DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Planning, Policy and Programming

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Project Title:
Electric Fleet Adoption Strategies – Addressing Storage and Infrastructure Needs

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Electric Fleet Adoption Strategies – Storage/Infrastructure Needs

Evaluate mid to long-term energy storage needs of the electric grid for select fleet electrification scenarios.

WHAT WAS THE NEED?

Significant electrification of the transportation sector is necessary for the State to achieve several important greenhouse gas (GHG) reduction and renewable energy targets. These targets include the Governor's pillar goal of reducing petroleum use in vehicles by up to 50% by 2030. Current and proposed GHG emission targets (ex., reducing GHGs by 80% below 1990 levels by 2050 - Executive order S-3-05) also require electrification to play a central role among the mitigation strategies.

Fleet electrification places new demands on the electric grid, which are further complicated by increasing renewables integration into the grid as mandated by Senate Bill 350, with a target of 50% renewables percentage in the State's electricity mix by 2030. Significant short and long-term energy storage along with load flexibility will be necessary to manage increased renewables to the grid as mandated by Renewable Portfolio Standards (RPS) while also meeting the supply and infrastructure demands of the growing electric fleet.

Achieving these complex and sometimes divergent goals requires the ability to understand the nature of long-term demands, technology and market developments, resource and infrastructure requirements, and other factors.

WHAT WAS OUR GOAL?

This project evaluated the mid to long-term energy storage needs of the electric grid and conducted an assessment of fleet electrification and RPS scenarios. The goal was to calculate the energy storage required to achieve the 50% renewables percentage in the grid by 2030, and a scenario of 80% RPS by 2042 while adopting increased fleet electrification through 2030 and 2042.

WHAT DID WE DO?

The electrical energy storage (EES) requirements of several California grid scenarios were compared, including GHG emission caps, RPS mandates, and electrification trends. The power curtailment in the California Independent System Operator (CAISO) grid was evaluated that could potentially be used to produce hydrogen through the 'power to gas' (P2G) approach.

The Resolve model (Renewable Integration Solutions Model), an advanced power system planning model, developed for the California Public Utilities Commission, was used to conduct the analysis. Designed to answer planning and operational questions related to renewable resource integration, the Resolve model co-optimizes investment and dispatch over a multi-year horizon with one-hour dispatch resolution for a study area, and solves for the optimal investments in renewable resources, technologies, and energy storage options. The results included an assessment of the impact of key parameters on EES requirements, including GHG emission caps, RPS mandates, and Variable Renewable Energy (VRE) shares.

WHAT WAS THE OUTCOME?

Analysis of RPS scenarios with varying levels of renewable generation and fleet electrification shows that EES capacity requirements depend on a number of parameters, including the GHG cap placed on the specific scenario, the RPS target, Demand Response (DR), Electric Vehicle (EV) charging flexibility, and total EV population. However, the EES capacity requirement is heavily influenced by the GHG cap and the RPS targets and the EV deployment rates have a minimal effect on the overall storage needs and the costs associated with specific portfolios. The 80% scenarios require considerably higher EES capacity, likely due to the GHG reduction requirements.

There is considerable ongoing power curtailment in California throughout the year. Power-to-gas and other forms of long-term storage options can help mitigate curtailment losses while reducing the EES requirements. The most viable storage approaches including specific electrolysis technologies, hydrogen storage and transportation methods, and utilization technologies must be identified in order to realize the potential benefits of P2G. Incorporating both conventional and P2G based energy storage systems as part of future generating plants can help curtailment and increase the flexibility and resiliency of the electric grid.

WHAT IS THE BENEFIT?

The study provides an improved understanding of the parameters affecting the EES requirements of the California electric grid under a wide range of conditions including current state mandates and targets and proposed power mixes. This can help guide further analysis and decision making aimed at improving the resiliency and reliability of the state's electric grid.

IMAGES

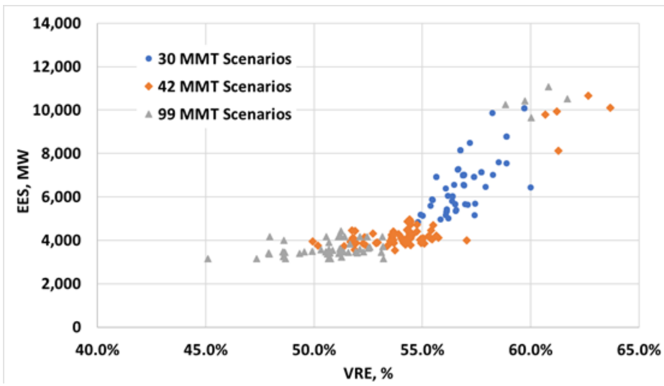

Figure 1: Total installed EES capacity for varying VRE percentages

Scenario Name	RPS		EVs deployed (millions)		EES capacity (GW)		VRE %		Dominant Tech (PV-Wind Ratio)		EES/VRE (GW/%)	
	2030	2042	2030	2042	2030	2042	2030	2042	2030	2042	2030	2042
Scenario 1	50%	NA	3.29	NA	4.14	NA	54%	NA	4.04	NA	7.61	NA
Scenario 2	50%	NA	3.32	NA	4.14	NA	54%	NA	4.04	NA	7.61	NA
Scenario 3	50%	NA	3.50	NA	4.15	NA	54%	NA	4.04	NA	7.64	NA
Scenario 4	60%	NA	5.00	NA	4.25	NA	54%	NA	3.84	NA	7.81	NA
Scenario 5	60%	80%	5.00	11.01	4.32	20.10	55%	65%	3.92	5.13	7.86	31.15
Scenario 6	60%	80%	5.00	13.40	4.19	20.40	55%	65%	3.91	5.28	7.63	31.34
Scenario 7	60%	80%	5.00	13.40	3.94	19.94	55%	65%	3.92	5.38	7.18	30.45
Scenario 8	60%	80%	5.00	8.70	4.25	18.47	55%	65%	3.92	4.94	7.73	28.20
Scenario 9	60%	80%	5.00	13.40	4.26	19.41	56%	67%	4.16	5.80	7.58	29.02
Scenario 10	60%	80%	5.00	13.40	4.08	13.69	52%	63%	3.40	4.63	7.88	21.88
Scenario 11	60%	80%	5.00	13.40	4.26	17.36	56%	66%	4.18	5.51	7.59	26.28
Scenario 12	60%	80%	5.00	13.40	4.08	11.26	52%	61%	3.41	4.29	7.87	18.43

Table 1 Electrification Scenario Results