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| **Description:** | 2A. Matthew Bravante, Bloomberg NEF |
| **Filer:** | Raquel Kravitz |
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BloombergNEF remarks

California Energy Commission 2022 hydrogen consultation

Matthew Bravante

June 21st, 2022
Hydrogen market growth

More scale at a lower cost
Electrolyzers are getting cheaper, which will lead to cheap hydrogen

BloombergNEF estimates for electrolyzer capital costs, 2021 and 2025

Levelized costs of hydrogen production in California, 2021 and 2030

$W (nominal)

<table>
<thead>
<tr>
<th></th>
<th>Western PEM 2021</th>
<th>Western PEM 2025</th>
<th>Western ALK 2021</th>
<th>Western ALK 2025</th>
<th>Chinese ALK 2021</th>
<th>Chinese ALK 2025</th>
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<tbody>
<tr>
<td>2021</td>
<td>1.40</td>
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<td>1.20</td>
<td>0.60</td>
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$/kg (real 2020)

<table>
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<tr>
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<th>2030</th>
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<tbody>
<tr>
<td>6.0</td>
<td>7.4</td>
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$/MMBtu (real 2020)

<table>
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<th>2030</th>
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<tbody>
<tr>
<td>52.1</td>
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‘Green’ renewable hydrogen
‘Blue’ hydrogen from natural gas with CCS
‘Gray’ hydrogen from natural gas without CCS

Source: BloombergNEF
Electrolysis for hydrogen production is gaining traction

Electrolyzer shipments

Source: BloombergNEF
There is a large amount of manufacturing capacity ready for projects.

**Electrolyzer shipments**

![Graph showing electrolyzer shipments from 2018 to 2022. The graph includes conservative and optimistic scenarios.]

**Electrolyzer Manufacturing**

![Graph showing electrolyzer manufacturing capacity for 2021 and 2022. The graph shows 6,700 MW for 2021 and 13,500 MW for 2022.]
Hydrogen demand in California

How to use a scarce resource
Hydrogen will be most important to decarbonize Industry

The prospects for widespread adoption of clean H₂ in various sectors

- **Unavoidable**: Ammonia production, Oil refining, Methanol production
- **High potential**: Steel production, Aluminum production
- **Medium potential**: Peaking / seasonal power, Ships, Aircraft
- **Low potential**: Trucks, buses, Heating homes, Cement
- **Uncompetitive**: Passenger cars

Source: BloombergNEF, concept from Liebreich Associates
Low-carbon hydrogen should be thought of as a scarce and valuable resource

Estimated annual hydrogen demand for California refineries

Source: BloombergNEF. Note: Assumed average hydrogen demand for PADD 5 refineries.
California would have to dedicate a lot of the expected solar and wind to hydrogen

Potential hydrogen production from all expected solar and wind built in CA, 2022-2025

66% of cumulative wind and solar installed in California over the next 4 years (roughly 8.4GW)

Source: BloombergNEF. Note: Assumed average hydrogen demand for PADD 5 refineries. This analysis assumes a 40% capacity factor for electrolysis system.
Hydrogen could grow if used to alleviate the growing interconnection queue

Source: Lawrence Berkeley National Laboratory.
Fuel Cell vehicles are struggling to compete with electric vehicles

Model availability of zero tailpipe emission heavy trucks

Range of available zero tailpipe emission heavy trucks

Source: BloombergNEF
To summarize

1. Electrolyzers are becoming cheaper and more abundant, which will lead to cheaper hydrogen.

2. In the near term, clean hydrogen will be a scarce resource. It should be thought of as a valuable tool for deep decarbonization.

3. Hydrogen can relieve interconnection challenges and provide a higher value market for renewables competing in low-price electricity environment.
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