



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION



Energy Programs Office

Pennsylvania Energy Storage Assessment: Status, Barriers, and Opportunities

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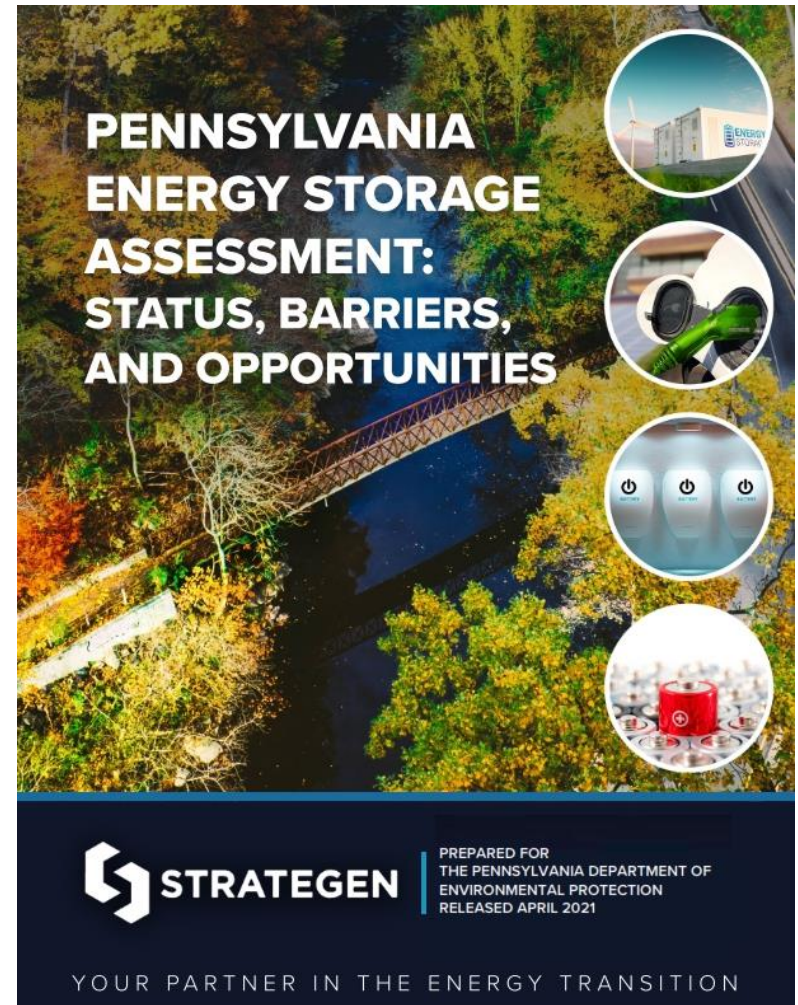


Agenda

1. Introduction
2. Energy Storage Technologies and Applications
3. Energy Storage in Pennsylvania Today
4. Analysis of Energy Storage Potential
 - Standalone behind-the-meter storage
 - Large-scale solar-plus-storage
5. Barriers to Energy Storage and Policy Recommendations

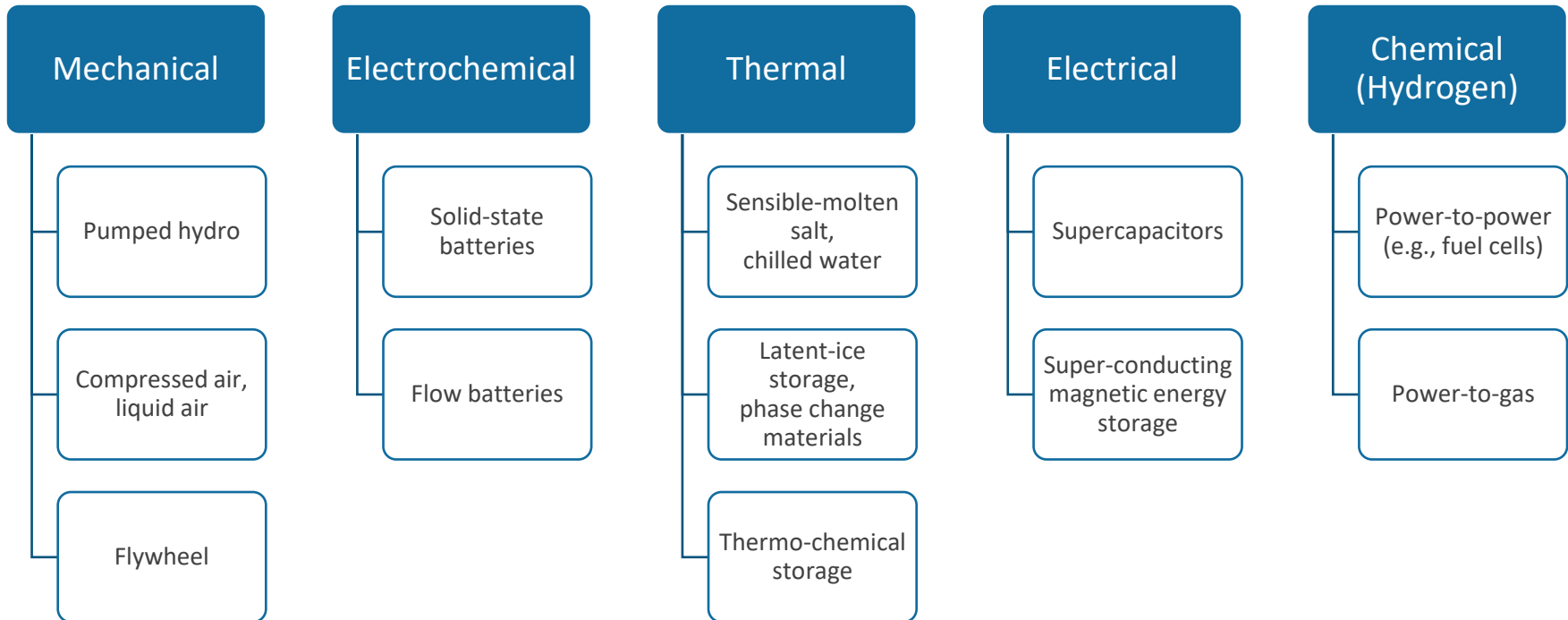
Introduction

- + Purpose of this Report:
 - + Assess the current landscape of energy storage in the Commonwealth of Pennsylvania
 - + Explore the potential benefits of storage
 - + Identify barriers and provide recommendations
- + Today's Objectives:
 - + Provide an overview of the Energy Storage Assessment
 - + Discuss results of analysis and policy options



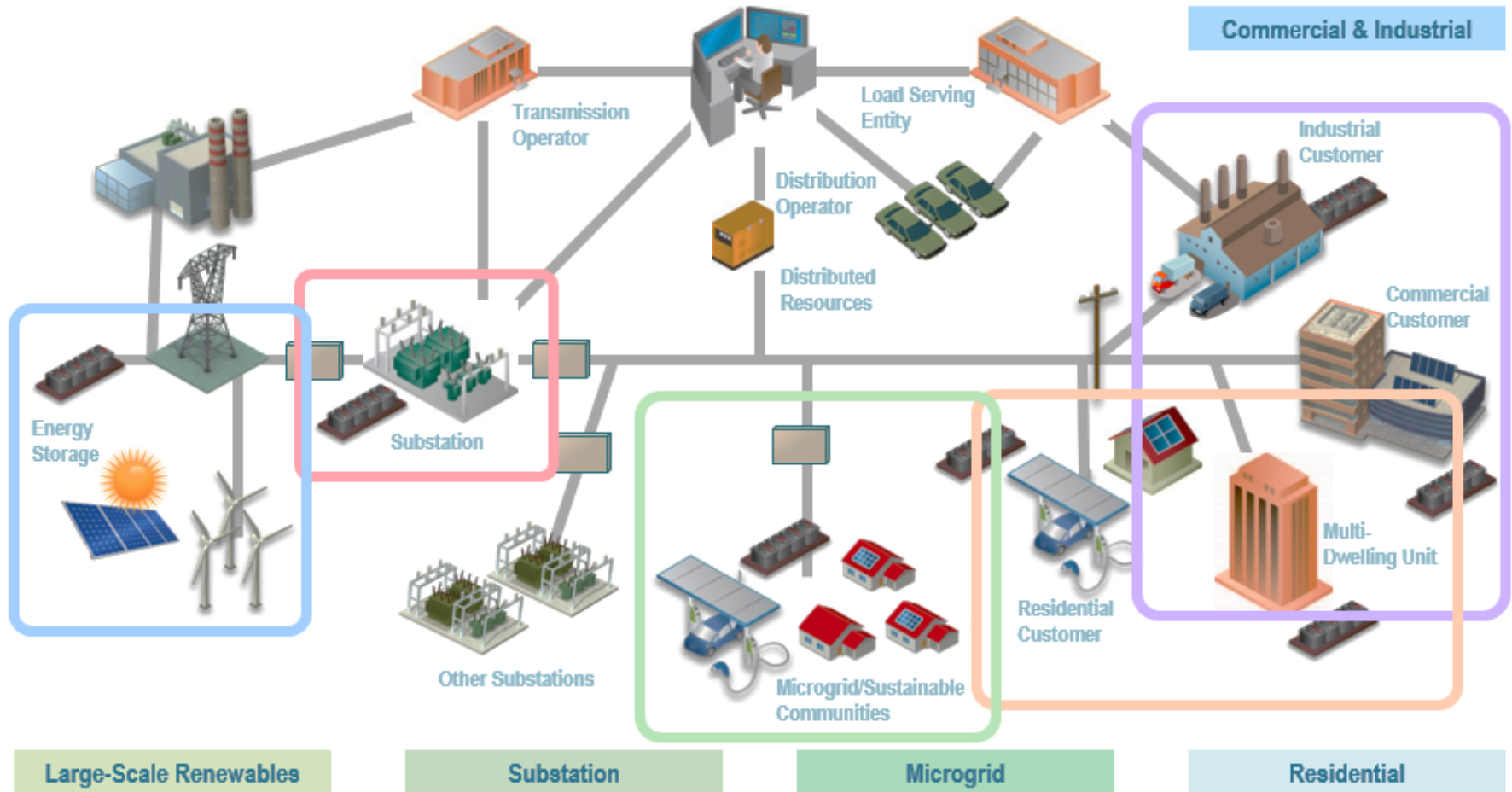
Energy Storage Technologies and Applications

Energy Storage Technologies



Although “energy storage” encompasses a diverse set of technologies, this report focused on the fastest-growing segment: batteries

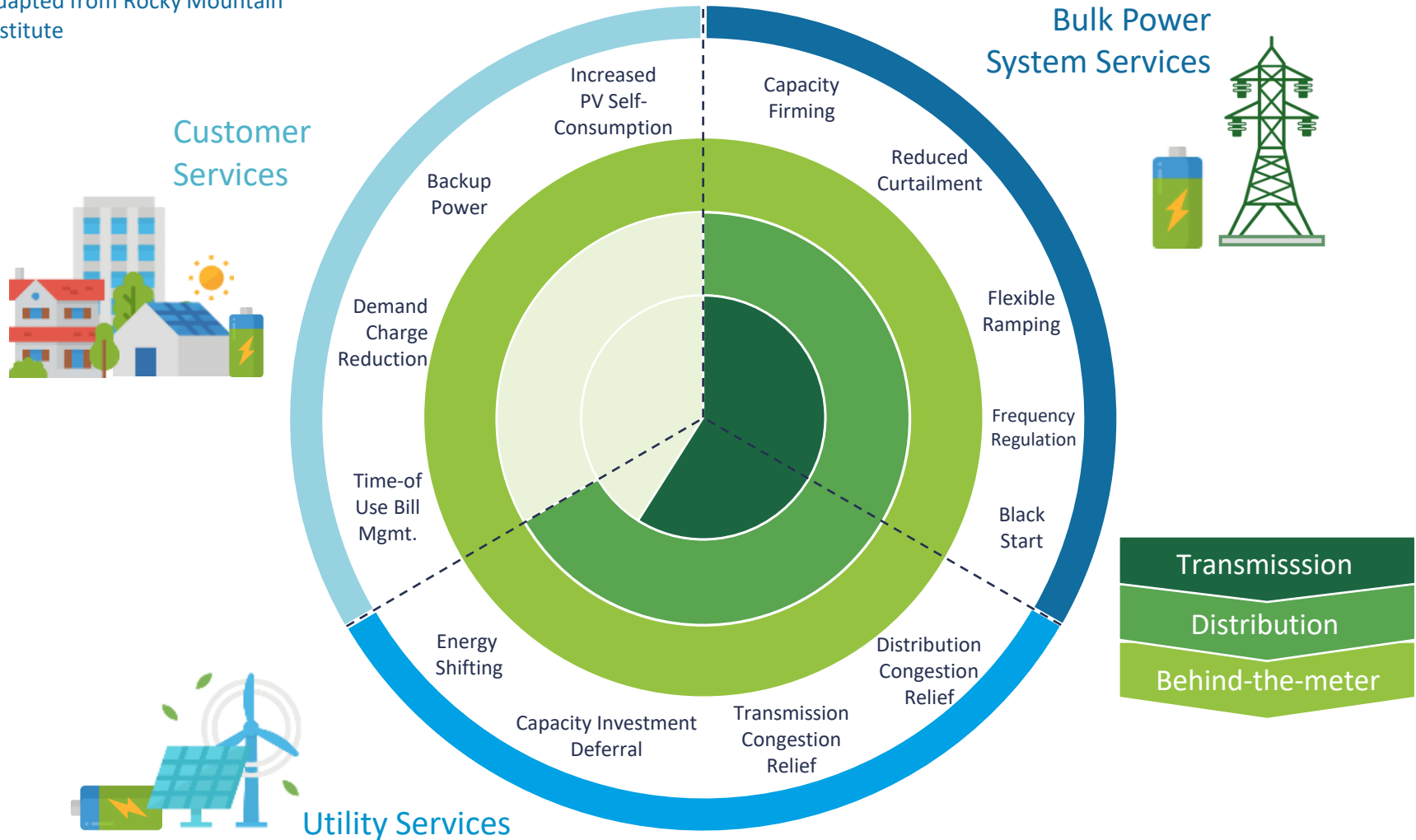
Widespread Potential for Energy Storage



Energy storage can enhance Pennsylvania's climate and resilience initiatives across the entire electric grid – generation, transmission, and distribution

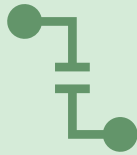
Energy Storage Applications

Adapted from Rocky Mountain Institute



Energy storage can provide value and benefit streams to many stakeholders

Potential Benefits of Energy Storage



Increase grid resilience, reliability, and flexibility



Integrate renewables and reduce GHG emissions



Diversify the energy resource mix and create jobs



Empower customer choice and reduce energy bills



Reduce generation and transmission infrastructure costs



Deploy quickly in modular sizes and in diverse settings

Energy storage may play an important role in advancing many of Pennsylvania's energy priorities

Energy Storage in Pennsylvania Today

Energy Storage in Pennsylvania Today

- + **22 operational or announced standalone, utility-scale energy storage projects**

Pumped hydro: *1.07 GW*

Lithium-ion batteries: *18 MW*

Lead-carbon batteries: *12.5 MW*

Thermal storage: *8 MW*

Lead-acid batteries: *3 MW*

- + **Increasing support for renewable energy that can benefit from energy storage as a grid-balancing resource**

“Pennsylvania’s Solar Future” goal of 10% solar by 2030



Flywheels in Hazle Township

Beyond legacy pumped hydro, new advanced energy storage projects are in the early stages of deployment in the state

Energy Storage in Pennsylvania Today

- + **Growing levels of utility-scale solar and solar + storage**
- + **Interest in storage as a distribution grid asset to support resilience and reliability**

PUC Docket No. M-2020-3022877

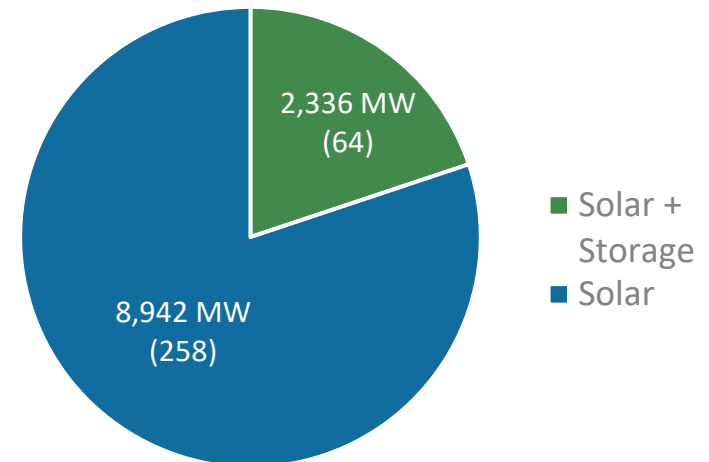
- + **Recent changes to applicable PJM wholesale market rules**

FERC Order 841 requires energy storage market participation options

- + **RGGI participation**

Revenues from RGGI could support and standardize storage projects

Pennsylvania Solar in PJM Queue



The potential for energy storage is a growing topic of discussion in the state and region

Analysis of Energy Storage Potential in Pennsylvania

Overview of Analyses

1. Behind-the-Meter (BTM)

- + **Customer-sited, standalone battery energy storage system designed for a typical commercial customer**

What are the potential benefits to customers (i.e., electricity bill savings) from installing storage “behind-the-meter?”

What additional rates, incentives, or market revenue streams may be needed to encourage deployment?

2. Solar-plus-Storage

- + **Large-scale, hybrid solar-plus-storage system designed as an additive component to a renewable energy power purchase agreement**

What are the costs and benefits to customers and the grid from including storage as an add-on to a standard solar PPA?

What level of incentive or program support may be needed to encourage this deployment?

Two discrete analyses were conducted in parallel to estimate the benefits from energy storage to Pennsylvania customers

BTM Analysis: Financial Analysis

	Without storage	With storage					
		100 kW, 2-hr	100 kW, 4-hr	150 kW, 2-hr	150 kW, 4-hr	300 kW, 2-hr	300 kW, 4-hr
Energy Consumption (kWh/yr)	6,694,518	6,709,091	6,715,204	6,715,828	6,724,785	6,735,045	6,752,434
Peak Demand (kW)	1,733	1,638	1,638	1,591	1,591	1,557	1,500
Energy Cost (\$/yr)	\$162,468	\$160,304	\$159,660	\$159,300	\$158,398	\$156,255	\$154,662
Demand Charge (\$/yr)	\$81,889	\$77,386	\$77,044	\$76,379	\$74,979	\$74,690	\$71,550
Annual Bill (\$)	\$244,357	\$237,690	\$236,704	\$235,679	\$233,377	\$230,945	\$226,212
Storage System Costs (\$)		\$69,400	\$133,200	\$104,100	\$199,800	\$208,200	\$399,600
Savings from Storage		\$6,667.76	\$7,653.03	\$8,679	\$10,980	\$13,413	\$18,146
		2.7%	3.1%	3.6%	4.5%	5.5%	7.4%
NPV		-\$17,261	-\$80,190	-\$37,918	-\$124,827	-\$111,698	-\$284,326
IRR		4%	-3%	2%	-4%	-2%	-7%

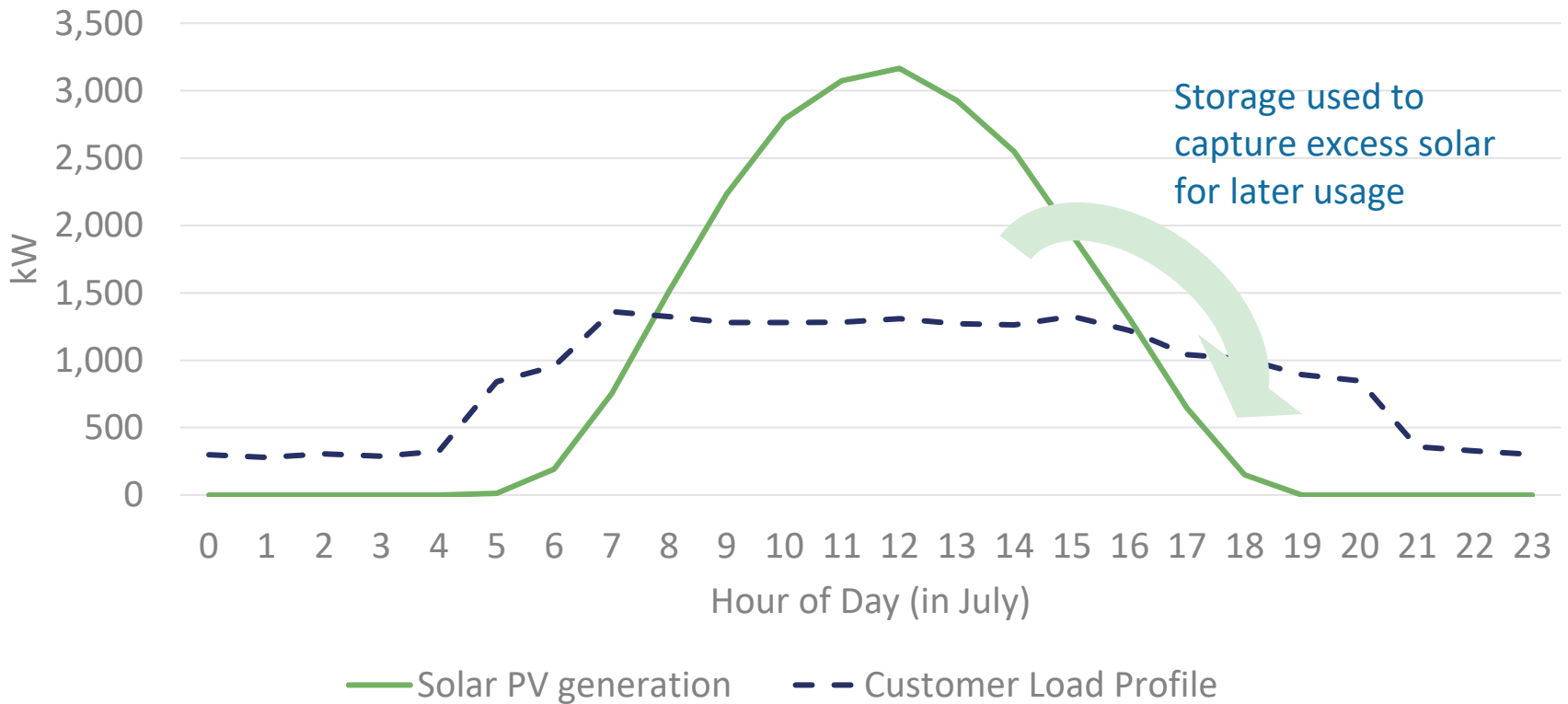
Under current retail rates, BTM energy storage projects generally appear to be uneconomic and suggest that rate reforms could unlock their full value

Solar + Storage Analysis: Results

	Scenario			
	1	2	3	4
Solar Deployment (GW)	11	11	11	11
Solar Paired with Storage	50%	50%	25%	25%
Co-located Storage (GW)	3.1	3.1	1.5	1.5
Storage Duration (hrs)	2.3	2.3	2.3	2.3
Incremental Cost of Storage Component (\$/kW-yr)	\$84.17	\$84.17	\$84.17	\$84.17
Cost Share	50%	25%	50%	25%
Total Program Cost (\$M/yr)	\$129.6	\$64.8	\$64.8	\$32.4
Total Grid & Environmental Value of Solar + Storage Projects (\$M/yr)	\$545.36	\$545.36	\$272.68	\$272.68

Leveraging funding from public programs to buy down the cost of storage could help to accelerate and standardize solar + storage projects

Solar + Storage Projects



Increasingly, solar PV projects are being paired with battery storage as a means of better matching load of customers and the grid

Solar + Storage Analysis

- + **Examined a *hypothetical* “time-matched” renewable power program**

Targeted to support more solar + storage PPAs that are more closely matched to customer load, in lieu of traditional REC PPAs

Renewable energy supply purchases are 24x7-style – i.e., generation coincides with end-use demand

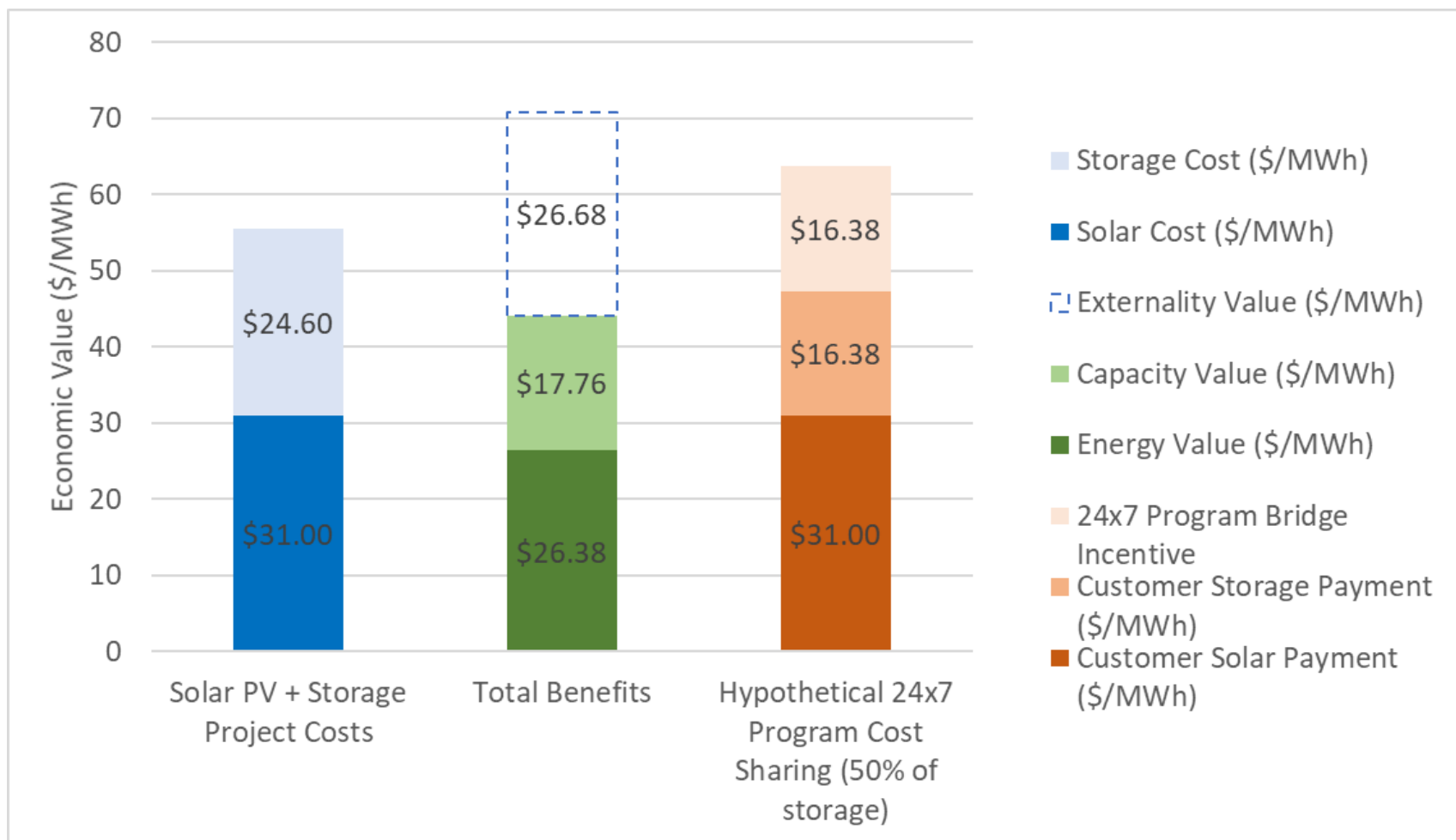
E.g., Google’s 24x7 carbon-free energy commitment

- + **Findings:**

A typical C&I customer in southeastern PA could match over 80% of their load from renewable energy by adding storage to a solar PPA at a premium of approximately \$33/MWh

This option provides an innovative approach with unique benefits that could advance the renewable energy PPA market in Pennsylvania

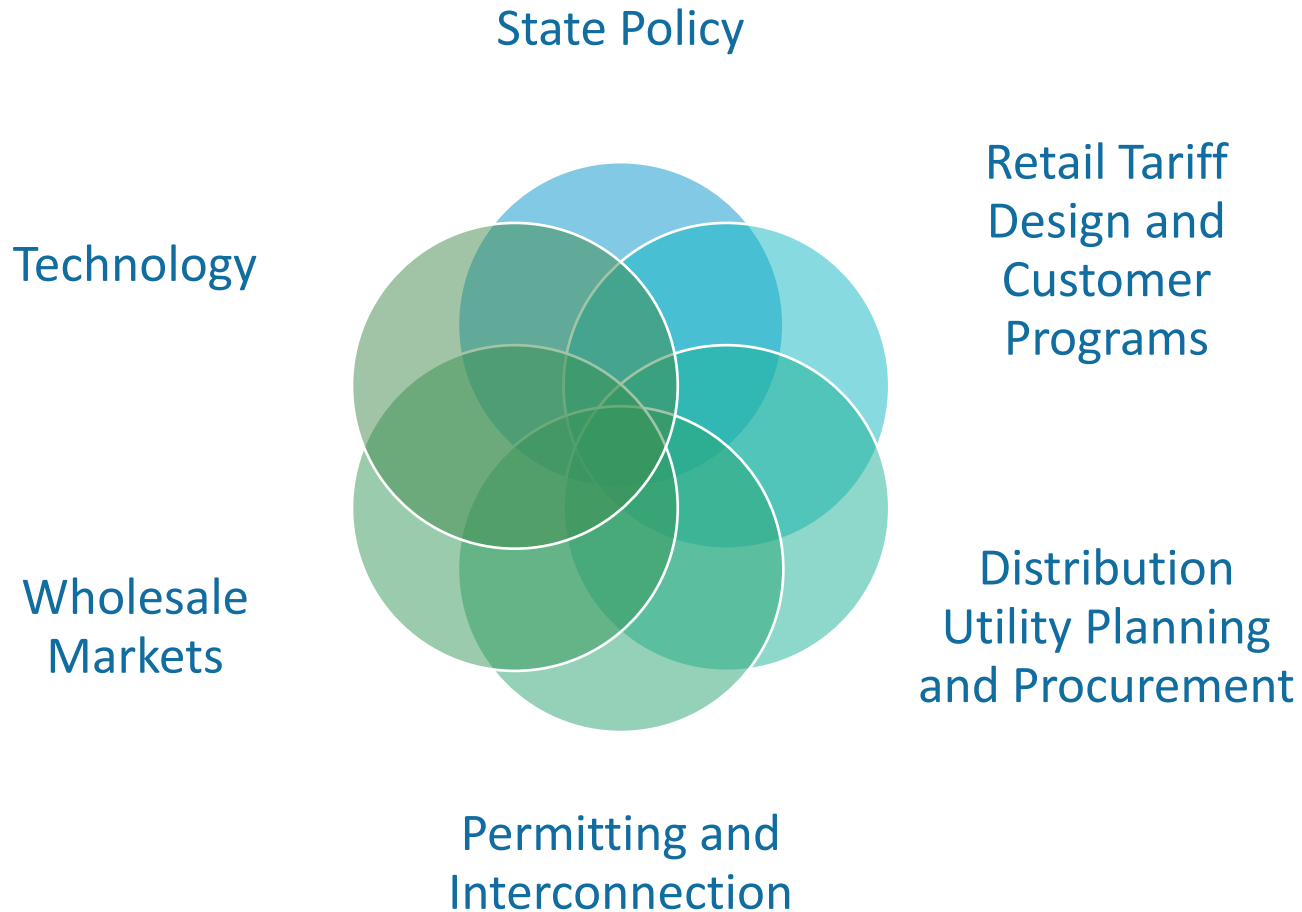
Solar + Storage Analysis: Time-Matched PPA Program



Deploying solar + storage projects could yield significant environmental and energy system benefits, but may benefit from a dedicated solar + storage tariff

Barriers to Energy Storage in Pennsylvania and Policy Recommendations

Barriers and Recommendations



Barriers to Energy Storage in Pennsylvania

State Policy

- Lack of storage or clean energy targets or requirements

Retail Tariff Design and Customer Programs

- Lack of retail programs and rates tied to grid services
- Limited pathways for retail customers to provide grid services through DERs

Distribution Utility Planning and Procurement

- Lack of framework and incomplete valuation of storage in procurement and planning

Permitting and Interconnection

- Cumbersome local permitting and interconnection processes
- Limited local industry experience in advanced battery technologies

Wholesale Markets

- Restrictive requirements for participation in PJM energy, capacity, and ancillary services markets
- Unclear market participation rules for hybrid systems, storage as transmission, and DER aggregations
- Limits on market access for multiple uses for storage

Technology

- Potentially high battery costs and technical limitations

Recommendations and Policy Actions

State Policy



Establish a storage procurement goal or target



Designate public funding to accelerate storage deployment



Convene a statewide “Storage Issues Forum”



Accelerate microgrid deployment at critical facilities

A storage deployment goal linked to 25% of the Solar Futures goal would equate to 1,500 MW of storage by 2030

Recommendations and Policy Actions

Retail Rate Design and Customer Programs



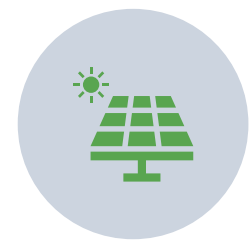
Establish direct
incentive programs
for storage
projects



Expand retail
customer
programs



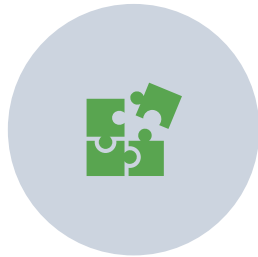
Enact retail rate
reforms



Develop a tariff for
distribution-
connected solar +
storage

Recommendations and Policy Actions

Wholesale Markets



Adopt a multiple-use application framework



Seek wholesale market improvements through PJM stakeholder processes



Consider changes to resource adequacy rules and oversight

Recommendations and Policy Actions

Distribution Utility Planning and Procurement

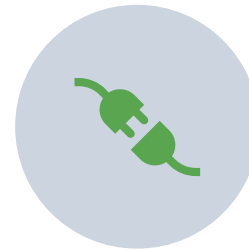


Enhance
distribution
planning and
procurement
processes

Permitting and Interconnection

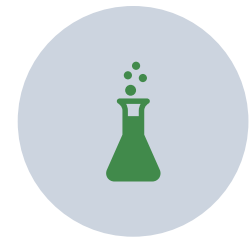


Streamline
permitting on state
and local levels



Update the
interconnection
process for
distributed energy
resources

Technology



Support research
and development
of new energy
storage
technologies

▶ Summary and Timeline of Recommendations	Near-term	Mid-term	Long-term
1. Establish a storage procurement goal or target	■		
2. Convene a statewide “Storage Issues Forum”	■		
3. Designate public funding to accelerate storage deployment	■		
4. Participate in PJM stakeholder processes	■		
5. Consider changes to resource adequacy rules and oversight	■		
6. Accelerate microgrid deployment at critical facilities		■	
7. Develop a tariff for distribution-connected solar + storage facilities		■	
8. Establish direct incentive programs for storage projects		■	
9. Adopt a multiple-use application framework		■	
10. Update the interconnection process for DERs		■	
11. Enhance distribution planning and procurement processes			■
12. Enact retail rate reforms			■
13. Expand retail customer programs			■
14. Streamline permitting on state and local levels			■
15. Support R&D of new energy storage technologies	■	■	■



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