CPUC Emerging Strategies Workshop

Renewable Energy-Based Electrolytic Hydrogen

Technology RD&D, market gaps, and ways that state funding can play a role in an equitable, affordable, and climate-safe future

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The "Green" Hydrogen Definition

- There is no precise state definition of green hydrogen (GH2)
- AB 1550 (Bennett, 2023/24 two-year bill) – seeks to resolve that, with sector-specific deployment goals
- SB 1075 (Skinner, 2022, hydrogen development, deployment, and use) definition – "green electrolytic hydrogen"
- Green Hydrogen Coalition definition – "non-fossil"
- Environmental Justice definition – renewables based electrolysis with no polluting feedstocks or processes. See March 2023 "EJ and Enviro Hydrogen Principles": https://drive.google.com/file/d/1tJIFyryKwR5JXfb17DmCiTCKgp91DfyM/view

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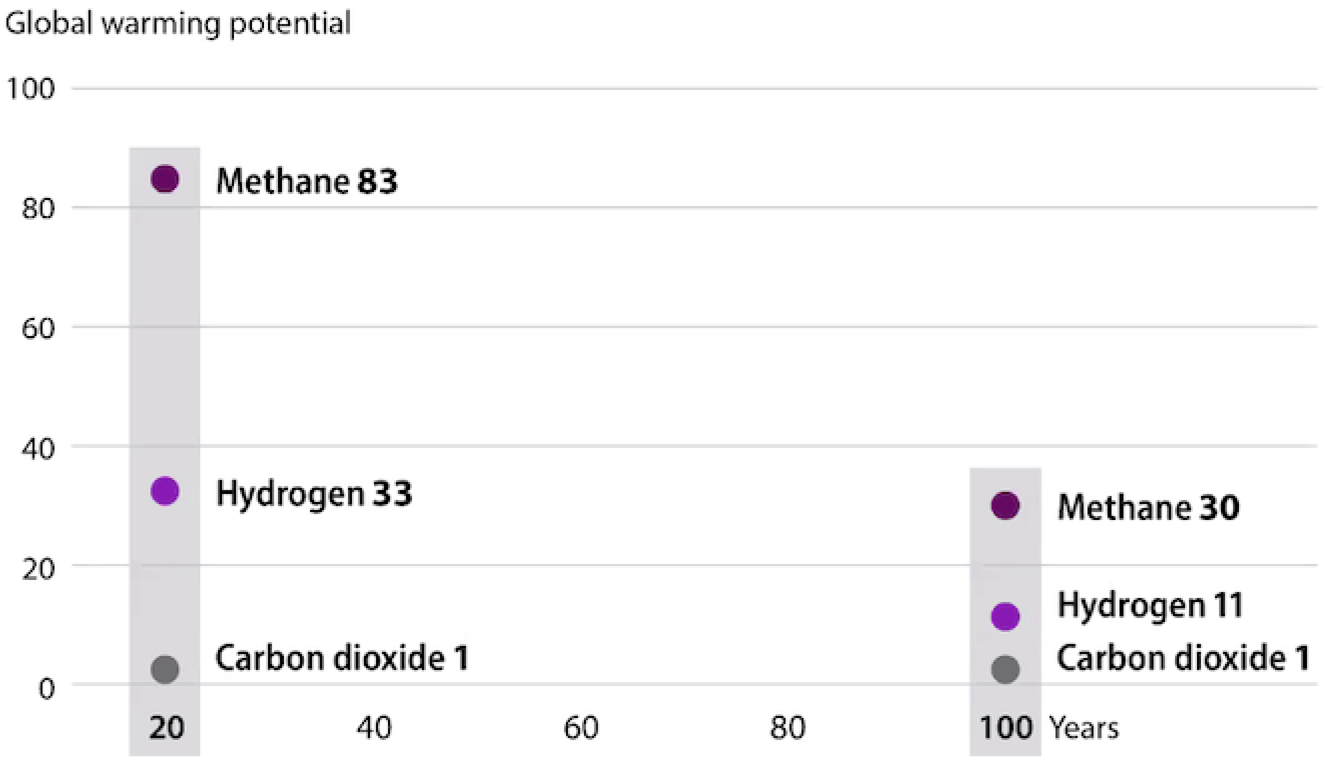
Hydrogen is an indirect but potent greenhouse gas



Source: David Schlissel, Inst. for Energy Economics and Financial Analysis

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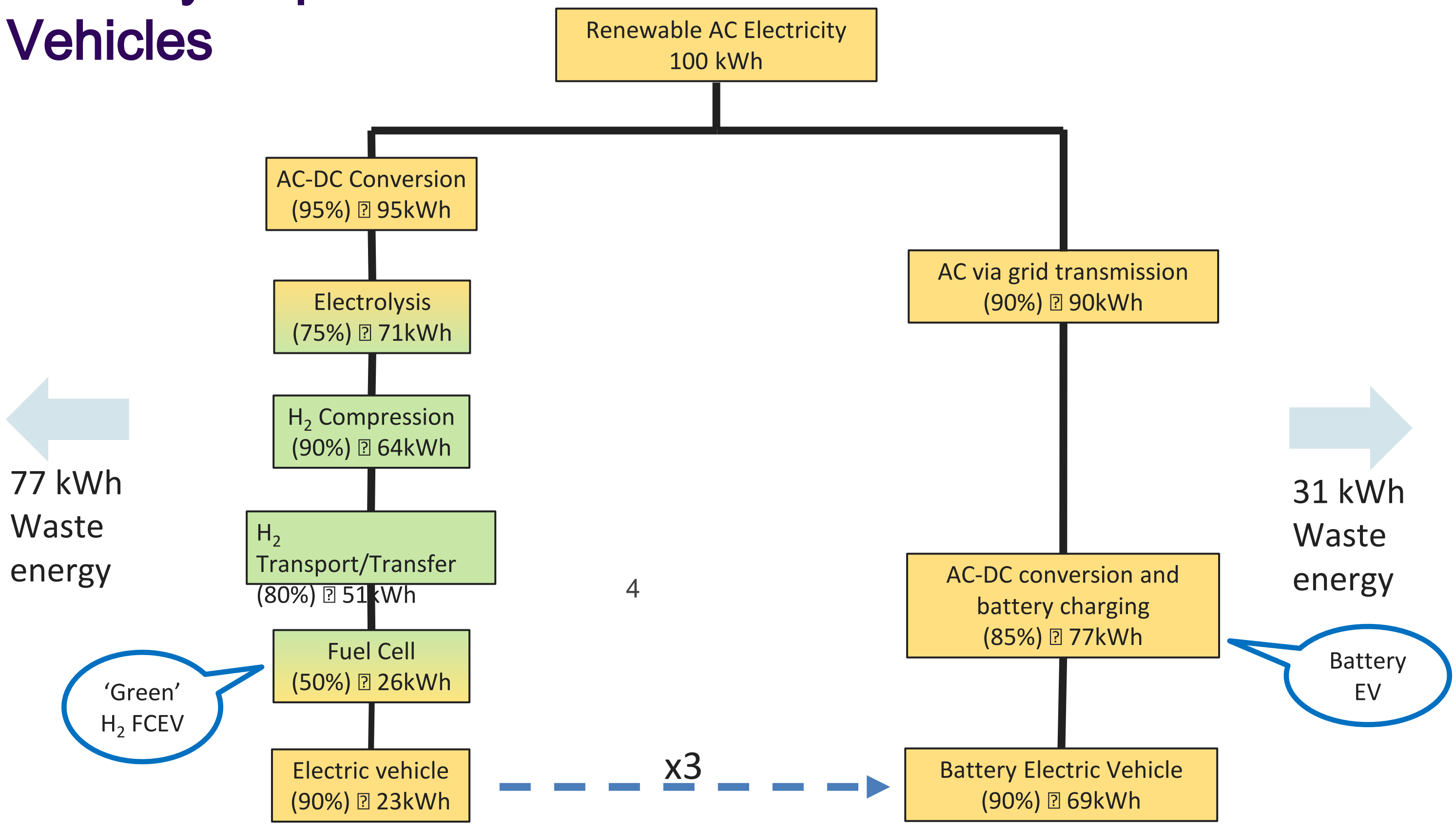
The Efficiency Gap: Vehicles

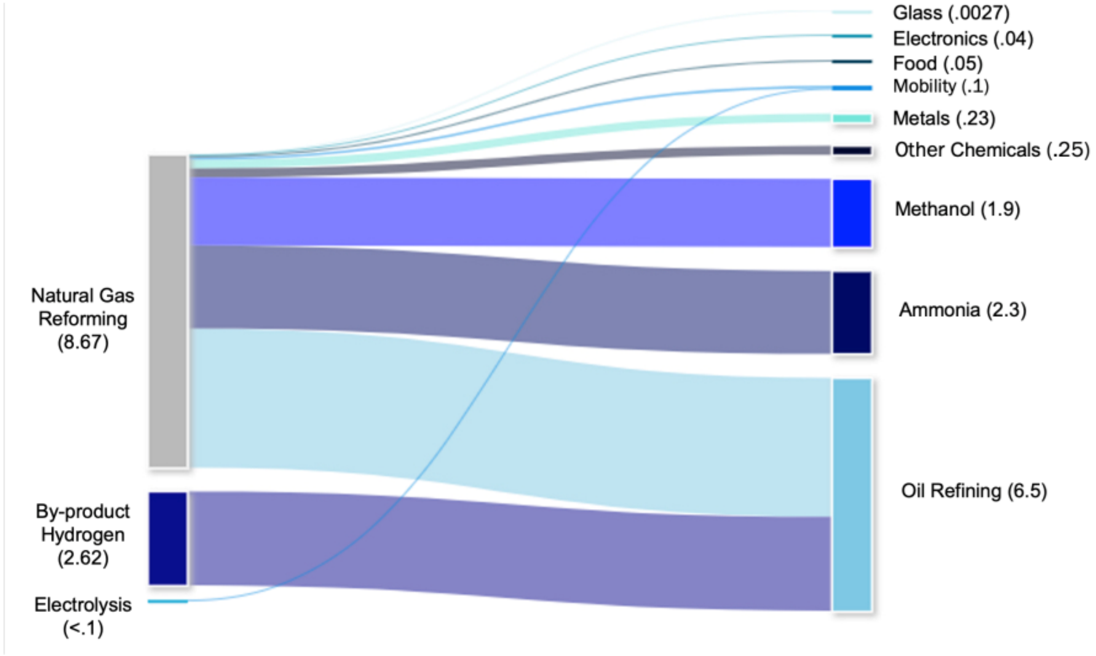
Slide Credit: David Cebon, PhD, Univ. of Cambridge, UK



3x more renewable electricity to power a hydrogen FCEV than a Battery EV: 3x cost!

The Market Gap: Electrolysis for mobility amounts to less than one-tenth of one percent of hydrogen production annually

Figure 1: Current Hydrogen Supply and Demand Balance in the United States (Mt)[22,23]



Natural gas reforming makes up most of hydrogen production in the United States today, which predominantly supplies the refining industry and ammonia production. Some refineries produce hydrogen as a byproduct of other processes and consume all hydrogen produced. Hydrogen produced by electrolysis is on a small scale and mostly supplies demonstration-scale mobility end uses. Data from FCHEA, 2020 and D.R. Brown, 2016.

Source: Energy Futures Initiative, *"The Future of Clean Hydrogen in the United States"* Sept. 2021

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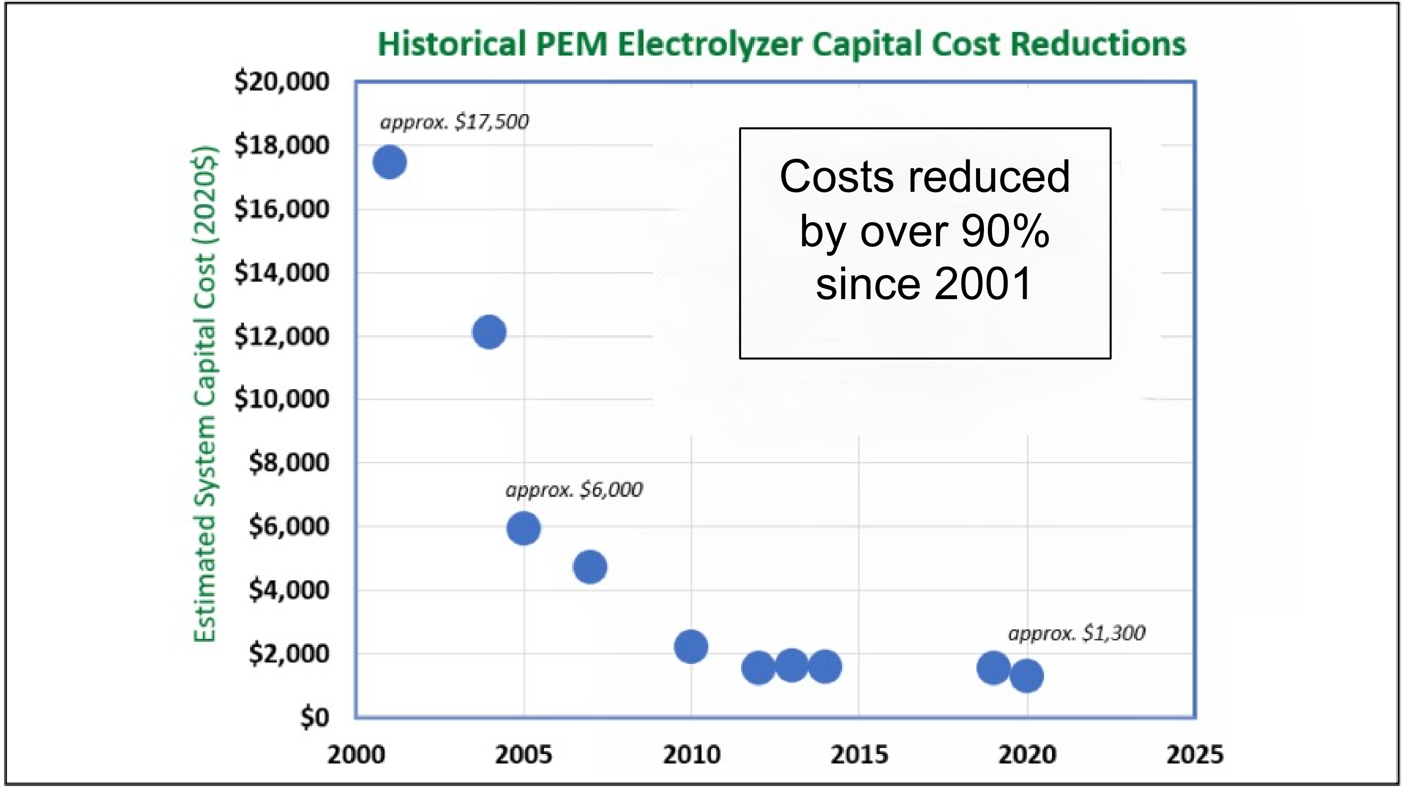
Adjusted capital costs for manufacture of proton exchange membrane electrolyzer systems from 2000 to 2020 ($/kW capacity)



Source: US DOE "Historical Cost Reduction of PEM Electrolyzers" https://www.hydrogen.energy.gov/pdfs/22002 - historical-cost-reduction-pem-electrolyzers.pdf

Stationary Fuel Cell Installed Cost Trend

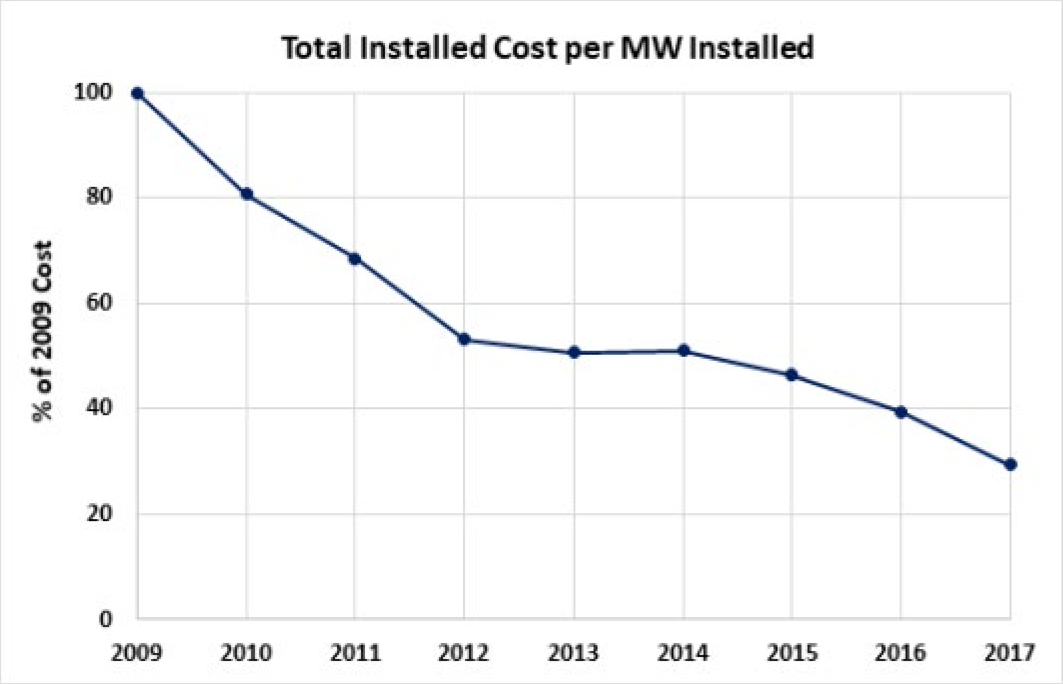


Figure 1. Total Installed stationary fuel cell costs as a function of 2009 costs from manufacturer data

O&M costs have experienced a similar declining trend.

Focus RD&D on further reducing costs and increasing durability.

Source: National Fuel Cell Research Center, May 2018: http://www.nfcrc.uci.edu/PDF_White_Papers/Stationary_Fuel_Cell_Cost_Trends_051918.pdf

Ways that state funding of RD&D can advance an equitable, affordable, and climate-safe future

- Public investments in RD&D should begin with addressing the question of how to develop and deploy a GH2 economy without repeating the mistakes and harms of the past to communities and the environment;
- Prioritize funding on the GH2 production side, not deployment side, to address the problems with electrolytic hydrogen and bring costs down;
- RD&D should focus on how to deploy within the framework of the “three pillars” of hydrogen production: 1) Electrolyzers to be powered by *new* sources of zero-emissions electricity that 2) Directly supply the distribution circuit the electrolyzers are connected to, and 3) Do so at the same time that the generators are running – hourly matching.

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Ways that state funding of RD&D can advance an equitable, affordable, and climate-safe future (continued)

- Fund analyses of economics and technology challenges of deployment scenarios where GH2 production and end uses are co - located;
- Evaluate how GH2 can be used to optimize variable resources, harness curtailed solar and wind, and evaluate the viability of a business model that would focus on harnessing curtailed power.

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Ways that state funding of RD&D can advance an equitable, affordable, and climate-safe future (continued)

- Evaluate potential GH2 end uses for difficult -to electrify sectors. The evaluations should assess social impacts, potential GHG emissions reduction, cost, and energy efficiency of using hydrogen compared to alternatives such as electrification, as well as associated health, safety, environmental, and climate risks;
- Evaluate how hydrogen can play a role in advancing an equity - centered, resilient, decentralized, democratized, and decarbonized energy grid.

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Thank you!

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