Integration of Sustainable Fueling/Charging Systems with Grid Energy Storage at Highway Rest Areas

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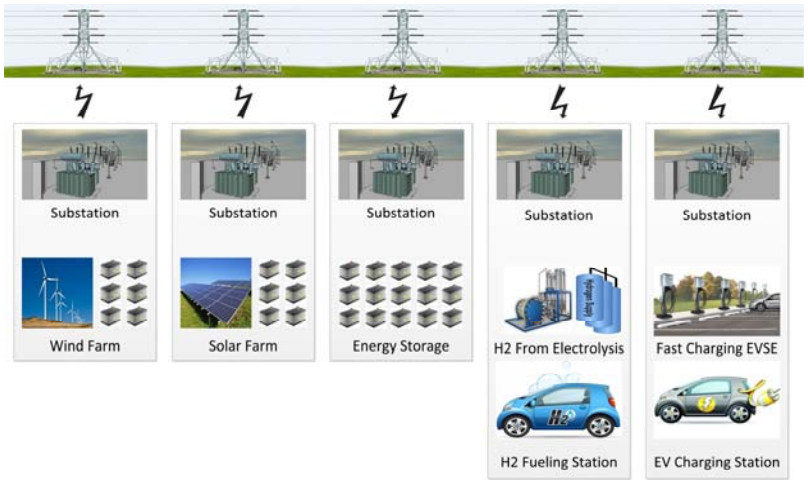
Background

The transportation and electricity sectors are facing the challenge of shifting toward a sustainable future. In the transportation sector, plug-in electric vehicles (PEV) and hydrogen fuel cell vehicles (FCV) are key players in the electrification of the automobile industry to achieve a GHG reduction of 80% by 2050. There is a need to deploy hydrogen fueling stations and DC fast charging stations in the suburb areas and along inter-state highways to give FCV and PEV drivers "range confidence" that fueling/charging is available when they want to travel between communities and/or make long distance trips. The electricity sector is increasing the share of total electricity generated from renewable sources such as wind and solar. The efficient use of renewable energy resources relies on the ability to store energy when it is produced and distribute it when it is needed. All of these new technologies pose challenges to the decades-old fueling infrastructures and electrical grid systems. Building vehicle fueling/charging stations and installing grid-level energy storage to deal with the increasing renewables are expensive and require long-term and smart infrastructure investment.

Present Fueling/Charging Stations and Centralized Energy Storage

Present hydrogen fueling stations, fast EV charging stations, renewable power sources, and energy storage are usually located at different sites and connected to the utility grids individually. This is not cost effective in terms of planning and system operation.

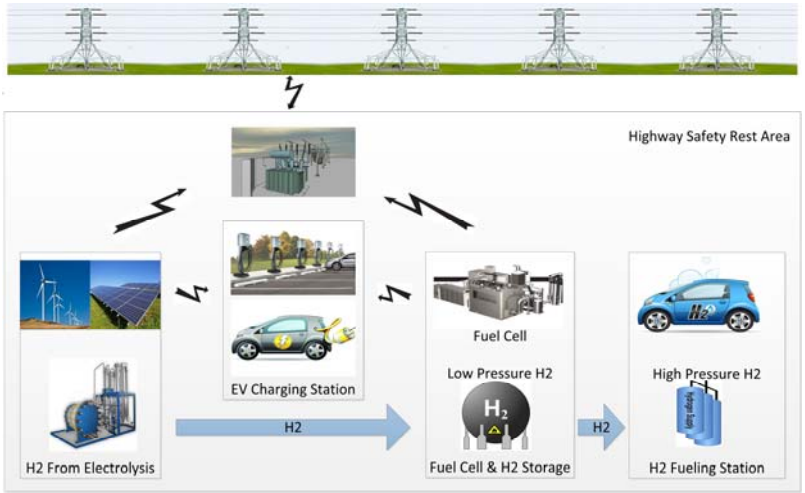


Present Fueling/Charging Stations and Centralized Energy Storage at Different Sites

Presently, most of the hydrogen fueling stations and the fast EV charging stations are designed and installed without considering integration with renewable power sources and ways to reduce their high initial investment cost. The hydrogen fueling stations cost an average of about $2 million each, but can cost up to $5 million per station. DC fast chargers cost $60,000 or more each and can provide up to an 80% charge in 10- 20 minutes. Most of the fast charging stations require 50 to 90 kW from the grid. California's Fast Charge Electric Highway as part of the West Coast Electric Highway is an extensive network of electric vehicle (EV) DC fast charging stations located along Interstate 5 and other major roadways. However, at California Safety Rest Areas, where DC fast charging is most needed, few DC fast charging stations are available due to the need for expensive electrical grid upgrades. Energy storage using batteries is still expensive with a limited lifetime (5-10 years). At the present time, the cost of batteries for utility-scale applications is between $500-$700/kWh.

Integration of Sustainable Fueling/Charging Stations with Distributed Energy Storage at HRA Areas

This research will study the feasibility of the deployment of the renewable hydrogen fueling / fast EV charging stations at California Highway Rest Areas (HRA) and their integration with the utility grid as energy storage to lower the infrastructure construction cost and accelerate the usage of renewable energy in the California transportation sector. Hydrogen generated from electrolysis using local renewable energy sources can be employed as an energy carrier. The fueling/charging stations function as both vehicle fueling/charging stations and distributed grid energy storage to benefit both the transportation and utility sectors and make the fueling /charging stations more sustainable in terms of accessibility, efficient use of land, economic feasibility, and scaling up.



Integrated Fueling/Charging Stations and Energy Storage at HSRA Areas

- ❑ Easy accessibility of fueling/charging stations (near 100 statewide roadside rest areas)
- ❑ Efficient use of land and natural resources
- ❑ Economic feasibility (cost), and
- ❑ Easy scaling up by installing solar panels over the parking areas and along the highway and installing more hydrogen tanks.

Research Approach

This study will include technical and cost data collection of present renewable fueling/charging stations, renewable power sources, and utility-scale energy storage, and evaluate the proposed sustainable fueling/charging stations based on the collected data. The attractiveness of the integrated renewable fueling/charging development will be compared to other approaches for providing similar services for EVs and fuel cell vehicles as battery and electrolyzer technologies improve, costs are reduced, and the number of advanced vehicles sold increases.

SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS
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