Lumen
ENERGY STRATEGY

Energy Storage Procurement Study

Stakeholder Workshop #3: Report Draft for Stakeholder Comment

Prepared for:

California Public Utilities Commission and stakeholders

November 4, 2022

Overall Study Context

CPUC Decision 13-10-040 requires the CPUC Energy Division to conduct a comprehensive program evaluation of the CPUC Energy Storage Framework and energy storage procurement in compliance with Assembly Bill (AB) 2514 (Skinner, 2010)

Determine whether the CPUC Energy Storage Procurement Framework and design program and all other energy storage procurement meets the stated purposes of optimizing the grid, integrating renewables, and/or reducing greenhouse gas (GHG) emissions

- Determine progress towards energy storage market transformation
- Learn from actual storage operations and cost data
- Determine best practices for safe operations
- Also investigate other procurement policies in practice, realized value stacking, how to get the most ratepayer value from currently deployed and future procurement, peaker replacements, and recycling and end-of-life options

Progress Towards AB 2514 Goals

Over the past decade, the California state agencies, utilities, and many other stakeholders explored many uncharted pathways to accelerate development of a variety of stationary energy storage technologies and use cases—and successfully launched a vibrant energy storage market in the state.

Grid Optimization

Successes
Energy storage providing a wide variety of grid services; energy time shift and RA capacity value at a large scale and growing

Challenges
Untapped potential to value-stack bulk grid services provided by customer-sited and distribution-sited resources

Renewables Integration

Successes
Energy storage providing grid flexibility through ancillary services, energy time shift of renewable generation, reducing curtailments

Challenges
Upcoming needs for longer-duration energy storage and how to adapt our planning and procurement mechanisms

GHG Emissions Reductions

Successes
With energy time shift, energy storage reducing emissions of natural gas-fired generation during evening periods

Challenges
Untapped potential of narrowly-focused use cases; natural gas-fired peaker replacements

Workshop Agenda

<u>Today's Objective</u>: We provide enough information so you have a good understanding of our study's key findings and recommendations, and you can efficiently review and absorb the study report and attachments.

Approx. Time (PDT)	Minutes	Topic	Q&A
10:00–10:15 a.m.	15	Introductions	Polls
10:15–10:45 a.m.	30	Recap of Study Scope and Methods	
10:45–11:15 a.m.	30	Tour of Report	10 min
11:15–11:20 a.m.	5	—BREAK—	
11:20 a.m.–12:20 p.m.	60	Study Results + Discussion	20 min
12:20–12:50 p.m.	30	—BREAK—	
12:50–1:50 p.m.	60	Policy Recommendations + Discussion	20 min
1:50–2:00 p.m.	10	Closing Remarks	

Meeting Logistics

Audio All participants are muted; please "raise hand" to be unmuted during Q&A

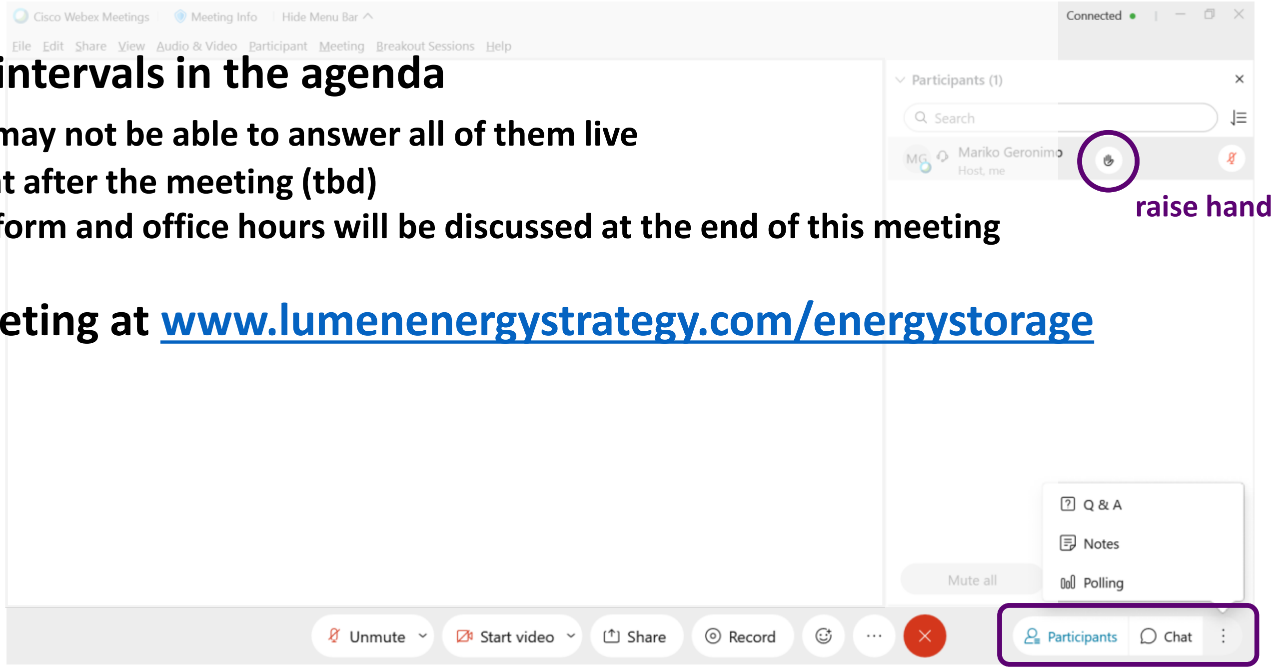
Video Sharing your video is optional, but we highly recommend video off to avoid bandwidth issues

Chat We encourage you to chat during presentations to share ideas

—Please keep your comments friendly and respectful

Q&A We will open Q&A at designated intervals in the agenda

—Depending on volume of questions, we may not be able to answer all of them live
—We may follow-up with a Q&A document after the meeting (tbd)
—We would like your feedback: feedback form and office hours will be discussed at the end of this meeting



Presentation Slides will be posted after the meeting at www.lumenenergystrategy.com/energystorage

Stakeholder Comment Logistics

Survey URL:
https://us1.list-manage.com/survey?u=f41e07b6f7191ffd7ccacb374&id=f2fa6381a3&attribution=false

- Please complete survey by Friday December 2, 2022
- Seeking comments on:
  - Clarity of content and reasoning for recommendations
  - Actionability of recommendations
- Please contact us if you have any difficulty or would prefer to provide feedback by another means
- Thank you for any feedback you can provide!

We are seeking your feedback on the CPUC/Lumen Energy Storage Procurement Study DRAFT report and special studies

This survey refers to the **DRAFT report and special studies released in October 2022** by the CPUC and Lumen Energy Strategy, LLC for the Energy Storage Procurement Study. The study team will provide an overview of the materials in Workshop #3 on Friday November 4, 2022 10 a.m. to 2 p.m. PDT. The documents and workshop registration form are available at www.lumenenergystrategy.com/energystorage.

Below please provide your feedback on the study team's analytical findings, key observations, and draft recommendations to the CPUC contained within the draft report and special studies.

The study team specifically seeks your views on (a) the clarity of logical progression from analytical findings, to key observations, to draft recommendations, and (b) to what degree the draft recommendations are realistic and actionable.

Each text box is limited to 1,000 characters. Questions may be skipped by selecting "no comment" as appropriate. Please complete this survey before close of business on Friday December 2, 2022.

Thank you for your participation!

Audience Polls

Recap of Study Scope and Methods

Overall Study Framework

Data

- Project characteristics
- Actual operations
- Deferred investments
- CAISO market settlements
- BTM storage customer characteristics
- Project financials & contract data
- Industry reports &studies

including cluster analysis

Analyses

Impacts (2017–2021)

- Bulk grid services
- Capital investments
- Local/site services
- GHG emissions

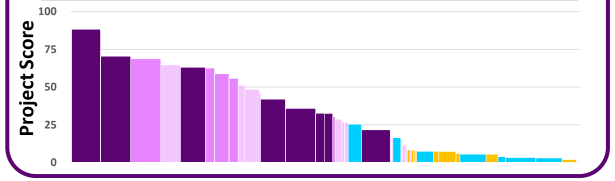
Benefits $ (2017–2021)

Costs $ (2017–2021)

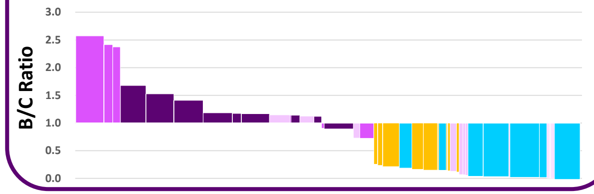
Score & Rank

Effectiveness at meeting AB 2514 Goals

- Production & investment cost savings
- System/local/site services provided
- Avoided renewable curtailments
- GHG emissions reductions



Cost-effectiveness (2017–2021)



Policy & Market Drivers

- Profiles of **most effective** storage in operation
- Identify **barriers** faced by least effective storage projects
- Industry & storage development market **lessons learned**
- Special studies including **economic potential**

Policy Pathways

1. **Evolve signals for resource adequacy investments**
2. **Bring stronger grid signals to customers**
3. **Remove barriers to distribution-connected installations**
4. **Improve analytical foundation for resilience related investments**
5. **Enhance safety**
6. **Improve data practices**

What is Our Added Value?

This study's analytical approach builds upon and expands California's evaluation methodologies across four dimensions.

1. We evaluate and learn from historical resource-specific storage operations
2. We evaluate at a finer granularity to capture meaningful temporal and spatial patterns in benefits
3. We evaluate storage installed at any location (customer, distribution system, transmission system) with a single consistent approach
4. We attempt to quantify the full spectrum of benefit types identified by stakeholders

		Services that can be provided based on **Grid Domains**		
	Services to Grid and Customers	**Transmission**	**Distribution**	**Customer**
Energy & AS Markets and Products	Energy	✓	✓	✓
	Frequency Regulation	✓	✓	✓
	Spin/Non-Spin Reserve	✓	✓	✓
	Flexible Ramping	✓	✓	✓
	Voltage Support	✓	✓	✓
	Black Start	✓	✓	✓
Resource Adequacy	System RA Capacity	✓	✓	✓
	Local RA Capacity	✓	✓	✓
	Flexible RA Capacity	✓	✓	✓
T & D Related	Transmission Investment Deferral	✓	✓	✓
	Distribution Investment Deferral		✓	✓
	Microgrid/Islanding		✓	✓
Site-Specific & Local Services	Bill Management			✓
	Increased Use of Self-Generation			✓
	Backup Power			✓

Caveats and Limitations to Historical Analysis

The historical evaluation in our report is not intended to be—nor would it be correctly interpreted as—a prudency review of any individual energy storage resource procurement.

Not a prudency review

- California's journey with energy storage development included substantial investment in the innovation process.
- This necessitates learning from pilots, demonstration projects, and early stage procurements to facilitate future potential benefits of a larger fleet.
- The resource-level rankings presented are intended to illuminate key themes in successes and challenges to guide development of effective policies as we move forward, rather than to identify "good" or "bad" energy storage installations.

Caveats and Limitations (cont.)

The historical evaluation is useful to assess relative benefits and to identify successes and challenges, and it cannot be extrapolated to other evaluation contexts without further analysis.

Our historical analysis:

✓ Can show how resources and groups of resources **compare**

✓ Can identify **areas of market growth** towards meeting state policy goals at a large scale

✓ Can reveal **patterns of untapped benefit potential** and associated challenges

✓ Can highlight **major discrepancies** with forward-looking evaluations

× Cannot revisit **prudency** of past procurements

× Cannot extrapolate resource-level results to **the full life** of an installation

× Cannot readily apply high-level historical results to support forward-looking studies without further consideration of how the grid and markets will evolve

⇨ see Chapter 3 (Moving Forward) for further discussion

Stakeholder Engagement

Stakeholder inputs have been instrumental in shaping the study scope and evaluation

CPUC issued a Request for Information (RFI) to determine desired study scope, timeline and contractor requirements (Mar 2020)

CPUC incorporated RFI responses and released a competitive solicitation to select a contractor to support CPUC for the energy storage study (Aug 2020)

Notice of Intent to Award (Dec 2020)

Contract award & study kickoff (Mar 2021)

STAKEHOLDER WORKSHOP 1 (May 2021)

- Introduced study and presented draft storage evaluation framework, and methodologies
- Collected feedback via written comments and follow-up meetings

STAKEHOLDER WORKSHOP 2 (Sep 2021)

- Presented final evaluation framework, and initial observations on project use cases and operations
- Collected feedback via written comments and follow-up meetings

Draft report posted

Main report Oct 24
Special studies Oct 31

*** Today's meeting ***

STAKEHOLDER WORKSHOP 3 (Nov 2022)

- Draft report findings, conclusions, recommendations
- Seeking out stakeholder feedback by Dec 2nd

2020 **2021** **2022**

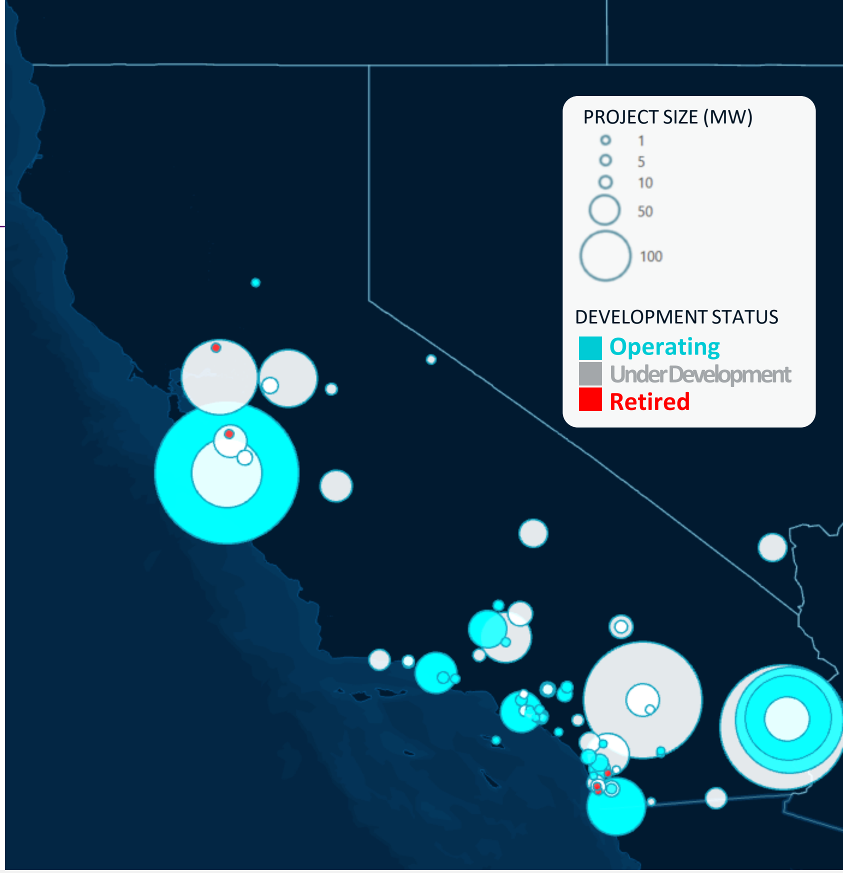
Continuous engagement with CPUC, CAISO, IOUs, and other stakeholders for data collection

Coordination with other CPUC efforts

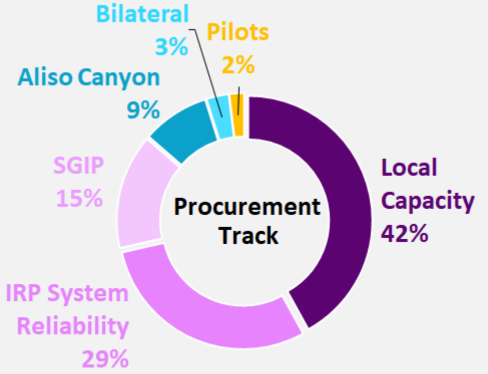
Projects Included

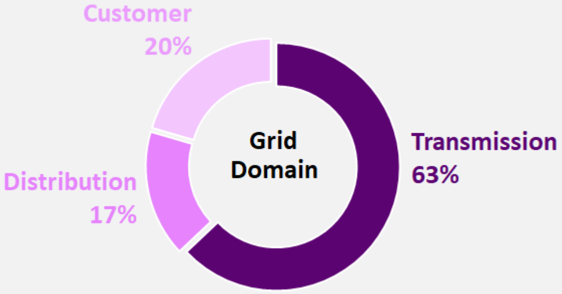
Historical analysis include resources procured by LSEs under CPUC jurisdiction

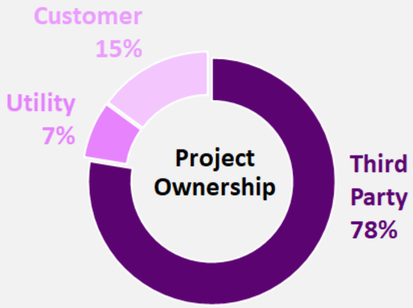
- Counting towards AB 2514 goals and D. 13-10-040 requirements
- Operated within the study period 2017–2021
- In service by April 2021 (for sufficient operational data to analyze)
- To utilize available data, also included three resources procured for system RA capacity (Gateway, Vista, Blythe) but not counting towards AB 2514 goals
- Some resources could not be analyzed due to data limitations
- See **Figure 27** of the report for the full list of resources included

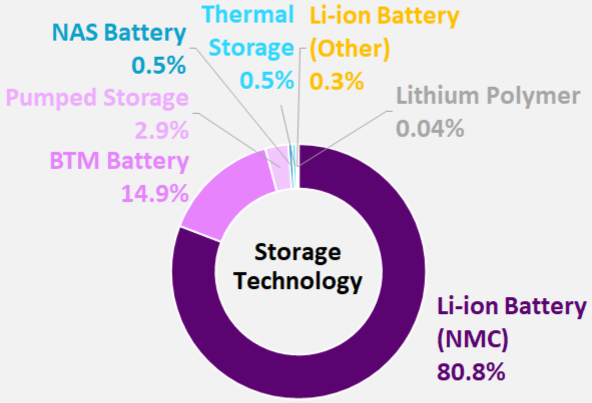


Share of capacity analyzed (1,374 MW total)

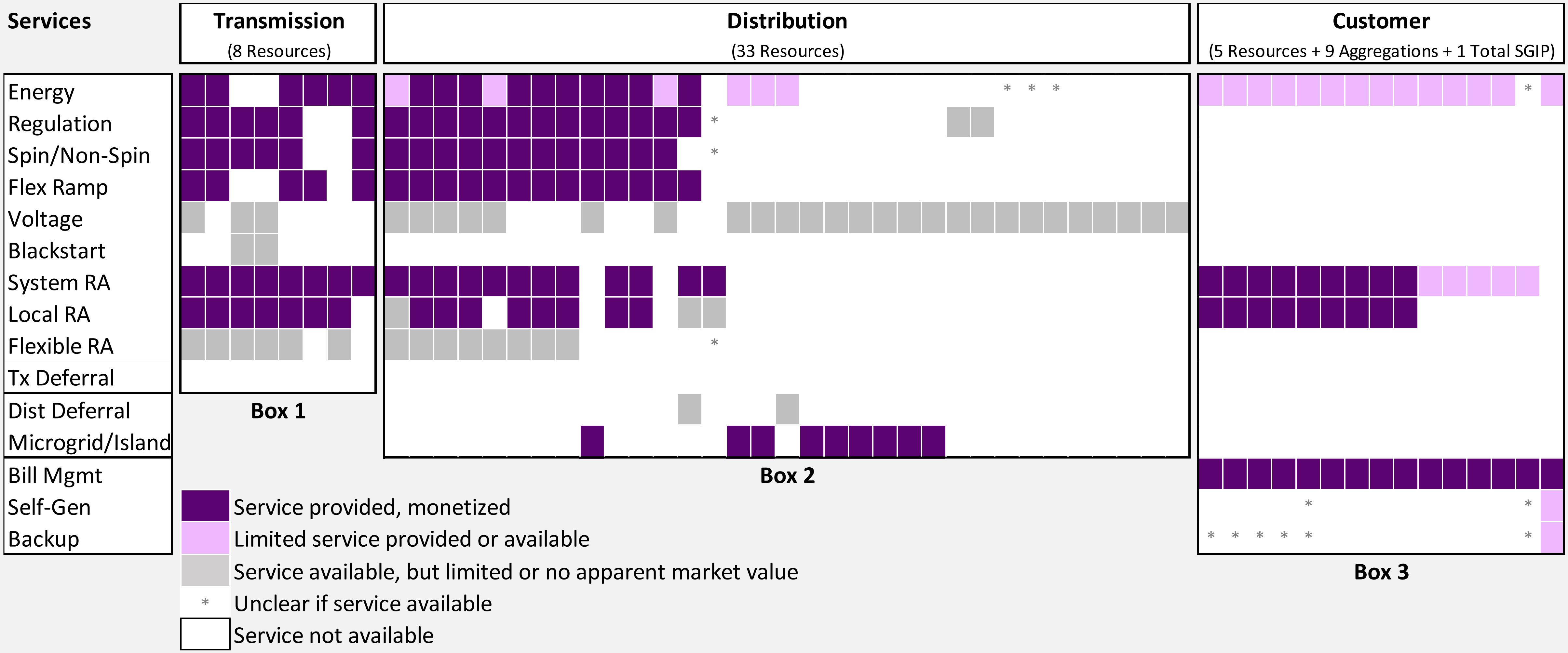








Screening Analysis



Cost-Effectiveness Perspectives

Cost-Effectiveness Test	Approach		
Participant Test	Measures quantifiable benefits and costs to the customers participating in a program	✗	Participant vs. non-participant distinction does not apply to our study
Ratepayer Impact Measure (RIM) Test	Measures what happens to customer bills or rates due to changes in utility revenues and costs (only non-participant)	✗	
Program Administrator Cost (PAC) Test	Measures net cost of a program as a resource option based on costs incurred by the utility or program administrator	✓	For our study, this reflects total ratepayer impact excluding out-of-pocket participant costs
Total Resource Cost (TRC) Test	Measures net cost of a program as a resource option based on total costs, including both participant's and utility's costs ** Societal cost test is a variant of TRC test;* *<u>Key differences</u>: lower societal discount rate, effects of externalities (e.g., air quality) and social cost of CO_2 emissions*	Partial	All benefit streams included, but the actual project costs are available only for a small subset of projects that are utility-owned

Benefit Metrics Considered

Energy and ancillary services value	Net of charging costs; Not included under total ratepayer benefits if under RA only contract
Resource adequacy (RA) capacity value	Includes system, local, and flexible RA
Transmission investment deferral value	Overlaps with local RA value; Considered only if storage defers an actual transmission alternative
Distribution investment deferral value	Considered only for distribution-interconnected and customer-sited storage
Avoided RPS cost	Based on avoided renewable curtailments; Valued at RPS cost in PCIA
GHG emission reduction value	A portion of this is already captured under energy value; Considered only incremental value (if any)
Customer outage mitigation value	Private benefit to customers who install distributed storage; Not included under total ratepayer benefits

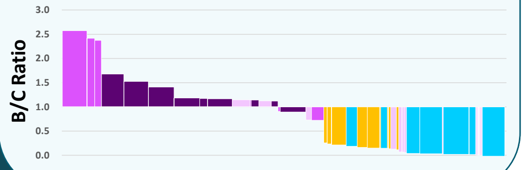
Benefit-Cost Ratios for Final Comparisons

Calculate monthly & annual values for each benefit and cost metric for the study period

Convert to 2022$ by adjusting for inflation using historical GDP deflator

Calculate capacity-wtd average ($/kW-month) costs and benefits over the study period

Benefit/cost ratios



- Retrospective benefits and costs so no PV/discount rate; only adjust for inflation to show results in 2022$
- Results normalized for storage capacity so they can be compared across projects; capacity-weighted averages to account for changes of project capacity over time (e.g., due to staged installation, degradation)
- Looking at only initial years of operation creates inherent bias against front-loaded cost recovery, so we estimate and use levelized cost of lump-sum investments instead of revenue requirements

Project Scoring

Contribution towards AB 2514 Goals

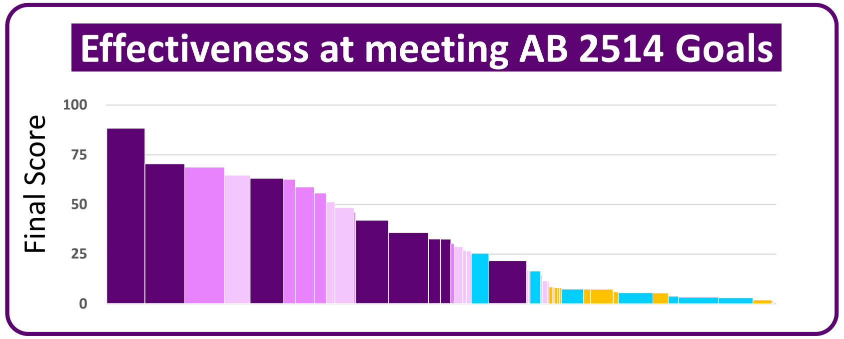
	Grid Optimization	Renewables Integration	GHG Reduction
Energy time-shift	✓	indirect	indirect
Ancillary services	✓	✓	indirect
Resource adequacy (RA) capacity	✓		indirect
Transmission investment deferral	✓		
Distribution investment deferral	✓		
Avoided renewable curtailments		✓	indirect
GHG emission reduction			✓
Customer outage mitigation	✓		

Grid Optimization Score | *Renewables Integration Score* | *GHG Reduction Score*

FINAL SCORE

Compare final scores of all projects

- Purpose: assess effectiveness at meeting AB 2514 goals
- Start with service-level scores based on use case and capacity utilization during 2017–2021
- Then develop normalized score (0–100) for each policy goal based on average scoring for relevant services
- Final score average of rankings
- Sort and graph scores for all projects

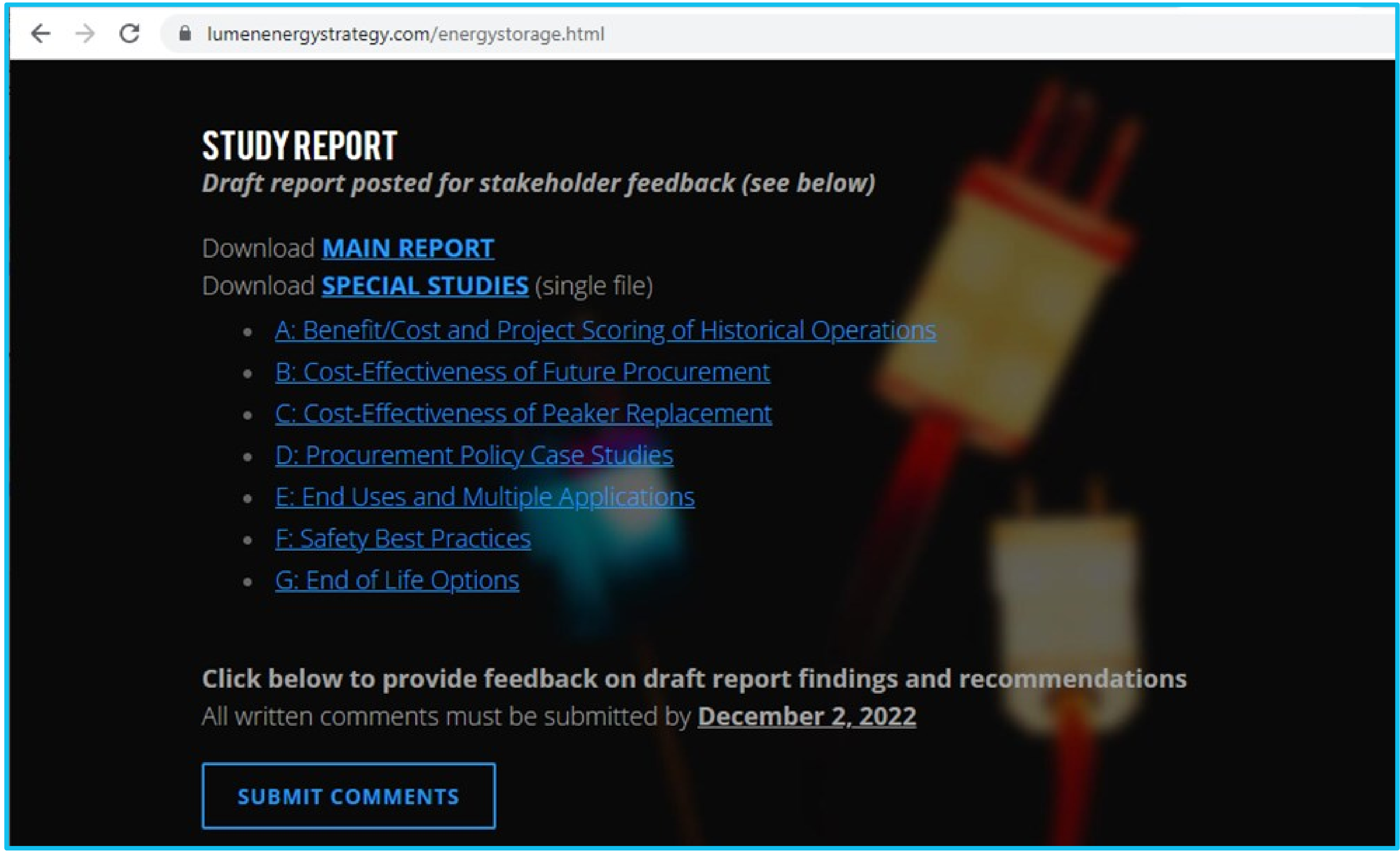


Tour of Report

How to Access the Report

- Access draft report and special studies on our website
- Also through email campaigns

  (Subscribe and add energystorage@lumenenergystrategy.com to your contacts)
- Final report will follow stakeholder comments



Report Tour: Chapters

The main report flows from a historical analysis, to going-forward implications, to recommendations.

Chapter 1	Chapter 2	Chapter 3	
Market Evolution	**Realized Benefits and Challenges**	**Moving Forward**	**Recommendations**
2010–2021	2017–2021	2022–2032/2045	
Historical policy and planning context to the evolution of California's market for stationary energy storage	Procurement, energy market, and storage operations outcomes of the CPUC's energy storage procurement framework	Going-forward implications of current policies, grid needs, market trends, and observed challenges to energy storage development	Recommendations on policy adjustments and next steps to unlock the full potential of the state's energy storage portfolio

Report Tour: Attachments (Core Study)

Two report attachments are tied to our core study scope: technical documentation on our historical analysis (Attachment A) and safety best practices (Attachment F).

- Details on analysis of 2017–2021 actual energy storage operations, benefits, and costs
- Evaluation framework
- Benefit/cost ratios
- Project scoring

Attachment A

Benefit/Cost and Project Scoring of Historical Operations

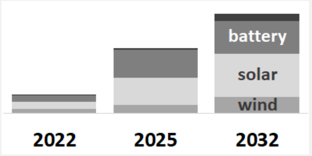
Attachment F

Safety Best Practices

- Harvests lessons learned from 11+ safety events
- Outlines best practices and a broadly-applicable risk management framework
- Identifies gaps and needs as battery energy storage installations accelerate

Report Tour: Special Studies (Analytical)

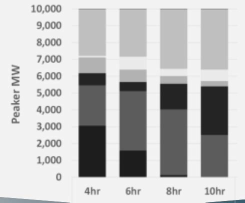
Two special studies present additional analytics on energy storage procurement cost-effectiveness: future procurements to meet resource adequacy (Attachment B) and gas-fired peaker replacements (Attachment C).



Attachment B

Cost-Effectiveness of Future Procurement

- Indicative analysis to supplement IRP-LTPP
- Evaluates aggregate net benefits of planned 13.6 GW energy storage in the CPUC's 2021 Preferred System Plan
- 8,760 optimization of battery operations in the year 2032



Attachment C

Cost-Effectiveness of Peaker Replacement

- Unit-specific cost-effectiveness screen on 100 operating peakers (10 GW)
- Evaluates battery configurations that could replace peaker operations in 2020
- Explores alternative MW/MWh and solar co-location configurations

Report Tour: Special Studies (Research)

Three special studies provide industry research to support exploration of new policy levers to bolster realized benefits of the energy storage fleet: procurement policies in other states (Attachment D), end uses and multiple applications (Attachment E), and end of life options for lithium-ion batteries (Attachment G).

Attachment D

Procurement Policy Case Studies

- Innovative practices in NY, HI, AZ, NV
- Relevant to specific challenges faced by CA

Attachment E

End Uses and Multiple Applications

- Applications and services that can help guide expanded value-stacking in CA

Attachment G

End of Life Options for Lithium-Ion Batteries

- Overview of recycling, repurposing, and disposal
- Multi-sector policy activities and challenges

Suggestions for Report Review

Depending on your needs and availability, we recommend review of the following sections.

	Top-down review	Bottom-up review
Less time to review	A. Preface and Executive Summary	A. Attachment(s) of interest
	B. (A) + Chapter 3	B. (A) + section(s) of interest in Chapter 1, Chapter 2, and/or Chapter 3
	C. (B) + sections of interest in Chapter 1 and Chapter 2	C. Recommendation theme(s) of interest in Chapter 3
More time to review	D. Entire main report	D. Executive summary for more holistic view of study

Q&A

- Stakeholder comment logistics
- Recap of scope and methods
- Report pieces and navigation

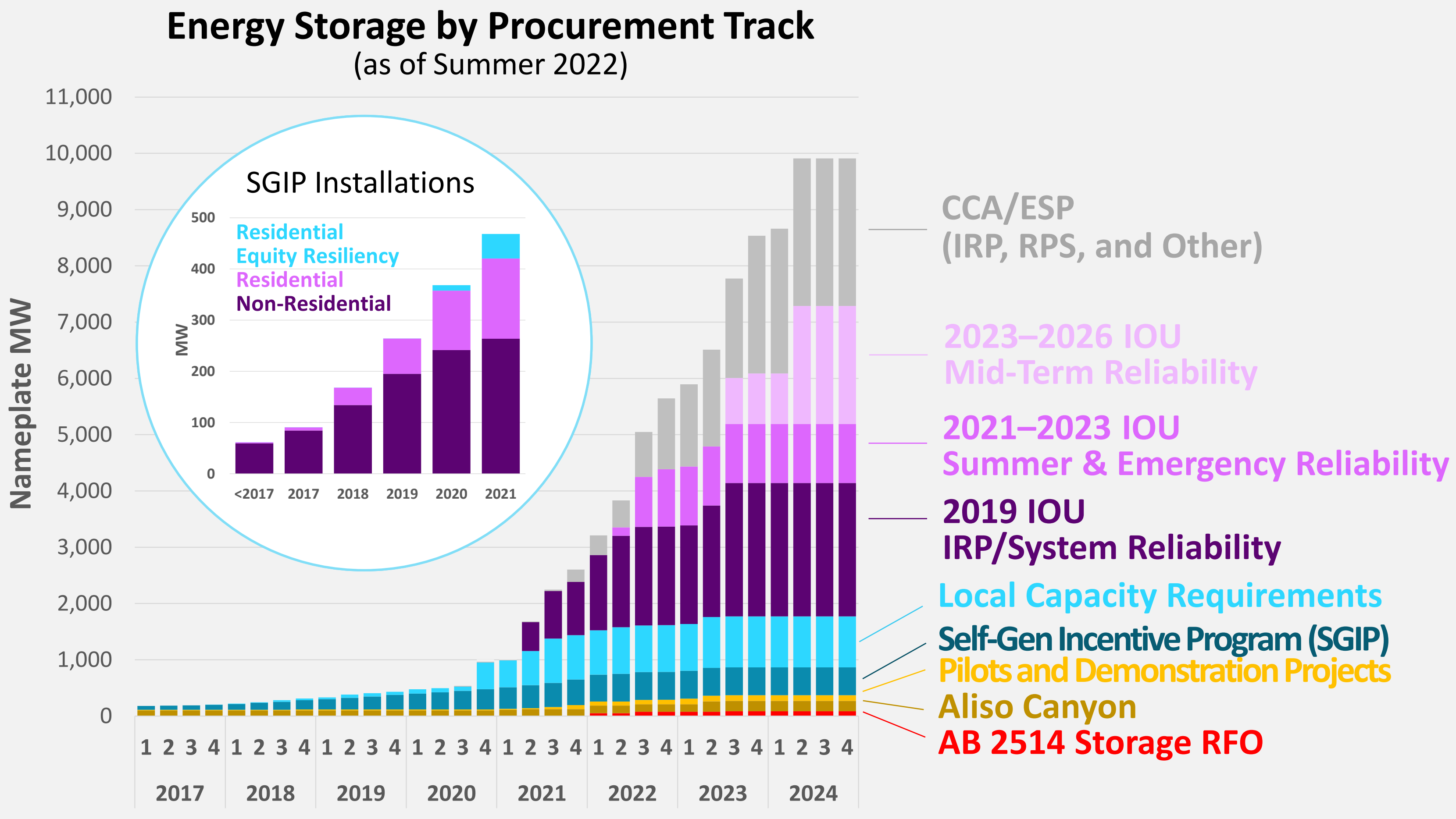
5-MINUTE BREAK

WILL RETURN AT 11:20 A.M. PDT

NEXT UP: STUDY RESULTS AND DISCUSSION

Overview of Study Results and Discussion

From Pilot to Commercial Scale



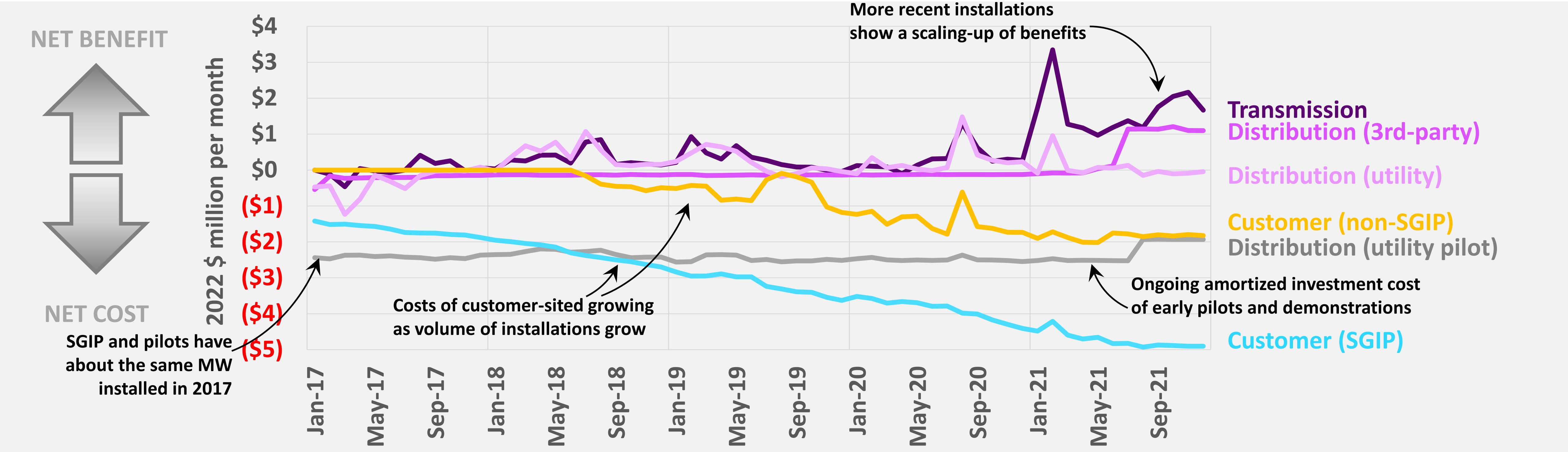
Source: Lumen research on utility applications and CPUC decisions on various resource procurement tracks, and other public information on project status.

- Market for stationary energy storage matured from pilot phase into commercial scaling of lithium-ion batteries
- Significant growth in energy storage capacity driven by various procurement tracks, increasingly for system reliability

From Pilot to Commercial Scale (cont.)

Time profile of ratepayer impacts reveals three striking trends over time:

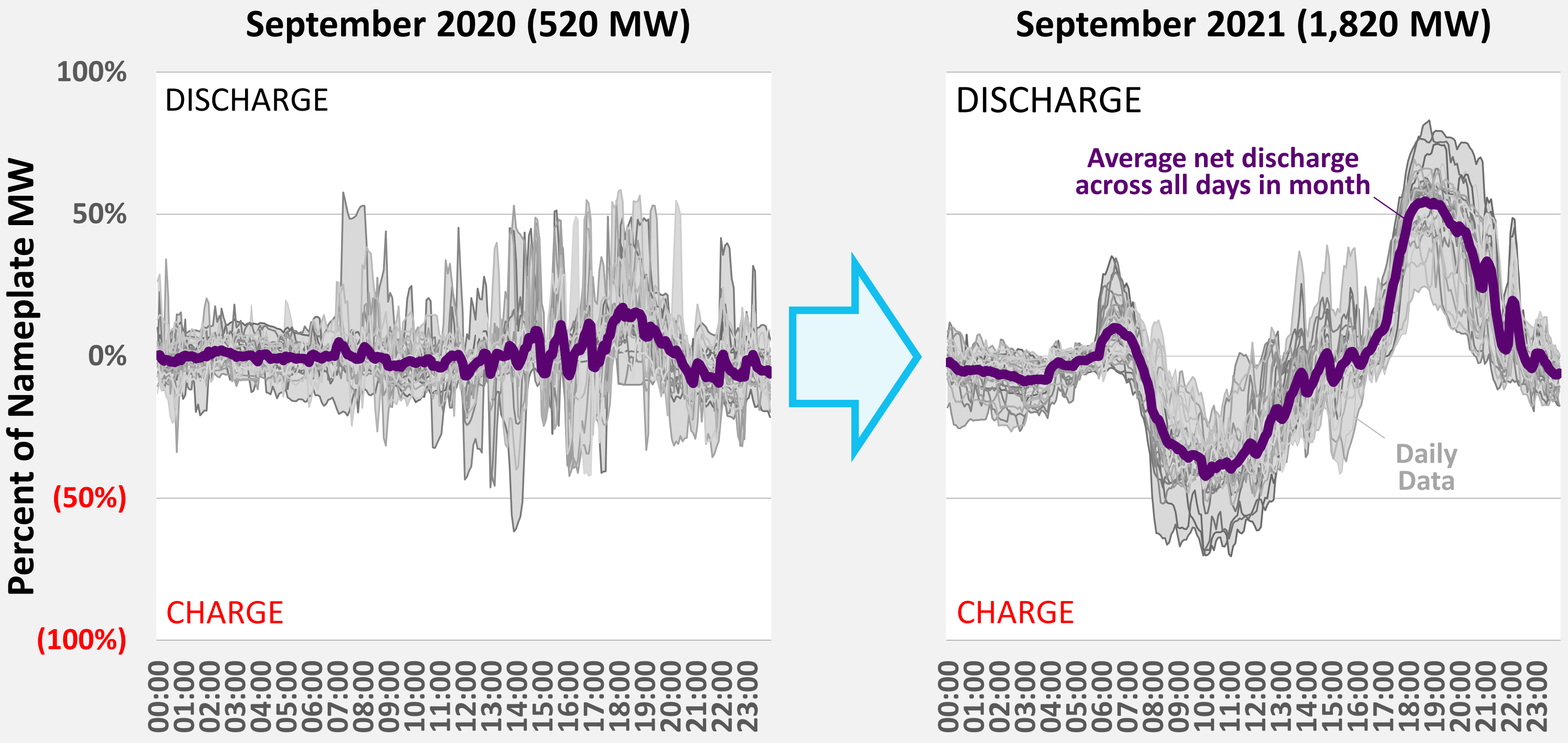
- Steady ongoing amortized investment cost of early utility-owned pilot and demonstration programs
- Steady buildup of net ratepayer cost of customer-sited installations
- Recent growth in net ratepayer benefit of distribution- and transmission-connected installations



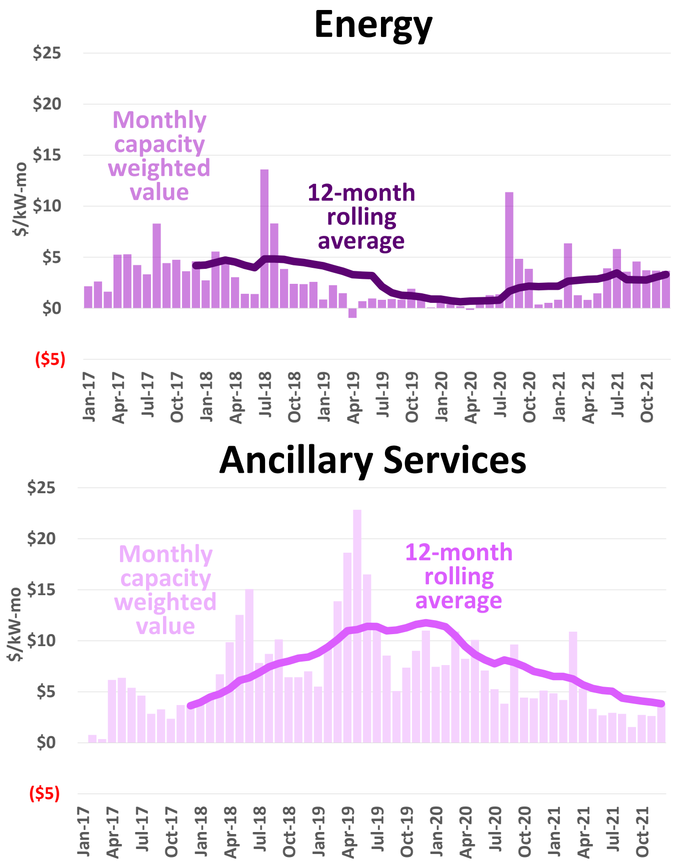
Observed Shift in Value Proposition

Use case in the CAISO marketplace expanded from ancillary services, into energy time-shift and peak capacity

CAISO Aggregate Battery Output

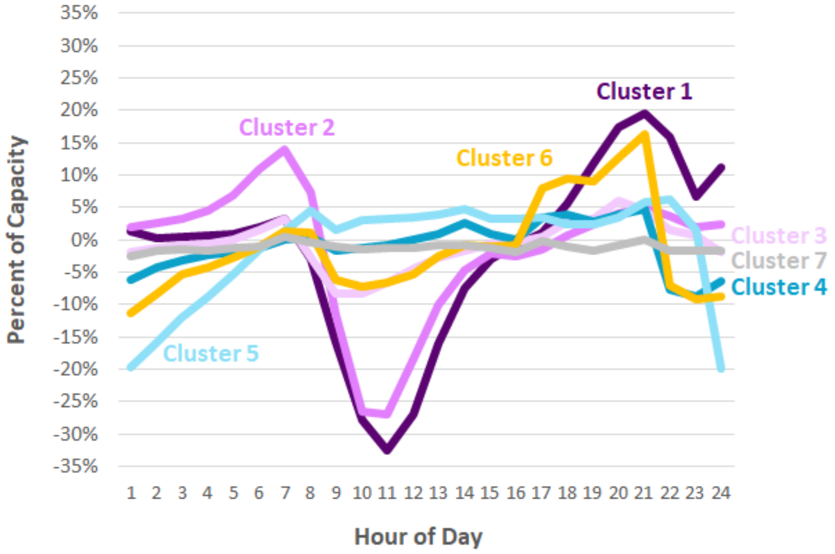


CAISO Revenue Across Storage Fleet

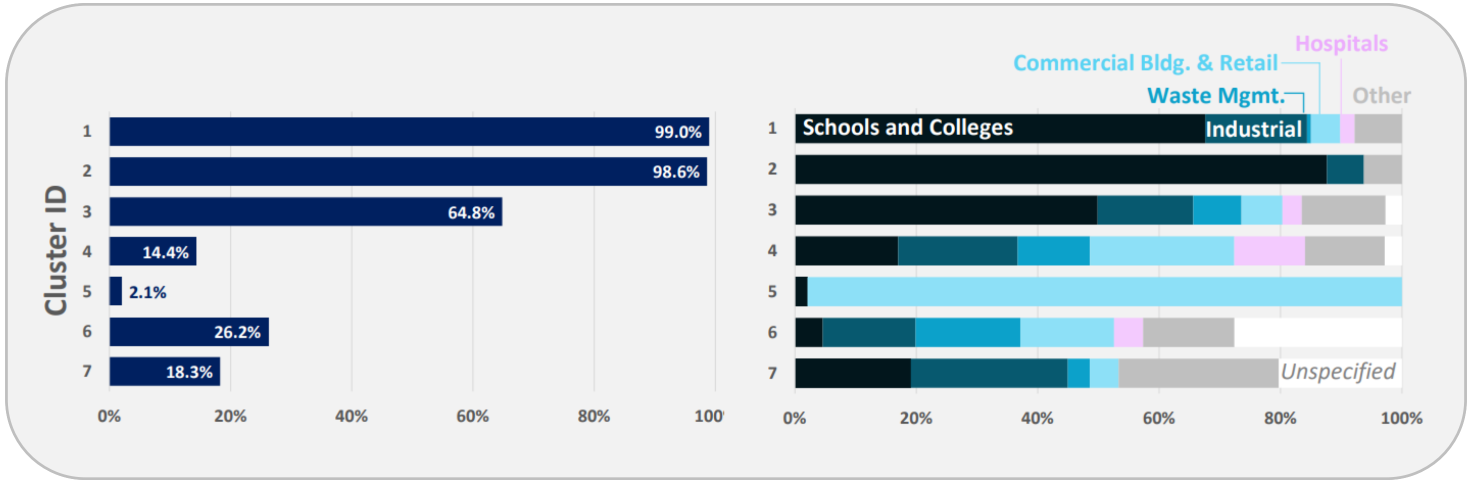


SGIP Cluster Analysis

SGIP Non-Residential Average Daily Operational Profiles
(Positive = Discharge, Negative = Charge)



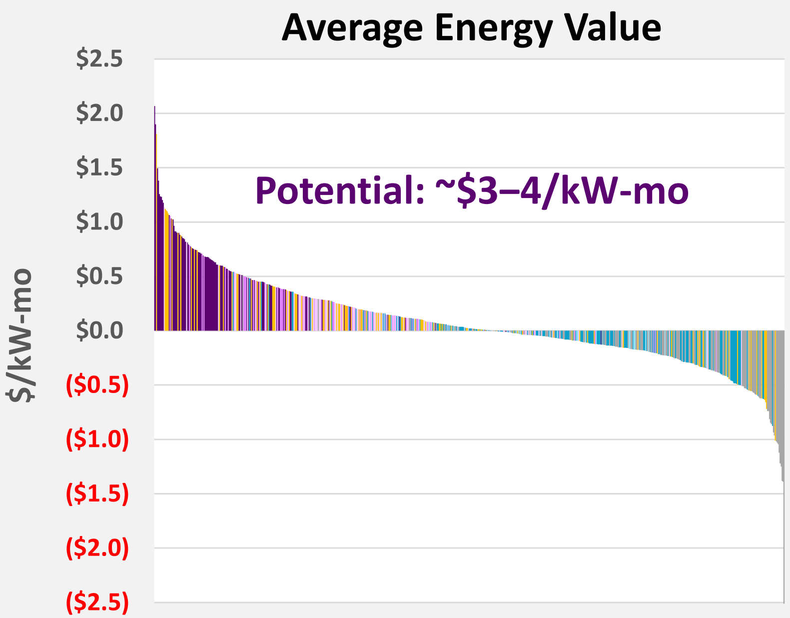
Share of Solar Pairing | **Building Types**

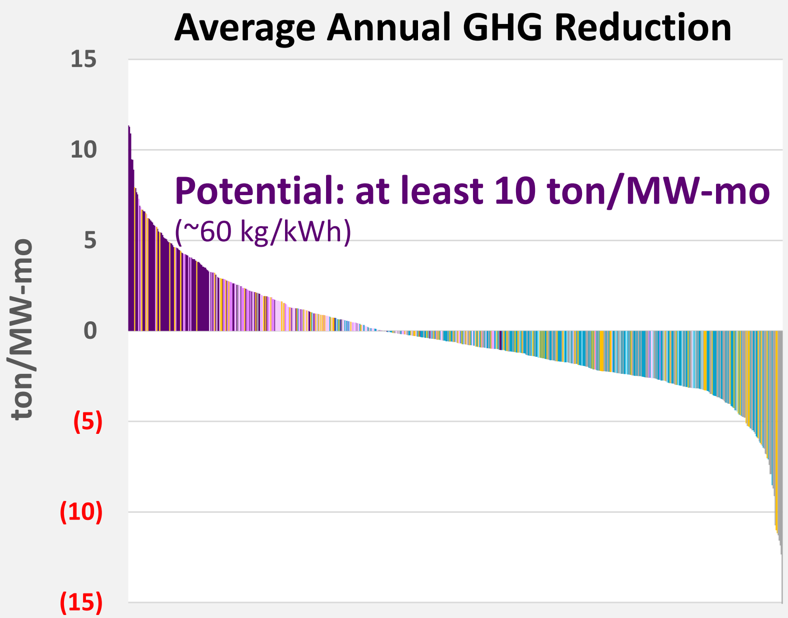


For non-residential SGIP-funded projects, conducted an analysis to group 674 resources into 7 clusters based on each installation's interval-level operating behavior during the historical period

- Clusters 1, 2, and 3 have operating patterns synergistic with the grid: Charge midday and discharge morning and/or evening ramps
- Clusters 4–5 demonstrate a traditional demand charge management: Storage discharged throughout the day, mostly unresponsive during morning and evening ramps, then charged at night.
- Cluster 6 is similar to clusters 1–3, but with significant night charging when renewable supply is not abundant.
- Cluster 7 is a catch-all category with no clear use case identified

SGIP Energy Value and GHG Impact Results





- Most nonresidential storage projects provided a low grid value and increased emissions
- Schools and colleges fared better with high solar PV attachment rates, but still performed below their potential
- Known issue since 2016; but effects of new GHG requirements not observed yet

* Each bar represents an individual nonresidential SGIP project, where the colors indicate identified clusters based on operating profiles.

Cluster 1
- Midday Charge
- Evening Peak Discharge

Cluster 2
- Midday Charge
- Morning Discharge

Cluster 3
- Midday Charge
- Morning+Evening Discharge
- Low Utilization

Cluster 4
- Night Charge
- Distributed Discharge
- Low Utilization

Cluster 5
- Extended Night Charge
- Distributed Discharge

Cluster 6
- Midday+Night Charge
- Evening Peak Discharge

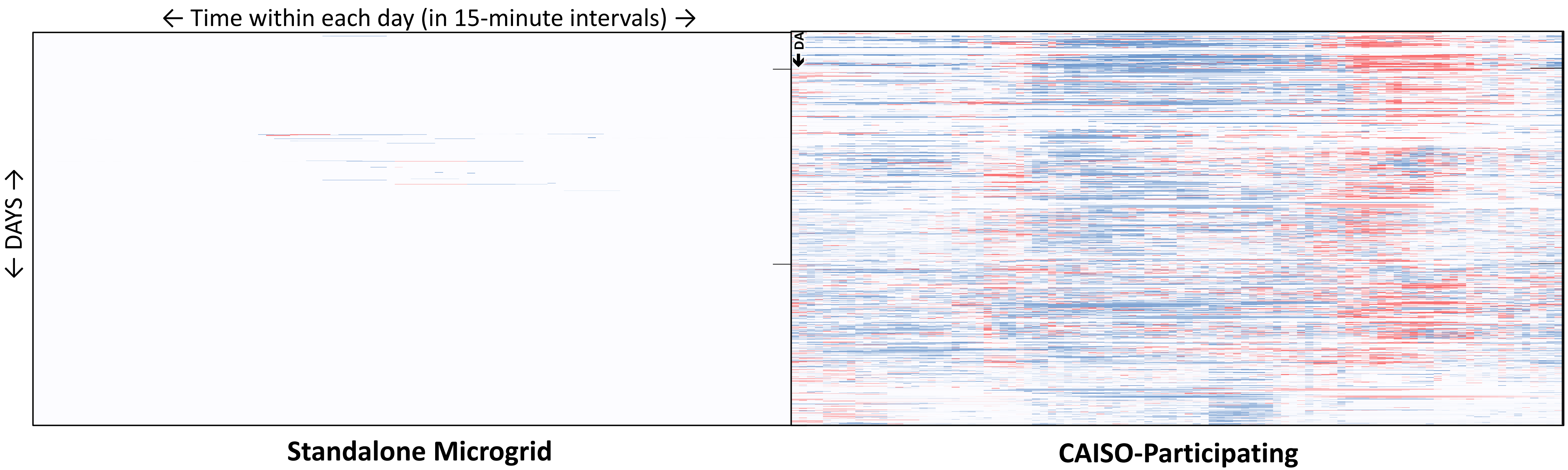
Cluster 7
- No apparent charge/discharge pattern
- Low Utilization
- Low Efficiency

CAISO vs. Non-CAISO Distribution-Connected

Utility-owned distribution-connected resources developed for microgrid and other distribution-related services provided very little value overall and contributed to GHG emissions increases.

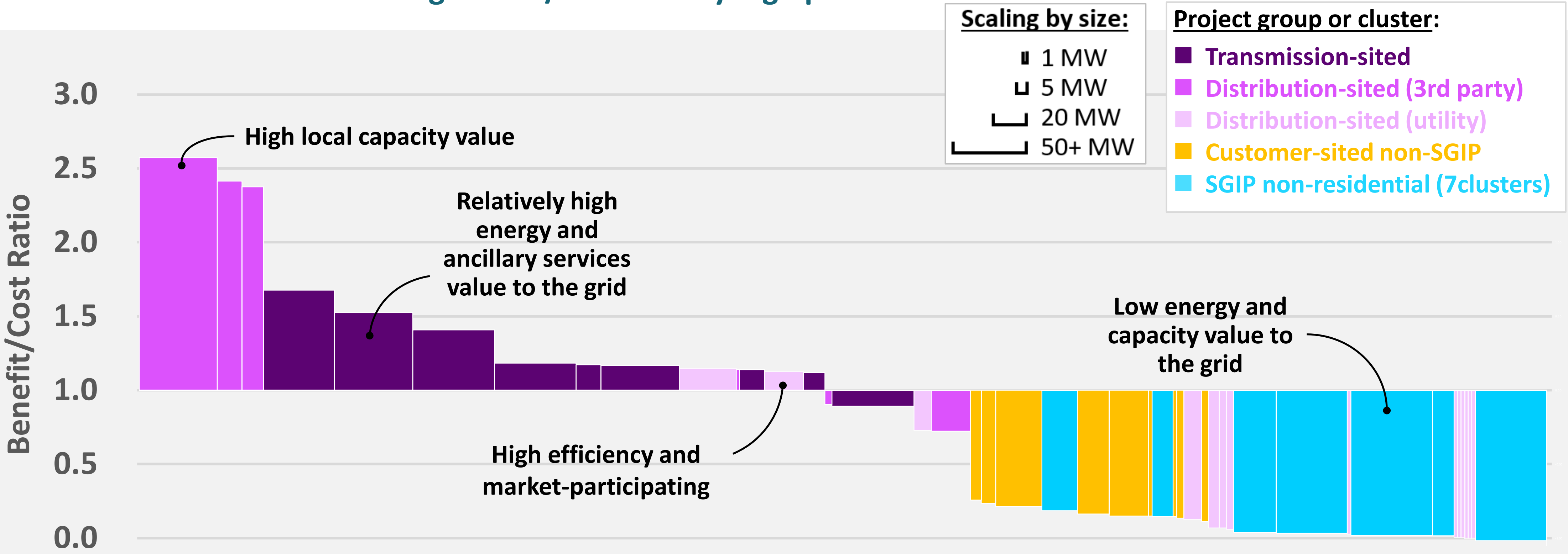
Standalone Microgrid vs. Multiple Use Operations in 2019–2020

(Red = Discharge, Blue = Charge, in 15-minute intervals)



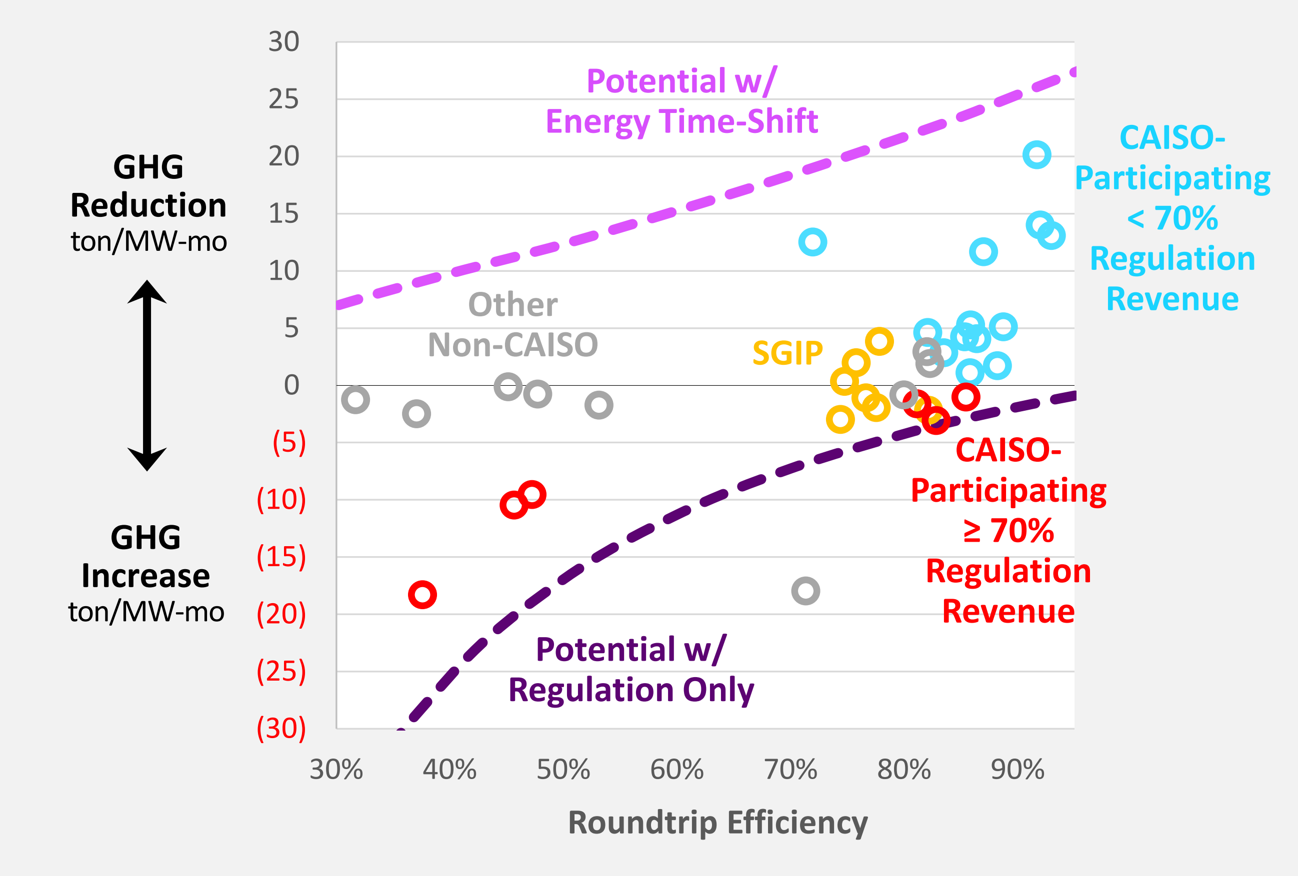
Ratepayer Benefit/Cost Ratio Results

CAISO-participating transmission- and distribution-connected resources performed relatively well, while customer-sited resources and most utility-owned distribution-connected resources performed poorly due to lack of services to the transmission grid and/or relatively high procurement costs



GHG Emission Impact

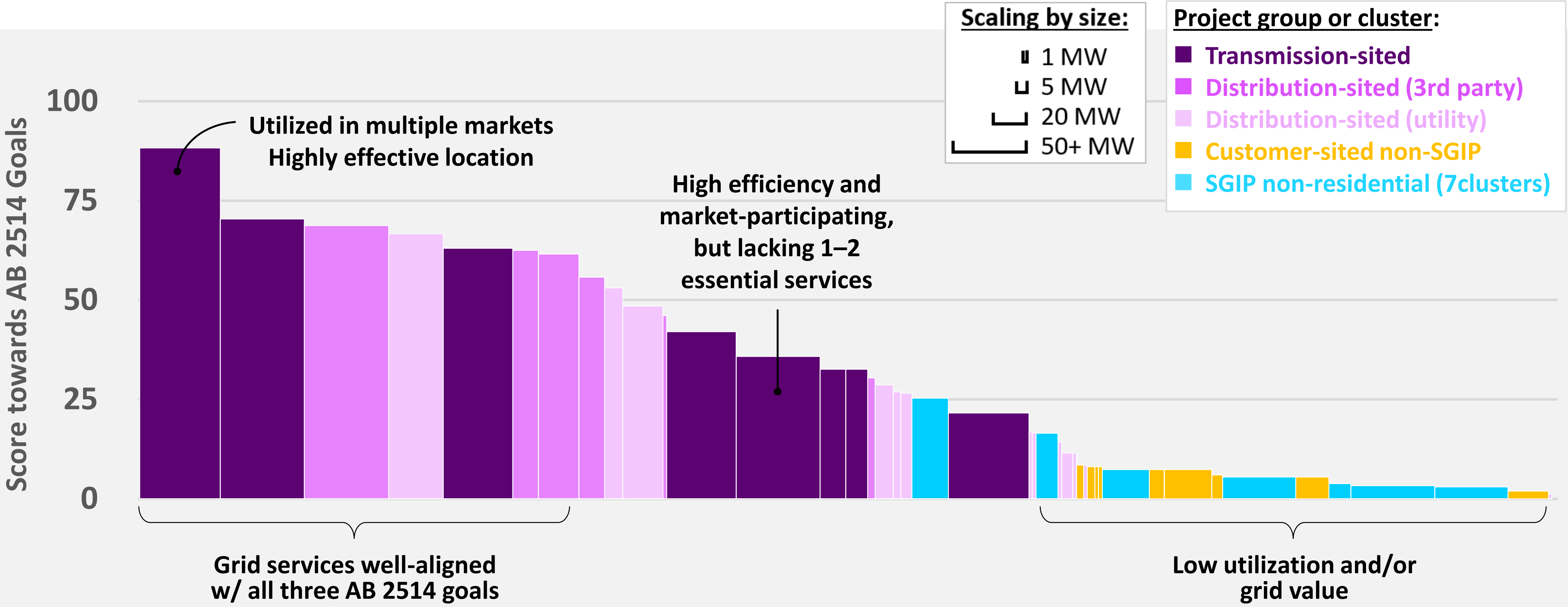
Many initial use cases led to GHG emission increases including ancillary services, microgrid and other distribution-related services, customer demand charge management; but with the market transition to energy time-shift, CAISO-participating resources are starting to reduce GHG emissions



- For storage resources to provide GHG emission reduction benefits, (a) they need to be highly efficient, and (b) their use cases should allow shifting bulk energy from periods with low GHG intensity to periods with high GHG intensity
- *Drawback of frequency regulation use case:* Charge/discharge patterns while following regulation signals are uncorrelated with system's GHG intensity, and combined with 15-20% efficiency losses, it leads to GHG emissions increase
- *Drawback of standby losses:* Utility-owned storage developed for microgrid and other distribution-related services contributed to GHG emissions increase as most of them were on standby while continuously drawing energy from the grid

Project Scorecards

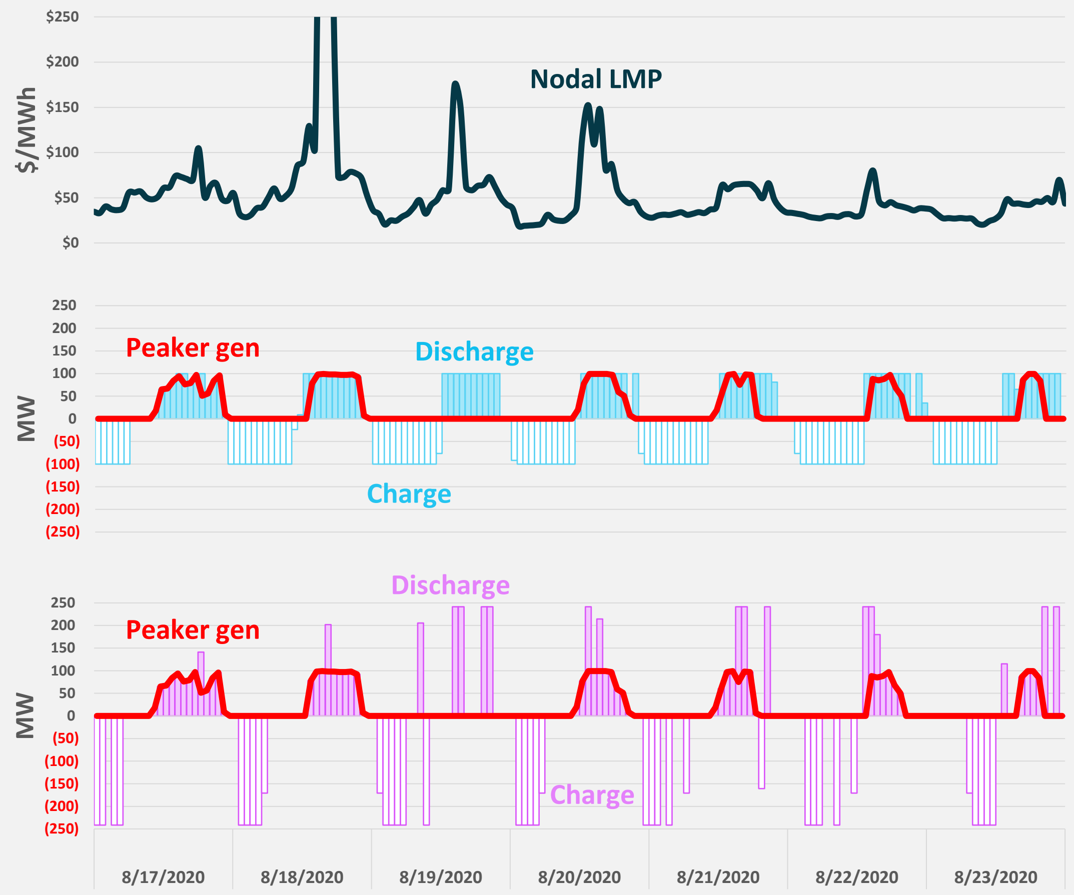
As with benefit/cost analysis results, third-party-owned distribution- and transmission-connected resources performed relatively well, while customer-sited resources performed at the bottom



Special Study—Peaker Replacement

Scope: Analyze the cost-effectiveness of individual natural gas peaker units' replacement with energy storage under the challenging system conditions observed in 2020

- Energy storage capacity and hourly dispatch optimization tool to determine minimum level of storage capacity that can displace all of peaker's historical generation, while also maximizing market revenues
- Investigate economic trade-offs among various energy storage configurations:
  - Durations of 4–10 hours
  - Standalone development vs. pairing with solar

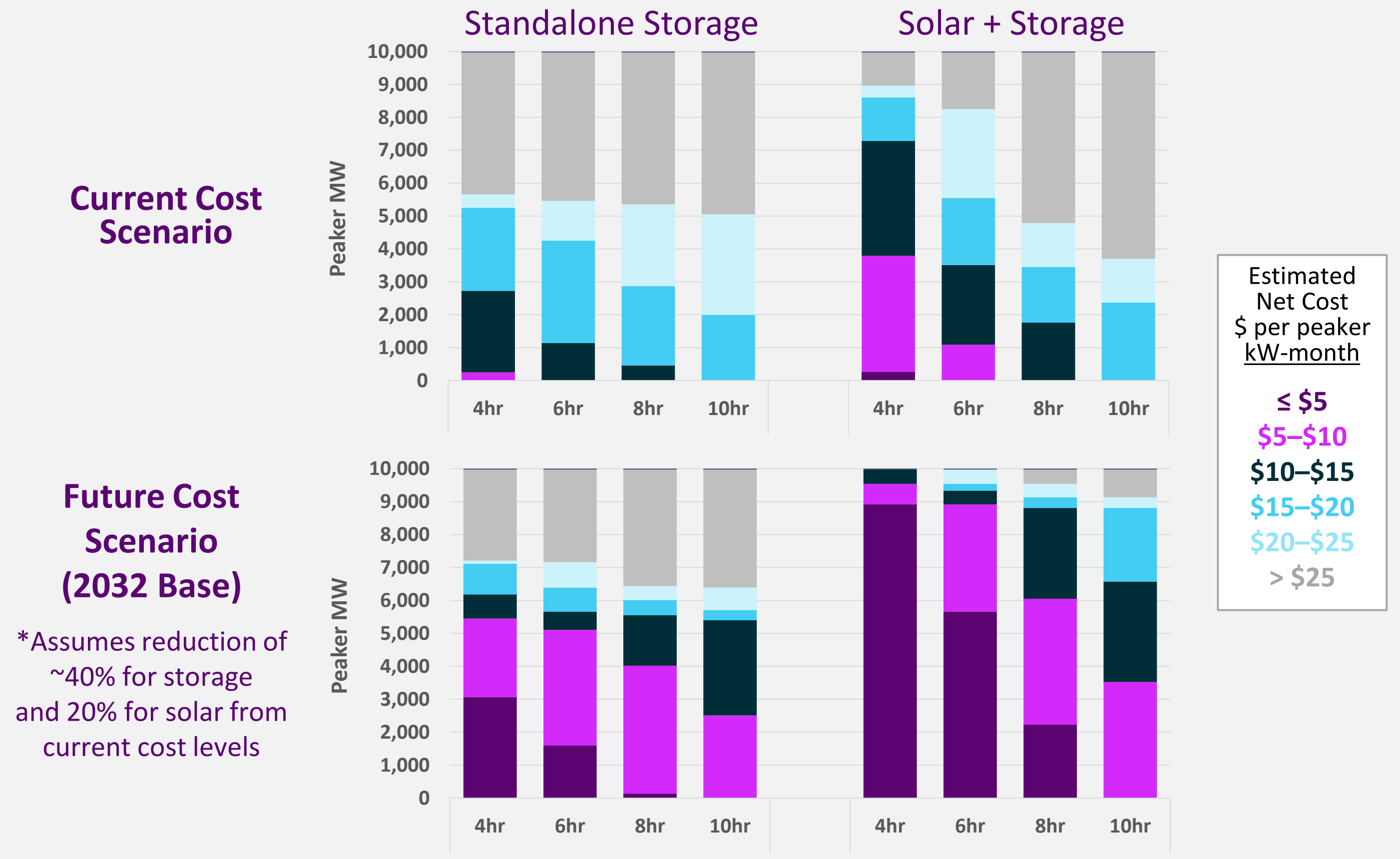


100 MW storage w/ 10-hr duration
- Avg charge at $32/MWh
- Avg discharge at $94/MWh
- Weekly net market revenue = $393,000

250 MW storage w/ 4-hr duration
- Avg charge at $28/MWh
- Avg discharge at $114/MWh
- Weekly net market revenue = $577,000

Special Study—Peaker Replacement (cont'd)

Distribution of Peaker Replacement Net Cost
with no limitation on grid interconnection



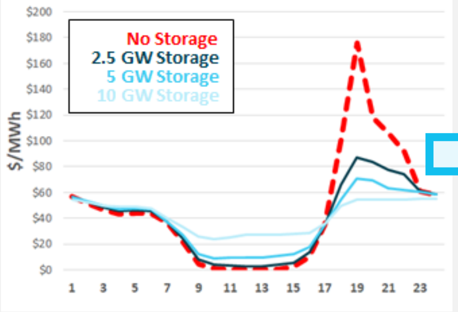
* 4-hour storage configurations need to significantly oversize their MW (relative to peaker capacity) to meet total energy required during extended reliability events. Storage with longer duration needs less oversizing as it can provide same MWh with fewer MWs. See Attachment C for study details and discussion of alternative storage configurations analyzed.

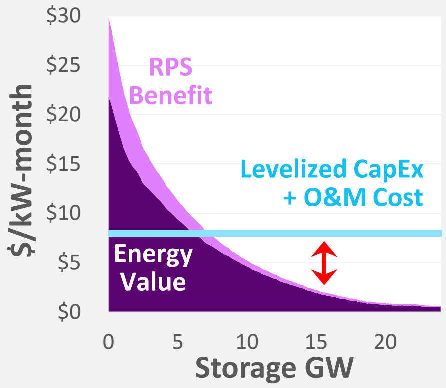
- Replacing peakers with standalone energy storage would require either significantly overbuilding storage MW or installing long-duration storage at relatively high cost
- If there is sufficient interconnection capability, overbuilding storage MW with a 4-hour duration can be more cost-effective in replacing the peakers, than installing long-duration storage
- If there is land, pairing storage with solar can significantly reduce net replacement cost
- If storage (and solar) costs continue to decline as expected, economic feasibility of replacement scenarios may improve drastically, especially when storage is paired with solar

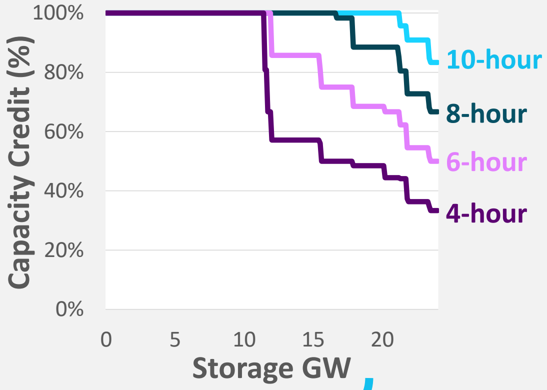
Special Study—Future Storage

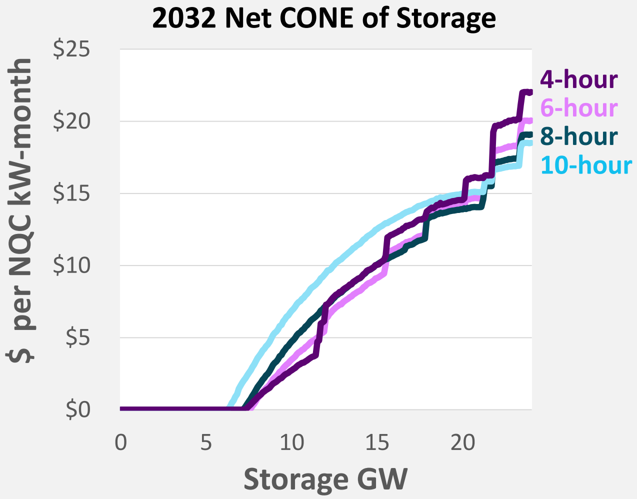
Scope: Analyze benefits and costs of additional energy storage procurement to meet state's clean energy goals and grid needs over the next 10 years (Attachment A)

- Expand on core evaluation of actual storage operations
- Utilize a forward-looking modeling approach to analyze benefits/costs of storage in 2032, considering effects of renewables buildout and market saturation
- Goal to develop *indicative* estimates of the overall economic potential of projects that can provide broad, system-level benefits in California
- Findings are also used to estimate the net portfolio benefits of the planned storage buildout in CPUC's 2021 PSP



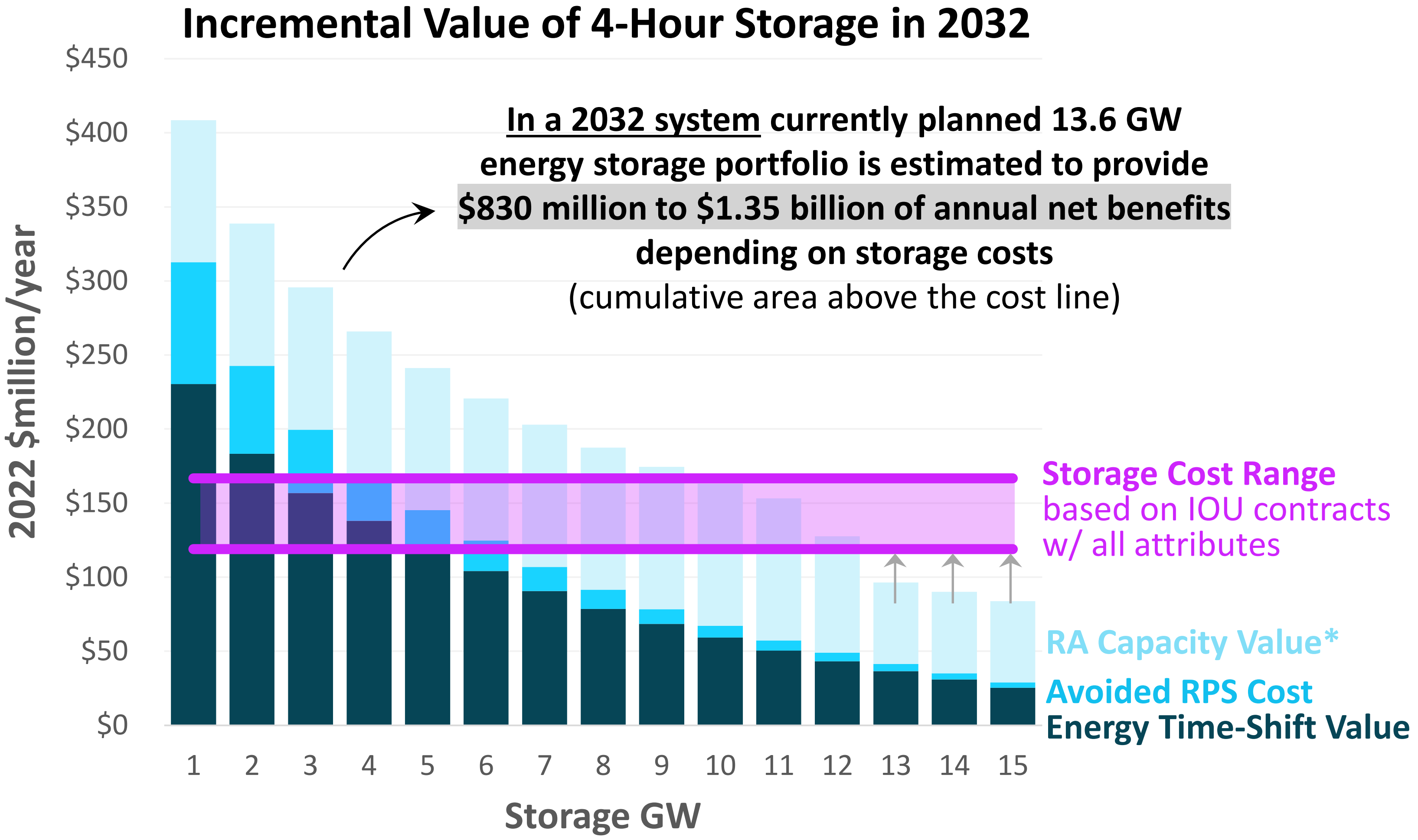






- Renewables increase the need for and value of storage, but marginal value declines as more storage is added
- Decrease in capacity contribution of 4-hour storage can be steep when the evening peak is flattened, which can eventually make longer duration storage more cost effective
- But timing and magnitude of the need is highly uncertain and sensitive to complex portfolio dynamics and ELCC modeling assumptions

Future Benefits of the Planned Storage Portfolio



* Marginal RA value is shown at $8 per NQC kW-month in line with the top 10% of system RA contract prices for 2021 delivery. At high penetrations, RA price would likely be higher to incentivize storage or other clean investments needed for reliability.

- Declining marginal value based on 2032 simulations with varying levels of storage deployment
- "2032 snapshot" of the grid-scale storage portfolio value at $830 million to $1.35 billion, relative to current procurement cost
- Does not show RA value beyond what is needed to incentivize storage investment (conservative)
- Additional potential benefits and grid resilience can be realized by expanding community and customer outage mitigation services provided by distributed energy storage resources

Implications for the Future

- Continued cost of earlier exploratory projects and incentive programs at $85 million per year on average over the full amortization period
- Expansion of transmission and distribution-sited resources yielding net benefits as the state scales up to meet the 2021 Preferred System Plan
  - Total net benefit of $830 million to $1.35 billion per year by 2032
- Additional value with policy changes to unlock value from customer-sited resources
  - Total net benefit of $1 to $1.55 billion per year by 2032
  - A more diversified and effective portfolio
- Unlock additional value (not monetized) with policy changes to:
  - Break down barriers to distribution-sited builds and local grid value
  - Buildout for resilience
  - Improve reliability and the permitting process via safety-related enhancements

Q&A

—STUDY RESULTS

30-MINUTE BREAK

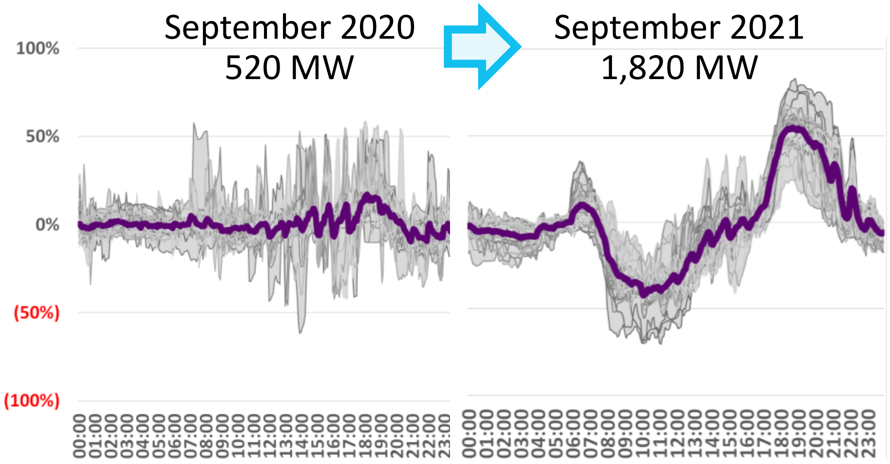
Will return at 12:50 p.m. PDT

Next up: Policy recommendations and discussion

Overview of Policy Recommendations and Discussion

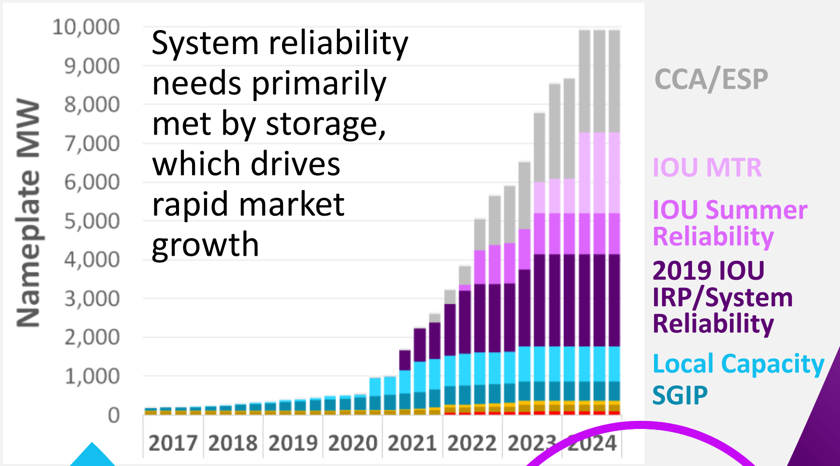
Overview of Recommendations

- Six areas of recommendations
  - Evolve Signals for Resource Adequacy Capacity Investments
  - Bring Stronger Grid Signals to Customers
  - Remove Barriers to Distribution-Connected Installations
  - Improve Analytical Foundation for Resilience-Related Investments
  - Enhance Safety
  - Improve Data Practices
- CPUC and stakeholders are already active in most of these areas
- Recommendations are designed to build from these efforts



Use case in the CAISO marketplace expanded from ancillary services, into energy time-shift and peak capacity

Market for stationary energy storage matured from pilot phase into commercial scaling of Li-ion batteries



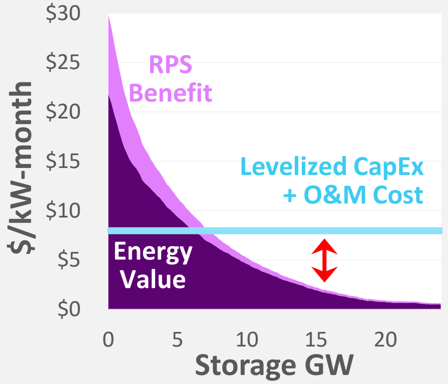
Market Evolution

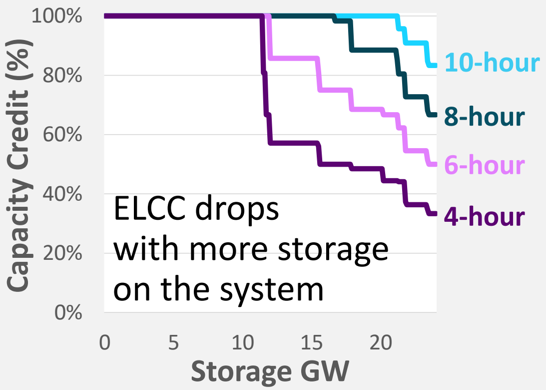
Realized Benefits and Challenges

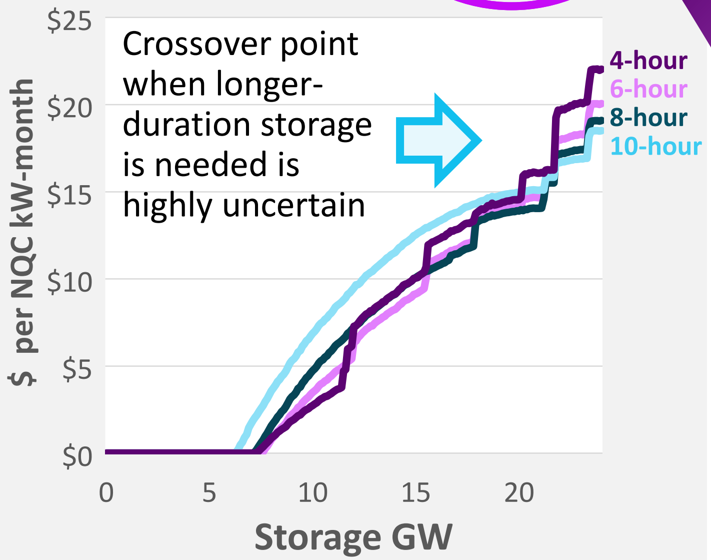
Moving Forward

Evolve Signals for Resource Adequacy Capacity Investments

There will be an increasing reliance on the RA capacity market with more storage on the system





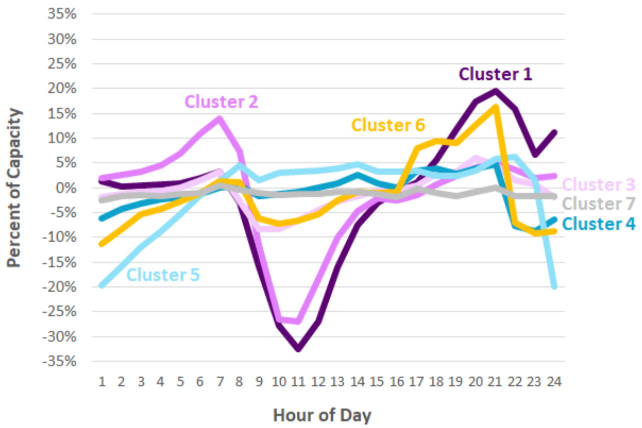


Continue development of ELCC methods

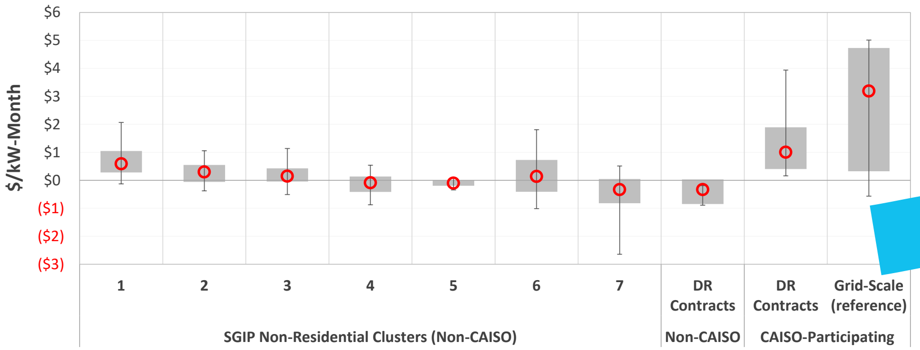
Further validate ELCC signals for longer duration storage investments

Incorporate real options for longer-duration energy storage installations

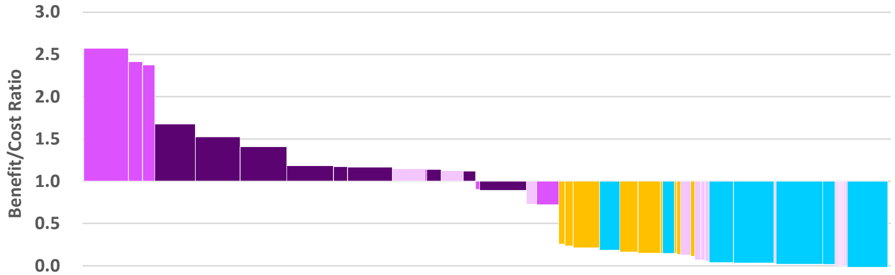
Incorporate impacts of climate change and weather-driven extreme grid events in resource planning and ELCC models

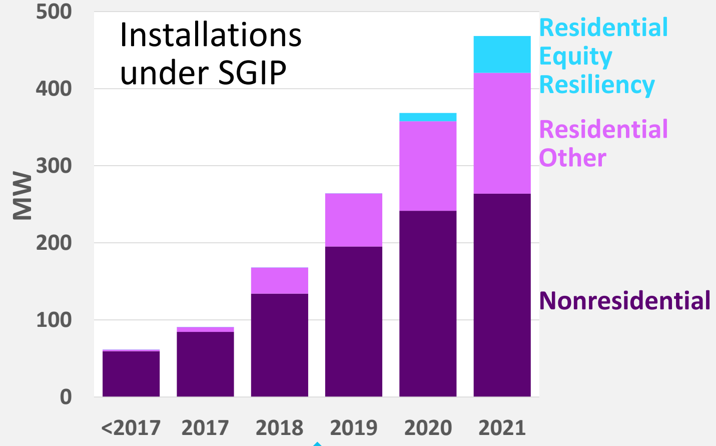


Non-residential storage installations operated in 7 distinct patterns (clusters)

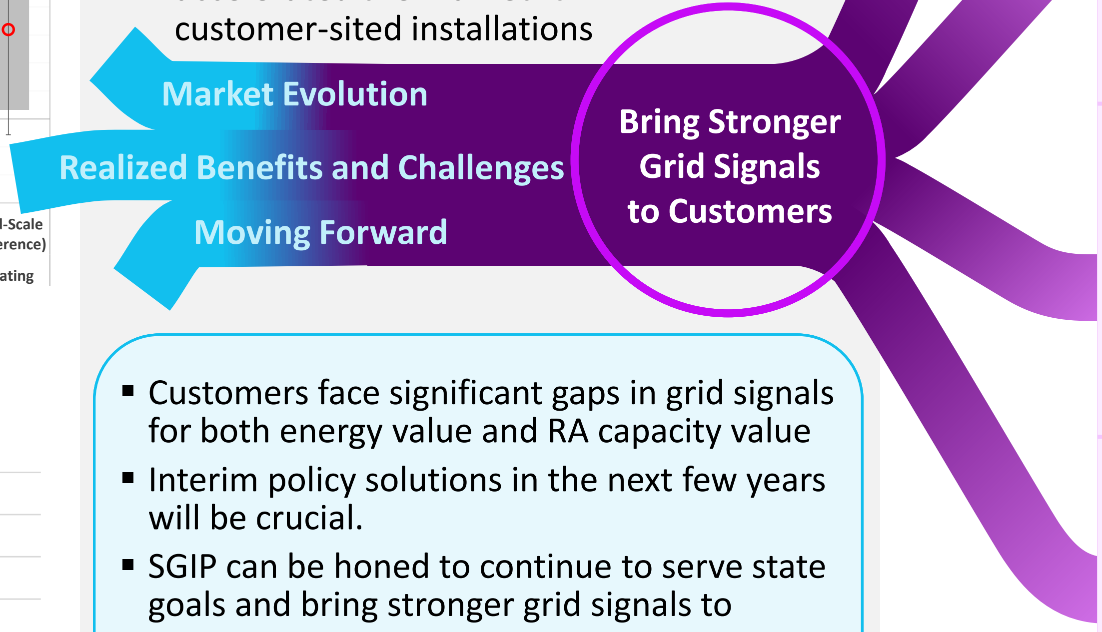


- Energy value of customer-sited storage is well below $3–$4/kW-month potential
- GHG emissions impact correspondingly poor





SGIP successfully **accelerated the market** for customer-sited installations



- Customers face significant gaps in grid signals for both energy value and RA capacity value
- Interim policy solutions in the next few years will be crucial.
- SGIP can be honed to continue to serve state goals and bring stronger grid signals to customers.
- Scale of untapped potential for grid benefits could potentially avoid grid-scale investments of $118–$285 million per year.

Bring stronger grid signals to customers overall

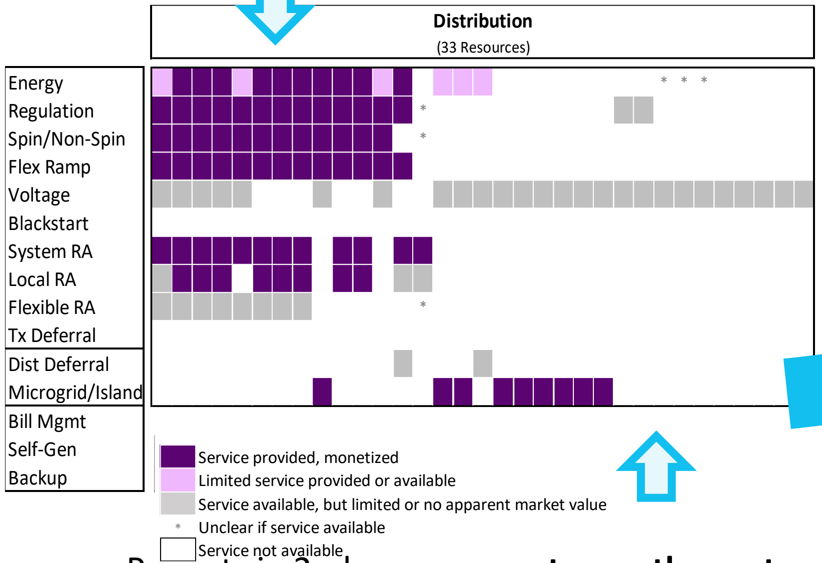
Elevate assessment of effectiveness of GHG signals in SGIP

Strengthen grid signals in SGIP

Incorporate more flexibility in IOU contracts for customer aggregations

Distribution-connected resources that achieved commercial operations fall into 2 groups:

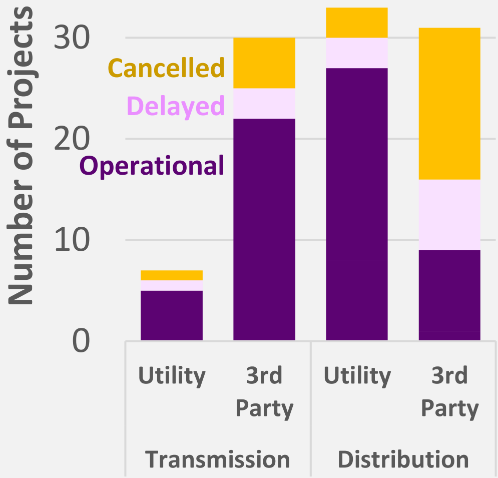
Projects in 1st group are **highly beneficial**, yielding multiple services including services in the CAISO marketplace, local RA capacity

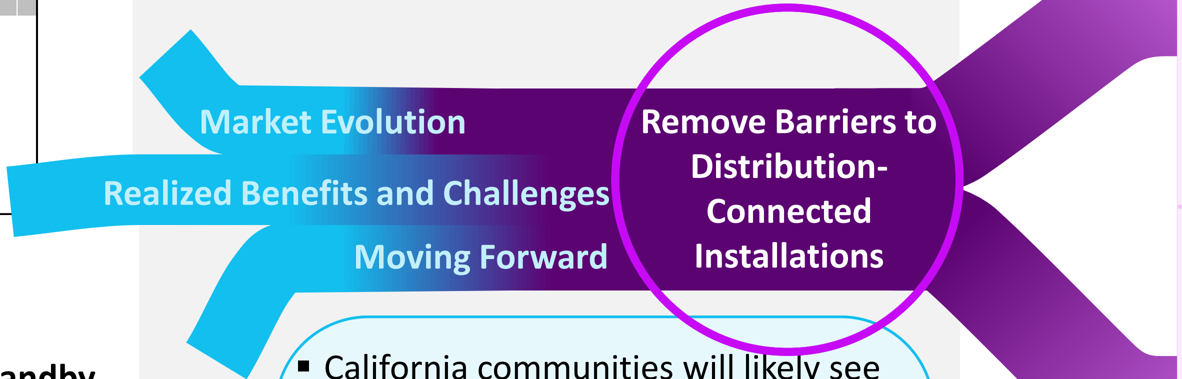


Projects in 2nd group **operate mostly on standby**, do not stack value, and are a net draw to the system and increase GHG emissions

- Distribution deferral needs in terms of MW size and timing are inherently difficult to pinpoint exactly.
- The needs shift and can disappear, and development plans and utility-contracted use cases do not appear to be flexible enough to adjust.

3rd-party distribution-connected projections have the highest cancellation rate and did not reach commercial scalability

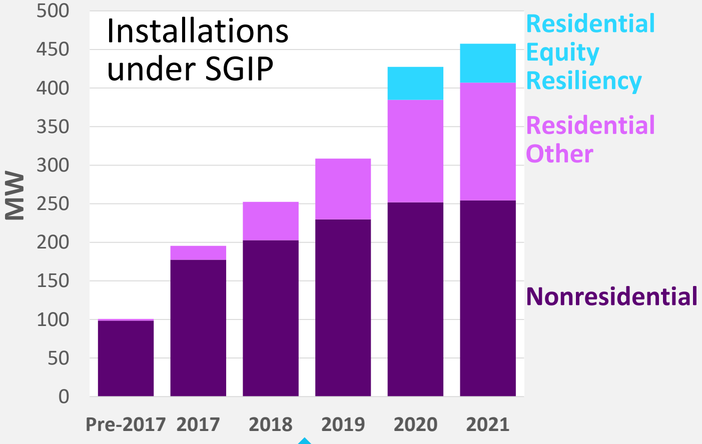




- California communities will likely see a continued need for distribution-level solutions to local grid problems as the system transitions to clean energy
- Distribution-connected resources can provide downstream benefits to the grid and customers, including resilience
- The economics of peaker replacements are not clear-cut and depend on site-specific factors and future market conditions

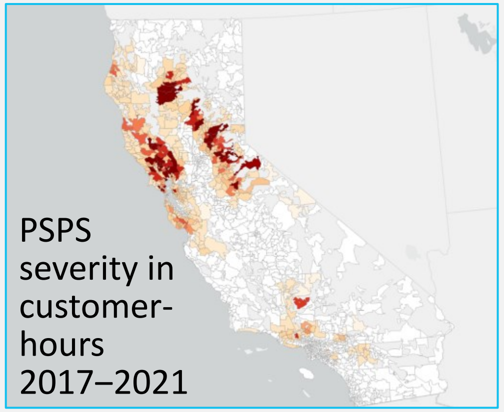
Accelerate market transformation

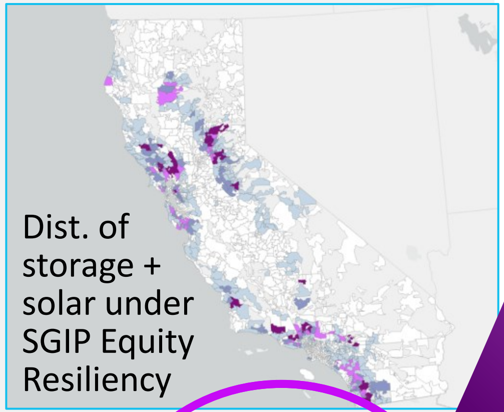
Enable multiple use applications



SGIP successfully **accelerated the market** for customer-sited installations

- The resilience risk profile is **growing and changing**
- Resilience not **fully addressable** at the bulk grid level
- Challenges with scaling up **distribution-connected** storage



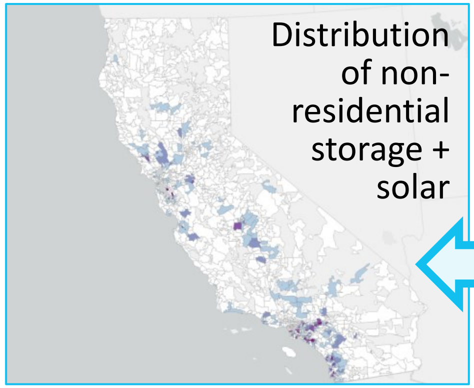


Market Evolution

Realized Benefits and Challenges

Moving Forward

Improve Analytical Foundation for Resilience-Related Investments



20% of non-residential storage installations are located in PSPS areas and installed with solar PV

Value difficult to assess due to lack of California-specific and statistically significant estimate of the cost of multi-hour and multi-day outages to customers

- Non-residential solar + storage in PSPS areas: avg. outage mitigation value of $10/kW-month
- Varies widely by customer depending on the extent of outages

Need:

- Planning and solutions at the customer and community level
- To define resilience
- Stronger resilience planning framework to produce net benefits to both ratepayers and the individual customer
- To capture rapidly changing and future resilience risk profile

Continue focus on equity and resilience in SGIP

Pursue initiatives to significantly improve the state's understanding of the cost of outages

Expand and periodically update estimates of customer resilience-related vulnerabilities

Further investigate barriers to non-residential enrollment under SGIP Equity Resiliency budgets

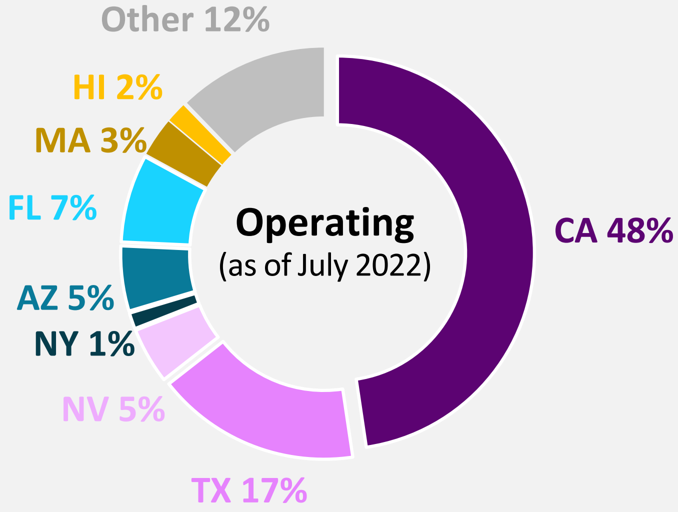
Further analyze the market potential and tradeoffs of developing distributed versus grid-scale storage to improve resilience

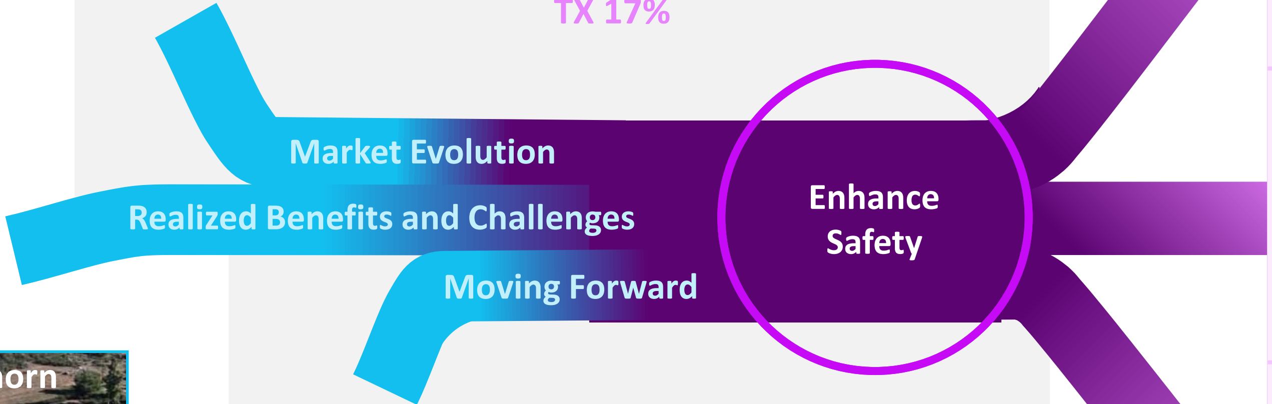
In 2019, a **disaster at the McMicken** facility in Arizona raised safety awareness to the national and international stage

Best practices have emerged but requires **proactive system and site design** and **rigorous coordination and communication** among all parties involved

Safety events at **all three Moss Landing** installations highlight risks to local areas and to resource availability to the bulk grid

California is the **national leader** in energy storage development





- California can expect at least a handful of safety events to occur over the next 10 years
- State faces unprecedented situation to address safety gaps quickly for such a large upcoming fleet
- Safety codes and standards do not address site-specific factors, the safety-reliability link, or implications for a large fleet
- Support for local agencies may help improve speed and quality of permitting process

Form a storage safety collaborative

Explore the safety-reliability link

Develop guidance materials to support local agencies

Energy storage presents a unique set of data-related challenges:

- It is a controllable resource with many types of services and multi-service use cases possible
- It crosses all grid domains and traditional boundaries in industry expertise
- It is scalable down to 8 kWh for residential installations so presents a sheer data volume issue.

Examples of specific data challenges

- No operational data at all for several early utility-owned pilot and demonstration projects & projects under non-SGIP programs
- Quality control and/or non-standardized data issues in several datasets
- Unreliable or not retained state of charge and grid/resource outage data
- Barriers to access customer-sited data + data size and data processing tools required
- Cumbersome to document resource characteristics in a “flat” data file/spreadsheet (single m × n matrix)

- Lessons learned from ratepayer-funded pilots and demonstrations are not always accessible
- Data gaps in installation cost trends over time creates barriers in market evolution assessment

- Modularity of storage yields changing configurations, site expansions, multiple contracts
- Upcoming wave of solar + storage builds adds a dimension of complexity
- Small customer-sited installations growing rapidly and so will sheer size of data and data management needs
- Use cases and multiple applications may grow in complexity

Require that all pilot and demonstration projects funded by ratepayers yield a broadly accessible research report

Develop universal and standardized data collection, retention, quality control, and reporting of interval-level operations

Develop a broadly-useful relational energy storage database

Collect project-specific cost data

Q&A

—POLICY RECOMMENDATIONS

Next Steps

- Please complete survey by Friday December 2, 2022
- After stakeholder comments are reviewed, we will finalize the report
- Thank you!

Photo by Zach Reiner on Unsplash