Synapse
Energy Economics, Inc.

Making Energy More Affordable in Pennsylvania

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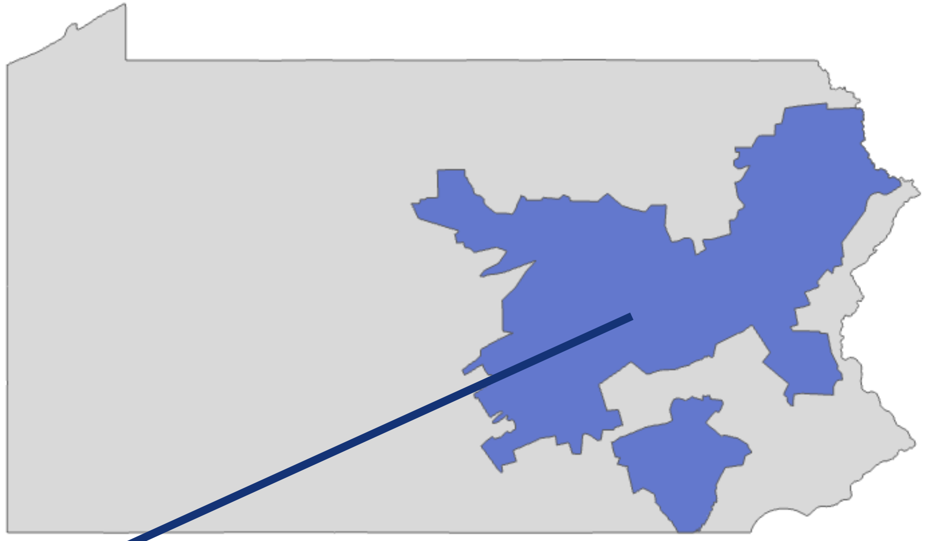
Energy is becoming increasingly expensive.

Policy solutions can provide savings.

We estimate that, as a result of policy solutions deployable in the next four years, residential electric customers in PPL's service territory could save $2.4 billion from 2027 to 2030.

These savings translate to $841 per household in 2030.

Savings are modeled for the typical PPL customer, but similar savings from these policies are likely for other electric utilities.



Our analysis examines the impact of implementing these policy solutions in PPL's service territory:

- **Resolve supply-demand imbalances in PJM's wholesale markets with clean energy** to ensure customers are not burdened by new large load additions.
- **Correct utility return on equity** to ensure that customers are not being unreasonably charged for utility profits.
- **Expand initiatives and incentives for customer-owned power and grid efficiencies—**increased deployment of virtual power plants (VPPs) and technologies like dynamic line ratings (DLRs) can yield greater access to clean energy and community-oriented benefits.

Detailed Results: Savings for PPL Customers

Table 1. Annual residential electric bill savings (2024 $ per household)

	2027	2028	2029	2030	Four-Year Cumulative
Resolve supply-demand imbalances in PJM wholesale markets with clean energy	$83	$56	$219	$492	$849
Correct utility return on equity	$46	$47	$54	$58	$204
Expand initiatives and incentives for customer-owned power and grid efficiencies	$69	$138	$216	$291	$714
Total residential bill savings	**$197**	**$240**	**$489**	**$841**	**$1,767**

Table 2. Annual residential systemwide savings (2024 $ million)

	2027	2028	2029	2030	Four-Year Cumulative
Resolve supply-demand imbalances in PJM wholesale markets with clean energy	$120	$80	$317	$714	$1,231
Correct utility return on equity	$60	$62	$70	$76	$268
Expand initiatives and incentives for customer-owned power and grid efficiencies	$89	$179	$280	$377	$925
Total residential systemwide savings	**$268**	**$321**	**$668**	**$1,167**	**$2,424**

Assumptions:

- *All analysis focuses on residential customers in PPL's service territory.*
- *Systemwide savings are converted into residential electric bills generally by dividing the quantity of savings by the expected number of customers.*
- *Savings from a reduction in utility return on equity could start in 2027, illustrating a hypothetical where policy interventions are made as soon as possible. This table assumes an illustrative 2 percentage point reduction in ROE.*
- *Savings estimated from increased deployment of customer-owned power are inclusive of avoided costs of energy, capacity, transmission, distribution, and RPS compliance. All savings are gross; all ratepayer-funded customer-owned power deployed for a cost lower than shown here will yield net benefits to consumers.*

Resolve Supply-Demand Imbalances in PJM Wholesale Markets with Clean Energy

Per-household savings: up to $492/year

Resolving supply-demand imbalances in PJM wholesale markets with low-cost clean energy could save PPL residential customers **$714 million** per year by 2030, translating to **$492 per household**.

- **Background:** High data center load forecasts and supply-side constraints (mainly due to interconnection queue delays, as well as permitting challenges) are causing supply-demand imbalances in the PJM wholesale markets, which are driving up energy and capacity prices. Two potential mechanisms by which to resolve these imbalances are data center self-supply of electricity or resolving interconnection queue delays and permitting challenges.
- **Methods:** To calculate the impacts of resolving these wholesale market imbalances, we rely on data from two different recent PJM-specific analyses performed by Synapse. We use these analyses to estimate residential bill impacts for PPL customers.
  - Analysis #1 describes the impacts related to data center self-supply. It models a "with data centers" scenario and a "without data centers" scenario, allowing us to estimate the impacts of PJM's data centers not materializing or being met with self-supply. This analysis uses the same overall approach to resource supply in both scenarios.
  - Analysis #2 describes the impacts of increasing resource supply (especially for clean energy) in PJM. It models a "low-supply" and a "high-supply" scenario, letting us estimate the impacts of more supply. This analysis assumes the same load levels (including data center load) in both scenarios.
  - Data center self-supply could likely be implemented on a faster timeline than queue reform. To avoid double counting benefits from these two policy interventions, we use the bill impacts from the first analysis in the near-term (through 2028) and bill impacts from the second analysis for 2029–2030.
- **Detailed results:** Table 3 summarizes the annual residential bill impacts for PPL.

Table 3. PPL residential savings achievable by resolving supply-demand imbalances in PPL (2024 $ per year)

	2027	2028	2029	2030
Million $ savings for all residential customers	$120	$80	$317	$714
Annual savings per household	$83	$56	$219	$492

Notes
- Numbers in 2027–2028 are based on Analysis #1. Numbers in 2029–2030 are based on Analysis #2.
- Fluctuations in residential bill impacts in 2027–2028 are due to year-on-year variations in the relative rate of capacity additions relative to data center loads, resulting in different supply-demand equilibriums.
- Rising bill impacts, especially in the 2029–2030 period, are due to increasingly greater differences in system capacities between the two scenarios.

Correct Utility Return on Equity

Per-household savings: $58/year

Utility pre-tax return on equities (ROEs) impose costs of **$251 per year** on PPL customers in Pennsylvania in 2026. Lowering post-tax ROEs by an illustrative 2 percentage points could save all customers **$76 million** and typical customers **$58 per year in 2030**.

- **Background:** Utilities in Pennsylvania, like PPL, earn a ROE for every dollar spent on utility distribution infrastructure. Ratepayers also pay for the federal and state corporate taxes paid on utility earnings. PPL proposed an 11.3 percent ROE in a rate case filed on September 30, 2025. The Pennsylvania Office of the Consumer Advocate proposed an 8.4 percent ROE. The Pennsylvania Public Utility Commission just approved a settlement agreement in the rate case prior to this document's publication. We model a range of possible ROEs to illustrate the potential savings for customers.
- **Methods:** For PPL, we examined the most recently approved rate base (which includes distribution assets), equity ratio, and ROE to determine how much of a return all ratepayers currently pay, and how that return would decrease if ROE were lower. We escalated revenue and rate base by the rate base growth rate between PPL's last rate case in 2016 and the 2027 future test year used in this rate case. We assumed that the ROE reduction policy reduces ROE immediately, to apply to 2027 and every year thereafter, in line with the Office of the Consumer Advocate's proposal. We examined three illustrative policy cases: a 1, 2, and 3 percentage point reduction. In each policy case, we reduced incremental rate base growth in 2027 due to the lower ROE (Dunkel Werner, Jarvis 2025). We allocated savings based on revenue responsibility for the residential class. Savings are compared to the total bill.

  An updated ROE for PPL was just approved by the Commission in Docket R-2025-3057164 but was not incorporated into this analysis. This analysis is meant to provide a strictly illustrative level of savings comparing two ROE levels.
- **Detailed results:** Table 4 summarizes the annual residential bill impacts for PPL.

Table 4. Residential savings achievable in 2030 by reducing ROE (2024 $ per year)

	1% reduction	2% reduction	3% reduction
Million $ savings for all residential customers	$38	$76	$114
Annual savings per household	$29	$58	$87
% impact to annual bills	-1.3%	-2.6%	-3.9%

ROE rates nationwide

A recent summary by the Michigan administrative law judge (ALJ) in Case No. U-21870 provides a set of statistics across 104 electric ROEs authorized from 2023–2026:

- Range: 8.63 to 11.45 percent
- Average: 9.68 percent
- Median: 9.70 percent

Expand Initiatives and Incentives for Customer-Owned Power and Grid Efficiencies

Per-household savings: up to $291/year

Installing additional customer-owned power and making the grid more efficient will produce benefits for all customers. These strategies yield 2030 savings of **$291 per household**, or **$377 million** for all residential PPL customers.

- **Background:** In this analysis, we define customer-owned power to include the building blocks of virtual power plants (VPPs): traditional energy efficiency measures, demand response, distributed solar, and distributed storage. This analysis also includes dynamic line ratings (DLRs), which make the grid more efficient by allowing grid operators to make real-time adjustments to transmission line capacity. Customer-owned power reduces the need for firm capacity, avoids investments in the transmission and distribution system, and reduces renewable portfolio standard compliance costs—which benefit all customers. Installing additional customer-owned power also reduces energy costs for participants.
- **Methods:** For each type of customer-owned power, we develop both a business-as-usual (BAU) trajectory and an ambitious trajectory. We then calculate the difference between these two series for each year from 2027 through 2030, and we apply avoided costs to calculate utility system benefits resulting from more customer-owned power. We focus only on avoided costs that impact customer bills, including avoided energy, avoided capacity, and avoided transmission and distribution. Other avoided costs (including societal costs, such as those quantifying the impacts of avoided greenhouse gas emissions) are not part of this analysis. Annual average residential bill savings are calculated by dividing utility system avoided costs by the number of residential customers in PPL's service territory in 2024. All savings are gross savings and do not include program costs; resources modeled here will still yield customer savings as long as ratepayer-funded program costs are lower than estimated savings. Our analysis does not account for changes to retail revenue and resulting impacts on bills. See the Appendix for more.
- **Detailed results:** Table 5 shows detailed results for 2030. Cumulative four-year bill impacts total $925 million for all residential customers, or $714 per customer.

Table 5. Benefits of customer-owned power

	Residential savings in PPL, 2030			Utility system avoided costs (2024 $M)	Annual bill savings, average residential customer (2024 $)
	BAU	Ambitious	Incremental		
Energy efficiency	34 GWh	204 GWh	169 GWh	$25	$19
Demand response	3 MW	25 MW	22 MW	$5	$4
Distributed solar	497 MW	1,242 MW	745 MW	$215	$166
Distributed storage	135 MW	338 MW	203 MW	$32	$25
Dynamic line rating	0 upgrades	4 upgrades	4 upgrades	$100	$77
Total				**$377**	**$291**

Appendix

Assumptions and Uncertainties: Supply-Demand Imbalance Analyses

- While these analyses relied on the best available data at the time, availability of new information has and will continue to change the expected trajectory of some important parameters. Although the results of these analyses are directionally robust, the magnitude of the impacts may vary depending on these trajectories. The table below describes key supply- and demand-side assumptions in the underlying analyses, as well as expected directional impacts if reality were to vary from these assumptions.
- Other factors that have changed since these analyses were conducted include:
  - **Rollback of clean energy tax credits:** Minimal expected impact. Developers that meet Safe Harbor designations will continue to be able to claim tax credits in the 2027–2030 period. Furthermore, the degree of projected supply-demand imbalance means that we would expect the high electricity prices to continue driving modeled resource build-out despite loss of credits.
  - **Changes to and enrollment in the Regional Greenhouse Gas Initiative program:** Minimal expected impact. Recent changes to RGGI are minimal during the 2027–2030 period for which bill impacts are reported. The study we rely on that spans these years assume that Pennsylvania is a RGGI state or as a RGGI-like program in effect, and assumes that energy market costs associated with participation in RGGI are refunded on customer bills.
- For more detail on other input assumptions for each study, see full report for Analysis #1 here and full report for Analysis #2 here.

Table 6. Scenario detail for Analysis #1 and Analysis #2

	Analysis #1 (Published December 2024)	Analysis #2 (Published April 2025)	Directional impact of variance from forecast
Data center load forecast	Data center peak load impacts rise from 17 GW in 2027 to 29 GW in 2030. Load forecast data sources: PJM 2024 load forecast, EPRI 2024 report, Dominion 2024 IRP	Data center peak load impacts rise from 13 GW in 2027 to 32 GW in 2030. Load forecast data source: PJM 2025 load forecast	**Capacity prices:** PJM capacity market prices are capped through the 2029–2030 delivery year. Reduced data center load could drive down capacity prices below the caps. Increased data center load would likely cause the capacity market to continue clearing at the price caps through 2030. **Energy prices:** Reduced data center load would shift energy market clearing prices down the supply curve, reducing energy prices. Increase data center load would shift energy market prices up the supply curve, leading to even higher energy prices.
Incremental resource additions in policy scenario compared to base scenario by 2030	Supply-side resource additions are assumed to be sufficient to fully meet data center energy needs but are not modeled explicitly.	+10 GW of solar +5 GW of battery storage +3 GW of onshore wind -0.6 GW of gas (displaced by new resource additions)	**Capacity prices:** Lower levels of capacity additions would likely cause the capacity market to continue clearing at the price cap through 2030. Higher quantities of firm capacity additions may drive the capacity market price down below the price caps. **Energy prices:** Lower levels of capacity additions would lead to increased reliance on old, inefficient fossil fuel generation, increasing energy prices. Increased additions of new, low-cost energy generation (especially zero-marginal-cost renewables) would drive down energy prices.

Assumptions: Customer-Owned Power and Grid Efficiencies

Table 7. Customer-owned power and grid efficiency trajectories

	BAU trajectory	Ambitious trajectory
Energy efficiency	Calculated using PPL's energy efficiency savings from the *Phase V Energy Efficiency and Conservation Plan*.	Based on maximum achievable potential for EE in the *PA EE and Peak DR Market Potential Study Report* for the Phase V period.
Demand response	Calculated using PPL's persistent peak demand savings from the *Phase V Energy Efficiency and Conservation Plan*.	Based on maximum achievable potential for DR in the *Phase V Demand Response Potential Study*.
Distributed solar	Assume that the current number of distributed solar installations (about 2 percent of residential PPL customers) will double by 2030 to 4 percent of residential PPL customers. Installations are linearly interpolated from 2027 to 2030.	Assume that the current number of distributed solar installations quintuples by 2030 to 10 percent of residential PPL customers. Installations are linearly interpolated from 2027 to 2030.
Distributed storage	Assume that the number of households that have distributed storage is equivalent to half of the households with distributed solar (2 percent of residential PPL customers in 2030). Installations are linearly interpolated from 2027 to 2030.	Assume that the number of households that have distributed storage is equivalent to half of the households with distributed solar (5 percent of residential PPL customers in 2030). Installations are linearly interpolated from 2027 to 2030.
Dynamic line rating (DLR)	Assume no further dynamic line rating upgrades.	Assume one transmission line gets a DLR upgrade, each year from 2027 to 2030.

Table 8. Avoided cost sources

Avoided cost	Source
Electric energy	*Phase V Energy Efficiency and Conservation Plan*
Electric capacity	
T&D	
Energy and demand line losses	8.75%, *Phase V Energy Efficiency and Conservation Plan*
Energy and Capacity DRIPE	*Phase V DRIPE Study*
RPS compliance	Calculated using REC prices and RPS target
VOLL	Calculated using LBNL ICE Calculator

Notes

- We calculate avoided RPS compliance costs using REC prices and the PA RPS target. We calculate value of lost load (VOLL) using the LBNL Interruption Cost Estimate Calculator.
- We assume that each storage installation is 5 kW with a 4-hour duration. We also assume 150 dispatches per year and a roundtrip efficiency of 85 percent.
- Dynamic line rating is a type of advanced transmission technology (ATT). We calculate avoided congestion costs from DLR based on PPL's reduced congestion costs from implementing DLR on the Susquehanna-Harwood #1 and #2 and the Juniata-Cumberland lines. PPL planned to also implement DLR on five additional transmission lines by June 2024. We have not found additional information on those projects, including avoided congestion costs.
- ATTs also include advanced power flow controls, topology optimization, and advanced reconductoring.

Additional Cost Information: Customer-Owned Power and Grid Efficiencies

- Deploying more customer-owned power and grid efficiencies would entail incentive payments or administrative costs. These costs or incentives could be paid through the state budget or electric rates. If costs are paid through rates, the modeled ratepayer savings from the programs described on slide 6 would be reduced. Table 9, below, provides an estimate of per-unit costs (including both incentive and administrative costs) for combined energy efficiency and demand response, and dynamic line rating based on data published by PPL. We estimate per-MW annual incentive costs for distributed solar and storage that would continue to yield cost-effective programs on a consumer-cost basis alone.
  - Energy efficiency per unit program costs include demand response program costs. These are an average of the residential portfolio costs provided in the PPL Phase V EEC Plan across the plan years.
  - PPL's DLR cost is based on data from *DLR From the Utility Perspective*. We convert this into an annualized cost using an approximated 10 percent financing rate.
  - We calculate a combined implied annual incentive payment for demand response and distributed solar by dividing the total customer-owned power and grid efficiencies net utility system avoided cost by the incremental MW savings from demand response and distributed solar.

Table 9. Benefits of customer-owned power

	Incremental savings (from previous slide)	**Gross Benefits (from previous slide)**		**New calculations and net benefits**				
		Utility system avoided costs (2024 $M)	Annual bill savings, average residential customer (2024 $)	Per unit costs (2024 $)	Total costs (2024 $M)	Utility system avoided costs (2024 $M)	Annual bill savings, average residential customer (2024 $)	Implied annual incentive payment (2024 $/W)
Energy efficiency	169 GWh	$25	$19	$53/MWh	$8.92	$16.0	$12.32	-
Demand response	22 MW	$5	$4	-	-	$5.4	$4.20	-
Distributed solar	745 MW	$215	$166	-	-	$215.2	$166.10	$0.39
Distributed storage	203 MW	$32	$25	-	-	$32.1	$24.77	
Dynamic line rating	4 upgrades	$100	$77	$25,000/upgrade	$0.10	$99.6	$76.90	-
Total		**$377**	**$291**	**-**	**$9.02**	**$368.4**	**$284.28**	**-**

