DNV·GL

ENERGY STORAGE ROADMAP

Summary of Survey Results

California ISO
Shaping a Renewed Future

California Public Utilities Commission

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1 INTRODUCTION

The California Independent System Operator (ISO), California Energy Commission (Energy Commission), and California Public Utilities Commission (CPUC) are individually examining issues associated with the development of energy storage in California through various initiatives, proceedings, and research and development efforts currently underway or planned at each agency. However, the agencies recognize that there may be many other key issues affecting energy storage that also need to be addressed. As a result, the ISO, Energy Commission, and CPUC have agreed to partner on the development of an energy storage roadmap to ensure that the full spectrum of barriers facing energy storage are identified. Thus the objective of the roadmap is to understand needed policy, technical, and regulatory actions that will facilitate the development and utilization of electric grid energy storage in California. The roadmap will accomplish this by identifying the challenges and barriers for energy storage, prioritizing these, and identifying the appropriate venue(s) where each needs to be addressed.

This summary report represents the first step towards development of an energy storage roadmap by presenting the input received from stakeholders through a public outreach effort that included an invitation to complete an online survey as well as targeted outreach discussions with some stakeholders. This public outreach was conducted in late July and the first half of August, 2014. A workshop has been scheduled for September 4, 2014 to discuss this information with stakeholders, identify any additional key issues, and to solicit ideas on how these key issues should be addressed. Following a subsequent round of stakeholder outreach and a second public workshop, the final roadmap will be published in December 2014.

2 INTEREST IN ENERGY STORAGE IS ACCELERATING

Policy makers and regulators, at both the state and federal level, have recently expressed interest in and support for energy storage. In 2010, California Assembly Bill 2514[1] 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 determine targets for energy storage procurement to be achieved by each load-serving entity. 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 the end of 2024.[2]

Also in 2013, the Federal Energy Regulatory Commission (FERC) issued Order 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 ISO 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

[1] California Assembly Bill 2514 was approved by the Governor on September 29, 2010.

[2] CPUC Decision 13-10-040 issued on October 7, 2013.

Interconnection Request, but shall not include the Interconnection Customer's Interconnection Facilities."[3]

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 short, 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 the year.

3 STAKEHOLDER PROCESS

The ISO, Energy Commission, and CPUC launched the energy storage roadmap effort in July 2014 and began with outreach to stakeholders to gather input. Stakeholders were invited to complete an on-line survey to provide their input and perspective 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 ISO, Energy Commission and CPUC email distribution lists. A website was established for access to the latest roadmap information and for stakeholders to access the on-line survey.[4] An email box was also made available for stakeholders to provide additional comments or questions.[5] Additional outreach was conducted with some stakeholders to gain further input.

The outreach phase closed August 8 and the results analyzed by the roadmap team to identify key issues. Section 4 below provides an overview of the key findings, comments raised by stakeholders, additional barriers identified and feedback provided regarding the development of the stakeholder process. A separate comprehensive overview of all results and comments received is available as a separate appendix to this report. The barriers identified and the issues and solutions raised by stakeholders during the outreach process are presented below and will be the focus of the stakeholder workshop scheduled for September 4, 2014.[6] In addition to presenting the key issues identified, the workshop will also be used to identify any additional issues that should be included in the roadmap, as well as how each key issue should be addressed.

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[3] FERC Order 792, paragraphs 227, 228. In its compliance filing submitted on August 4, 2014, the ISO incorporated the tariff revisions set forth in FERC Order 792 into the definition of the term Generating Facility in appendix A of the ISO tariff as well as appendices EE and FF.

[4] http://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx

[5] EnergyStorage@caiso.com

[6] A link to an ISO market notice announcing the September 4 workshop and instructions on how to participate can be found at: http://www.caiso.com/Documents/EnergyStorageRoadmapWorkshop9414.htm

A second phase of stakeholder outreach will ensue following the September 4 workshop to further refine the list of key issues and how each issue should be addressed. Particular emphasis will be placed on the priority of each key issue and the specific venues for addressing them including a research agenda for those issues better addressed through research and development. Based on this input, a draft roadmap will be developed and discussed at a second stakeholder workshop that is tentatively scheduled for October 13. A final roadmap will be published in December.

The Agencies are supported by DNV GL in partnership with Olivine, Inc., who provide consulting support and facilitation of the roadmap development.

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

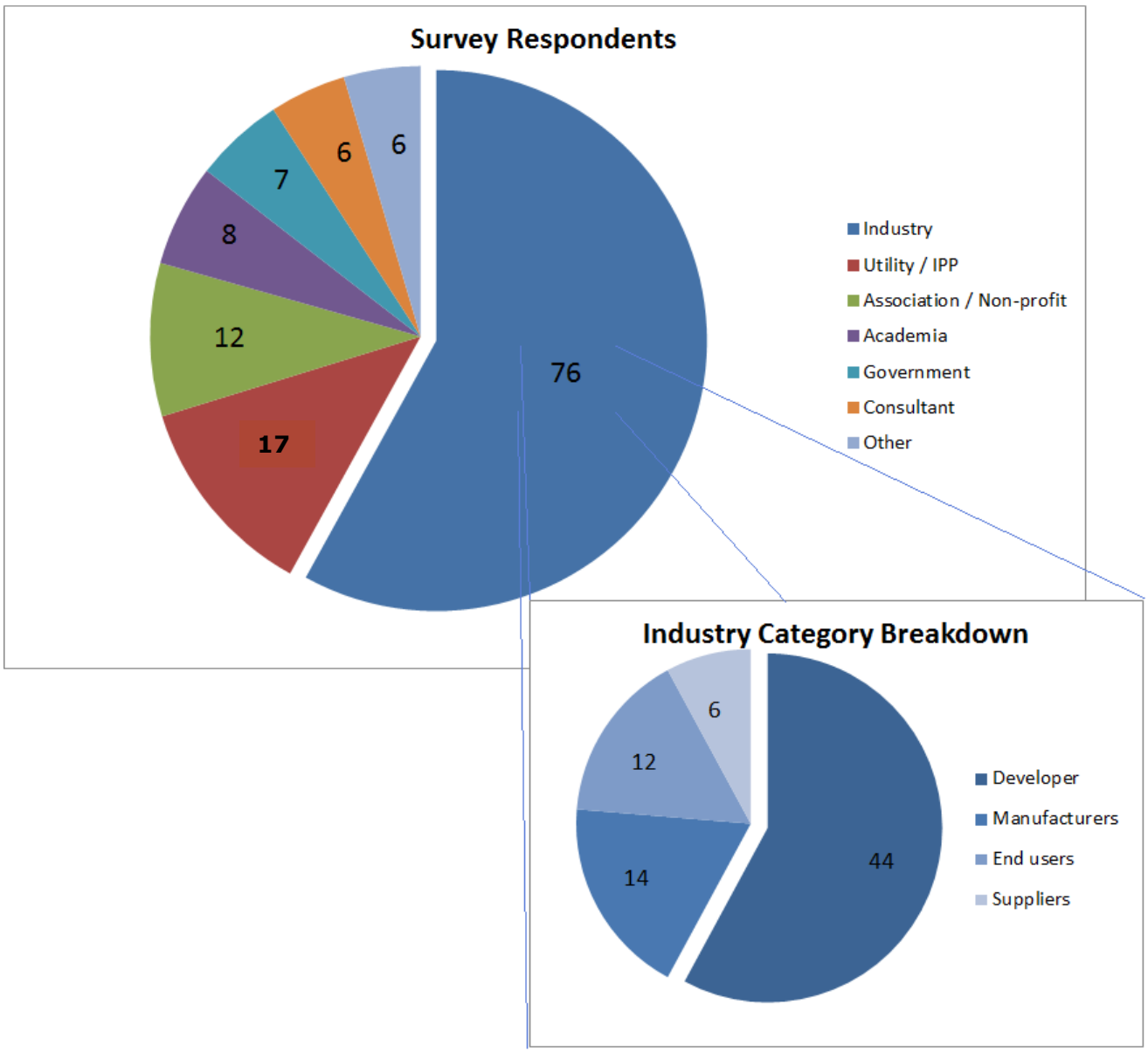
Table 3-1 Energy Storage Roadmap Timeline and Process Overview

Energy Storage Roadmap Stakeholder Process Schedule		
Step	**Date**	**Activity**
First phase of stakeholder outreach: Key issue identification / collection	July 21 – August 8, 2014	On-line open survey
Publish survey results	August 28, 2014	Summary of outreach findings and barriers
Stakeholder workshop #1	September 4, 2014	First workshop to present and discuss barriers and how to address each issue
Stakeholder comments due	September 18, 2014	Stakeholder comments on the August 28 survey results and September 4 workshop discussion
Publish draft Roadmap	October 2, 2014	Initial draft of the Roadmap
Stakeholder workshop #2	October 13, 2014	Second workshop to discuss draft roadmap
Stakeholder comments due	October 30, 2014	Stakeholder comments on the draft Roadmap and October 13 workshop discussion
Publish final Roadmap	Mid-December, 2014	Final Roadmap

4 SUMMARY OF SURVEY RESULTS

The outreach activities conducted by DNV GL and Olivine included an online survey available on the California ISO website as well as discussions with stakeholders and groups and an email-survey that followed the same format as the online survey. A total of 131 responses were gathered from various stakeholders, a majority of which were from the industry. Figure 4-1, below shows the responses received during this outreach effort by the (self-identified) category of stakeholder interest.

Figure 4-1 Overview of survey respondents



4.1 Barrier overview

Table 4-2 below provides a snapshot of the responses received, ordered by the importance given to each barrier by the respondents. The table identifies the number of respondents in each stakeholder group that gave the barrier a high score (9 or 10). Thus the table shows which of the barriers that most respondents consider the most important. Note, however, that the below table does not include any additional barriers identified by stakeholders (these are listed in section 4.3 below). Furthermore, the results presented in table 4-2 gives equal weight to each respondent. Therefore the

table represents a ranking of barriers that are *perceived* as important and does not attempt to link or prioritize the barriers according to any specific obstacles that could have been encountered for specific projects.

However, there are a few themes that appear to be cross-cutting general concerns among stakeholders, including:

- A need to identify services, benefits and values storage can provide
- Need to develop market or regulatory structures for storage resources to monetize services provided and reduce risks to investing in storage
- A need to define how storage satisfies resource adequacy (RA) and flexible RA requirements
- Stand-alone storage and storage in combination with solar PV appear to be leading configurations regardless of point of interconnection (customer, distribution, transmission).

Table 4-2 shows that respondents generally give a higher score to financial and ancillary service barriers than to technical issues such as telemetry, standards, or modeling.

Table 4-2 Number of 9 and 10 Scores

Barriers		Respondent Category						
Category	Specific	Academia	Association / Non-profit	Consultant	Government	Industry	Utility / IPP	Total
Ancillary Services Barriers	Not all benefits of storage can be monetized due to lack of product availability	0	5	1	2	23	4	**35**
	Lack of ability to access products from behind-the-meter points of connection	0	4	1	1	14	2	**22**
	No enablers that allow operators to leverage unique characteristics of storage (Regulation, Black Start, Spinning Reserve)	1	1	1	2	12	4	**21**

Table 4-2 Number of 9 and 10 Scores (continued from table above)

Barriers		Respondent Category						
Category	Specific	Academia	Association / Non-profit	Consultant	Government	Industry	Utility / IPP	Total
Financial Barriers	Lack of electricity tariffs that allow all storage benefits to be monetized	3	3	1	1	26	5	**39**
	Lack of access to all revenue opportunities for storage preventing financing packages being established for storage	0	4	1	0	28	3	**36**
	Lack of long-term contracts for energy storage make financing projects difficult	1	3	1	0	22	3	**30**
Interconnection Barriers	Complex interconnection rules inhibiting adoption	1	1	1	0	19	3	**25**
	Cost to meet interconnection rules inhibiting adoption	1	1	1	14	1	1	**19**
	Cost and complexity of the WDAT specifically	1	0	1	0	9	1	**12**
Market Rules and Regulatory Barriers	Storage is not defined as an asset, either generation or transmission or unique class	2	3	1	3	18	2	**29**
	Minimum size requirements to participate in market opportunities	1	2	1	0	12	3	**19**
	ISO treatment of storage assets as conventional generation in regards to ancillary service certification quantities and maximum generation	1	0	1	1	9	4	**16**
	One LSE per PDR (and presumably per NGR due to procurement issues) prevents widespread deployment	1	0	1	0	7	2	**11**
Metering Barriers	Inability to track where/how storage is being charged preventing enabling tariffs from being applied	0	1	1	2	4	2	**10**
	Increased expense of duplicative metering	0	2	1	0	5	1	**9**

Table 4-2 Number of 9 and 10 Scores (continued from table above)

Barriers		Respondent Category						
Category	Specific	Academia	Association / Non-profit	Consultant	Government	Industry	Utility / IPP	Total
Modelling Barriers	Hybrid applications of storage not accurately being modeled or benefits not being fully accounted for	2	2	1	0	19	3	**27**
	Some storage technologies not accurately being modeled by ISO	2	2	1	1	11	1	**18**
	No standard cost-effectiveness modelling tool available to the industry	1	2	2	0	11	1	**17**
Standards Barriers	Lack of vetted standards in areas such as safety and reliability preventing storage from being easily installed and deployed	1	1	1	2	8	2	**15**
	Lack of local codes / approval listings creating difficulty and time in commissioning projects	1	1	1	2	7	1	**13**
Telemetry Barriers	Cost and complexity of required telemetry	1	2	1	1	6	1	**12**
	Undetermined telemetry requirements for behind-the-meter frequency regulation	0	1	1	0	7	1	**10**

4.2 Issues raised by stakeholders

The first phase of the stakeholder outreach was designed to be inclusive in nature. Hence, the outreach process focused on three approaches for gathering input from the stakeholder community: Direct email address to send specific comments or barriers (energystorage@caiso.com), an open survey posted on the ISO Energy Storage Roadmap web site (http://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx), and a detailed input survey that was sent to and discussed with stakeholders and groups.

The input process was also divided into two phases where the first outreach was designed to capture all potential barriers listed or encountered by key stakeholders. Hence, the survey tools categorized barriers by topic areas and provided an initial set of barriers, with the intention that stakeholders would comment on the suggested barriers and then add additional barriers that may not have been listed. This comprehensive list

of barriers is to be discussed during the September 4th workshop. This section identifies the comments that were received from stakeholders in addition to their ranking of specific barriers and also highlights additional barriers that were raised.

It is important to note that the goal is to collect all barriers and then prioritize and identify agencies that are best able to address and remove the barriers. The Energy Commission, CPUC and the California ISO intends this to be a collaborative and participatory process between the agencies and stakeholders.

A summary of the findings and comments for each barrier is provided below along with new barriers identified.

4.2.1 Ancillary Services Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Not all benefits of storage can be monetized due to lack of product availability	7.0	69%
Lack of ability to access products from behind-the-meter points of connection	5.6	71%
No enablers that allow operators to leverage unique characteristics of storage (Regulation, Black Start, Spinning Reserve)	6.1	67%

Summary of responses from surveys

1. Lack of product availability and access to products for Ancillary Services, some of the benefits mentioned that cannot yet be monetized include:
    a. Over generation relief for RPS,
    b. Help meet local generation requirement,
    c. Regular/flexible resource adequacy,
    d. Voltage control,
    e. Reactive power support,
    f. Inertia,
    g. Black start
    h. Spinning reserve,
    i. Transmission upgrade deferral

2. ISO procuring ramping in the energy market as spin from providers who do not hit accuracy targets makes it difficult to value Fast Response REM in the post-FERC 755 market.

3. Lack of ability to access products from behind-the-meter points of connection

4. Challenges to aggregating behind-the-meter resources, especially the potential costs of metering, communication, dispatch and verification.

5. For building thermal storage, respondents suggested a more wide-spread time-varying pricing and incorporating the value of meeting a utility's resource adequacy.

4.2.2 Financial Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Lack of electricity tariffs that allow all storage benefits to be monetized	7.7	69%
Lack of access to all revenue opportunities for storage preventing financing packages being established for storage	7.3	69%
Lack of long-term contracts for energy storage make financing projects difficult	6.9	71%

Summary of responses from surveys

1. Lack of electric tariffs that allow all storage benefits to be monetized"

2. Lack of access to all revenue opportunities for storage preventing financing packages being established for storage".

3. Complexity of products and market rules, and fragmented nature of revenue opportunities for different services make it difficult for storage to be cost-effective.

4. Inability to capture revenue by credits for energy exports beyond the utility meter
    a. Time- and location-based value of demand for retail resources,
    b. Regular or flexible resource adequacy credits that recognize the flexibility benefits

c. Potential reduction of uplift costs such as Residual Unit Commitment costs
d. Value for system upgrade deferral, inertia response, black start, and reactive power.

5. Lack of defined market rules for storage to participate in existing ISO products, such as synchronized reserve and frequency regulation, is a barrier.

6. the uncertainty around the Permanent Load Shifting (PLS) program , coupled with the program's very slow implementation and short time-frame, left thermal energy storage providers and potential end-users of TES technology with a great deal of financial uncertainty that led to less adoption across California from 2010 to 2013."

7. No long term guaranteed payment programs

8. Several respondents suggested that existing products such as ancillary services should be procured on a forward basis through long-term contracts.

9. The current price structures (PPAs) do not allow for the long lead time, cost uncertainty, and project uncertainty. For example, a significant barrier for pumped storage is the long lead time for development and construction."

10. On the other hand, several respondent including two utilities, do not think long-term contracts are a significant barrier. One cautioned that in the interest of ratepayers, there might be some risks for technology lock-in when using long-term contracts.

11. Addressing the issue of dual participation, that is, the ability of a storage resource to provide both market services, and distribution system and/or site-level services must be addressed. Metering constraints that require resources to be either entirely in the market, or entirely out, must be addressed before the theoretical value streams open to storage resources can be realized.

12. A storage resource's eligibility to provide Resource Adequacy capacity, counting rules that are consistent at the CAISO and CPUC to determine the qualifying capacity amounts, and must offer obligations designed to meet peak, or flexible needs, without being overly onerous are required to assess cost effectiveness necessary for long-term contracting. Including the inability for municipal utilities to take advantage of federal incentives

13. Both the WDAT and CPUC tariffs will require revision to address storage resources, particularly assessing the rate treatment and cost recovery for the charging/load function and developing sufficiently time-granular retail commodity tariffs. Until the tariffs are updated, accurately assessing the cost/benefit of storage resources will be difficult.

14. Uncertainty of investment tax credit

15. Lack of incentives for biogas storage

16. High cost of technology,

17. Bankability challenge caused by immaturity of storage technologies,

18. Lack of long-term operating data or maintenance data.

4.2.3 Interconnection Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Complex interconnection rules inhibiting adoption	6.4	66%
Cost to meet interconnection rules inhibiting adoption	6.3	65%
Cost and complexity of the WDAT specifically	5.3	61%

Summary of responses from surveys

1. Energy storage charging for wholesale market functions should be at wholesale rates.

2. Lack of Charging Tariff Design. Standalone or generation-paired resources should be excluded from the definition of end-use retail load, therefore removing any ambiguity with respect to the ISO's intent to allow such resources to be eligible for wholesale market participation for both charging and discharging.

3. Disconnection Requirements. Rule 21 should be revised to rationalize and standardize disconnection requirements.

4. Streamlining Rule 21/WDAT Transitions. The Commission should address streamlining the interface between Rule 21 and PTO queue management processes. An applicant should be able to transfer immediately from the Rule 21 distribution queue to the WDAT transmission queue if study results indicate that is appropriate, without having to wait for the next open window.

5. Worst Case Study Assumptions & Upgrade Requirements. Energy storage resource interconnections can be cost prohibitive when they are studied assuming worst case charging/discharging. Studying worst case may actually run counter to the point of installing energy storage devices, which are in many cases being built to mitigate worst case impacts that are very unlikely to occur.

6. Safe Harbor for Energy Storage Material Modification Approval when PMax not changing. Adding storage to existing interconnection requests should not be deemed material so long as the PMax does not change.

7. Unpredictability and high cost of interconnection.

8. Large deposit required in Phase 1 of interconnection studies may keep small players out of the market.

9. Another commented that time delays due to transmission study queue backlog as critical.

10. No clear rules on interconnection—one example given is how full deliverability will be determined for both charging and discharging.

11. Simplified rules or cost waived for projects below a certain size should be created.

12. Regarding the WDAT costs and complexity, requirement for individual projects that make up an aggregation to go under WDAT is cost prohibitive for small customers who seek to participate in the wholesale market

13. Not enough clarification on the segue between WDAT and Rule 21 Interconnection processes for aggregated assets.

14. Lack of clarification on "wholesale charge and discharge costs, versus station load retail costs, and why a load study needs to be done in parallel with the WDAT battery interconnection study."

15. Need to adopt interconnect rules for roaming inverters for AC V2G, as covered in SAE J3072.

16. Lack of up to date knowledge within utility interconnection groups. One set of our projects was delayed by 6 months due to the reviewing engineer using an out of date form.

17. Inability to export excess power. The self-generation incentive programs do not allow you to export power period. Even if you are meeting all of your onsite needs. There should be a clause whereby if you are meeting the MW hours of the SGIP but still producing excess power that it can be exported without voiding the SGIP

18. Which entity -- CPUC or FERC -- has jurisdiction, from and interconnection perspective, over storage resources that intend to participate in both wholesale and retail markets? What rules and/or retail pricing provisions need to be implemented to ensure that otherwise retail loads aren't being served through a resource's wholesale market activities?

4.2.4 Market Rules and Regulatory Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Storage is not defined as an asset, either generation or transmission or unique class	6.7	62%
Minimum size requirements to participate in market opportunities	5.1	65%
ISO treatment of storage assets as conventional generation in regards to ancillary service certification quantities and maximum generation	5.8	63%
One LSE per PDR (and presumably per NGR due to procurement issues) prevents widespread deployment	4.9	53%

Summary of responses from surveys

1. Treating storage assets as conventional generation in regards to ancillary service certification would undervalue the benefits of storage:
    i. It would exclude the discharge range of storage and thereby undervaluing the capacity value of storage systems
    ii. Does not fully recognize the value of storage being able to respond faster in ancillary services
    iii. Forcing storage to model Transmission Upgrade at Full Deliverability obviates the value of Storage for Transmission Upgrade Deferral

2. The current requirement to bid a resource's maximum ancillary service capability may not be a good fit for storage that seeks to both participate in the market while simultaneously performing other functions, and should be addressed

3. Minimum size requirement poses a barrier for smaller behind-the-meter installation.

4. Aggregation will be required to meet the size requirement; however, one LSE per PDR makes aggregation of geographically distributed resources more difficult.

5. In markets where grid operators (DSOs...) are regulated entities and generation & supply face competition the potential problem is that a single energy storage unit will not be able to provide services for the regulated and deregulated business at a time

6. The high costs of deliverability studies for customer side resources are prohibitive to the degree aggregated resources could be used for and wish to provide RA.

7. Some ancillary service operating requirements, such as required run time may not be conducive to storage technologies.

8. General market uncertainty in California due to long regulatory work and rework

9. Lack of clear definition of boundary line and accounting treatment for energy and services when storage devices are in use at distribution levels or aggregated at distribution levels.

10. Equal treatment of PV + storage as CSP w/ thermal storage

11. Treatment of PV with storage as an RA-able resource

12. Confusion created by inconsistent terminology and market rating. E.g., calling a 45 minute resource a 3 hour ramping resource vs. flexible resource which is 4X more flexible

4.2.5 Metering and Telemetry Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Inability to track where/how storage is being charged preventing enabling tariffs from being applied	5.2	62%
Increased expense of duplicative metering	5.0	66%
Cost and complexity of required telemetry	4.9	63%
Undetermined telemetry requirements for behind-the-meter frequency regulation	5.4	59%

Summary of responses from surveys

1. Metering and telemetry costs can be disproportionately high relative to the size of the facility (for customer sited facilities especially).
    a. Costs should be limited by the value gained by that each type of metering, with alternatives and modeling employed where more cost effective
    b. Lack of a low cost, "off the shelf" metering and telemetry solution to enable smaller resource aggregation

2. Measurement and Verification (M&V) requirements were excessive and unnecessarily onerous, particularly around metering for Permanent Load Shifting programs.
    a. Improvements can be made monitoring system kW shifted.
    b. A utility respondent cautioned that data and visibility should not be compromised at the expense of saving metering costs.

3. Inability to distinguish between charging associated with the provision of wholesale services and the provision of customer side services is important to allow the rate to of the energy purchased to be appropriately assessed at the wholesale or retail level. Currently all charging on the customer side of the meter is assessed at the retail level."

4. Utilizing ISO wholesale telemetry requirements for behind-the-meter assets is cost prohibitive. Revisions to the telemetry requirements for aggregated behind-the-meter resources is needed.

5. From SDG&E's perspective, the expense of meter installation is a barrier as is the lack of a clear methodology for separating/metering a resource's market activities (both charging and export) from its other, non-market activities.

4.2.6 Modeling Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Hybrid applications of storage not accurately being modeled or benefits not being fully accounted for	6.7	66%
Some storage technologies not accurately being modeled by ISO	6.5	58%
No standard cost-effectiveness modelling tool available to the industry	6.1	69%

Summary of responses from surveys

1. That the current ISO models need to improve on cycle depth dependent degradation of batteries, load/supply balance across state, and transmission level ancillary services (FERC 755 Pay for Performance Ancillary Services).

2. Problematical to go through the GIS as an NGR where the only viable option to model transmission upgrade costs is to select Full Deliverability – particularly when curtailment could be limited to a fraction of a facilities annual operating period.

3. Certain technologies are not being modeled at all.

4. Failure to adopt a public and consistent cost effectiveness valuation methodology greatly inhibits the ability of providers to determine the value of their services and to design and site products to meet high value needs. This also inhibits evaluation of procurement decisions. However, this view is not shared by all respondents.

5. Lack of standard modelling tools

6. Cost-effectiveness analysis available has a strong focus on batteries, but leave out other storage technologies.

7. Modeling puts too much focus on ancillary service market and insufficient modelling of large scale, long duration resources capable of replacing NGCT.

8. Some modelling challenges mentioned in the comments include:
9. Uncertainty in future hourly share and volatility of both day-ahead and real-time energy prices

10. Uncertainty in future prices and depth of market for ancillary services

11. No publicly-available data on degradation characteristics of energy storage devices

12. Control of the resource and how it fits into a self-healing grid is more of an issue then installation models.

13. The estimation of greenhouse gas impacts of different types of storage should be estimated ex ante and ex post to inform public policy development. Such an assessment would need to estimate which incremental generation resources operated when storage was charging and which resources did not operate when storage was discharging.
14. Seasonal Storage is not recognized as a future need and is not built into models.

4.2.7 Standards Barriers

From DNV GL survey list

Specific Barriers	Respondents' Average Score	Response Rate (% of total responses)
Lack of vetted standards in areas such as safety and reliability preventing storage from being easily installed and deployed	5.4	64%
Lack of local codes / approval listings creating difficulty and time in commissioning projects	5.7	62%

Summary of responses from surveys

1. Need uniform codes to eliminate the cost of one-of-a-kind applications, several recognize that it is a regional issue and expect some jurisdictions to be easier to work with depending on their familiarity with storage.
2. Utilities/IPP and consultants score the "lack of vetted standards in areas such as safety and reliability" as relatively high (score= 7.4 and 7.5). However, they did not provide more specifics regarding this barrier.
3. Lack of alignment on chemical safety and fire suppression standards, for instance, creates unnecessary work for storage manufacturers to align on a single product specification.
4. UL or CSA standards usually not available for these systems and not all components are failure tested. System or packaged approval needs to be developed for non-utility owned projects.
5. Lack of standards for measuring storage performance
6. Lack of design guideline
7. No communication interface standards exist, which drives up NRE and operational expenses.
8. Lack of inverter and utility control/coordination standards are preventing the use of storage for advanced applications, and thus the full compensation for storage benefits
9. Lack of common use case definitions and defined functional requirements for such use cases, and performance test standards to ensure system meet those functional requirements.
10. Lack of standard information models and communication protocols mean that customers cannot mix and match best-of-breed components to build their energy storage systems and significant custom engineering must happen in each project to piece together the system and wire it into the utility's existing grid control systems. SunSpec in the solar PV world and OpenADR in the demand response world represent the kind of efforts also needed in storage. MESA is a nascent industry effort in this area that would benefit from public sector support.

4.3 Additional Barriers Provided by Stakeholders

4.3.1 Technology

Summary of responses from surveys

1. Maturity of the storage technologies

a. Lack of long term operating data is a barrier to finance
b. Battery life cycle costs including major maintenance capital requirements especially for long-term PPAs

2. Technology is too expensive

4.3.2 Scheduling Barriers

Summary of responses from surveys

1. No real tutorial or instruction on how to bid, schedule energy, and participate in ancillary services for storage

2. Lack of understanding to how will the ISO DMM will view the failure to provide an energy or AS product? Is an energy storage owner required to buy energy to charge the battery system at any cost?"

4.3.3 Additional barriers

1. Lack of public information on storage and get the word out. Also, Trimark Associates believe that public education will increase energy storage acceptance.

2. Lack of courses on storage at schools and universities need to prepare students to consider, integrate and use energy storage technologies.

3. Utilities' employees seem to not be aware of these technologies to better integrate them (grid planning phases, simulation tools, operations...),

4. Public security agencies are not aware of some specific storage technologies (firemen, etc.) Insurance companies and financing institutions also need to be informed regarding energy storage.

5. Utility RFOs- RFOs are too general in describing what the utility wants. Different needs dictate different technologies and it is just too expensive to try to bid every possible storage technology, hoping one is what the grid / utility is looking for.

4.4 Roadmap guidance-

Some respondents also offered input on how to best move the energy storage roadmap forward. These comments are highlighted below:

- Roadmap should include guiding principles: cost-effectiveness; simplicity; minimal rate impacts; GHG reduction; etc.
- Roadmap should include identification of critical missing information that will govern ability of storage to meet market needs.
- Roadmap should address cost effectiveness of storage compared to other options to achieve the same result. Cost effectiveness should include any enabling costs (such as metering, telemetry, etc.) regardless of who pays.

5 NEXT STEPS

This document is intended to provide a summary of the stakeholder outreach efforts prior to, and as background information for, the first Energy Storage Roadmap workshop on September 4, 2014. Following this workshop, the Energy Commission, CPUC, and ISO will develop a draft roadmap targeted for finalization and publication by December 2014.

During the roadmap process, the Agencies will seek further inputs from stakeholders. Through the end of 2014, please mark your calendars for the following opportunities to contribute to the roadmap development:

September 18. Last day for stakeholder comments following the September 4 workshop.

October 13. Second stakeholder workshop to discuss and review draft roadmap.

October 30. Last day for stakeholder comments following the October 13 workshop.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.