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Objectives in today's presentation

- Examine activities in other states on storage
  - How storage has been advancing in other states
  - Are their lessons that can be gained from activities
    - Focusing on California and Hawaii
  - Are there recommendations that can be made

- Examine the current state of various storage technologies
  - Types of Storage technologies
    - Electromechanical (advanced and traditional)
    - Pumped hydro
    - Thermal
    - Mechanical
  - Map characteristics of technologies to applications

California Storage Initiatives

- History behind the 1.325 GW "mandate" for energy storage in the State
  - Much like New York, California began to push very aggressive renewable goals for the state – initially 33% penetration by 2020 during the 2008-2010 period
  - CAISO and CEC examined the impact of high penetration of renewables – 2010 KEMA *"Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid"*
  - Study showed the potential impact of high penetration of variable generation and need for 3-5 GW of fast, flexible devices to mitigate those potential impacts
    - ***Study shed light on the timeline of deploying 3-5 GW from 2010 to 2020***

- AB 2514 – Storage Initiative
  - California (through Janice Lin's efforts) launched initiatives to examine Use Cases for Storage as a means to accelerate deployment
  - Analysis was forward thinking and examined benefits for storage in the cost effectiveness of storage to determine whether a "no regrets" level of deployment could be created
  - Process focused on benefits of storage at:
    - Wholesale level,
    - transmission/distribution,
    - Customer side applications

California Storage Initiatives

- Results of the AB 2514 process culminated with the October 2013 Ruling on a storage mandate
  - Encouraged the use of storage at the transmission, distribution, and customer level
  - Targeted deployments over a 7-year period between 2014 and 2020
  - Ushered in concepts of Utility Ownership and customer sited storage being utilized for utility and grid operations
  - Despite the ruling incorporating “off-ramps” for utilities, deployments are ahead of schedule

Proposed Energy Storage Procurement Targets (in MW)[22]

Storage Grid Domain Point of Interconnection	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	**90**	**120**	**160**	**210**	**580**
Pacific Gas and Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	**90**	**120**	**160**	**210**	**580**
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	**20**	**30**	**45**	**70**	**165**
Total - all 3 utilities	**200**	**270**	**365**	**490**	**1,325**

- California Roadmap
  - In addition to the mandate, the CPUC, CEC, and CAISO created a roadmap on potential barriers that could inhibit storage deployment in the State and examined multiple areas on policy, tariffs, processes and actions to address identified barriers

- Unique Approaches to Storage Deployment
  - The process of adoption of storage by the utilities led to improvements in understanding business cases, ownership structures, or ways for utilities and customers to partner and share resources

Hawaii Storage Initiatives

- Hawaii and Impacts of Renewable Penetration
  - Hawaii was unique in that it had the ability to test a number of theories around high penetration of variable renewable generation
    - The State is driving to 100% renewables by 2045 and in some places are already above 50% penetration
    - In addition to the renewable activity at the generation level, there is also a surge of residential solar adoption, from 15-20% penetration
      - Ebbing of net metering tariffs are also driving innovative approaches to solar – storage application
  - Hawaii has moved beyond recognition of potential issues and is taking steps, through programs such as DOE Solar Shines, to examine how to integrate solar and storage

- Adoption of fast response devices mandated for renewable interconnection
  - To mitigate the issues that were being created by the high penetration of renewables, the state mandated that renewable systems needed to utilize fast response devices to
  - Most developers were able to comply due to the cost of energy, projects were still able to be deployed economically

Current State of Storage Technologies

- Storage is advancing and proving itself in multiple application, and for some specific applications, nearing price parity with traditional solutions.
  - Cost reductions are occurring faster than anticipated
  - Advancements in technologies are continuing even as advanced technologies commercialize
  - However…“On the Precipace” may be an appropriate description as there are still challenges

- It has been stated before, storage simply isn’t one technology nor is it “advanced” technologies
  - The key to deployments is still mapping the application needs to the storage characteristics.
  - Technologies such as lithium are advancing rapidly in cost reductions and deployments, but that doesn’t mean that it is always the best technology for every application

- Multiple application requirements and mix of traditional, advanced, power, and energy technologies still creates knowledge gaps on storage
  - Cost components, cost reductions vary across technologies and are not occurring evenly across technologies

Quick summary of family of technologies

- Today, Storage may not need to go “beyond lithium”, but it is definitely more than just lithium

- Electro-mechanical – It is Power and Energy
  - Power: Lithium, with its fast response capabilities make it ideal for renewable integration. It’s rapid price decline is allowing it to be stretched into energy applications
  - Energy System: Seeing new entrants, less commercialized, but may be more appropriate for utility, distributed application if or when they match lithium price declines

- Pumped Hydro
  - Still by far the largest deployed storage technology. Still questions on the role the technology can play in supporting renewable goals and grid modernization

- Thermal:
  - Considered more of a “load shifting technology” rather than a pure storage, but communications and controls are creating pathways for systems to optimize its load shifting capabilities

- Mechanical
  - Viable option, questions on whether technology can keep pace with price advancements

Recommendations?

- Are there lessons that can be learned from States that have deployed technologies?

- Common theme is conducting analysis to determine actual needs to help planners understand what may be necessary to attain New York renewable goals
  - Now that renewable goals have moved beyond “targets,” modeling to examine how much storage is needed in the State is an essential next step
  - Understanding “edge of grid activity” is something that needs to be examined to understand not only how much will be deployed, but whether it can be utilized for grid operations

- Close the knowledge gap!
  - This is a result of rapid advancement of storage
  - The proposed studies not only help determine targets and how much storage the state may need, but as California has shown, it builds consensus around cost, cost trends, technologies, and applications