ORA

OFFICE OF RATEPAYER ADVOCATES

Overview of Energy Storage and Related Proceedings

September 10, 2015

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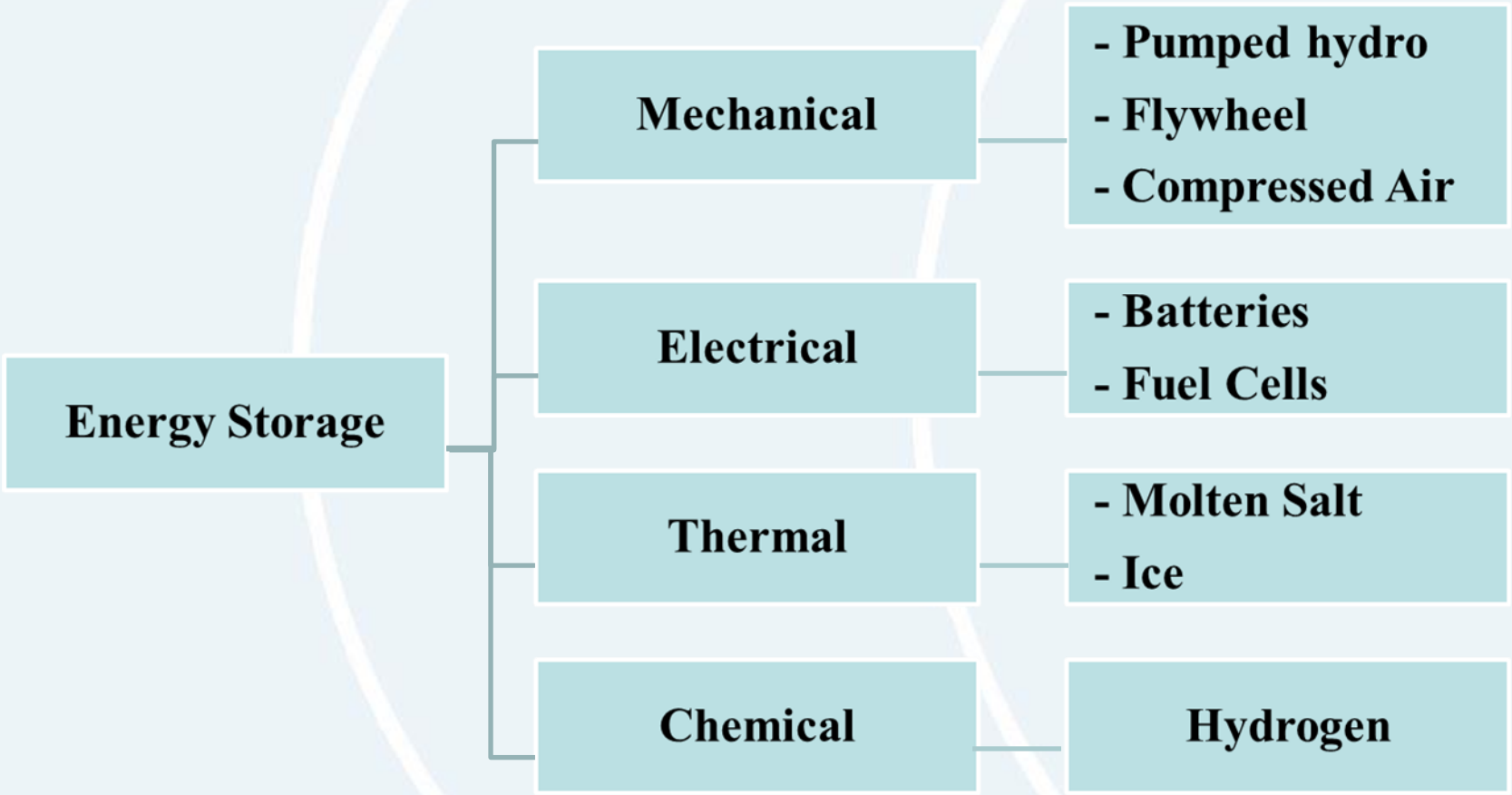
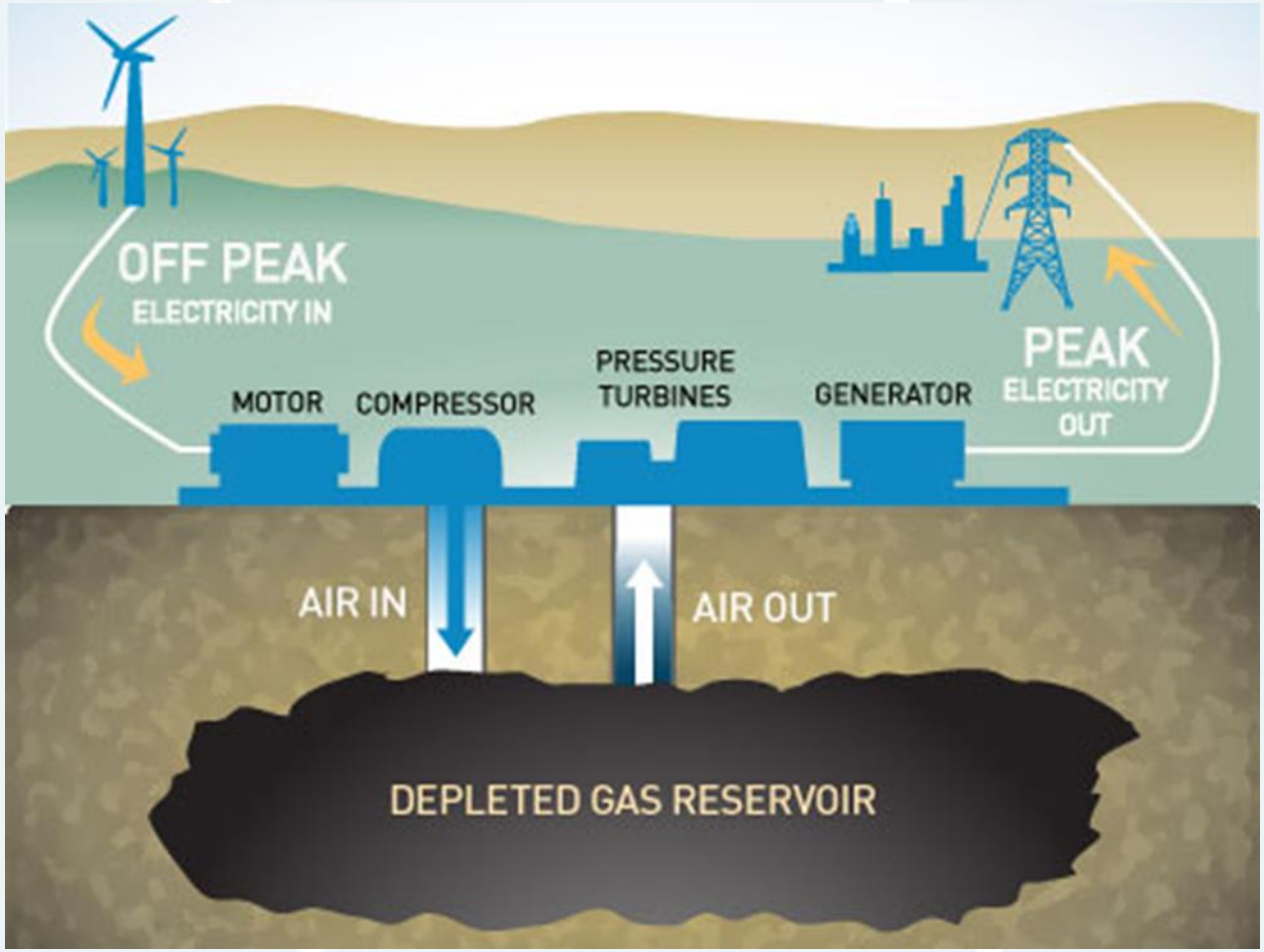
Agenda

- **Technologies and Deployment**
- **Legislation**
- **First Storage Rulemaking (R.10-12-007)**
- **Energy Storage Procurement Efforts**
- **Current Storage Rulemaking (R.15-03-011)**
- **Related Proceedings**
  - **CPUC**
  - **CAISO**

Types of Energy Storage

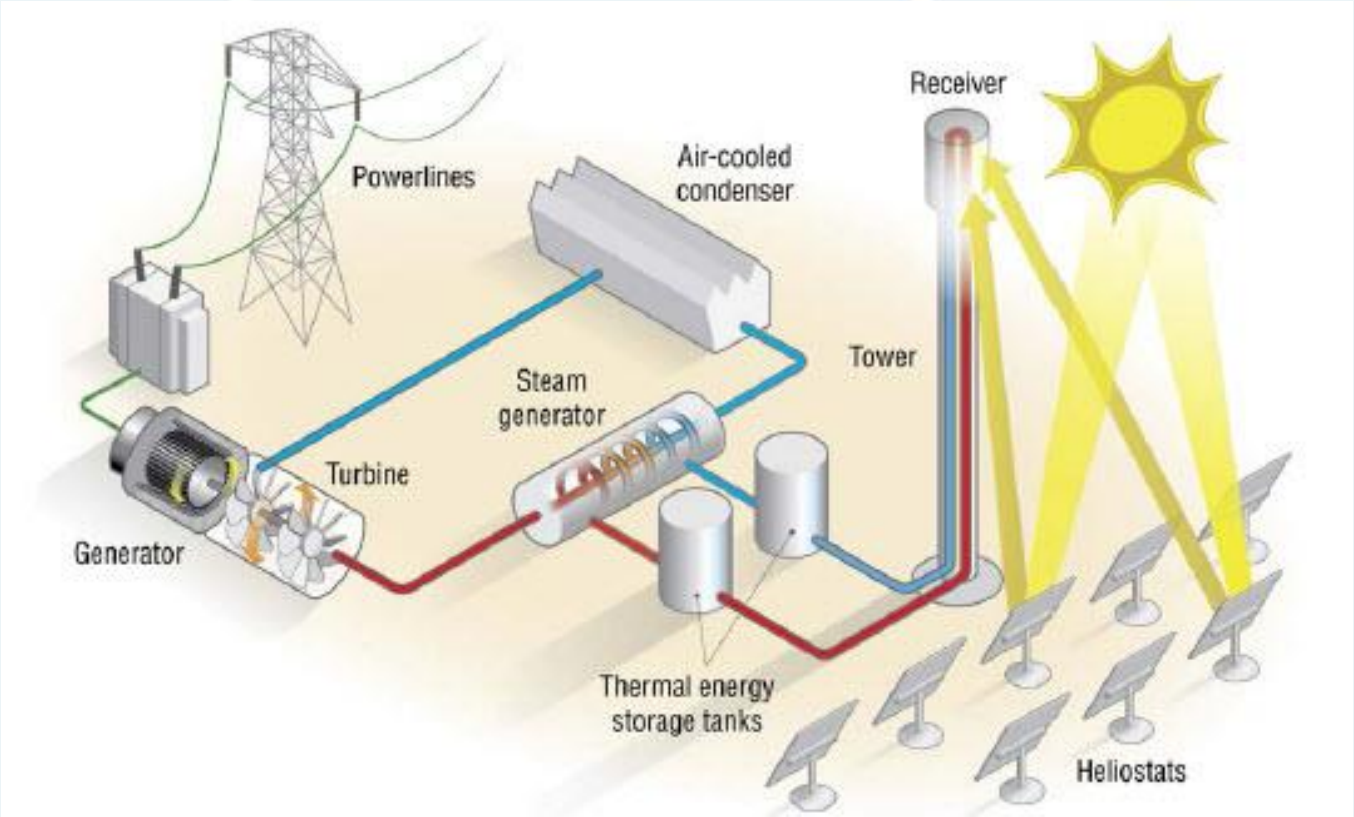


Types of Energy Storage – Compressed Air Energy Storage



Source: http://www.pge.com/en/about/environment/pge/cleanenergy/caes/index.page

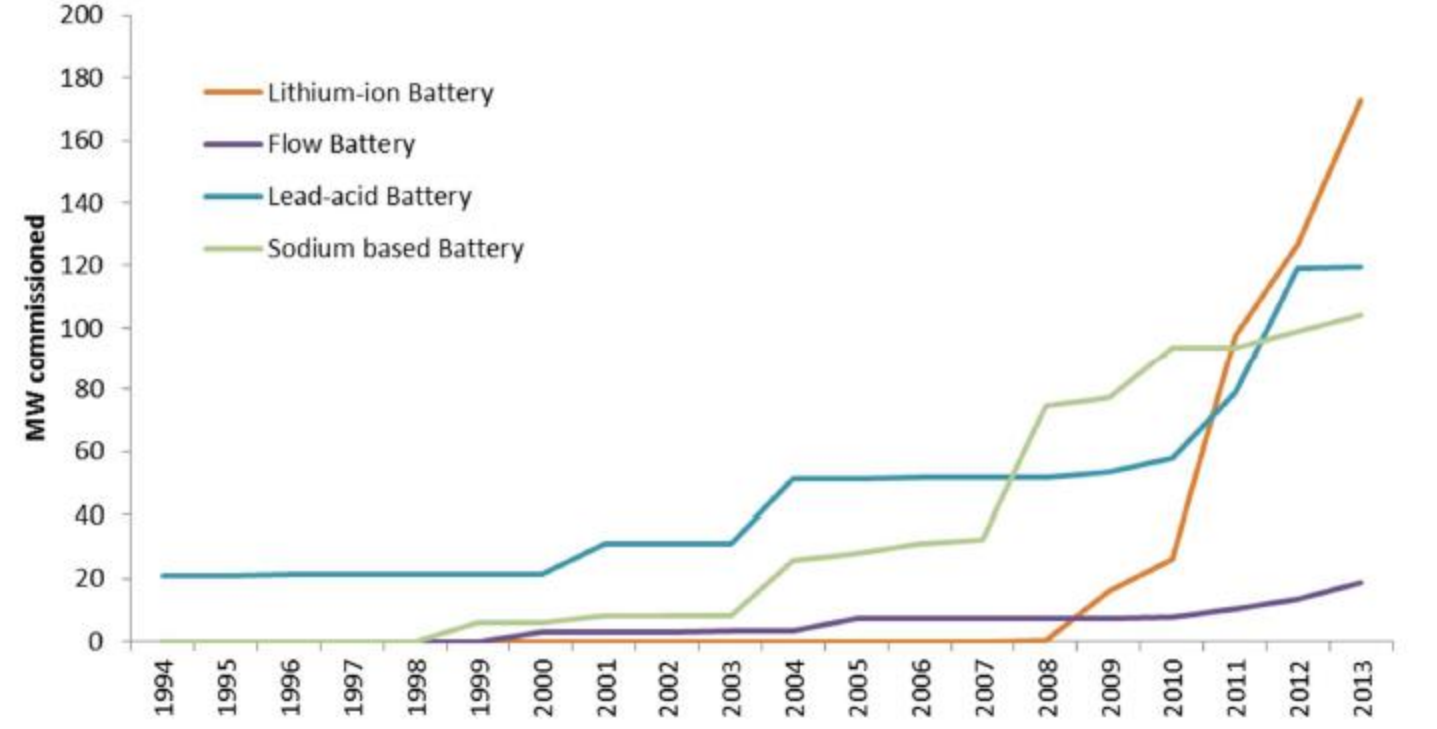
Types of Energy Storage – Thermal (molten salt)



Source: http://decarboni.se/publications/2014-year-concentrating-solar-power/how-thermal-storage-works

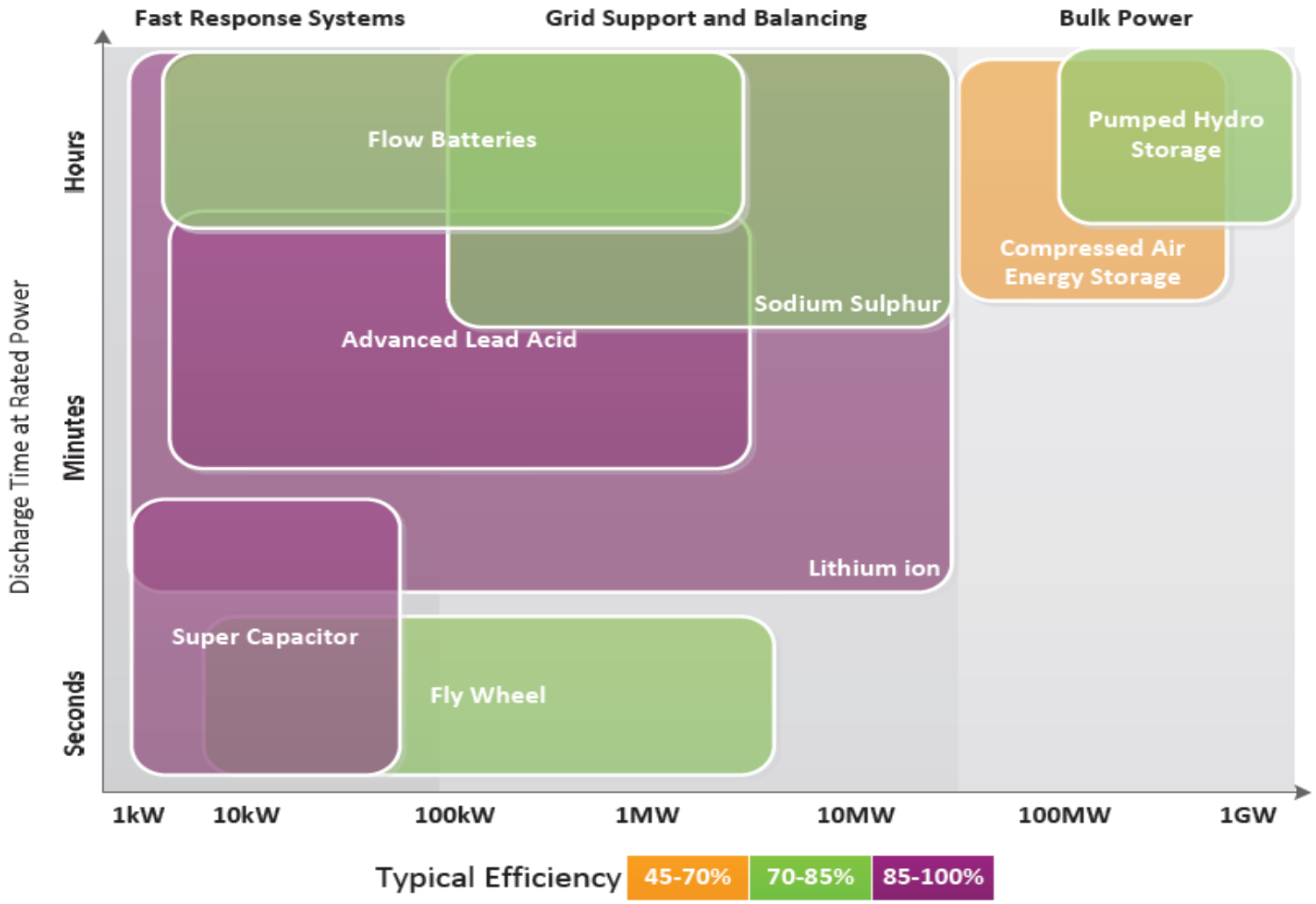
Types of Energy Storage – Batteries

Cumulative Global Capacity (MW) of Battery Storage by Technology



Source: AECOM Australia Pty Ltd. *Energy Storage Study: A Storage Market Review and Recommendations for Funding and Knowledge Sharing Priorities*, July 13, 2015, Figure 13, p. 32.

Comparison of Storage Technologies



Source: AECOM Australia Pty Ltd. *Energy Storage Study: A Storage Market Review and Recommendations for Funding and Knowledge Sharing Priorities*, July 13, 2015, Figure 8, p. 27.

Drivers of Storage Deployment

- **Renewable Energy Adoption**
  - Smooth intermittency and manage supply and demand
- **Grid Optimization**
  - Lower network costs and inefficiencies
  - Improve asset utilization through reduced system peak demand
- **Customer Savings**
  - Lower peak demand charges and time of use energy shifting
- **Reliability**
  - Backup power
- **GHG Emission Reductions**
  - E.g., Efficient electrification of the transportation sector

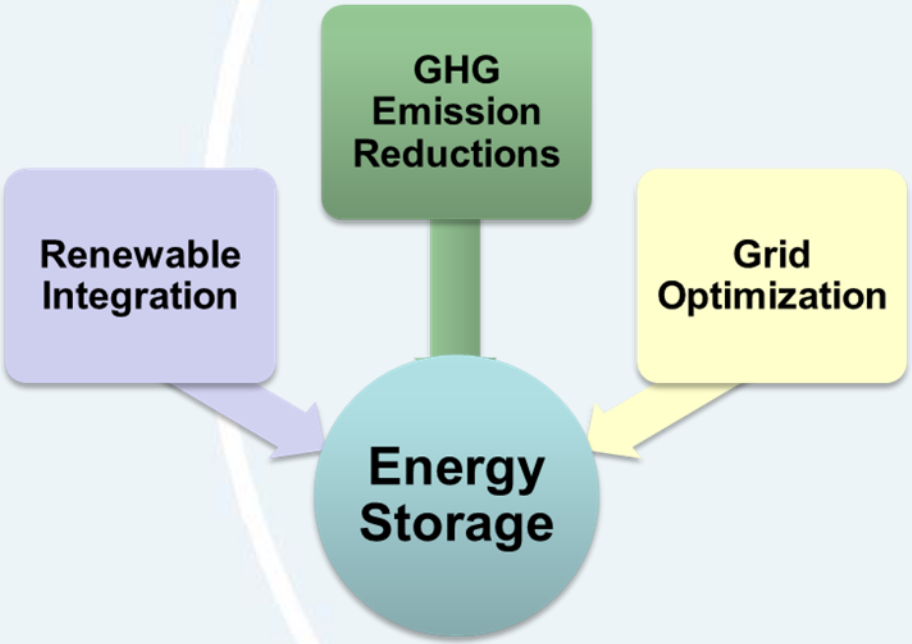
Global Storage Deployment

Technology Type	Projects	Rated Power (MW)
Electro-chemical	699	1,476
Pumped Hydro	343	178,037
Solar Thermal	195	3,508
Electro-mechanical	58	2,250
Hydrogen	9	6

Source: Department of Energy, Energy Storage Database. http://www.energystorageexchange.org/projects/data_visualization

Assembly Bill 2514 (Skinner, 2010)

Directs the CPUC to determine appropriate targets, if any, for each load serving entity to procure viable and cost-effective energy storage systems.



1st Storage Rulemaking (R.10-12-007)

- Identified storage end uses and barriers to deployment
- Established procurement targets to encourage the development and deployment of new energy storage technologies
- Required CCAs and ESPs to procure energy storage equal to 1% of their annual 2020 peak load by 2020
- Allowed IOUs to count storage in their territories from the Self-Generation Incentive Program, Permanent Load Shift, and certain existing projects

IOU Storage Targets (MW)

Storage Target [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**

IOU 2014 Proposed Procurement
(A.14-02-006)

Utility	Transmission	Distribution	Customer	Total
SCE	No min/max	16.3	0	>16.3
PG&E	50	21.5	6.5	78
SDGE	10	6	0	16
Total 2014 Proposed Procurement	**> 60**	**43.8**	**6.5**	**> 110.3**

Approval of 2014 Storage Procurement Plans (D.14-10-045)

- Approves procurement proposals of SDG&E (16 MW); SCE (16.3 MW); and modifies storage proposal of PG&E to 80.5 MW
- Includes two way charging electric vehicle technologies and storage components of biogas, and thermal generation as "eligible" technologies
- Authorizes IOUs to use the Power Charge Indifference Adjustment mechanism to recover "above-market costs" associated with departing load for market or bundled energy storage procured in 2014
- Approves SDG&E, PG&E, and SCE's proposed Consistent Evaluation Protocol with two adjustments (including weighting of qualitative factors and revised definitions to clarify evaluation of concurrent benefits) for reporting and benchmarking purposes

Current Energy Storage Procurement Efforts

- **SCE's Local Capacity Requirement RFO: 264 MW**
  - 100 MW of in front of the meter storage
  - 164 MW of behind the meter storage
  - pending Commission approval
- **Energy Storage RFOs:**
  - Solicitations are underway
  - Applications will be submitted Nov - Dec 2015

Current Storage Rulemaking
(R.15-03-011)

- **Purpose:** to refine and evaluate the current energy storage framework and policies
- **Bifurcated:**
  - Track 1: issues that will impact 2016 procurement (i.e. new technologies, flexibility between grid domains, and cost recovery)
  - Track 2: additional issues to refine the Commission's storage framework and policy (i.e. multi-use, increased targets)
- **Progress:**
  - Proposed Decision to Track 1 – Nov. 2015
  - Track 2 Opening Comments – Oct./Nov. 2015

Related CPUC Proceedings

- **Rule 21 (R.11-09-011):**
  - Revisions to streamline Rule 21 interconnection for behind the meter "non-exporting" energy storage
  - Considering including both the discharging and charging modes of non-exporting behind the meter energy storage
- **Resource Adequacy (R.14-10-010):**
  - Established local and flexible capacity requirements for 2016 and 2017
  - Determined that storage's ramping abilities are capable of providing flexible capacity

Related CPUC Proceedings

- **Long Term Procurement Plan (R.13-12-010):**
  - Determined that storage can meet local and system capacity requirements
- **Distributed Resources Plan (R.14-08-013):**
  - Storage may be included as a distribution upgrade deferral asset
- **Electric Vehicles (R.13-11-007/A.14-04-014, et al.):**
  - Will evaluate the potential and value of vehicle-grid integration (VGI), including the use of vehicle batteries for DR or ES, and the development of new tariffs in each of the IOU territories (i.e. rate designs for plug in electric and natural gas vehicles) and policies for residential, multi-family, workplace, and fleet plug in vehicles.

Related CPUC Proceedings

- **Demand Response (R.13-09-011):**
  - The Commission has not yet clarified whether storage falls under supply or demand-side demand response, but has encouraged IOUs to integrate their supply side resources into the CAISO market
- **Integrated Demand Side Resources Program (R.14-10-003):**
  - Consider how to optimize the integration of demand-side resources
- **California Solar Initiative/Self-Generation Incentive Program (R.12-11-005):**
  - Concluded that storage paired with solar, under particular conditions, can interconnect with the existing NEM tariff
- **Net Energy Metering (R.14-07-002):**
  - Assesses how to incorporate customer-sited storage with the development of a NEM successor Tariff

Related Initiatives at the CAISO

- **Energy Storage and Distributed Energy Resources (ESDER)**
  - Seeks to refine the non-generator resource model, establish rules for dual use scenarios, and improve DER participation
- **Flexible Resource Adequacy Criteria and Must Offer Obligations– Phase 2 (FRACMOO-2)**
  - Expand the definition of flexible capacity to address ISO operational concerns that were not addressed in the original definition
  - Consider provision of flexible capacity by resources that have not been eligible thus far, such as imports and non-NGR energy storage facilities

Related Initiatives at the CAISO

- **Reliability Services Initiative – Phase 2 (RSI-2)**
  - Substitution rules for flexible RA resources on scheduled or forced outages

- **Metering and Telemetry (i.e. DERP)**
  - Clarify and advance the ISO tariff and business processes to support the participation of DER in the ISO markets
  - Framework to enable a DER provider to aggregate DER to meet the ISO's 0.5 MW minimum participation requirement

Back Up Slides

Storage Technologies

Electrochemical storage

Electrochemical energy storage largely consists of batteries, such as lead-acid; nickel-based; sodium-sulfur; lithium-ion; and flow batteries (power is produced by a rechargeable electrochemical cell and energy is stored in an electrolyte tank), etc. Each type of battery varies in terms of life expectancy, capacity, ability to complete numerous charge and discharge cycles, weight, and volume, etc., which determines their underlying cost-effectiveness and efficacy.

Lithium-ion batteries have taken up such a large market share at the moment because of their high power and energy density.

Storage Technologies

Thermal

Thermal energy storage that uses solar thermal power to generate electricity by concentrating sunlight onto a heat-transfer fluid (i.e. molten salt) that drives a steam turbine. This energy can be stored and then dispatched when needed. Thermal energy storage can also be used for heating, ventilation and air conditioning (HVAC) by storing and shifting cooling energy use to non-peak times. These devices chill a storage medium (i.e. water or ice) during periods of low cooling demand and then use the stored cooling energy later to meet air-conditioning load or process cooling loads.

Storage Technologies

Mechanical

Pumped Hydro uses off-peak electricity to pump water from a reservoir up to another reservoir at a higher elevation. When electricity is needed, water is released from the high reservoir through a hydroelectric turbine into the low reservoir to generate electricity. Pumped hydro plants have very long lives on the order of 50 years, and fast response times that enable them to participate equally well in voltage and frequency regulation, spinning reserve, and non-spinning reserves markets, as well as energy arbitrage and system capacity support. The Commission has capped pumped hydro eligibility at 50 MW because of its potential to commandeer the ES market (since it's a mature technology, economy of scale, etc.).

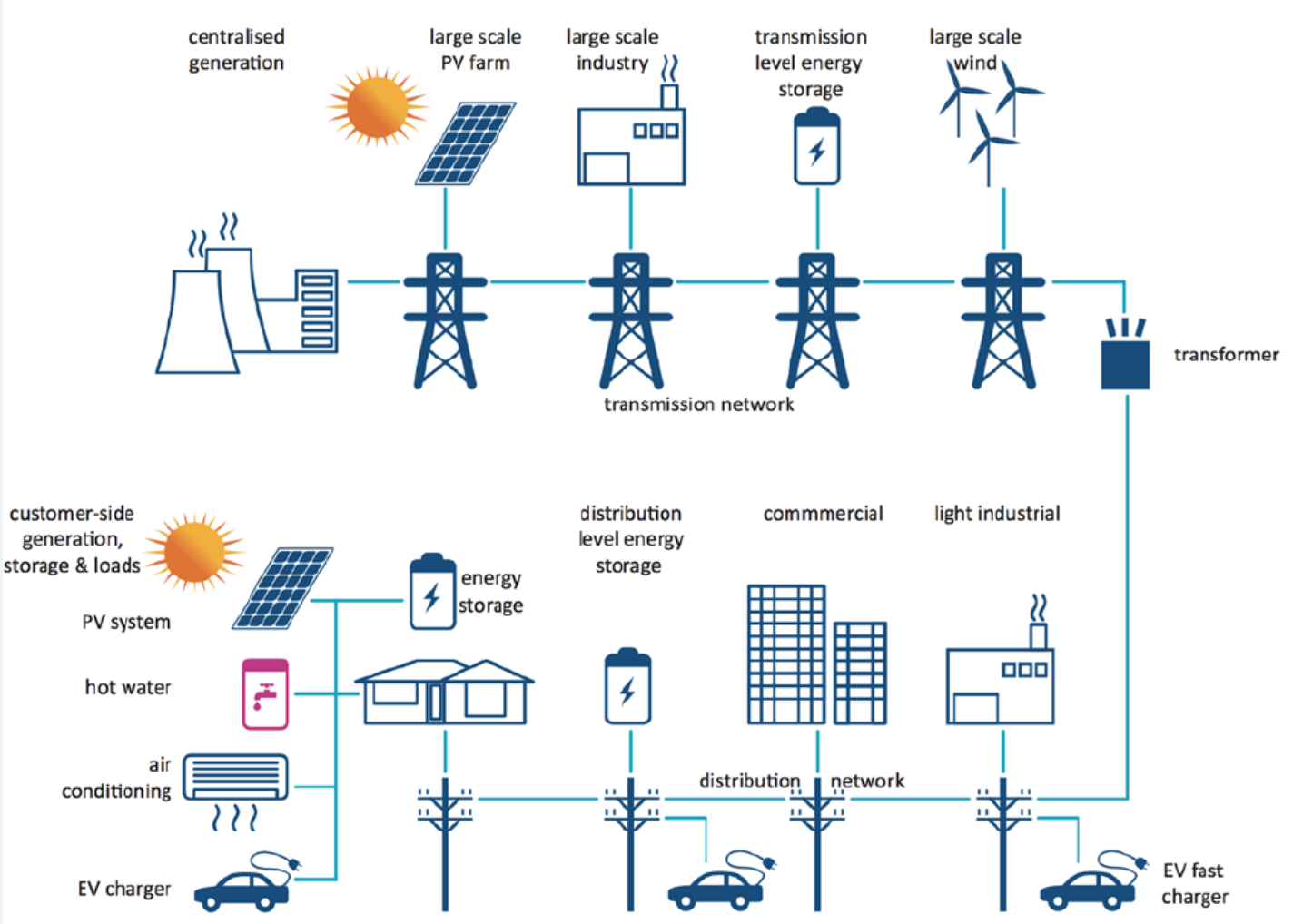
Storage Technologies

Mechanical

Compressed Air Energy Storage uses off-peak electricity to compress air and store it in a reservoir, either an underground cavern or above ground pipes or vessels. When electricity is needed, the compressed air is heated, expanded, and directed through a conventional turbine-generator to produce electricity.

Flywheel facilities store kinetic energy in a spinning rotor that is charged and discharged through a generator. Flywheels charge by drawing electricity from the grid to increase rotational speed and discharge by generating electricity as the wheel's rotation slows.

Storage Interconnection Points



Source: Australian Energy Market Commission. *Electric Energy Storage: Technology Overview and Applications*, July 8, 2015, Figure 7, p. 54

R.15-03-011

Track 1

- Procurement Best Practices
- Refinement of the Consistent Evaluation Protocol
- Flexibility of Energy Storage Targets Between Grid Domains
- Eligibility (new technologies not previously discussed)
- Safety Standards
- Energy Storage Target Tracking for CCAs and ESPs
- Cost Recovery/PCIA

Track 2

- Revision of Energy Storage Procurement Targets
- Eligibility (technologies previously discussed and excluded)
- Multiple Use Applications
- Station Power
- Third-Party Owned Energy Storage
- Measurement and Evaluation of the energy storage framework
- Deferral/Displacement of Transmission and Distribution Upgrades

Power Charge Indifference Adjustment

- Purpose: to maintain "bundled customer" indifference
  - This principle ensures that bundled customers are unharmed by departing load by holding departing load customers responsible for their fair share of any "above-market costs" associated with generation procured on their behalf prior to their departure.
  - The current PCIA methodology was adopted in D.11-12-018 and Resolution E-4475

Power Charge Indifference Adjustment

- D.14-10-045 authorized the use of the PCIA mechanism to recover the "above market costs" associated with energy storage procured in the 2014 storage solicitations.
- "Above market costs" are stranded costs that are not recovered because the market value of the procured storage are less than forecasted procurement costs.

CAISO Initiatives

- **ESDER:**
  - http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_AggregatedDistributedEnergyResources.aspx
- **FRACMOO-2:**
  - https://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleResourceAdequacyCriteria-MustOfferObligations.aspx
- **RSI-2:**
  - http://www.caiso.com/informed/Pages/StakeholderProcesses/ReliabilityServices.aspx
- **Metering and Telemetry:**
  - http://www.caiso.com/informed/Pages/StakeholderProcesses/ExpandingMetering-TelemetryOptions.aspx