CALIFORNIA'S HYDROGEN HUB: MEETING 2030 DEMAND

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ENVIRONMENTAL PROBLEM

Electrification is the commonly touted route to reduce greenhouse gas emissions and mitigate climate change. However, sectors like transportation use energy-dense fossil fuels and require a different, more energy-dense, decarbonization solution. Green hydrogen, from renewable electricity and water, can be a viable alternative for these industries but it must become cost-competitive with conventional fuels to be adopted at scale. At scale, green hydrogen could reduce carbon emissions in the highest-emitting sectors and help California achieve its climate goals.

OBJECTIVES

1. Estimate optimal siting locations, production quantities, and supply prices of electrolytic hydrogen in 2030
2. Evaluate statewide cost differences between centralized and distributed hydrogen production networks
3. Assess barriers that limit the competitiveness and speed of adoption for hydrogen as an alternative fuel

FINDINGS

Meeting California's 2030 hydrogen demand (415,399 kg/day) is possible under both centralized and distributed supply networks. But the distributed network will meet this demand at a lower cost largely due to its low to zero distribution costs.

Centralized Network

- Sited 30 large (50,000 kg/day) electrolyzers
  - Total CapEx: $1.59 billion
  - Max production potential: 1.5 million kg/day
- Total LCOH: $5 to $15 per kg
  - Higher distribution costs

Distributed Network

- Sited 195 small (4,500 kg/day) electrolyzers
  - Total CapEx: $1.11 billion
  - Max production potential: 877,500 kg/day
- Total LCOH: $3 to $7 per kg

The counties with the highest 2030 hydrogen demand are San Bernardino, San Diego, Los Angeles, San Joaquin, and Riverside. Supply and demand are mismatched across the state. Some counties have excess, and others lack, production potential compared to demand.

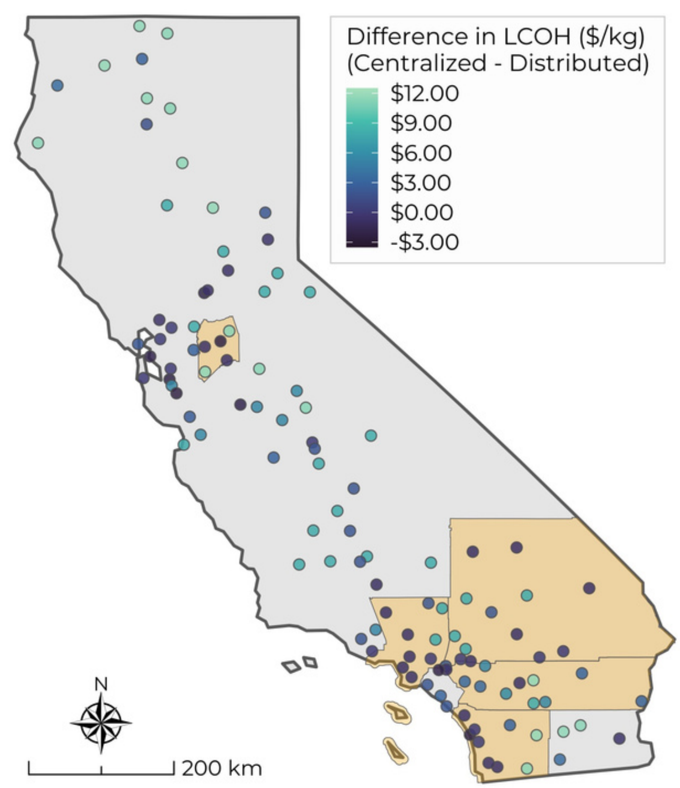

Figure 1. The distributed levelized cost of hydrogen (LCOH) is subtracted from the centralized LCOH at demand points to show cost differences. Centralized LCOH are based on one electrolyzer built to meet surrounding demand. A positive value indicates distributed is cheaper and a negative value indicates centralized is cheaper.

OUR APPROACH

We developed a three-phase electrolyzer siting model based on projected hydrogen demand and theoretical production potential at the county level. Phase 1 estimates green hydrogen resource potential and identifies green hydrogen demand. Phase 2 involves siting the two electrolyzer supply networks, calculating the LCOH, and comparing the costs. Phase 3 evaluates solutions to overcome barriers to foster quick, widespread adoption of hydrogen.

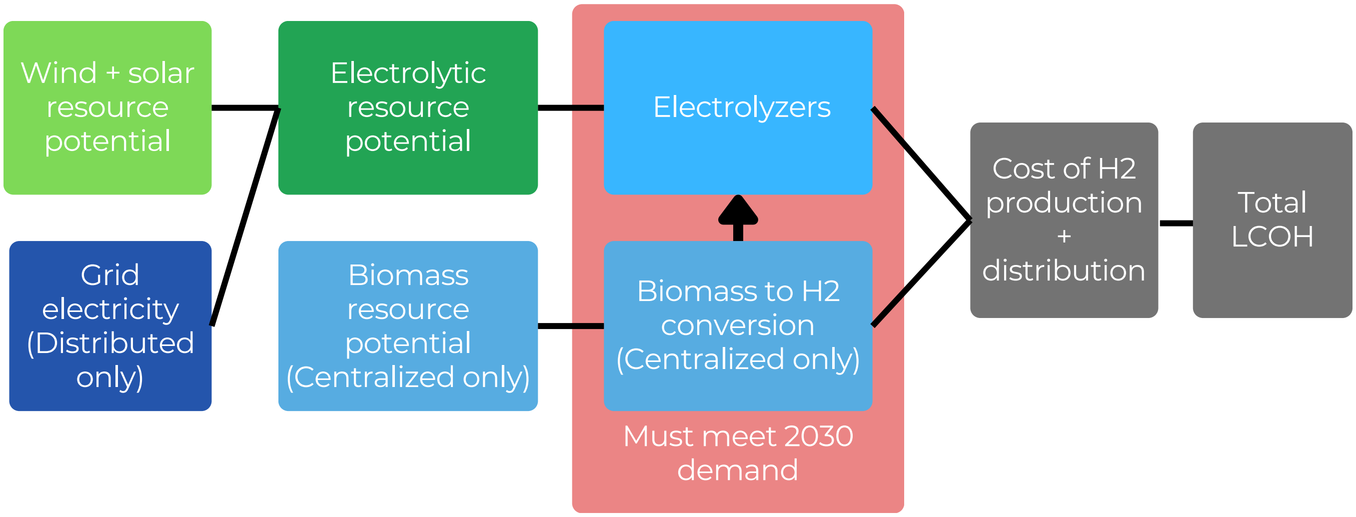

Figure 2. Flow chart of the electrolyzer siting model which spans Phase 1 and 2.

PROJECT IMPACTS

Supports green hydrogen adoption, enabling further transportation decarbonization and reduce harmful air pollutants like PM, SOx, and NOx in major freight corridors like the Los Angeles basin.

Emphasizes the importance of aligning state and local policies to facilitate hydrogen market development, such as eliminating barriers to utility-scale renewable projects.

Recommends that agencies like the California Air Resources Board and the California Energy Commission focus their efforts to reduce hydrogen adoption barriers in the counties with the highest demand.

FUTURE WORK

Future research should examine the effectiveness of a combination of a centralized and distributed supply network buildout across California to meet 2030 and 2050 demand. The 2050 analysis should consider hydrogen distribution by pipelines and integrate existing infrastructure once it is built.

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