

Draft Energy Storage Roadmap for California



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1. EXECUTIVE SUMMARY

California has adopted numerous policies to achieve a transition to reliance on sustainable, renewable energy sources. In this context, energy storage systems comprise a category of emerging technologies that could help significantly to optimize the use of wind and solar generation, assist in integrating increased amounts of renewable energy resources into the grid, and reduce emissions of greenhouse gases. However, there are challenges and barriers that may currently inhibit storage from achieving its potential.

The purpose of this roadmap is to facilitate the advancement of energy storage in support of California's energy and environmental policy goals by identifying actions to address challenges and barriers that have been identified by industry participants and other stakeholders.

The open questions and issues span virtually every aspect of developing storage projects and are related to core activities of the California Energy Commission (Energy Commission), the California Public Utilities Commission (CPUC) and the California Independent System Operator (CAISO). These three agencies must therefore coordinate their efforts to foster an effective commercial and regulatory framework to facilitate energy storage development. This energy storage roadmap was conceived as a tool for the agencies and stakeholders to identify the full range of questions and issues and formulate a plan for addressing them.

Some stakeholders have expressed a need for a longer-term vision for energy storage as a necessary element of the roadmap process. The agencies agree on the shared vision that energy storage is an essential component to achieving the state's clean energy goals. Several recent policy actions have provided near-term guidance for this vision, including (1) the CPUC decision for investor owned utility (IOU) energy storage procurement targets of 1,325 MW, (2) the Federal Energy Regulatory Commission (FERC) Order No. 792 which directs transmission providers to define electric storage devices as generating facilities that can take advantage of generator interconnection procedures, and (3) procurement actions by Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) under the CPUC long-term procurement plan. These actions raised a number of questions that need to be resolved for integrating energy storage facilities into the electric grid. The vision is that energy storage will be part of the grid; the roadmap captures key actions needed to realize this vision.

In the development of the roadmap, the Energy Commission, CPUC and CAISO are working closely with stakeholders to identify challenges and barriers for energy storage and devise actions to address them. To date, this stakeholder outreach has identified three broad categories of challenges and barriers: 1) uncertain or insufficient revenue opportunities; 2) high costs of development and interconnection; and 3) uncertainty regarding regulatory requirements, processes and timelines.

The roadmap focuses on actions to address identified challenges and barriers in all three categories. The table below provides a summary of how each of the actions described in this paper addresses one or more of the barriers brought forth by stakeholders. The roadmap team has attempted to capture a preliminary set of actions to address the identified challenges and barriers and invites stakeholders to provide feedback on these. Prior to publishing the final roadmap, the roadmap team may further refine the actions based on a consideration of this stakeholder feedback.

The roadmap team will hold a second stakeholder workshop on October 13 to present and discuss this draft roadmap and solicit additional feedback from stakeholders. The agencies plan to post a final roadmap in December.

Actions		Barriers							
		Ancillary services	Financial	Interconnection	Market and regulations	Metering	Modeling	Standards	Telemetry
Revenue opportunity	Defining and communicating grid needs will clarify gaps help identify new products		X	X	X				
	Clarify existing wholesale market product opportunities for storage	X	X		X				
	Refine existing and add new wholesale market products to meet grid needs	X	X		X				
	Identify gaps in rate treatment and identify existing rules that could address issues	X	X		X				
	Define multiple-use applications of storage to facilitate development of models and rules		X		X				
	Determine hybrid storage configurations to enable prioritization and development of requirements		X		X		X	X	
	Assess existing methodologies for evaluating storage and identify or develop a preferred common methodology		X				X	X	
Cost reduction	Review metering requirements for opportunities to reduce costs					X			X
	Review telemetry requirements for opportunities to reduce costs							X	
	Assess codes and standards to identify gaps and best practices			X	X	X			X
	Review interconnection process for small distribution-connected resources			X					
Processes and timing	Clarify interconnection processes to make it predictable and transparent			X					

2. INTRODUCTION AND BACKGROUND

a. The Roadmap will provide guidance to advance energy storage in California.

California has adopted numerous policies to achieve a transition to reliance on sustainable, renewable energy sources. In this context, energy storage systems comprise a category of emerging technologies that could help significantly to optimize the use of wind and solar generation, assist in integrating increased amounts of renewable energy resources into the grid, and reduce emissions of greenhouse gases. However, there are challenges and barriers that may currently inhibit storage from achieving its potential. The purpose of this roadmap is to facilitate the advancement of energy storage in support of California's energy and environmental policy goals by identifying actions, the relative priorities of the actions, and the appropriate venues for taking the actions, to address challenges and barriers that have been described by industry participants and other stakeholders.

b. A collaborative stakeholder process provides valuable insight into current barriers and potential needed actions.

The CAISO, Energy Commission, and CPUC, with support from DNV GL in partnership with Olivine, Inc., launched the energy storage roadmap effort in July 2014. As a first step, the roadmap team invited stakeholders to participate in an on-line survey and interviews to provide their input and perspectives on what gaps exist in California for storage and potential options for addressing them.

Announcements about the energy storage roadmap and the on-line survey were made using an ISO market notice and direct emails to stakeholders using CAISO, Energy Commission and CPUC email distribution lists. A webpage was established on the CAISO website to provide up to date information regarding the energy storage roadmap development for stakeholders.¹ An email box was also set up that allows stakeholders to provide additional comments, questions, as well as to communicate with the roadmap team.²

The outreach phase ended August 8 and the results were compiled and analyzed by the roadmap team to identify key issues, which were summarized in a brief report that was made available on the energy storage roadmap website on August 28. A separate comprehensive compilation of all survey results and comments received was also posted as an appendix to the summary of survey results.

On September 4 a stakeholder workshop was held to discuss and elaborate on the barriers identified in the initial outreach effort and to gather additional input and clarifications from stakeholders. To supplement the workshop, stakeholders were invited to submit written comments by September 18.

This draft roadmap has been developed based on information collected through the stakeholder process described above and represents a draft version of a final energy storage roadmap targeted for publication in December 2014. The roadmap team will hold a second stakeholder workshop on October 13 to present and discuss the draft roadmap and solicit additional feedback from stakeholders. Based on this feedback as well as additional review of existing processes and potential venues, actions and venues are likely to be revised and clarified.

¹ <http://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx>

² EnergyStorage@caiso.com

The following table summarizes the stakeholder process schedule for the energy storage roadmap.

Date	Activity
July 21 – August 8, 2014	Stakeholder outreach; on-line survey
August 28, 2014	Report summarizing survey results posted
September 4, 2014	Stakeholder workshop #1 (at ISO)
September 18, 2014	Stakeholder comments due
October 8, 2014	Draft energy storage roadmap posted
October 13, 2014	Stakeholder workshop #2 (at CPUC)
October 27, 2014	Stakeholder comments due
December 2014	Final energy storage roadmap posted

c. The Roadmap initiative was motivated by recent regulatory and policy actions and to support California’s vision for a clean, green electric sector.

Policy makers and stakeholders generally agree on the need to expand the role and volume of energy storage in California’s electricity system. Yet several open issues and questions must be addressed in order to achieve that goal. Thus, while the state’s storage procurement requirements have triggered numerous project proposals, project development has been hampered by a lack of clarity on how best to define, measure, compensate and ultimately realize the benefits that storage can provide.

The open questions and issues span virtually every aspect of developing storage projects and are related to core activities of the Energy Commission, the CPUC and the CAISO. These three agencies must therefore coordinate their efforts to foster an effective commercial and regulatory framework to facilitate energy storage development. This energy storage roadmap was conceived as a tool for the agencies and the stakeholders to identify the full range of questions and issues and formulate a plan for addressing them.

Recent policy and regulatory actions at both the state and federal levels have aimed to promote energy storage. In 2010, California Assembly Bill 2514 found that expanding the use of energy storage systems could optimize the use of wind and solar generation, assist in integrating increased amounts of renewable energy resources into the grid, and reduce emissions of greenhouse gases. This bill required the CPUC to consider setting targets for energy storage procurement to be achieved by utilities. In 2013, pursuant to this bill, the CPUC adopted an energy storage procurement framework and established a target of 1,325 MW of energy storage to be procured by Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), and San Diego Gas and Electric Company (SDG&E) by 2020, with installations required no later than by the end of 2024.

Also in 2013, the Federal Energy Regulatory Commission (FERC) issued Order No. 792 which, among other things, directed transmission providers to define electric storage devices as generating facilities that can take advantage of generator interconnection procedures. To comply with the directive, the CAISO filed a tariff amendment with FERC revising the definition of Generating Facility as follows: “The Interconnection Customer’s device for the production and/or storage for later injection of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer’s Interconnection Facilities.”

The CPUC order establishing procurement targets for energy storage had the effect of triggering a significant amount of energy storage interconnection requests in the ISO’s Cluster 7 application window that closed on April 30, 2014. In total, the ISO received interconnection requests for over 2,300 MW of energy storage. This consisted of approximately 1,342 MW of stand-alone storage (27 projects) and approximately 978 MW of storage combined with generation (12 projects). In fact, almost half of all projects in Cluster 7 are storage related.

In response to the CPUC order establishing procurement targets for energy storage, it is anticipated that California’s investor-owned utilities will issue energy storage requests for offers (RFOs) by the end of this year to procure their initial portions of the 1,325 MW requirement.

The Energy Commission in its role of managing research funds for the Public Interest Energy Research (PIER) and Electric Program Investment Charge (EPIC) programs, has contributed to the development of California’s energy storage policy by funding research. This includes projects under the PIER program to examine the cost-effectiveness of energy storage that was referenced in storage decision 13-10-040. The Energy commission has also funded a number of demonstration projects, such as the solar and storage integration demonstration for Alameda County jail, as well as efforts to advance modeling and evaluation practices for energy storage, such as LLNL’s study on using high speed computing to determine the need for and value of storage in California.

3. ACTIONS AND VENUES TO ADDRESS BARRIERS

The roadmap is intended to identify regulatory and policy issues and barriers that are currently perceived to prevent energy storage from achieving its full potential in California and that should be addressed by the CAISO, the Energy Commission and the CPUC.

This section presents a first attempt to map the identified challenges into potential actions that could be taken by the CAISO, the CPUC and the Energy Commission to address them. It is important to emphasize that the actions identified here provide a roadmap towards potential solutions rather than the solutions themselves.

The roadmap team has attempted to capture a preliminary set of actions to address the identified challenges and barriers and invites stakeholders to provide feedback on these. Prior to publishing the final roadmap, the roadmap team may further refine the actions based on a consideration of this stakeholder feedback.

The table below provides a summary view of how each of the actions described in this paper addresses one or more of the broad categories of barriers discussed in the September 4 workshop and during the initial stakeholder outreach process. The subsections following the table provide more detailed descriptions of specific proposed actions.

The actions that will ultimately be part of the roadmap and for which a draft is presented below, will likely need further discussion among stakeholders to build a consensus around the specific changes to existing policy that can be adopted by the CPUC, CAISO and other regulatory bodies such as municipal utilities and regulators. The roadmap team envisions that the Energy Commission will play a key role in facilitating workshops and other stakeholder venues to assist in translating actions into proposed policy that can be considered for implementation by the CPUC, CAISO and others as needed.

Actions		Barriers							
		Ancillary services	Financial	Interconnection	Market and regulations	Metering	Modeling	Standards	Telemetry
Revenue opportunity	Defining and communicating grid needs will clarify gaps help identify new products		X	X	X				
	Clarify existing wholesale market product opportunities for storage	X	X		X				
	Refine existing and add new wholesale market products to meet grid needs	X	X		X				
	Identify gaps in rate treatment and identify existing rules that could address issues	X	X		X				
	Define multiple-use applications of storage to facilitate development of models and rules		X		X				
	Determine hybrid storage configurations to enable prioritization and development of requirements		X		X		X	X	
	Assess existing methodologies for evaluating storage and identify or develop a preferred common methodology		X				X	X	
Cost reduction	Review metering requirements for opportunities to reduce costs					X			X
	Review telemetry requirements for opportunities to reduce costs							X	
	Assess codes and standards to identify gaps and best practices			X	X	X			X
	Review interconnection process for small distribution-connected resources			X					
Processes and timing	Clarify interconnection processes to make it predictable and transparent			X					

a. Actions to advance revenue opportunities

i. Defining and communicating grid needs will clarify gaps in existing markets and help identify new products

Potential products and services that can be monetized to create revenue opportunities for energy storage and other flexible resources need to be grounded in the operational needs of the transmission and distribution systems. Thus an essential task is to facilitate a clear articulation of grid needs that considers both the distribution system and the transmission system. Even though the operation of these two levels of the grid needs to be closely coordinated, there are important differences in system architecture, the actors, the regulatory frameworks and the rules. Whereas the CAISO operates the transmission grid and the wholesale spot markets, and is the custodian of operating rules and reliability requirements for this portion under FERC jurisdiction, the distribution grid is owned and operated by utilities under Local Regulatory Authority oversight. The CPUC is one such regulatory authority. In addition, the transmission grid is a meshed network in which power flows on given circuits can often reverse direction based on system conditions. In contrast, distribution

systems have traditionally had to manage flows in only one direction, from the transmission grid to the end-use customer. With the expansion of distribution-connected storage and other resources, distribution operations will face new operational requirements that represent both operational challenges to distribution utilities and potential opportunities for storage to provide valuable services at the distribution level.

Thus far there have been assertions by developers that energy storage can provide operational and planning benefits to the distribution system, but there has not yet been sufficient effort to define and quantify benefits and establish how they can be monetized. Answers to these questions will require careful assessment of how the operational needs of distribution systems will evolve with expanded volume and diversity of distributed energy resources (DER). Operational needs can then be used to define products and services that some types of energy storage and other distribution-connected resources could provide.

Action ³	Venue(s)
Describe and clarify operational needs at the transmission level, and the operating characteristics required of storage and other resources, connected at either the distribution or transmission level, in order to meet these needs.	CAISO
Describe and clarify operational needs at the distribution level, and the operating characteristics required of storage and other resources connected at the distribution level in order to meet these needs.	CPUC
Facilitate clarification by IOUs of operational constraints that would limit the ability to accommodate storage on the distribution system and behind the customer meter.	CPUC

ii. Clarify existing wholesale market product opportunities for storage

During the stakeholder outreach process and the first energy storage roadmap workshop, several stakeholders expressed the view that there is a lack of wholesale products that value the services that energy storage can provide. Based on a review of the comments, it appears that some of these stakeholder views are due at least in part to a lack of understanding of what market products are already available to CAISO market participants today. This highlights the need to clarify today’s existing products as a first step, and then to use the results of the previous set of actions to better define service needs, to provide a sound basis for refining existing services and defining new market products or services that are needed.

Similarly, the CPUC is responsible for the rules and eligibility requirements for resource adequacy demonstrations by load serving entities under its jurisdiction. As part of clarifying existing rules and requirements and how they apply or could apply to storage, the CPUC could further examine and help clarify the role of storage in an evolving resource adequacy framework.

Action	Venue(s)
Clarify existing energy and AS market products and requirements for energy storage to participate in the ISO market	CAISO
Clarify roles of storage in an evolving RA framework	CPUC

iii. Refine existing and add new wholesale market products to meet grid needs

The results of the action items in the previous two subsections will provide a logical foundation on which to identify gaps in the current market coverage and identify any needed refinements to existing market products,

³ WDAT and Rule 21 are addressed under section 2.C.i

tariffs, and procedures and, if appropriate, define new products and services. Any refinements to existing market products or new products should be designed to incentivize market participants to efficiently develop resources that are capable of offering the needed services. Actions in this area would include efforts by the CAISO to consider revising existing market products and defining new market products that may improve revenue opportunities for resources such as storage that can provide needed operational services.

Actions focused on addressing needs relating to the distribution system and behind-the-meter applications for storage will require action by the CPUC. In addition, actions at both the CPUC and ISO should further examine and clarify the roles that storage may play in deferring or eliminating the need for infrastructure upgrades at both the transmission and distribution levels. Actions in this area should also include identifying potential gaps in existing rules and market products and providing clarifications where the ability of storage to participate is not clear.

One specific issue raised was the need to revise the CAISO’s procedure for testing and certifying resources for ancillary services, because the existing approach designed for generators is not well suited for storage. Stakeholders also asked for clarification regarding aggregation of resources under the CAISO’s non-generator resources (NGR) model.

Action	Venue(s)
Identify gaps and consider changes or additions to existing wholesale market products that would better meet grid needs and improve revenue opportunities for resources such as storage that can provide those needs.	CAISO
Further examine and clarify the role of storage in deferring or eliminating the need for transmission or distribution upgrades	CAISO, CPUC
Consider revising the ISO’s procedure for testing and certifying resources for ancillary services	CAISO
Streamline rules for aggregations of distributed storage units to participate in CAISO markets, including participation via use of the NGR model.	CAISO
Evaluate the need and potential for the development of distribution level grid services and products that provide new revenue opportunities for distribution connected storage resources.	CPUC

iv. Identify gaps in rate treatment and identify existing rules that could address issues

Stakeholders have said that clarity is lacking regarding the rates that storage devices pay for charging and their exposure to other charges. Two key issues were raised: First, the treatment of and distinction between auxiliary load, station power and roundtrip efficiency loss needs to be defined⁴. Second, it needs to be clarified whether energy storage charging should be considered measured demand for purposes of infrastructure charges, such as transmission access charge, wheeling charges, and distribution access charges.

Currently, storage devices that are paired with net energy metering (NEM)-eligible generation facilities are governed by CPUC’s NEM Tariff (R.12-11-005). In decision 14-05-033 issued in May 2014⁵, the CPUC clarified existing policy and fees specific to storage devices that are paired with NEM-generating facilities. However,

⁴ FERC has addressed the issue of storage charging under a PJM filing by stating that electricity “stored for later delivery” is not “end-use” consumption and is therefore not subject to the jurisdiction of regulatory authorities over retail costs. In contrast, on-site auxiliary loads and station power are considered “end use” consumption and are subject to retail rate treatment. FERC did not opine on electricity withdrawn from the grid, not consumed in on-site end uses and not stored for later delivery, such as on-site losses.

⁵ <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M091/K251/91251428.PDF>

going forward, the CPUC opened a new proceeding (R.14-07-002) to address the successor of the current net metering tariffs by December 31, 2015. Issues that arise related to NEM, including petitions for modification of past decisions, will be raised in the context of this proceeding. However, behind-the-meter storage devices that are not paired with NEM-eligible generators currently charge at the retail rate and have no means to export electricity to the grid. Two actions could be considered to address this issue: either (1) consider the issue in CPUC’s general rate case process, or (2) through a new rulemaking that is specific to storage.

For storage devices connected to the transmission grid or the distribution system and participating in the wholesale market, CAISO market and settlement rules apply. For some stakeholders those rules may not be sufficiently clear. Thus, an action would be to clarify the rate treatment for the charging mode of storage participating in the wholesale market under current ISO market settlement rules.

For storage devices selected through the local capacity requirement (LCR) process, the current process is for utilities to file an application with the CPUC on a case-by-case basis to determine the applicable tariffs. The process has just began this year; if the CPUC expects a large number of applications or projects that are selected through the utilities’ LCR process going forward, the CPUC could consider streamlining the application process through a new rulemaking.

Action	Venue(s)
Clarify rate treatment for the charging mode of grid-connected or distribution-connected storage participating in the wholesale market under current ISO market settlement rules.	CAISO, CPUC
Clarify existing tariffs for Behind the Meter storage devices that are paired with NEM generators	CPUC
Consider new proceeding for stand-alone Behind the Meter storage devices to address rates for charging and exporting power	CPUC

v. Define multiple-use applications of storage to facilitate development of models and rules

The roadmap team noted a need to be more precise in distinguishing between the subject of this sub-section and that of the next subsection. To that end, for the subject of this sub-section this draft roadmap uses the terms “multiple-use” or “dual-use” to refer to scenarios in which a storage facility provides service to multiple entities and is compensated through multiple revenue streams. In contrast, for the subject of the next subsection, the roadmap uses the term “hybrid” to refer to configurations in which a storage facility is paired with and functions in coordination with another non-storage type of resource or an end-use customer load. As the discussion in the next sub-section will reveal, these two terms are not mutually exclusive. The roadmap team would welcome suggestions from stakeholders for how better to clarify this terminology.

In their comments and in the discussions at the September 4 workshop, parties expressed interest in various types of “multiple-use” arrangements of storage, including:

- Serving as a transmission asset and recovering part of its costs through the transmission access charge (TAC) while also participating in the markets and earning market revenues
- Providing reliability services to the distribution grid and market services to the wholesale market

- Providing load-management services to end-use customers while also participating in the wholesale energy market.

With regard to the first proposed scenario, parties seeking to develop resources that are compensated partly through the TAC and partly through the wholesale markets have raised such proposals before FERC. FERC has ruled that such arrangements are not appropriate and the facility would have to decide to be either a transmission asset and be approved as such through the ISO’s transmission planning process, or to be a market participant, but could not be both.

Multiple-use scenarios have also been suggested in investor-owned utility solicitations for local capacity requirements and in their applications to issue RFOs for storage procurement. Based on the storage proposals that are submitted by parties, the CPUC could consider opening a new rulemaking to define and develop rules for multiple-use storage scenarios.

Action	Venue(s)
Define and develop models and rules for multiple-use scenarios of storage where feasible.	CPUC, CAISO

vi. Determine hybrid storage configurations to enable prioritization and development of requirements

Stakeholders requested additional clarity regarding definitions, configurations and uses of behind-the meter storage and generation combinations. The lack of clear definition for the term “hybrid storage” and “dual use” with respect to site configuration and programmatic assumptions could create ambiguity with respect to which rules and regulations are applicable. It was proposed that clear single line drawings of resource configurations and the associated metering required for high priority use cases would be beneficial in helping to address both market rules and metering barriers.

Another issue is a perceived lack of a behind-the-meter resource type that supports the full range of market products. A more complete behind-the-meter (BTM) solution for CAISO-integrated, dual-use resources is a missing piece raised by many stakeholders that impacts many desirable use cases of storage. Such a solution supports a stakeholder position that only one meter is required to capture the “net” behavior of any given facility. The two current BTM solutions at the CAISO require either NGR for an asset dedicated to the wholesale market, or a proxy demand response (PDR) that allows dual use of the asset between the wholesale market and other local uses. While the NGR case could support dual use, the solution would not offer cost reductions. In contrast, the PDR was designed to rely on a single meter per location – the utility meter – to be the basis for all energy settlements with the ISO. At this time PDR has limitations, including that it is for load only and can therefore not export energy to the grid. This issue is related to an interpretation of FERC mandate, and could possibly be mitigated by clarifying the NEM rules for such assets. The second limitation of PDR – that it does not offer the full range of ancillary services allowed by FERC – becomes relevant for costs in two ways:

- PDR does not support regulation up/down. This drives resource owners towards NGR which has greater integration costs and requires meter duplication.

- Enhancing the PDR resource type to include regulation up/down could be accomplished while continuing to rely on the utility meter with the introduction of alternative NAESB baselines, or by eschewing all energy settlement for such resource types.

Because the scope of possible configurations and use cases is potentially quite large, it was suggested that it would be useful to identify and prioritize storage configurations (or use cases) so that for these higher priority configurations key requirements and drivers can be identified, such as metering requirements, value streams, billing treatment, and cost recovery strategies. It was also suggested that configurations be prioritized based on their likelihood of near-term development.

Action	Venue(s)
Identify and develop clear models of use cases for hybrid energy storage sites, and prioritize them for purposes of facilitating their participation	CAISO, CPUC, IOUs
For the use cases of greatest interest or greatest likelihood of near-term development, clarify the requirements and rules for participation.	CAISO, CPUC, IOUs

vii. Assess existing methodologies for evaluating storage and identify or develop a preferred common methodology

Several stakeholders expressed the need for a common methodology and common tools for evaluating storage for use by utilities and the CPUC in making procurement decisions. The CPUC identified several areas of value provided by energy storage and that should be considered in the IOU procurement filings in its 2013 decision on storage (D.13-10-040) under proceeding 10-12-007. The decision also identified tools currently in use to support valuation but stopped short of defining a specific methodology or tools to be used in the storage procurements that will bring at least 1,350 MW of storage online in California over the next ten years.

Under the PIER program, the Energy Commission has funded research and development of storage evaluation tools and methodologies for addressing at least some of the needs in determining the value of storage for the California grid and for energy storage developers. Under the EPIC program, the CEC also aims to fund the development of storage valuation methodologies and tools with the purpose of making such tools and methodologies transparent and publicly available. Thus, efforts have already been undertaken or are underway to assess existing methodologies and develop new standard modeling and evaluation methodologies and tools that could potentially become standard in the future. The CPUC as part of proceeding 10-12-007 on storage will in 2015 also determine the validity of methodologies used by IOUs in their energy storage procurement compliance filings. Based on its review and decision on these filings, the CPUC could potentially recommend a preferred methodology or set of tools for evaluating storage going forward.

Action	Venue(s)
Prepare report or summary of efforts underway to develop publicly available models for assessment of energy storage	CEC
Consider refinements to the evaluation methodologies used by IOUs for to support CPUC decisions on storage procurement	CPUC, CEC

b. Actions targeted at cost reduction

i. Review metering requirements for opportunities to reduce costs

Stakeholders have expressed concern over expensive and potentially duplicative metering requirements for energy storage assets and have identified several opportunities to reduce the cost of metering for energy storage resources. While the costs are magnified for smaller resources and for resources made up of aggregations of many assets, cost issues could impact larger installations as well. Two key metering issues were identified by stakeholders and are discussed below.

The first issue is duplicative metering requirements in the cases where both a utility meter and CAISO meter are required. In dual use configurations “in front of the meter”, energy storage assets require both a CAISO meter and a utility meter resulting in increased hardware and installation costs. Such metering is required when storage assets are providing services to the distribution grid and/or to a utility customer as well as the wholesale market. These configurations are generally operated by a utility and present solutions may include up to two CAISO meters and a single utility meter.

The second issue is lack of acceptance for embedded meters or other low cost asset metering solutions. In some cases, the physical asset has embedded metering or the standard installation of the asset includes a meter. In a variation of this issue, a service provider – perhaps the asset provider or resource owner – has meter data collection and VEE⁶ processes in place. These cases also result in duplicative metering, because CAISO requirements for market resources do not allow the use of these metering solutions, and in particular, require the selection from a short list of acceptable meters. As a result, resource owners need to install an additional CAISO approved meter at each asset along with the necessary connectivity for CAISO access to the meter.

CAISO metering requires network connectivity. This is typically provided over a “leased line”, the Energy Communication Network (ECN). However, it could potentially also be provided over the Internet as means to reduce costs. Stakeholders have commented that ECN is expensive for smaller resources while at the same time less secure than some alternative protocols.

Action	Venue(s)
Establish the value of and develop a regulatory and policy framework under which the ISO and UDC can share metering and/or meter data.	CPUC, CAISO
Establish rules for resource owners to submit settlement quality meter data	CAISO
Establish rules for UDC subtractive metering for BTM wholesale resources	CPUC
Establish rules for certifying sub-metering and third-party meter data collection and VEE	CPUC
Complete the Expanding Metering and Telemetry Options Phase I and II initiatives – “expand scenarios for SC metered entities”	CAISO

ii. Review telemetry requirements for opportunities to reduce costs

Cost of telemetry was identified as a potential barrier by stakeholders, in particular with respect to CAISO telemetry requirements. In addition telemetry requirements could also be imposed on resource owners by

⁶ VEE refers to Validation, Editing, and Estimating and is a necessary step to go from raw to settlement quality metered data.

the utility distribution company. Similarly to metering, telemetry requires the purchase and installation of hardware solution and network connectivity. Different from metering, this network connectivity needs to be available around the clock and, depending on the services offered to the asset, low latency. In addition, aggregations of assets require an additional system for combining real time telemetry to the resource level. Specific concerns include:

- The 4-second instantaneous telemetry requirement imposes increased costs, and may be unnecessary for certain types of resources / products.
- The relaxed 1-minute requirement – currently available for PDR – may be suitable for other types of resources / products.
- The relaxed 1-minute requirement may be more stringent than necessary in some cases.
- Clarify whether or not KYZ pulse outputs are sufficient for the purposes of telemetry.
- In some cases, telemetry may be unnecessary though it is required today (e.g., 10 MW energy-only PDRs or smaller A/S resources). Noting that in some cases the telemetry is required at the ISO to dispatch units and for settlement purposes for capacity compliance and pay for performance.
 - An alternate position is that telemetry is unnecessary because distribution/system operators can get system telemetry data by installing phase or measurement units at various points on the grid.
- Telemetry requirements develop consistently with CAISO requirements in terms of data points, frequency, latency, and protocols.
- Third parties separate from resource owners should be recognized to provide telemetry data to the CAISO.

Action	Venue(s)
Evaluate CAISO telemetry requirements for smaller resources	CAISO
Evaluate KYZ, increasing 1-minute requirement, 10 MW limit	CAISO
Evaluate value of common telemetry framework for California	CAISO
Complete the Expanding Metering and Telemetry Options Phase I and II initiatives – definition and support for “data concentrators”	CAISO

iii. Assess codes and standards to identify gaps and best practices

Stakeholders expressed concern over the lack of standards and codes that currently apply and should apply to energy storage. Examples include a lack of unified, stringent fire protection codes for different energy storage applications and technologies. There are also concerns among stakeholders that fire-related accidents could seriously damage the perception of the industry. To address these concerns and facilitate a more streamlined and lower cost set of standards, three actions could be considered: First, safety and operational standards and codes applicable to energy storage should be identified. Standards developed for DER and cyber-security are for example likely to apply to energy storage. Second, the areas in the energy storage deployment that require standardization should to be identified. This task could be undertaken by the Energy Commission. Third, existing standards applicable to energy storage need to be updated. It was noted by stakeholders that “one-size-fits-all” ordinances may not always be feasible given the range of circumstances of various municipal

and city regulations and codes. Actions to address this could include examination by the Energy Commission of the current state of requirements and identification of potential best practices for later consideration in state-wide regulations or development of standards by standard developers such as Underwriters Laboratories (UL) UL and MESA Standards Alliance (MESA)⁷

Action	Venue(s)
Review existing fire protection codes for various energy storage technology and applications and identify best practices	CEC
Determine applicability and scope of UL and other certifications for stationary storage systems	CEC

iv. Review interconnection process for small distribution-connected resources to reduce costs

Numerous stakeholders are concerned with interconnection costs, in particular small distribution-connected resources. One utility also noted that the regulations for how customer-side storage can participate in the wholesale market need to be addressed before interconnection requirements for such devices are re-examined. They also pointed out that recovering transmission and distribution costs through upfront interconnection costs, as opposed to standardized and ongoing transmission and distribution charges, will provide incentives for developers to locate storage in areas with lower-cost system upgrades. Another utility noted that safety and reliability are concerns that apply to any distribution-level generator, regardless of size, and the effort to reduce the cost should not come at the expense of safety and reliability.

Action ⁸	Venue(s)
Address certification process for integrated device metering	CPUC
Address fees for interconnection of non-exporting resources	CPUC

c. Actions focused on process and timing improvement

i. Clarify interconnection processes to make it predictable and transparent

Parties expressed the importance of having a clear and predictable interconnection process that includes:

- Process flowchart differentiating between interconnection levels, project configurations, and the project’s intended operating behavior based on the market products and services it will provide.
- Interaction between CPUC Rule 21 and the utilities’ wholesale distribution access tariff (WDAT)
- A streamlined process to move the project from Rule 21 to WDAT as business requirements change

The CPUC is responsible for making changes to storage interconnection under Rule 21 (R.11-09-011). The goal of the rulemaking is to “promote timely, non-discriminatory, cost-effective, transparent interconnection of new facilities to the grid”. Under this proceeding, staff issued proposal on July 2014 that examines issues, priorities and recommendations for energy storage interconnection⁹, including defining a fast track process for

⁷ MESA is used both for the organization and the standards approach: Modular Energy Storage Architecture

⁸ WDAT and Rule 21 are addressed under section 2.C.i

⁹ http://www.cpuc.ca.gov/NR/rdonlyres/FE95C3C5-F5FB-402C-AEA4-B6CC2C09A0ED/0/Rule21storageandinterconnectionFINAL724_2.pdf

interconnection. At the same time, CAISO has initiated a stakeholder process¹⁰ on energy storage interconnection to examine the extent to which existing interconnection rules can accommodate storage interconnection to the ISO controlled grid. While the CPUC and CAISO work closely together to coordinate Rule 21 and WDAT, in the past, the utilities have been successful in motioning to the FERC to adopt WDAT that is largely based on Rule 21 revisions. Potential near term actions to further clarify include continued actions by the CAISO and the CPUC under the existing processes described above.

Action	Venue(s)
Clarify existing interconnection processes, including developing process flow charts and check lists	CAISO, CPUC
Coordinate between Rule 21 and WDAT to streamline queue management processes	CPUC
Evaluate the potential for a streamlined or 'faster track' interconnection process for storage resources that meet certain use-case criteria	CAISO, CPUC, and IOUs

d. Identify interdependencies and determine priorities to minimize delays

Some storage barriers are more immediate than others. At the same time, many of the actions identified in this draft roadmap are related, and some actions will have little impact unless other actions are completed first. In order to minimize delays it is therefore important to get the sequencing of actions right as well as to focus on the storage configurations that are currently under development or proposed and thus most likely to be part of the first wave of storage coming online.

As part of the stakeholder process, the agencies have already received some stakeholder input that identifies priorities of actions and storage configurations. Using inputs already received as well as additional comments expected from stakeholders on the actions identified above, the final roadmap will determine the sequencing and priority of actions in order to remove the most important barriers to storage development in California.

4. AN ACTIONABLE ENERGY STORAGE ROADMAP APPLIES TO RELEVANT STORAGE CONFIGURATIONS AND USE CASES

In order for the actions of the roadmap to be meaningful, they must address issues that are faced by stakeholders today in developing and procuring energy storage. To illustrate how the actions will affect specific storage configurations and use cases, this part of the roadmap will provide examples of specific storage configurations and will identify how the actions above address barriers for specific storage configurations. Comments have already been received, some of them extensive, regarding what storage configurations should be considered and prioritized. The agencies, supported by DNV GL and Olivine will work

¹⁰ <http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorageInterconnection.aspx>

to develop a concise set of relevant configurations and will demonstrate how the actions of the roadmap will help alleviate energy storage barriers.

This section will be completed after the actions identified in this draft roadmap have been discussed with stakeholders and additional inputs regarding prioritization has been received from stakeholders and analyzed by the agencies.