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Long Duration Energy Storage - Waste to Value (WTV)

Additional submitted attachment is included below.

ELECTRIC PROGRAM INVESTMENT CHARGE (2021-2025) (EPIC 4)

Comments on Technology Advancements for Energy Storage

Need and Role of Mid-to-Long Duration Energy Storage: California is making an unprecedented progress to transition to renewable energy systems in a short time to combat climate change. The state is transitioning from fossil power plants which have been reliable sources of electricity for decades. The overproduction during the day has led to curtailment and expensive export of the excess electricity to neighboring states. There are also safety concerns associated with excess electricity which have led to forest fires. The severe drought conditions and prolonged record-high temperatures have increased the intensity frequency and acreage of forest fires. PG&E is proposing to put all high voltage lines underground to prevent which is estimated to cost over \$10 billion. The intermittency of renewables poses a demand-supply balancing challenge for the utilities especially for the long duration. More cost-effective, innovative solutions are needed. This challenge can only be resolved by Energy Storage, short-term, mid-term, long-term, and seasonal energy storage.

Energy Storage for Grid Reliability: As the Californian economy strengthens and digitalizes focusing on virtual communication, the reliability of the grid becomes ever more important. Increasing the reliability beyond 99% is needed, however this becomes much harder as the exceptionally high demand and/or low generations must be balanced. Balancing this gap is with conventional batteries is expensive as the batteries installed to achieve the last 1% will be sitting idle for 99% of the time. This begs the need for alternate innovative solutions – e.g. Hydrogen, RNG– which are not proportional to their installed capacity (**Figure 1**).

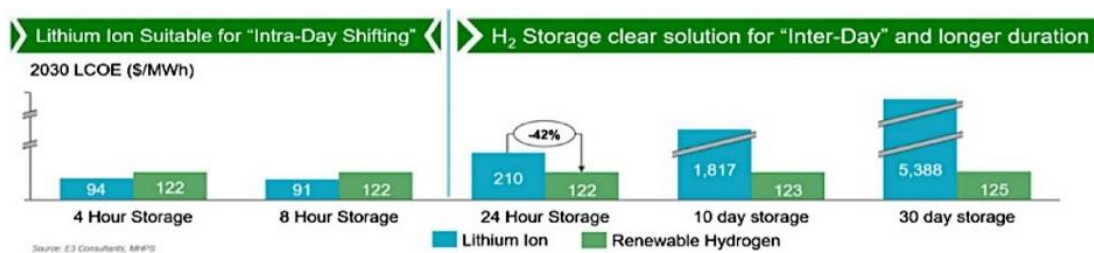


Figure 1. Cost of Energy Storage - Battery vs Hydrogen:
H₂ energy storage becomes competitive for long-term energy storage.

Lowering Energy and Infrastructure costs for EV Integration: California is leading the nation in EV adoption. It has made excellent progress in supporting the EV infrastructure. The EV charging in evening is increasing causing additional demand on the grid when the solar production is lower. The Californian utilities are already facing shortages in the evening (more than 25,000 MW or 25% of the state’s generation capacity) as shown by the duck curve (**Figure 2**).

There is a huge trough in electricity demand during the day when solar energy is at its peak. Increased penetration of EVs into the grid will exacerbate the duck curve. As shown in **Figure 3**, the EV charging is concentrated around the hours when the sun does not shine. H₂ energy storage is a win-win solution to provide the much-needed grid support, as well as facilitate the EV and FCEV infrastructure. H₂ energy storage also provides backup for critical facilities while supporting greater penetration of renewables to meet CA state mandates.

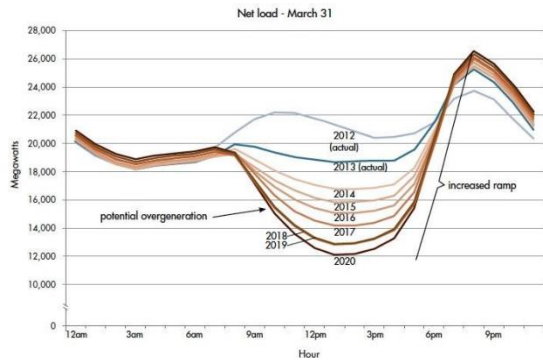


Figure 2. More Renewables Lead to Grid Instability: Huge fluctuations in supply/demand and electricity prices.

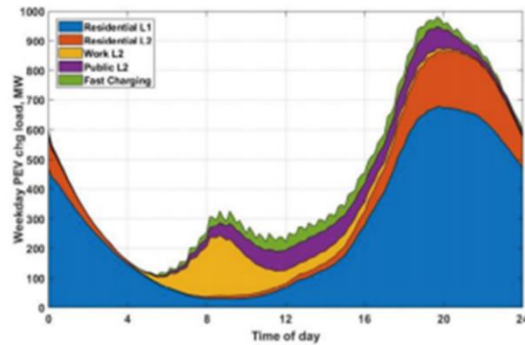


Figure 3. Impact of EV Penetration Worsens California's Grid with Intermittent Renewables: H₂ based energy storage facilitates EV charging during peak demand.

Most promising near-term technologies: Li-ion batteries are the obvious candidate for short-term energy storage given the huge global investment in its R&D and manufacturing. CEC should keep supporting Li-ion batteries and its promising alternatives for short-term energy storage. California is the largest economy in the country in agriculture and other manufacturing sectors. This corresponds to generating highest amount of wasted resources. A win-win strategy will be to create higher value energy storage from these wasted resources.

H₂ energy storage is a promising technology for long-term energy storage. Current renewable H₂ production is focused on water electrolysis. Though a promising technology, it is capital intensive to install and operate. It puts additional stress on water supply of the drought-prone California.

As per DOE estimations, there is enough biomass to make the CA grid 100% green and renewable. CEC should support projects to utilize the wasted resources and convert them into valuable products like green H₂, RNG, fertilizers, etc.

The most promising opportunities are:

1. The current CEC investments in advanced oxygen-free electrolysis technology promises huge returns in the energy storage portfolio.
2. The most promising strategy is to support **hybrid energy storage** that integrates the benefits of multiple energy storage technologies, e.g. fuel cell and battery hybrids used in FCEVs.

Technologies barriers that can should be resolved by EPIC: CEC should support the development of alternate fuels that consume little or no water. California has a huge potential for waste biomass which can be leveraged to produce these fuels. Since we're under the gun of climate change, CEC should support the demonstration of nascent but promising technologies at industrial sites.

1. Multi-purpose solutions to supply side issues (waste) and demand side (energy storage).
2. Producing green syngas from waste which can be used for H₂ energy storage as well for chemical industries for a greater revenue.
3. Support pilot-scale validation tests
4. Support pre-commercial prototype development and testing to gain stakeholder acceptance.
5. Support manufacturing R&D to retain jobs in the state and create export potential.



Efforts that can bridge the gaps between researchers, utilities, and policy makers:

1. Provide a platform for information exchange between the stakeholders.
2. Showcase data from current CEC funded projects to benefit all stakeholders.
3. Actively create and promote public-private partnership opportunities.
4. Pro-actively collaborate with federal agencies to leverage Californian resources and lead innovations.
5. Facilitate transition from basic research to applied research for the solutions created by researchers and universities
6. Hold workshops with policy makers to educate about emerging innovative solutions: Provide strategy for incentives for energy storage, policy classification for products created from wastes (solid, liquid and gaseous wastes).
7. Provide a special classification support for H₂ created from waste (green H₂?).