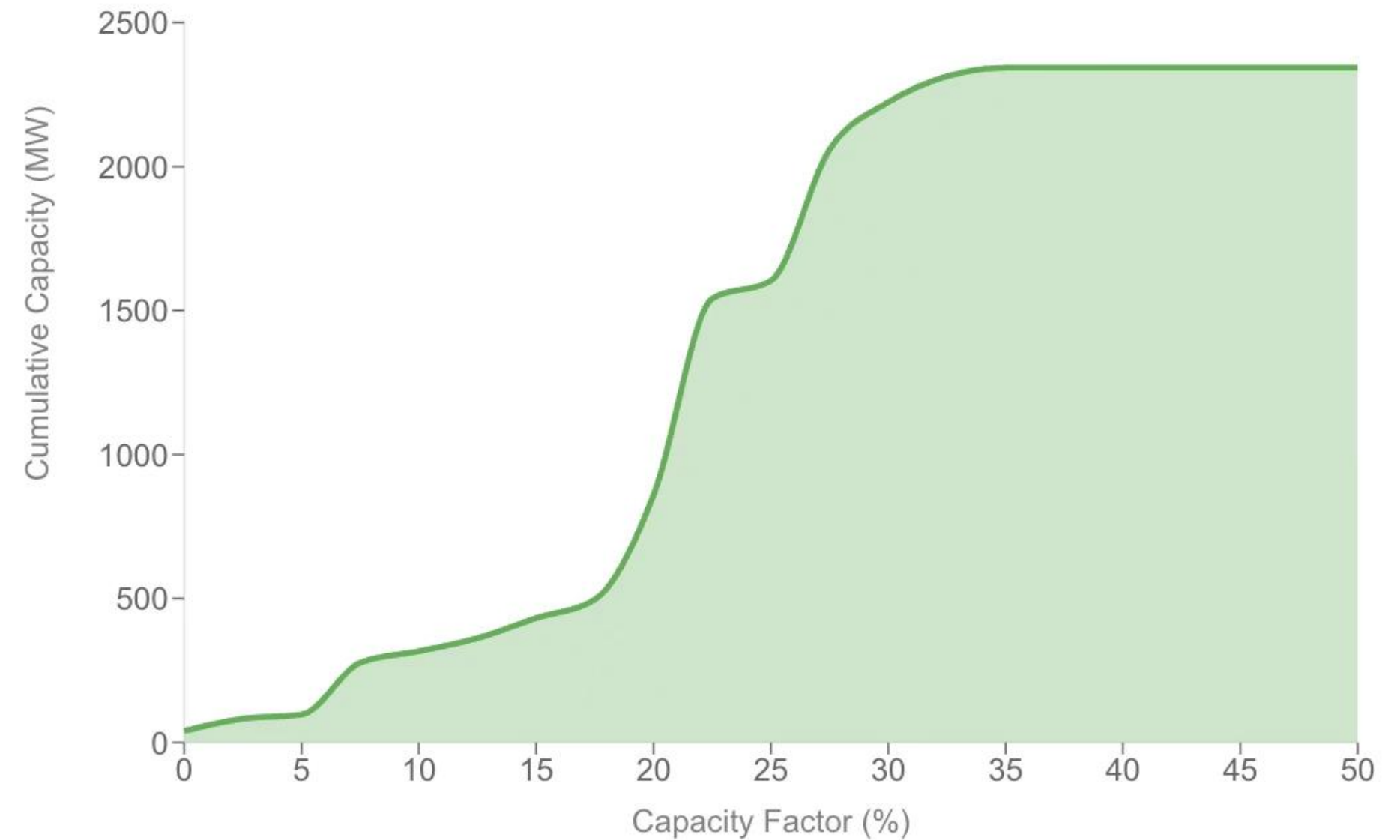
- Solar: 13.3% (799.6 MW)
- Wind: 23.9% (1,543.8 MW)

Aggregate Renewable Performance

- Total Capacity: 2,343.4 MW
- Average CF: 18.1%

The 2.3 GW renewable capacity utilizes their interconnection only 18.1% of the time

↗ Cumulative Renewable Capacity by Capacity Factor



Marginal Cost of Thermal Generation

§ Thermal Generation Economics

Pennsylvania's 34.2 GW installed thermal capacity shows clear variable cost stratification by technology. Gas CCGT (18.5 GW) and Coal (9.4 GW) dominate the low-cost range below \$40/MWh, while Gas CT peakers (1.8 GW) operate in the \$34-59/MWh range, and oil & gas steamers (4.5 GW) cluster around \$35-75/MWh. This cost structure determines dispatch order—higher variable cost units remain idle unless market prices justify their operation.

Capacity-Weighted Average Variable Costs

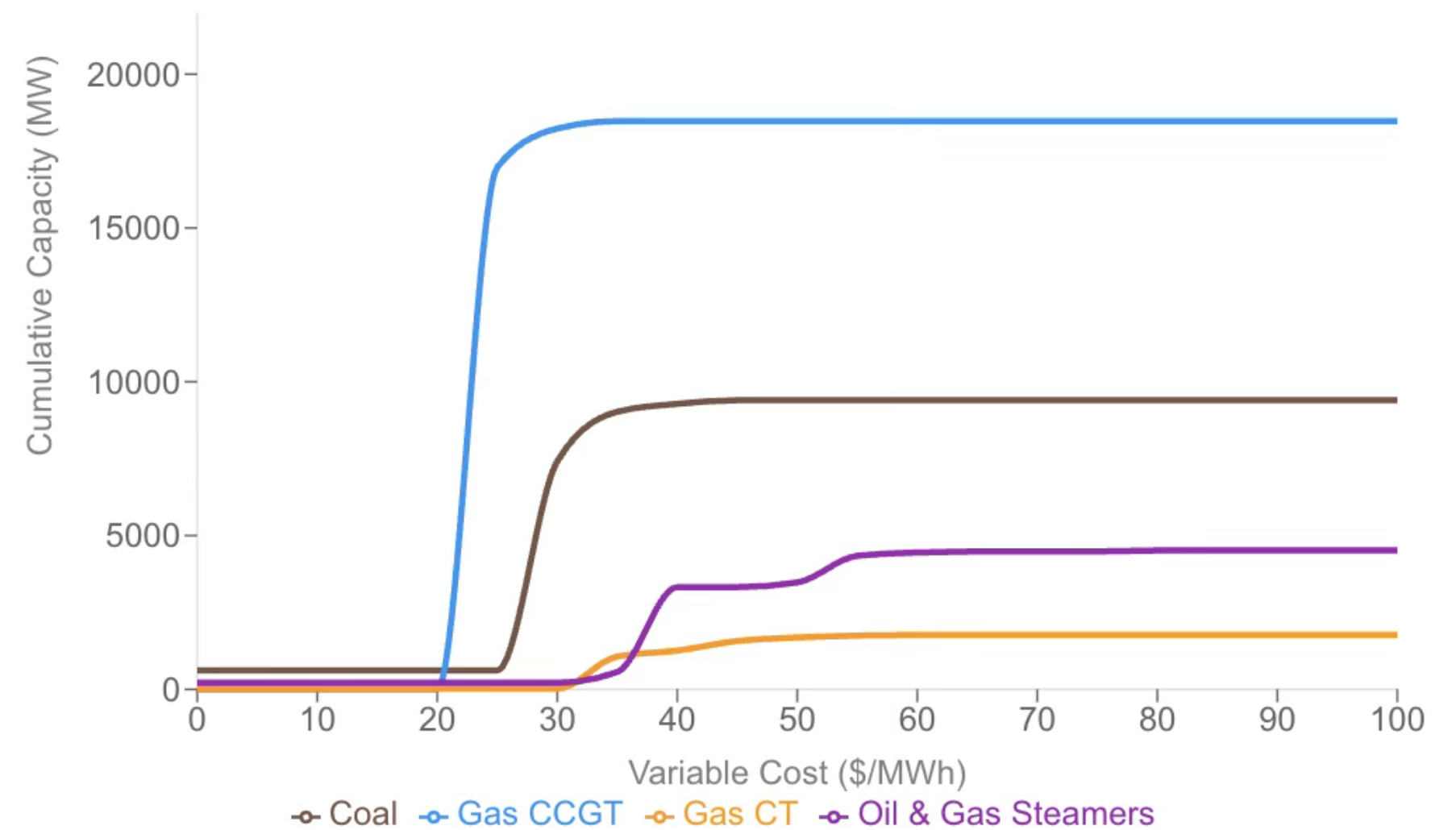
Variable costs include fuel and variable O&M—the marginal cost to generate each MWh

- Gas CCGT: \$24.07/MWh (18.5 GW installed)
- Coal: \$27.20/MWh (9.4 GW installed)
- Oil & Gas Steamers: \$40.44/MWh (4.5 GW installed)
- Gas CT: \$37.88/MWh (1.8 GW installed)

Economic Dispatch Impact

- Total Thermal Capacity: 34.2 GW
- Weighted Average VC: \$33.13/MWh
- 75.8% of capacity competes economically at <\$30/MWh

✓ Cumulative Thermal Capacity by Technology & Variable Cost



Coal and Gas CCGT dominate low-cost ranges while peakers (Gas CT) cluster in \$50-70/MWh range

Cost of Renewable generation

Renewable Generation Economics

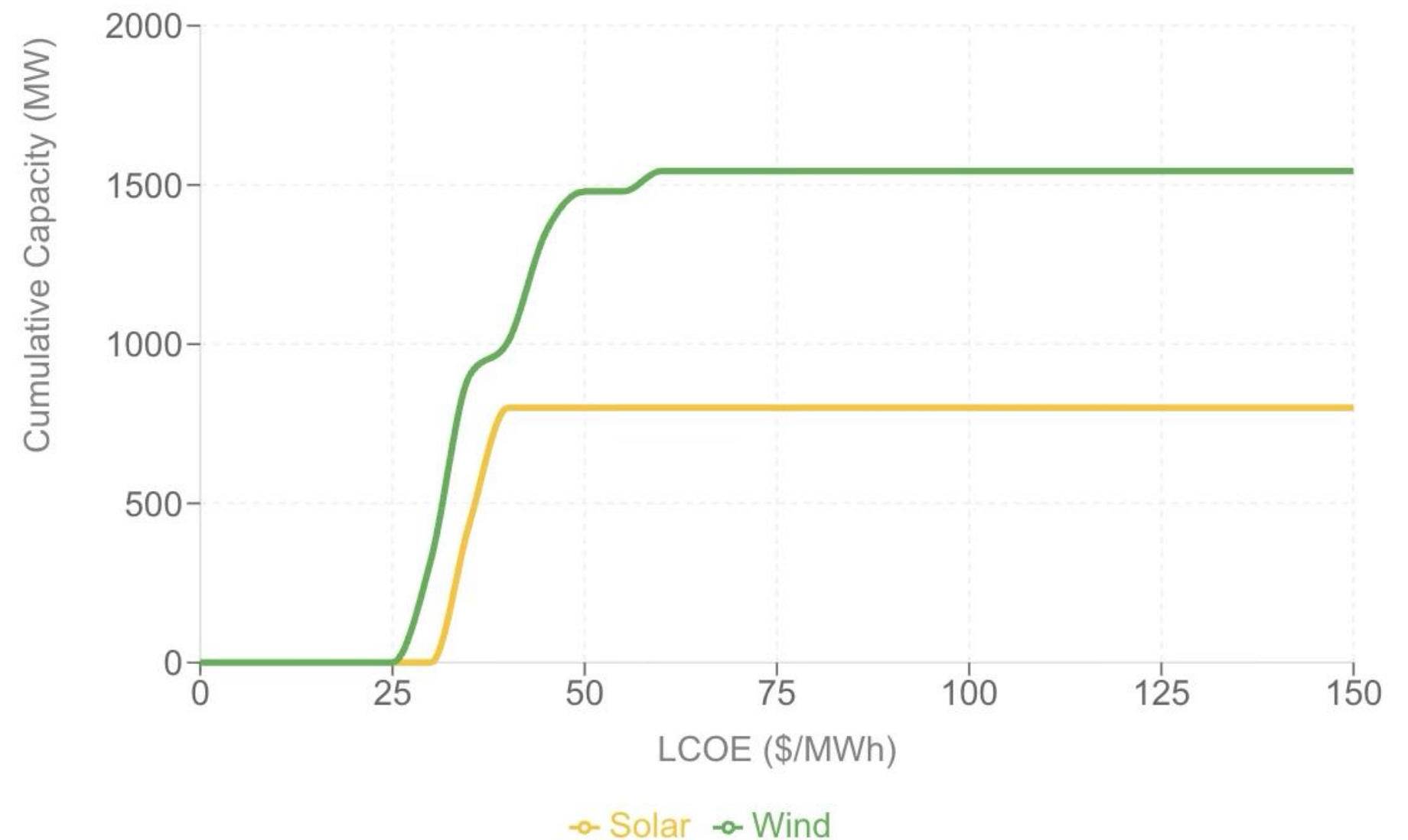
Pennsylvania's 2.3 GW renewable capacity shows unsubsidized costs (without IRA tax credits) comparable to thermal generation seen in the previous slide. Solar (0.8 GW) averages \$35.59/MWh unsubsidized. Wind (1.5 GW) averages \$35.62/MWh unsubsidized. These costs are competitive with the \$30-40/MWh variable costs of coal and gas CCGT plants shown previously.

Capacity-Weighted Average LCOE (2025)

Without IRA tax credits (unsubsidized LCOE)

- Solar: \$35.59/MWh (0.8 GW installed)
- Wind: \$35.62/MWh (1.5 GW installed)
- Total Renewable Capacity: 2.3 GW
- Solar below \$50/MWh: 100% of capacity
- Wind below \$50/MWh: 95.8% of capacity

Cumulative Renewable Capacity by Unsubsidized LCOE



Pennsylvania Installed Capacity

Capacity Breakdown

Thermal capacity dominates at 94% of total installed capacity, with Gas CCGT being the largest single source at 51% of total capacity.

Total Capacity: 36,503 MW

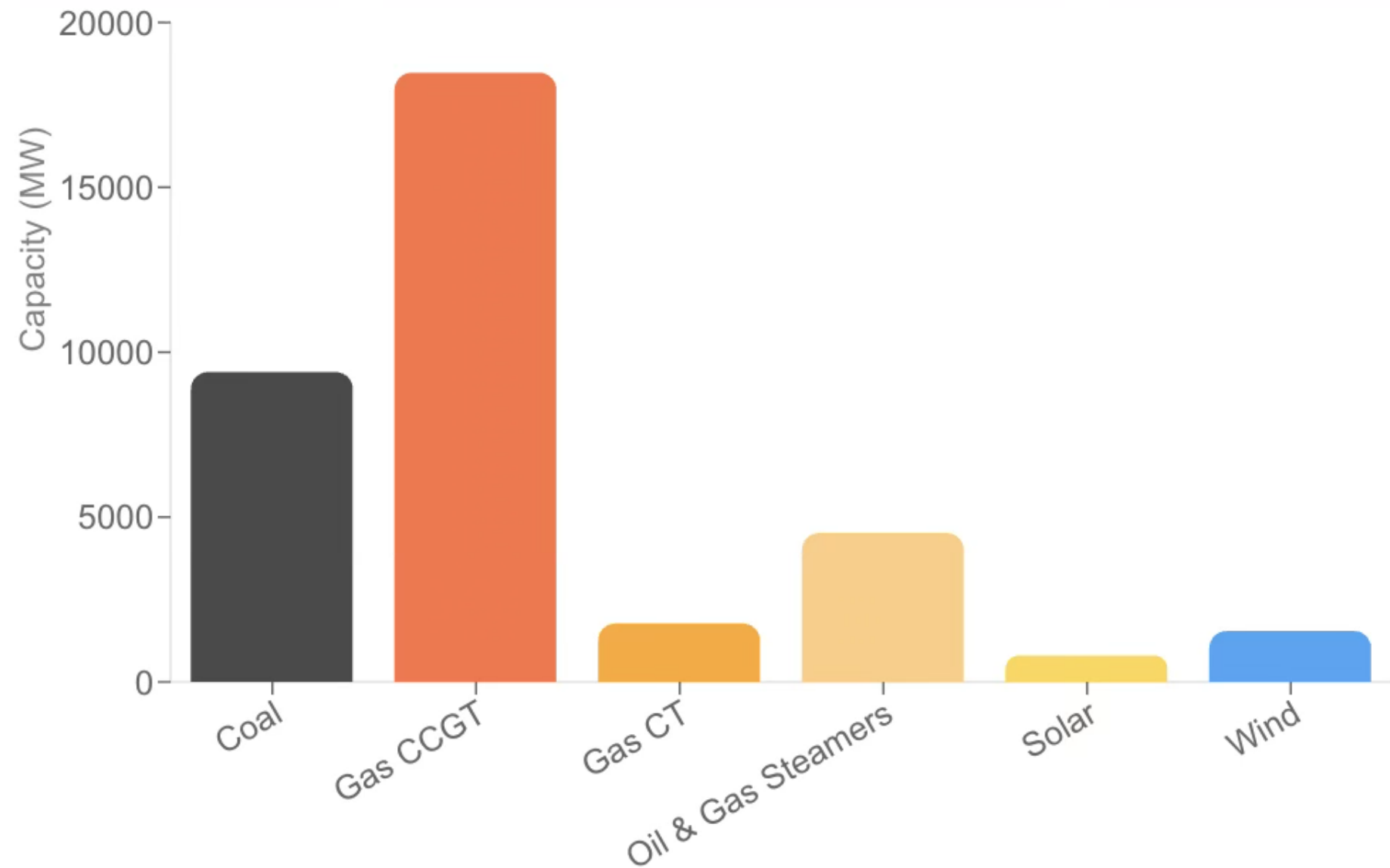
🔥 Thermal: 34,160 MW

- Gas CCGT: 18,476 MW (54%)
- Coal: 9,398 MW (28%)
- Oil & Gas Steamers: 4,515 MW (13%)
- Gas CT: 1,771 MW (5%)

⚡ Renewable: 2,343 MW

- 🌀 Wind: 1,544 MW (66%)
- ☀️ Solar: 800 MW (34%)

Installed Capacity by Technology (MW)



Thermal technologies account for 94% of installed capacity, while renewables represent 6%

PJM Capacity market prices have 10'x in last 3 years

Capacity Market Dynamics

Pennsylvania is entirely within PJM territory. PJM's Reliability Pricing Model (RPM) capacity market has experienced dramatic price increases, signaling tightening supply-demand balances and growing reliability challenges across the Commonwealth.

PJM RPM Capacity Prices (Rest of RTO)

- 2023/24: \$34.13/MW-day (baseline)
- 2024/25: \$28.92/MW-day (-15%)
- 2025/26: \$269.92/MW-day (+833%)
- 2026/27: \$329.17/MW-day (+22%)
- 2027/28: \$333.44/MW-day (price cap, 6,623 MW shortfall)

11.5x increase from 2024/25, with growing capacity shortfalls

Key Price Drivers

- Coal and gas plant retirements reducing supply
- Growing data center load in PJM territory
- Slow pace of new generation interconnection

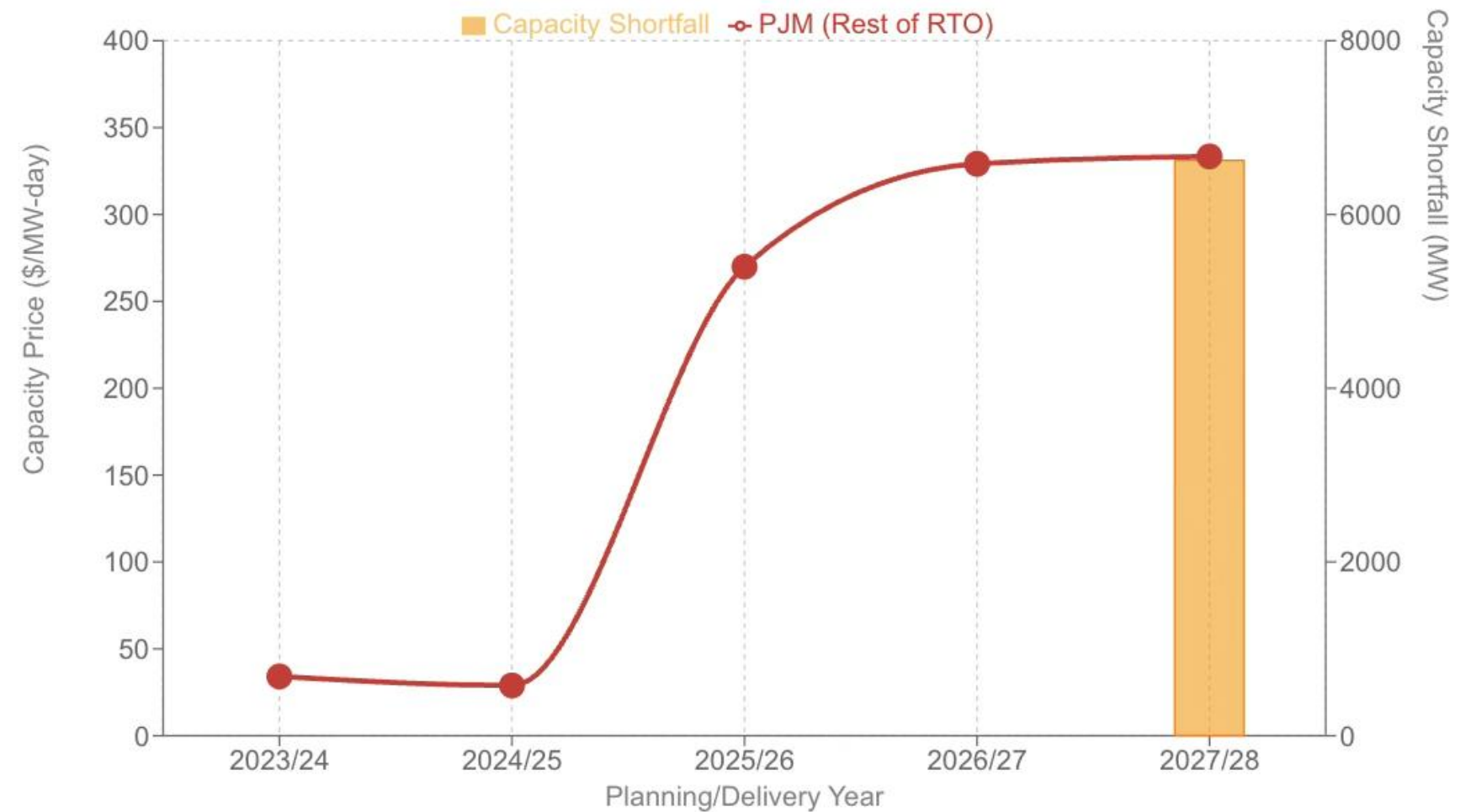
Surplus interconnection can accelerate new capacity additions

Investment Signal

- \$333.44/MW-day = ~\$121,706/MW-year capacity revenue
- Prices at or near the BRA price cap, with 6,623 MW RTO-wide shortfall in 2027/28 auction

These price levels reflect strong market signals for new capacity investment in Pennsylvania

Capacity Prices & Shortfalls by Auction Year



Solar only Scenario: 10 GW of Solar can be added at Thermal Plants

Solar-Only Deployment Scenario

We analyzed a solar-only scenario where only solar is installed at existing thermal plants, recognizing that wind development has become increasingly challenging due to permitting and siting constraints.

10 GW of solar can be integrated at existing thermal sites by 2030

- Base case: **5 GW** (2025) → **7 GW** (2027) → **10 GW** (2030)
- High fuel prices: **15 GW** (2025) → **28 GW** (2027) → **30 GW** (2030)
- Low fuel prices: **0 GW** (2025) → **0 GW** (2027) → **2 GW** (2030)

Impact of IRA Tax Credit Removal:

Without IRA tax credits, solar integration potential starts at 5 GW in 2025. By 2027, technology cost declines increase potential to 7 GW. By 2030, potential reaches 10 GW as solar costs continue declining.

Solar-Only Integration Potential by Year

All years without IRA Tax Credits (unsubsidized LCOE)

