Maryland Energy Storage Study Results

Prepared for American Clean Power Association

March 24, 2023

Shelley Kwok, Pat Knight, Sabine Chavin, Paul Rhodes, Jason Frost

 |

About Synapse

- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power and natural gas sectors
- Staff of 40+ includes experts in energy, economic, and environmental topics

Study objectives

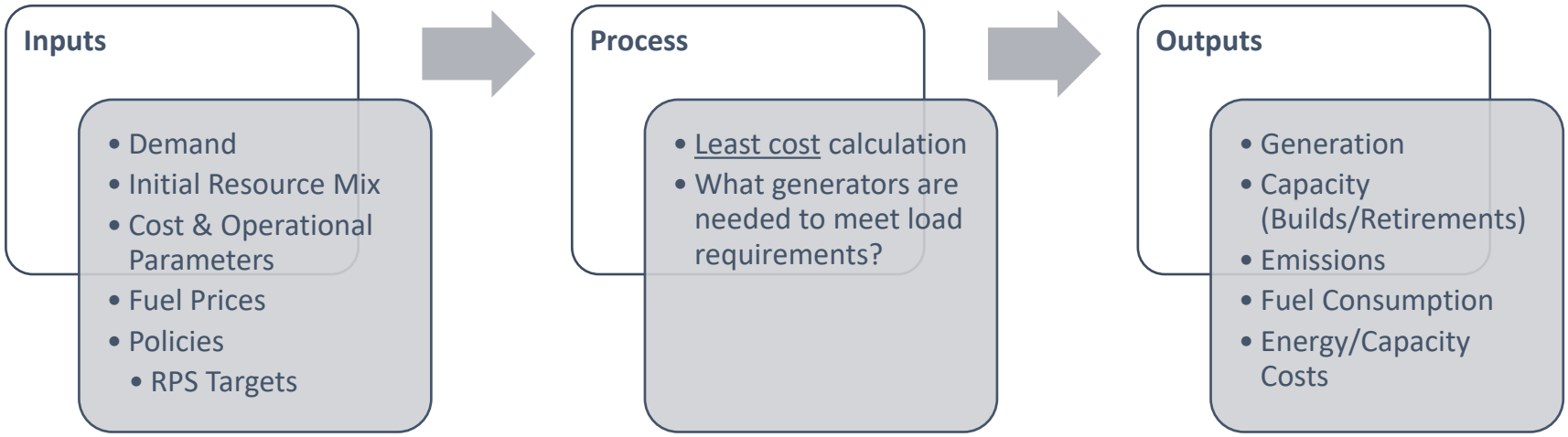
- Examine the net benefits of procuring energy storage in Maryland relative to a future that continues to rely on existing and new gas.
- Quantify and compare the differences between two scenarios using an electric-sector capacity expansion and dispatch model:
  - Continued Gas Dependence Scenario: Continue Maryland's reliance on gas resources to meet its peak and energy load between 2023 and 2033.
  - Increased Energy Storage Scenario: Procure at least 2,500 MW of energy storage resources in Maryland between 2023 and 2033.
- Analyze the potential benefits and costs to the utility system and individual ratepayers for each scenario.

Project approach

- Use EnCompass, an industry-standard electric sector software, to model capacity builds and energy dispatch in PJM and Maryland from 2023 through 2033
  - Calibrate historical dispatch and price data in years 2021 and 2022
  - Incorporate *Inflation Reduction Act* (IRA) tax credits for eligible resources, including adders for energy communities and wind domestic content
  - Allow economic retirements at the model's discretion
- Assess the impacts of energy storage in Maryland
  - Use the regional builds and retirement results as an input to Maryland-focused scenarios
  - Re-optimize Maryland builds with appropriate constraints
    - Gas Dependence scenario cannot build new battery storage in Maryland
    - Energy Storage scenario cannot build new gas plants in Maryland
- Calculate the difference in energy and capacity market costs between scenarios and the resulting impact on residential rates and bills

About the EnCompass model

- EnCompass is an industry-standard capacity expansion and production cost model developed by Anchor Power Solutions.
- The capacity expansion modeling outputs of our analysis defined the optimal capacity mix across the region. The model was given perfect foresight to look ahead through 2033 and pick the optimal resource mix for the entire time period for each scenario.
- The production cost model simulated the energy dispatch of the resulting portfolio at a more granular level. We modeled 12 hourly intervals for each calendar day of each year of the analysis.



Scenario design

	Scenario Description
Continued Gas Dependence	This scenario functions as a reference case and reflects the continued maintenance and expansion of gas-fired resources in Maryland. • *The model can select any amount of renewables it finds to be economic (must meet RPS).* • *No new storage resources can be built in Maryland.* • *By preventing storage from being built in this case, we ensure the price differences observed between scenarios are isolated to the impact of installing gas versus energy storage.*
Increased Energy Storage	This scenario reflects the installation of at least 2.5 GW of storage within Maryland by 2033. • *The model can select any amount of renewables it finds to be economic (must meet RPS).* • *At least 2.5 GW of storage will be built by 2033.* • *No new gas resources can be built in Maryland.*
High Gas Price Sensitivities	This sensitivity is applied to both scenarios above. • *This represents a higher gas price forecast, based on AEO 2022's Low Oil and Gas Supply case.* • *No new resource builds are permitted; this sensitivity only affects resource operation and dispatch.*

Caveats

- Findings are based on the most granular temporal resolution possible given time constraints. Capacity expansion runs were conducted using simpler settings and production cost runs modeled a higher number of unique intervals and days.
- Our modeling does not account for any possible changes to intra-regional transmission or distribution infrastructure.

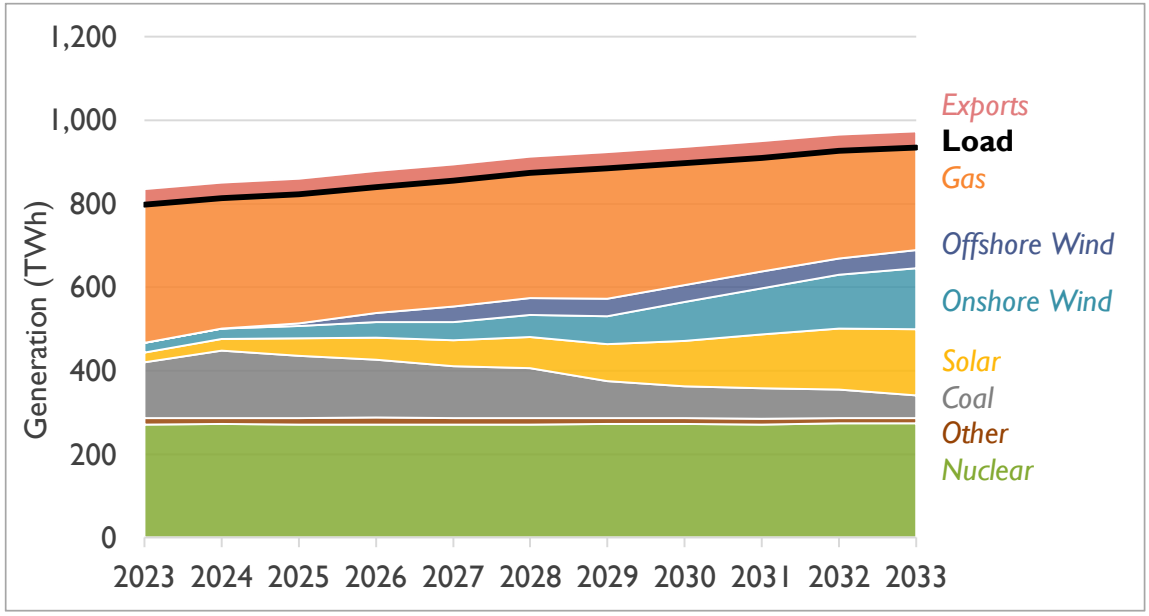
Main takeaways

- Our results suggest it is economic for Maryland to build over 3.6 GW of storage by 2033.
  - The Increased Energy Storage scenario builds 3.6 GW of storage in Maryland by 2033, with an average of over 400 MW built each year starting in 2025.
  - The storage is largely built in Pepco and BGE territories, and it facilitates the construction of over 16 GW of solar and wind in Maryland.
- In general, IRA tax credits make renewables and storage look more favorable than new gas and existing fossil.
  - The model builds renewables in excess of what is required to meet RPS requirements in PJM, the large mid-Atlantic regional transmission organization that serves Maryland.
  - In the Increased Energy Storage scenario, the model chooses to build twice as much solar in Maryland than in the case with no new storage. This suggests that increased amounts of batteries can facilitate more renewables.
- System and ratepayer costs are marginally lower in the Increased Energy Storage scenario relative to the Continued Gas Dependence case.
  - We observed that energy costs are roughly $2/MWh lower due to higher penetrations of storage and renewables by 2033, while capacity costs are roughly equal in both scenarios.
  - Deploying this level of storage would lower residential electric bills by about $1 per month compared to an alternative that is more dependent on gas.
- CO_2 emissions are notably less in the Increased Energy Storage scenario
  - The Increased Energy Storage scenario releases 47% less CO_2 in Maryland from 2023-2033 than the Gas Dependence scenario

Results

Generation and Load - PJM

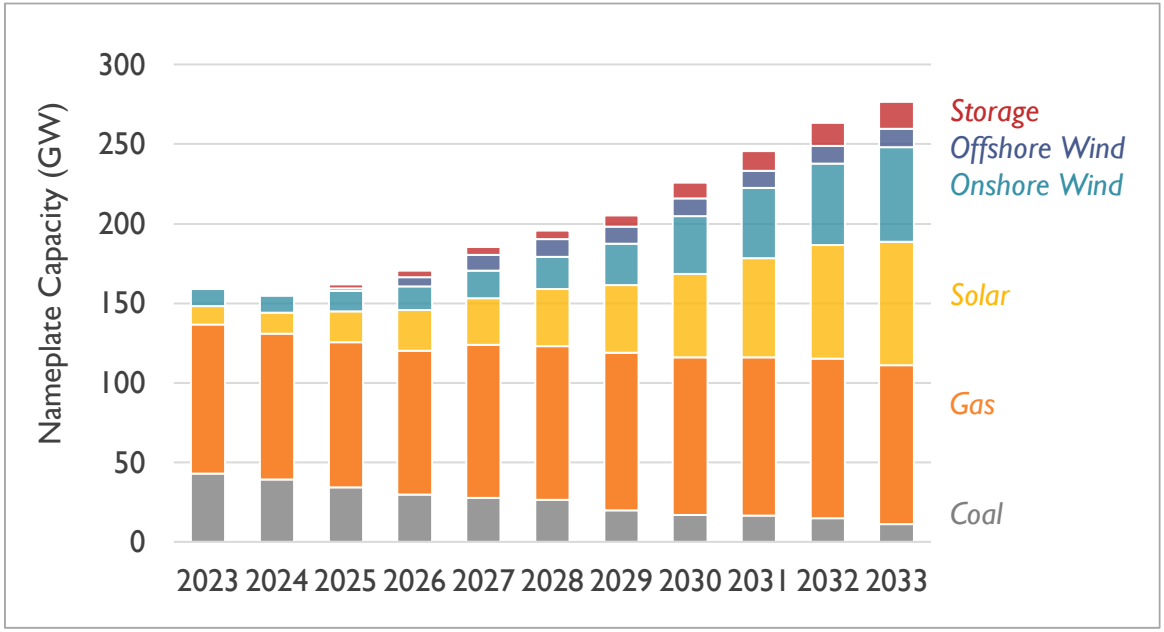
- The PJM generation mix is very similar between both scenarios. Shown below are the results from the Increased Energy Storage case.
- Fossil: Coal generation decreases by 60% by the end of the study period. Gas generation decreases by 23%.
- Renewables: Utility solar and wind generation in PJM increases over the study period, supplying 37% of electricity in 2033. IRA tax credits drive significant growth in renewables.
- New clean energy makes headway displacing existing coal and gas generation through the 2030s. By 2033, 65% of PJM-wide generation is from non-fossil sources.



Note: "Other" consists of hydro, landfill, biomass, and storage

Capacity changes- PJM

- At the PJM level, the resource mix is very similar between both scenarios. Shown below is the resource mix for the Increased Energy Storage case.
- Fossil: Over 30 GW of coal capacity retires in the mid-2020s through mid-2030s. Older gas turbines are retired as new gas combined-cycle units are built.
- Renewables: Sustained capacity additions of about 7 GW per year for both solar and wind occur throughout the study period, largely driven by IRA tax credits.
- Storage: Over 16 GW of battery storage is added to the PJM system by 2033, most of which is utility-scale 4-hour batteries.



Generation and Load - Maryland

Figure 1. Increased Energy Storage Scenario

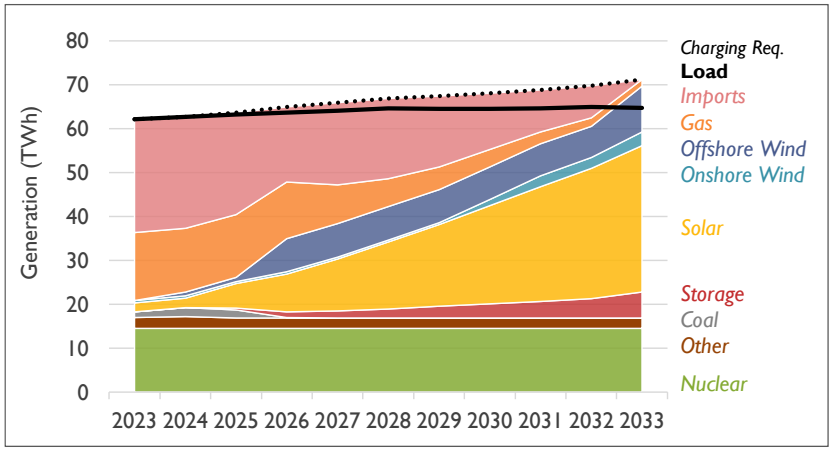
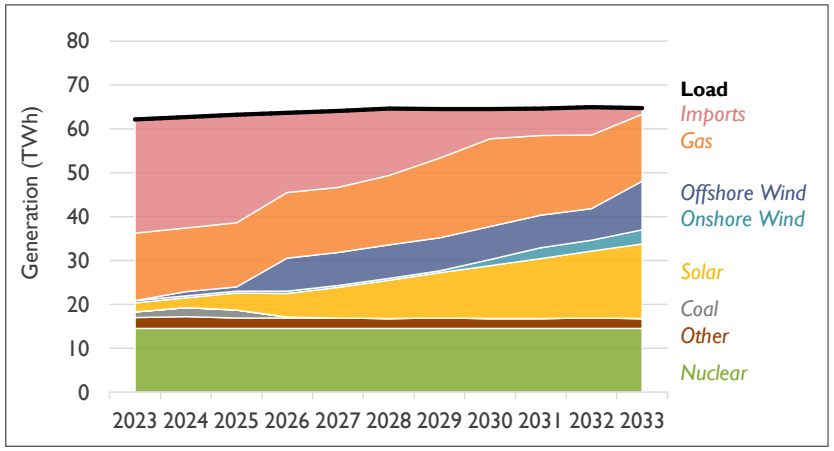


Figure 2. Continued Gas Dependence Scenario



- Increased Energy Storage scenario:
  - By 2033, 3.6 GW of battery storage is built in Maryland alone.
  - Most new generation in the state is from solar. Solar generation serves 51% of Maryland's load by the end of the study period. Wind generation increases to 22% of load by 2033, primarily due to new offshore wind projects.
  - By 2033, about 97% of Maryland's electricity is served by non-fossil resources.
- Continued Gas Dependence scenario:
  - By 2033, gas serves 24% of Maryland's load.
  - This scenario has comparable levels of wind and lower levels of solar generation than the Energy Storage scenario. By 2033, solar serves 26% of load and wind serves 22%.

Note: "Other" consists of hydro, landfill, and biomass.

Capacity changes- Maryland

Figure 1. Increased Energy Storage

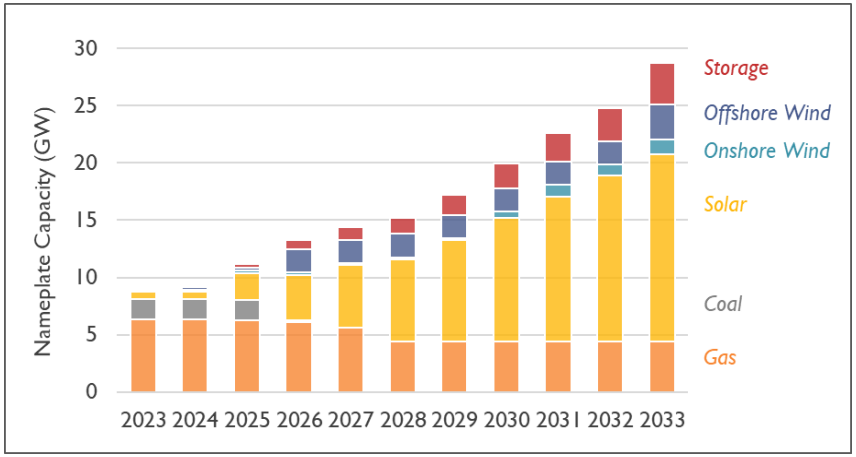
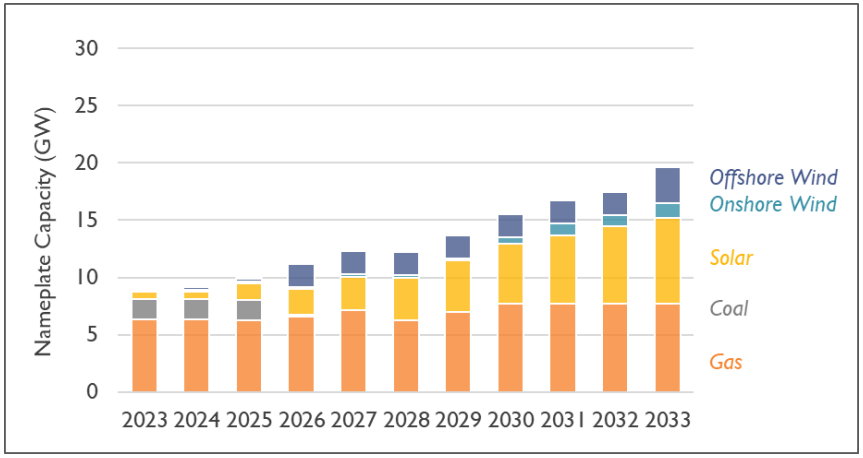


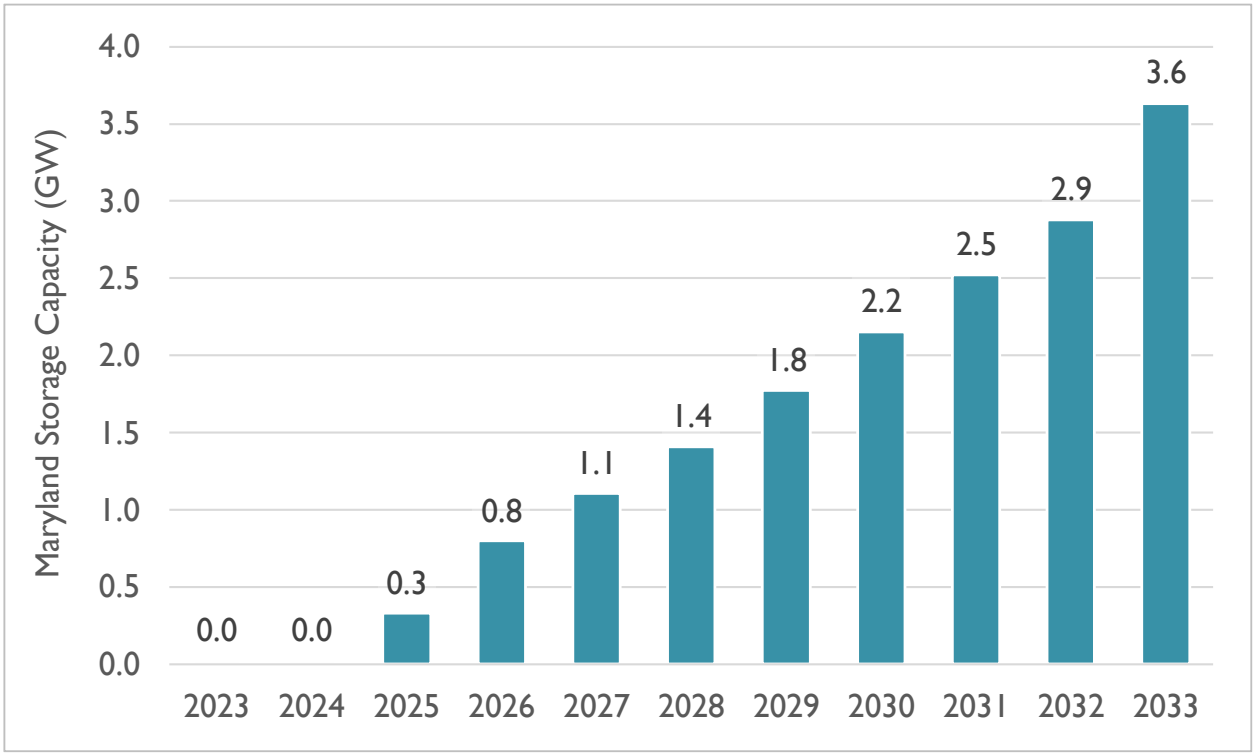
Figure 2. Continued Gas Dependence



- Increased Energy Storage scenario:
  - Coal: All coal in Maryland retires by 2027.
  - Gas: 2 GW of gas is retired by 2033. No new gas is built in Maryland, consistent with scenario constraints.
  - Offshore Wind: MarWin comes online in 2024. Skipjack and Momentum Wind come online in 2026. An additional 1 GW of offshore wind is built in 2033.
  - Onshore Wind: Roughly 1 GW of onshore wind is added in western Maryland over the study period.
  - Solar: Solar is added steadily across the modeling horizon, at about 1.7 GW per year in Maryland, amounting to 16.4 GW by 2033.
  - Storage: Battery storage additions amount to 3.6 GW by 2033.
- Continued Gas Dependence scenario:
  - Coal: All coal in Maryland retires by 2027.
  - Gas: 2.8 GW of new gas is built in Maryland by 2033, offsetting some gas retirements
  - Wind: Builds are identical to the Increased Energy Storage case.
  - Solar: 7.5 GW of solar is built in Maryland by 2033, less than half as much as the Energy Storage case.
  - Storage: No batteries are built in Maryland, consistent with the scenario constraints.

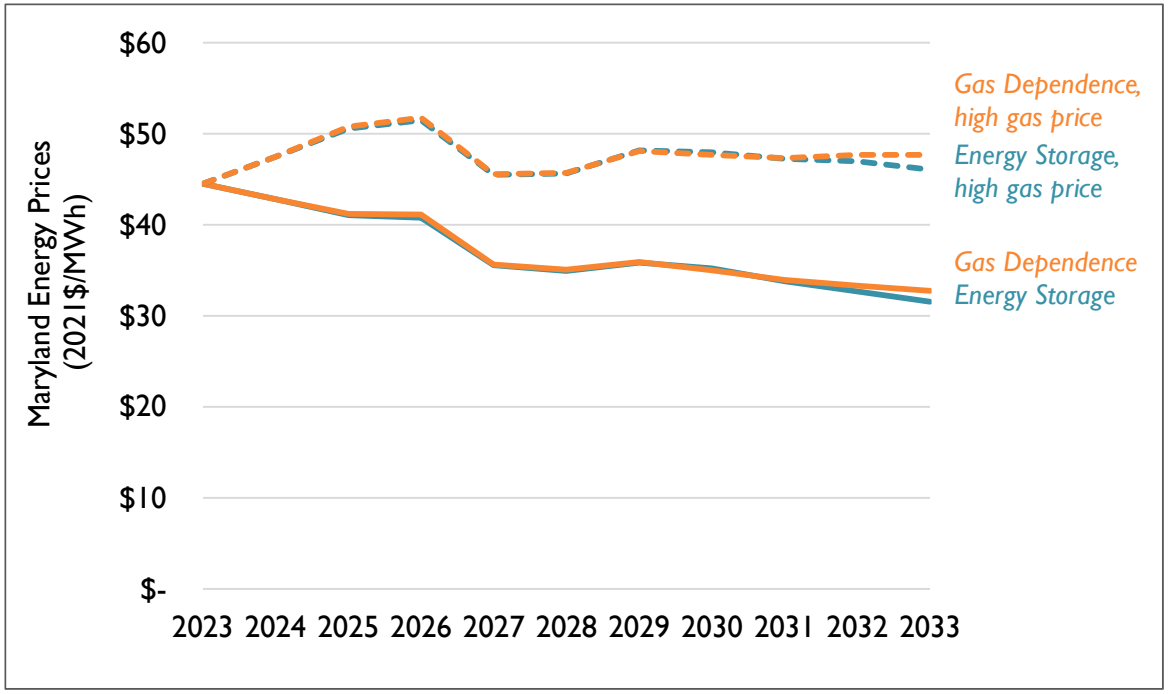
Storage builds vs. target

- Our results suggest that it is economic for Maryland to procure up to 3.6 GW of distributed and utility-scale storage by 2033.
- New storage was allowed starting in 2025. Starting in that year, the model builds roughly 400 MW of storage each year in Maryland.



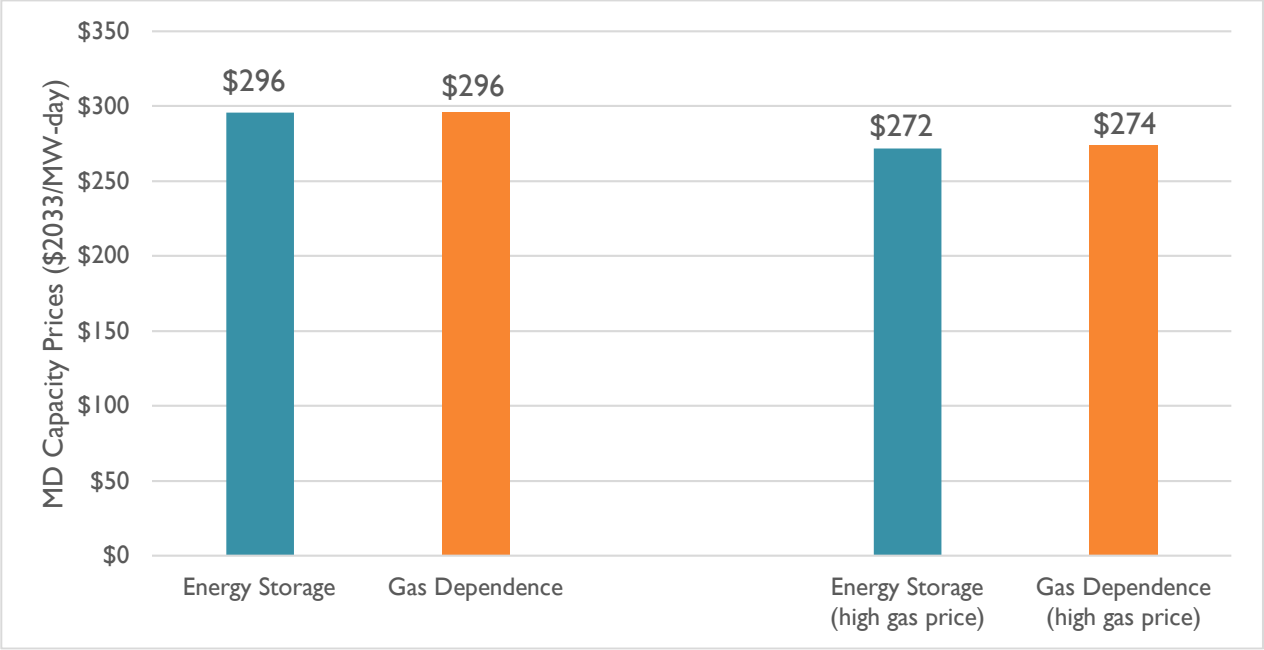
Energy prices

- Load-weighted locational marginal prices (LMPs) in the Gas Dependence and Energy Storage scenarios are within 5% of each other throughout the study time horizon, for both the main scenarios and the high gas price sensitivity.
  - The average energy prices of the two scenarios over the study period are within $1/MWh of each other.
- The two scenarios have similar marginal resources, with gas plants, imports, and battery storage tending to set the price in most hours of the year.



Capacity prices

- Capacity prices in 2033 in the Energy Storage and Gas Dependence scenarios are within 1% of each other because new fossil plants are the marginal capacity resource in both scenarios
- Capacity prices in both scenarios are ~8% lower under the high gas price sensitivity because energy prices are higher, meaning new fossil plants are earning more money from the energy market.
    - This means that new fossil plants can submit lower bids to the capacity market and still recover their high upfront capital costs.

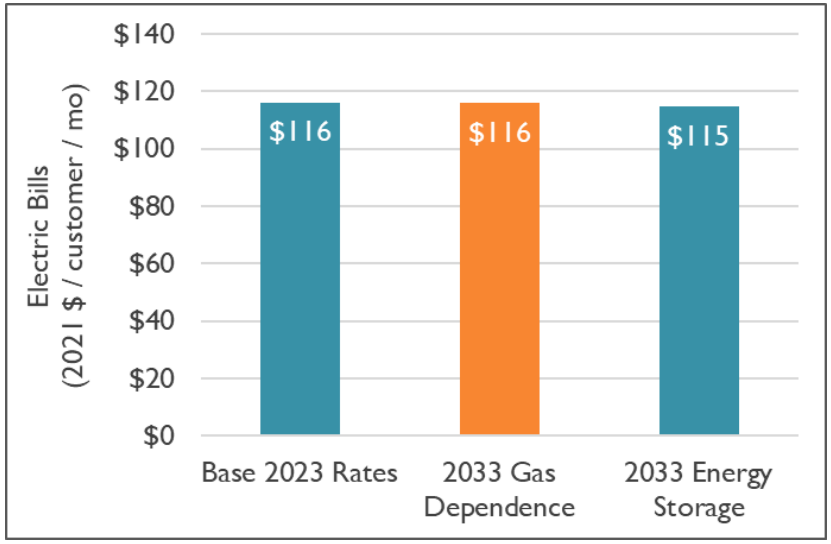


System-wide costs

- The Increased Energy Storage scenario results in net system cost savings to Maryland of approximately $74 million in 2033 compared to the Continued Gas Dependence scenario.
- The Increased Energy Storage scenario results in net system cost savings to Maryland of approximately $100 million in 2033 compared to the Continued Gas Dependence scenario under the high gas price sensitivity, due to lower energy costs.
- Higher penetrations of renewables (facilitated by batteries) in the Increased Energy Storage scenario result in lower energy costs compared to the Continued Gas Dependence scenario under both the moderate and high gas price cases.
- The total capacity costs for Maryland in 2033 are roughly $1 billion in both scenarios under the moderate and high gas price cases.

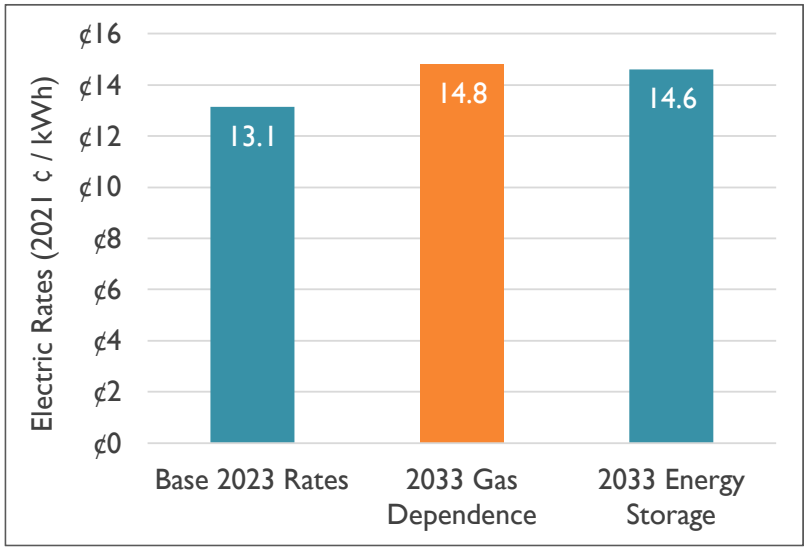
Residential rates and bill impacts

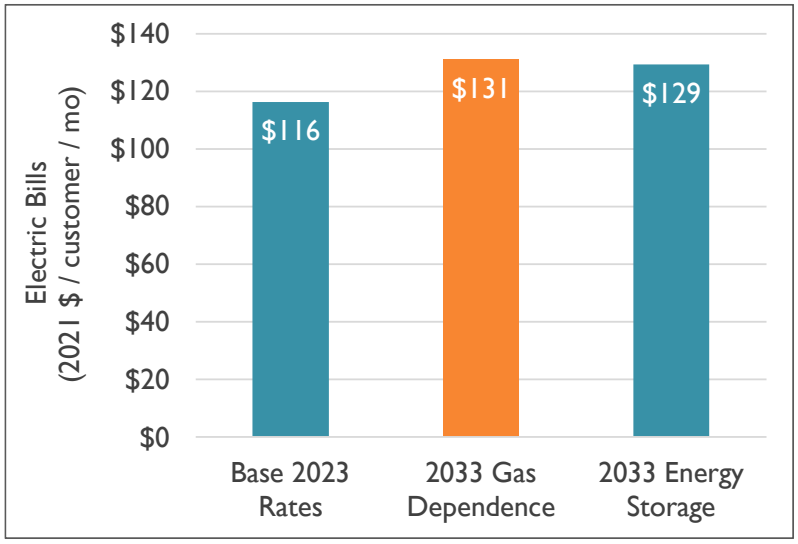
- Impacts of each scenario on residential rates and bills were quantified using a mix of historical data and EnCompass results.
  - Data from EIA-861 was used to determine historical sales, customers, and revenue across sectors, which were then used for cost and load allocation.
  - EnCompass energy and capacity prices were used as inputs in our overall system cost calculations.
- The Energy Storage scenario results in rates that are slightly lower (<1%) than the Gas Dependence scenario.
- Average monthly residential customer bills in the Energy Storage scenario are about $1 lower than the Gas Dependence scenario
- We assume rate impacts related to other factors, such as energy efficiency, distributed generation, and renewable energy credits are consistent across the two scenarios.



Residential rates and bill impacts- high gas price sensitivity

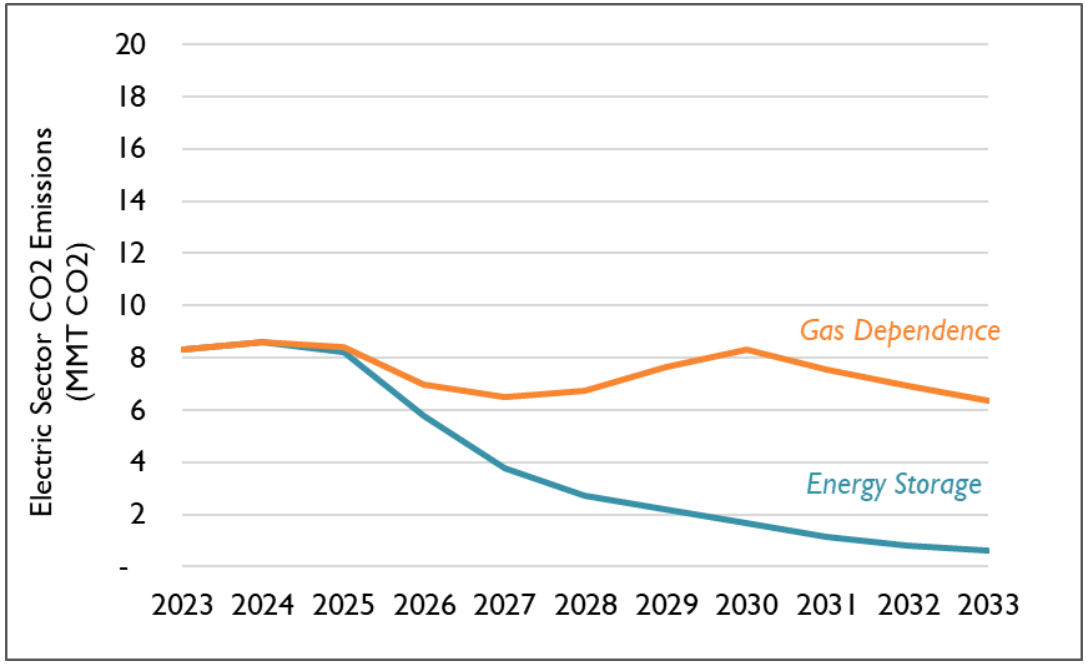
- The Energy Storage scenario results in residential rates that are slightly lower (~1%) than the Gas Dependence scenario under a high gas price future.
- Average monthly residential customer bills in the Energy Storage scenario are about $2 lower than the Gas Dependence scenario





Electric sector CO_2 emissions - Maryland emitters only

- The Energy Storage scenario emits 39 million fewer short tons of CO_2 than the Gas Dependence Case in Maryland over the modeling horizon
  - The Energy Storage scenario reduces Maryland emissions by 93% by 2033 relative to 2023
  - The Gas Dependence scenario reduces Maryland emissions by 23% by 2033 relative to 2023



Electric Sector CO_2 emissions - Maryland with imports

- After accounting for emissions associated with imported energy from the rest of PJM, the Energy Storage scenario emits 39 million fewer short tons of CO_2 than the Gas Dependence Case in Maryland over the modeling horizon
  - The Energy Storage scenario reduces emissions by 97% by 2033 relative to 2023
  - The Gas Dependence scenario reduces emissions by 65% by 2033 relative to 2023
- PJM-wide emissions are very similar between scenarios
- The dotted lines represent the emissions within Maryland only