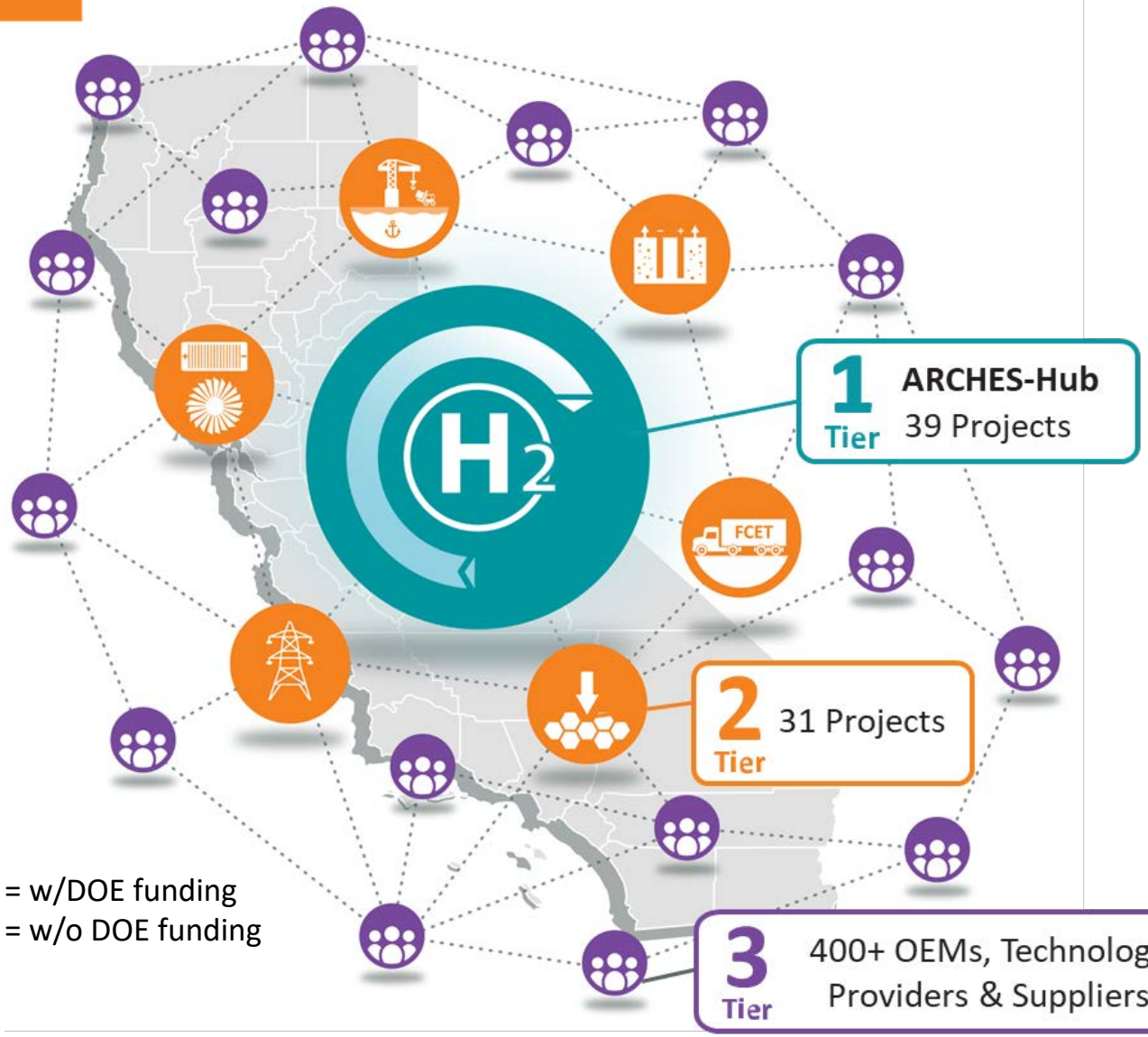
DOCKETED	
Docket Number:	24-IEPR-03
Project Title:	Electricity Demand Forecast
TN #:	256423
Document Title:	Presentation - Hydrogen Electricity Demand Estimates
Description:	Jack Brouwer and Jeff Reed, UC Irvine
Filer:	Raquel Kravitz
Organization:	University of California, Irvine
Submitter Role:	Public Agency
Submission Date:	5/16/2024 8:38:08 AM
Docketed Date:	5/16/2024

Hydrogen Electricity Demand Estimates

IEPR Workshop (16 May 2024)

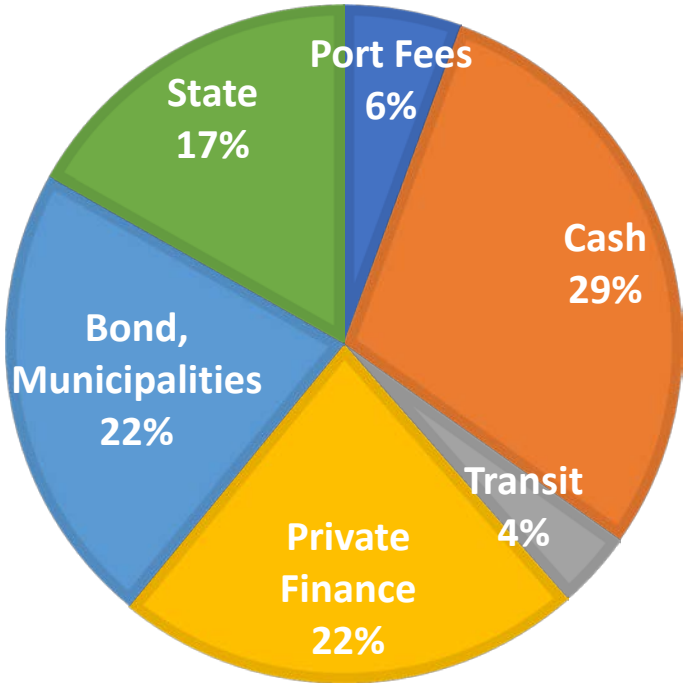
Prof. Jack Brouwer, Director
Clean Energy Institute, UC Irvine

Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES): A Resilient Hydrogen Ecosystem for California

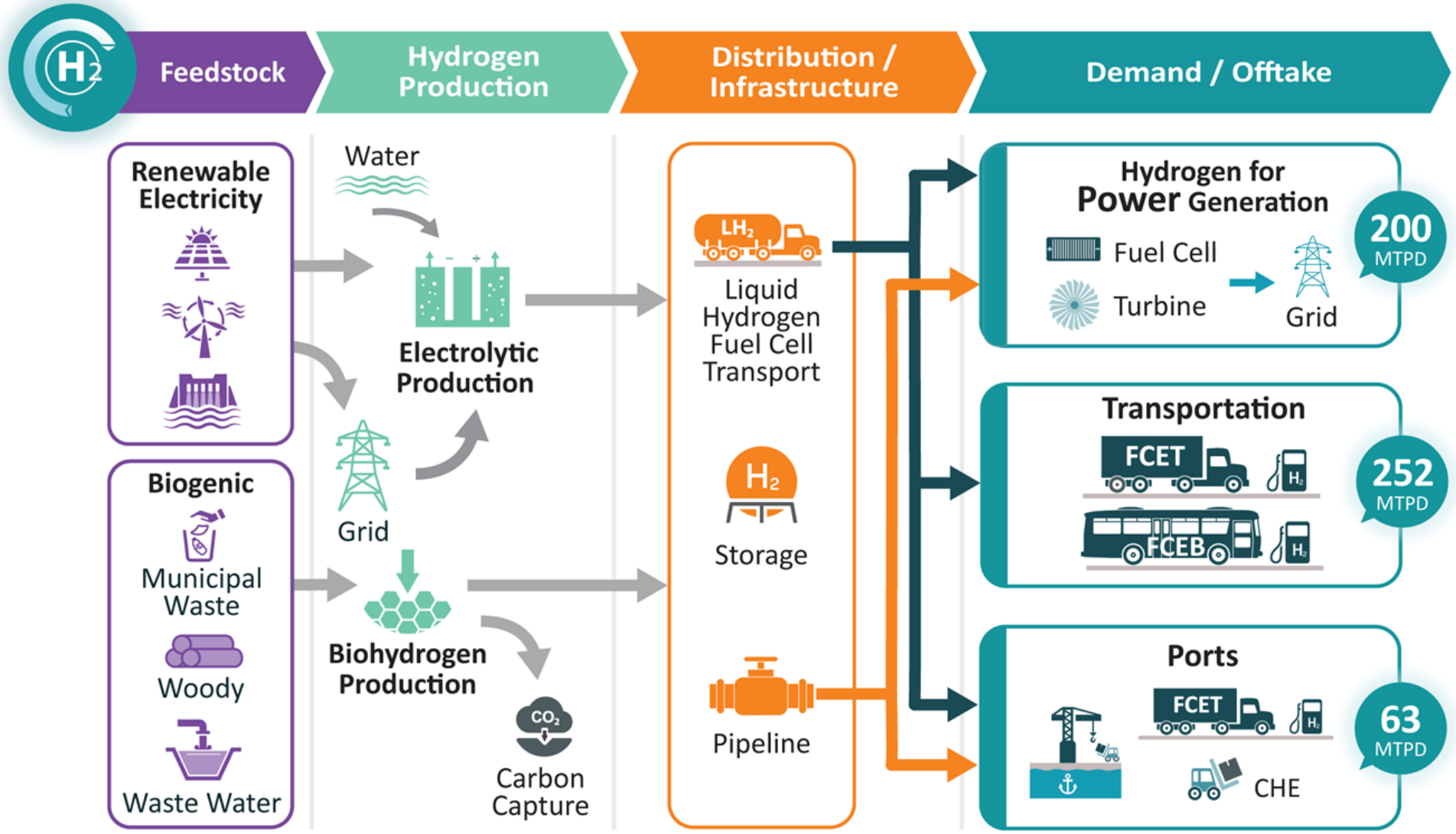


Tier 1 = w/DOE funding
Tier 2 = w/o DOE funding

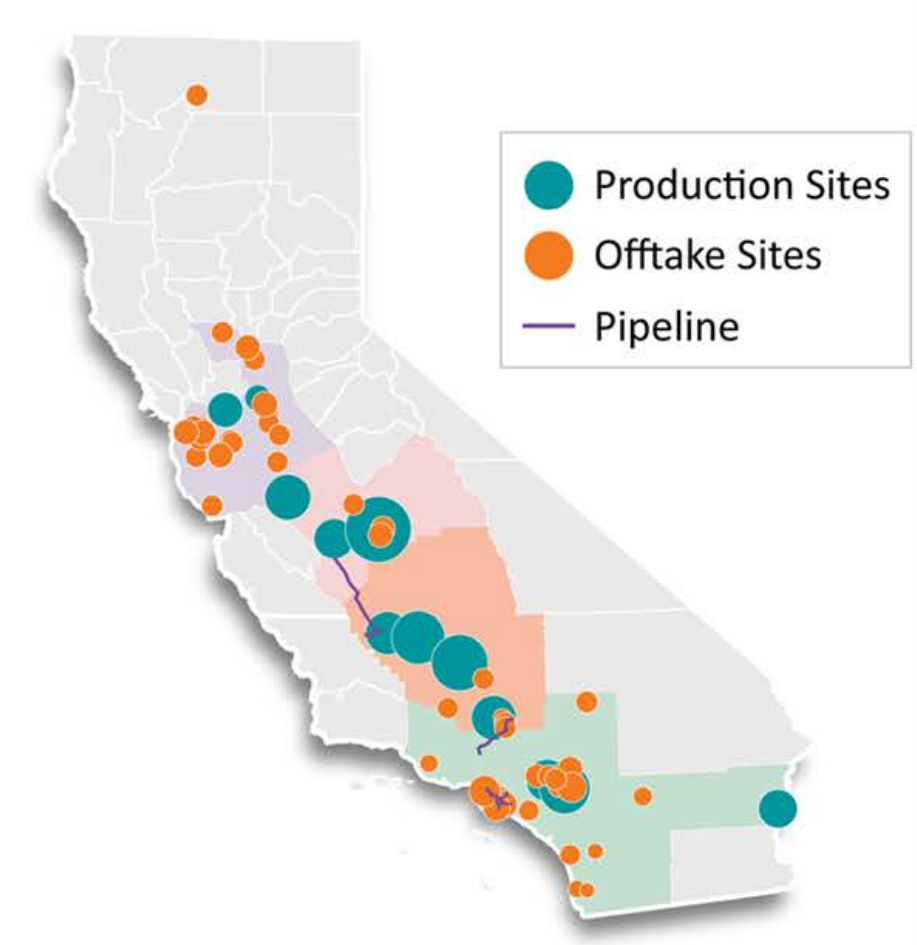
$1.2B DOE funds unlocks **$11.7B in matching funds**

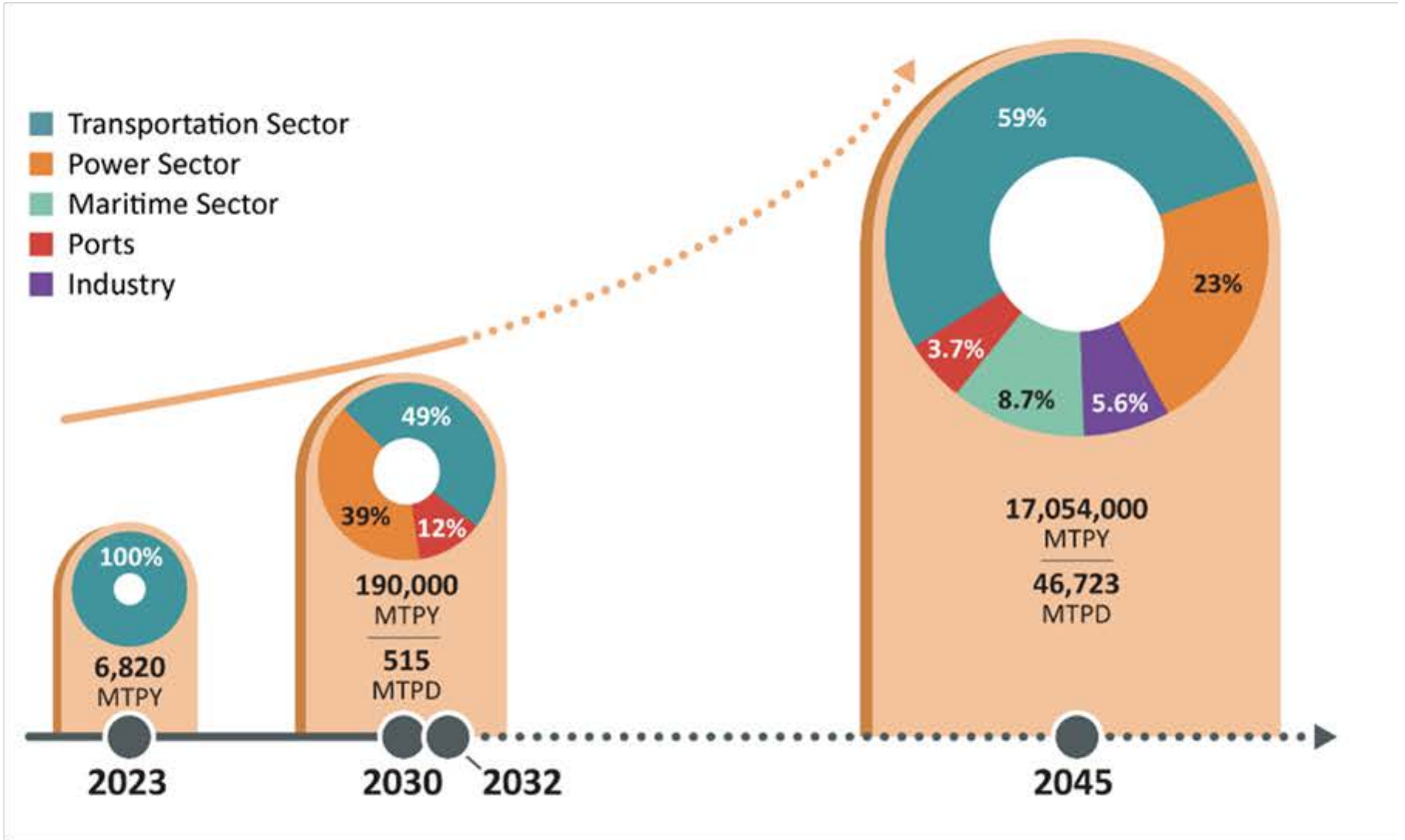


ARCHES Hydrogen Flow



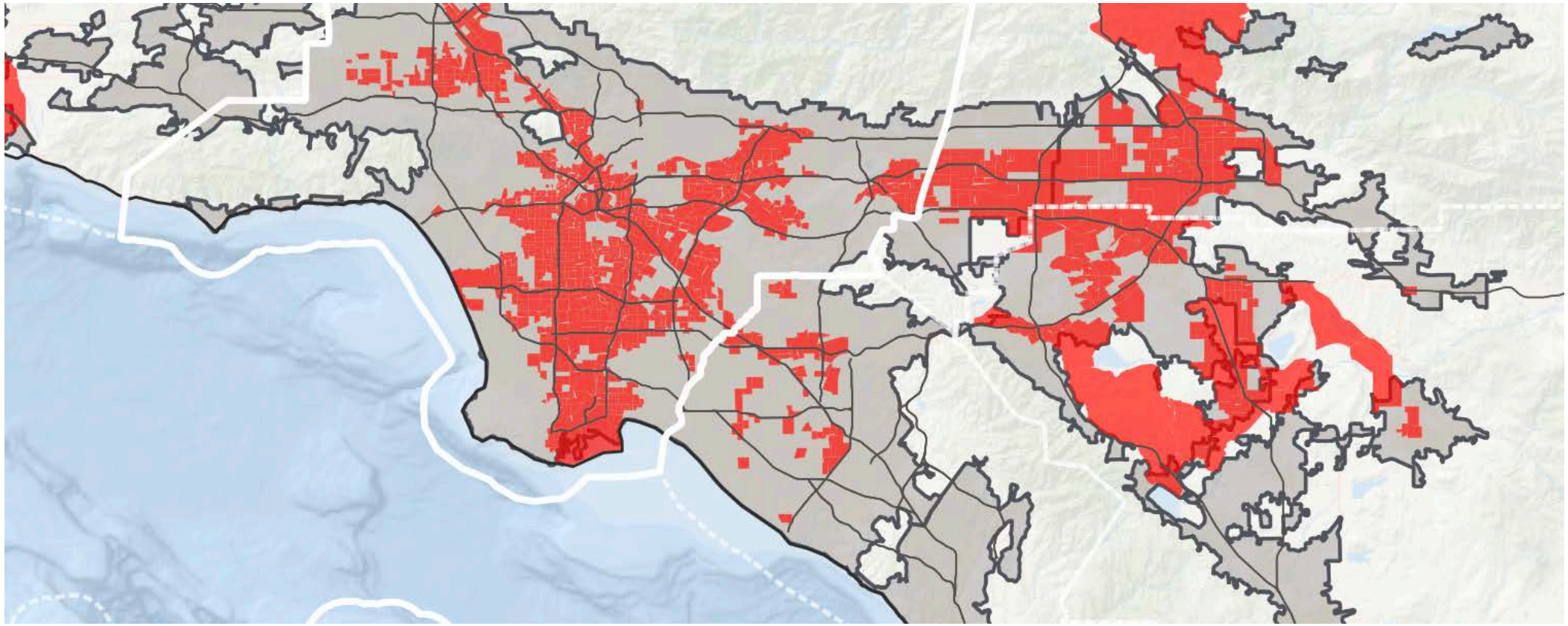
ARCHES Systems Approach Initiates Large Future Hydrogen Growth in California





Pollution severely impacts communities near ports & freight corridors

- Communities are most disadvantaged by diesel combustion emissions of freight
- Life expectancy in Long Beach is approximately 7 years lower than Beverly Hills



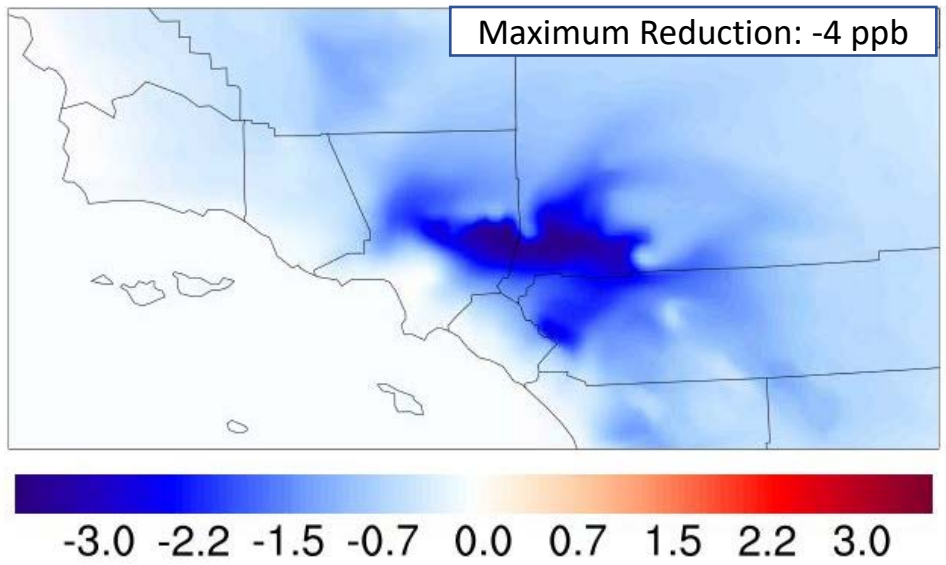
Communities of Concern (exposed to the highest pollution) in Los Angeles

Graphic Source: Strategen

Life Expectancy Data Source: Highway to Health: Life Expectancy in Los Angeles County

Hydrogen Air Quality Impacts – Ozone & Particulate Matter

2045 Reduction in Ozone

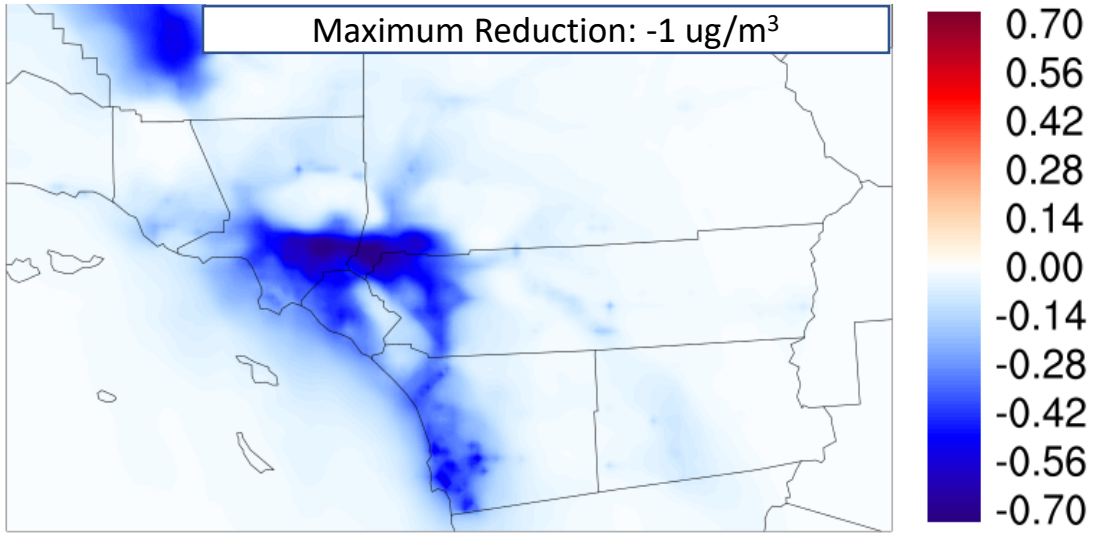


Important reductions in ozone & PM occur in freight corridors & Riverside and San Bernardino Counties which are highly populated and experience the worst ozone air pollution in the U.S*

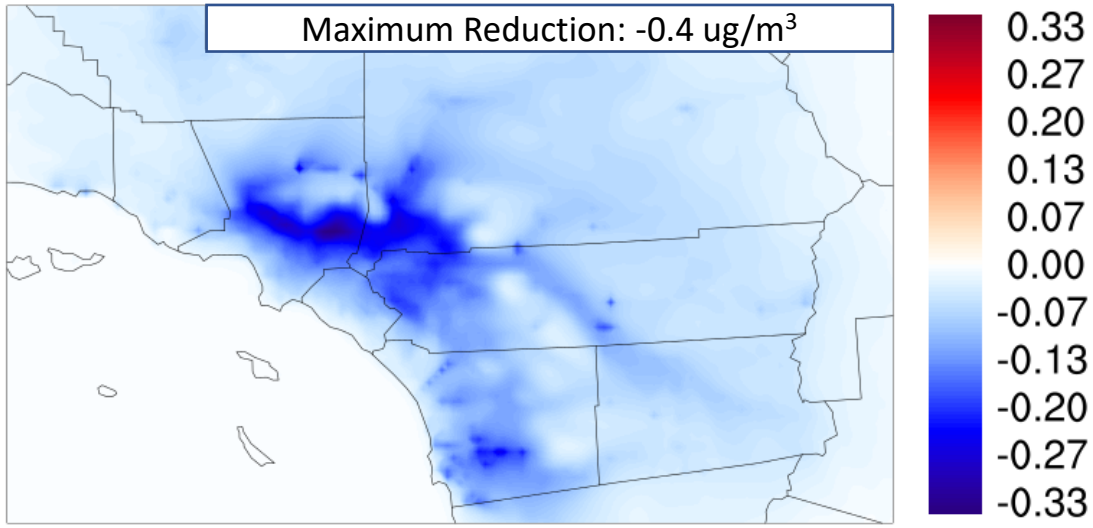
*American Lung Association, *State of the Air 2022*

H2 will improve quality of life and save lives!

2045 Δ Winter $PM_{2.5}$

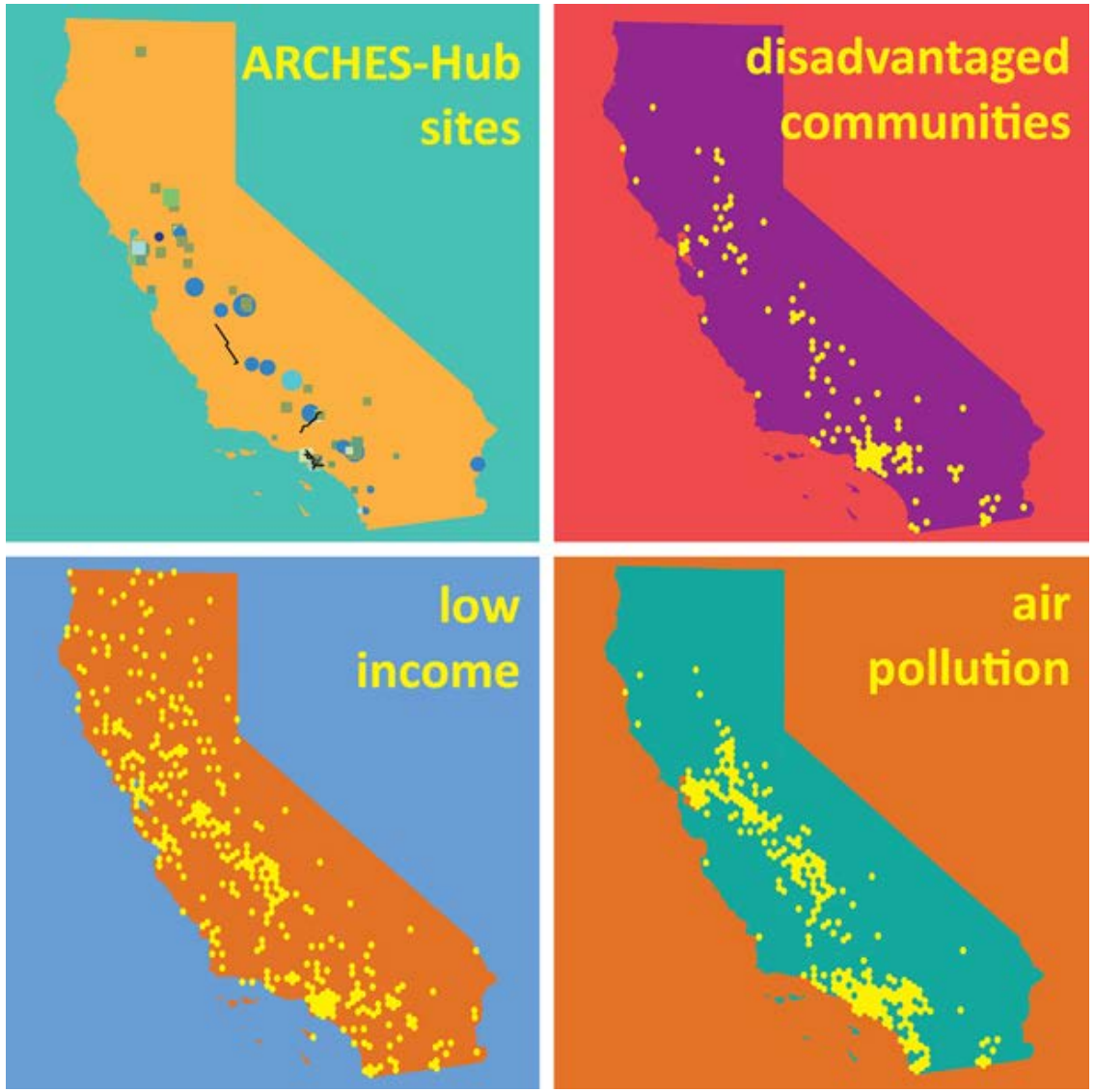


2045 Δ Summer $PM_{2.5}$



UCI

ARCHES Benefits California Communities



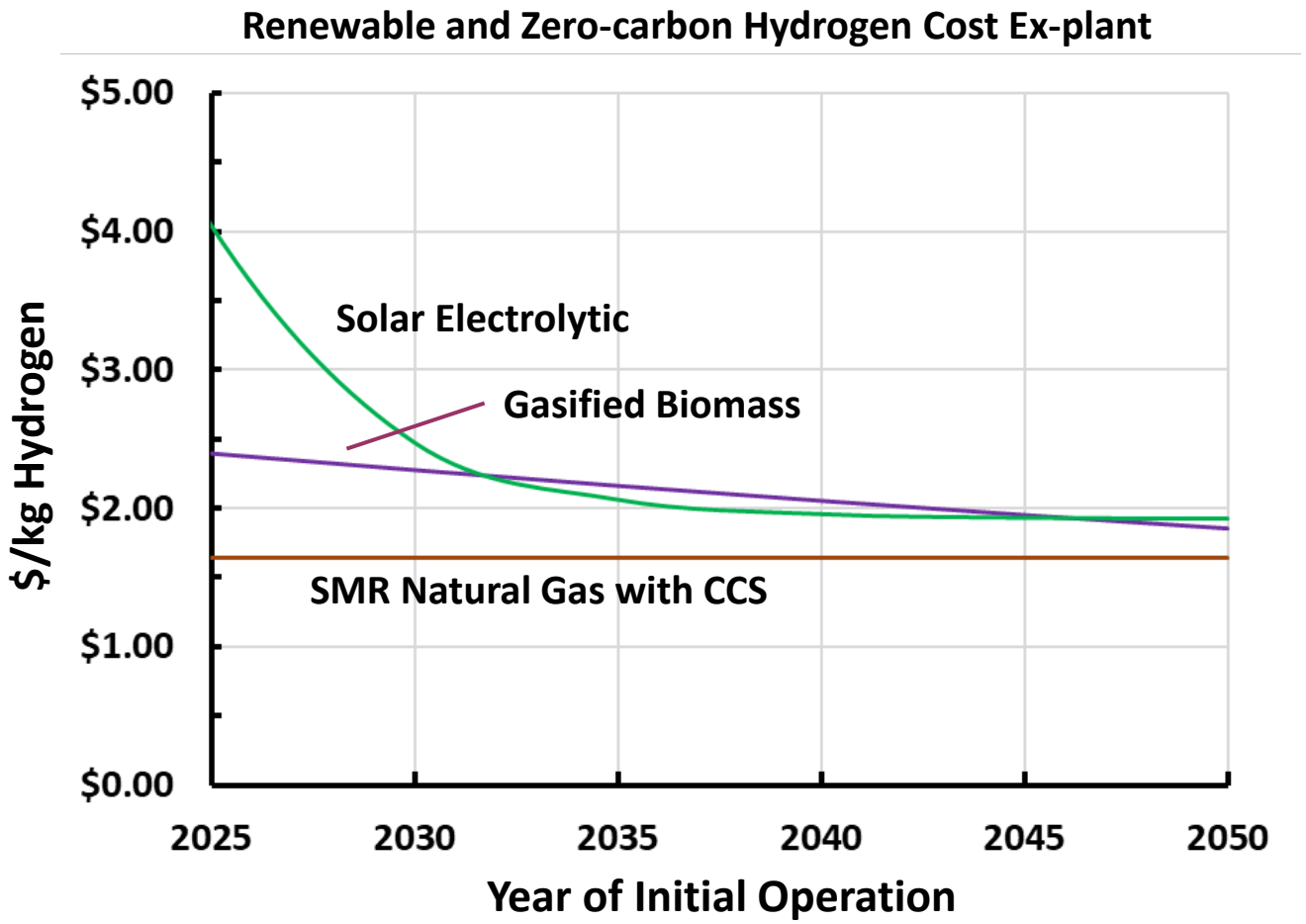
*EJ40 database and CalEnviroScreen

COMMUNITY

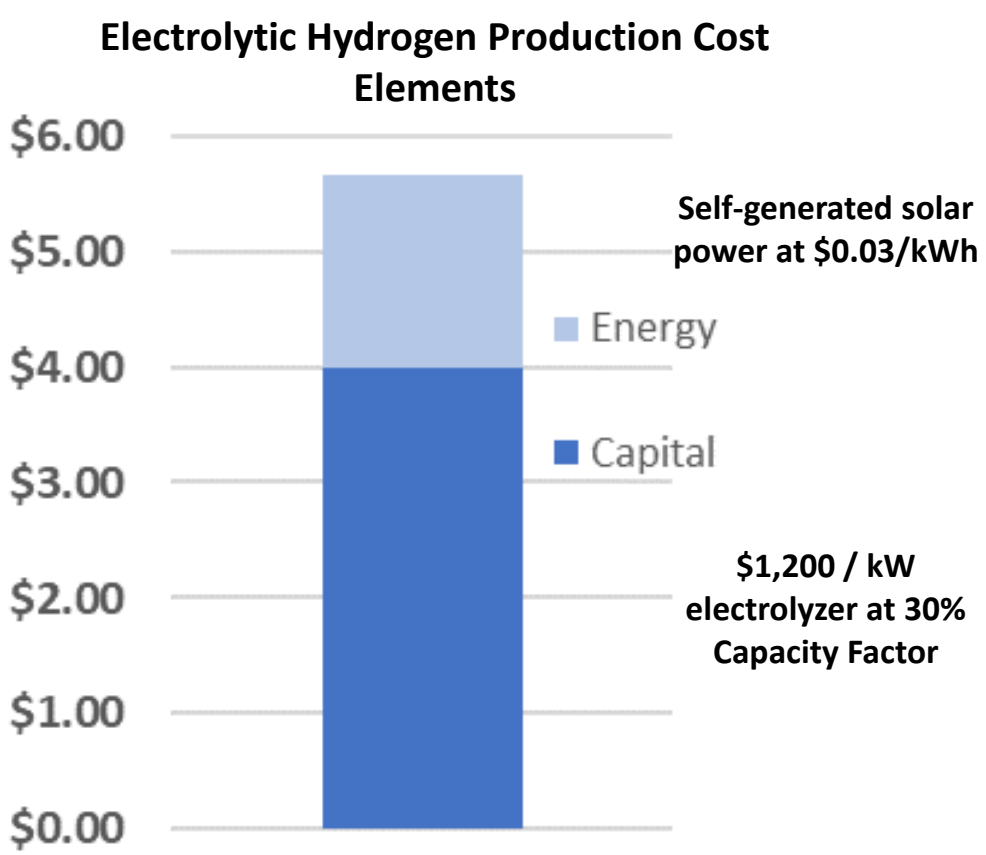
▲ $2.95 billion	Economic value of increased health* and associated health costs savings per year
▲ 222,400	Number of jobs created
▼ 2,097	Fewer hospitalizations for respiratory & cardiac illness per year
▼ 13,292	Fewer work loss days per year
▼ 6,900	Nitrogen oxide net emissions avoided MTPY
▼ 239	Sulfer dioxide net emissions avoided MTPY
▼ 326	Particulate matter net emissions avoided MTPY (PM 2.5, 10)
▼ 48	Fewer premature deaths per year
▲ $380 million	Invested in community benefits & workforce development

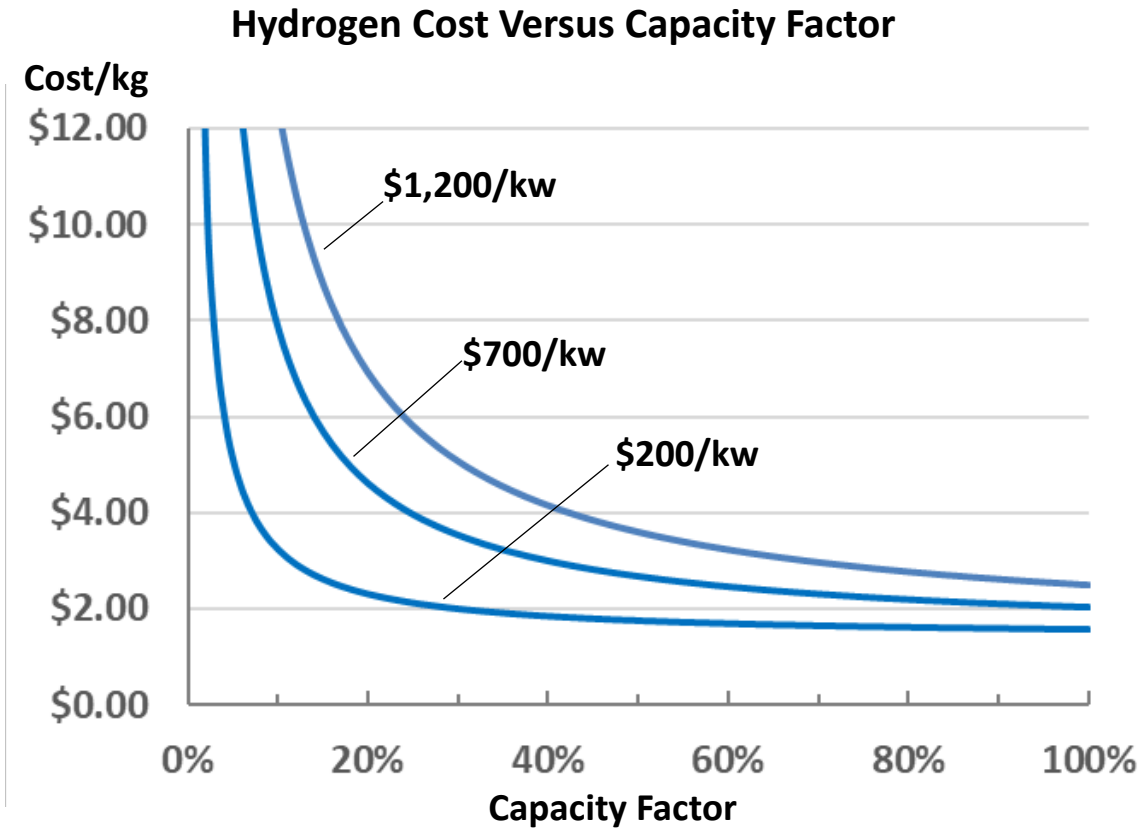
** Reduced premature death, asthma, cancer risk, missed work days*

Demand growth depends upon cost evolution of zero-carbon gaseous fuel pathways



Renewable Electrolytic (Green) Hydrogen Cost Components

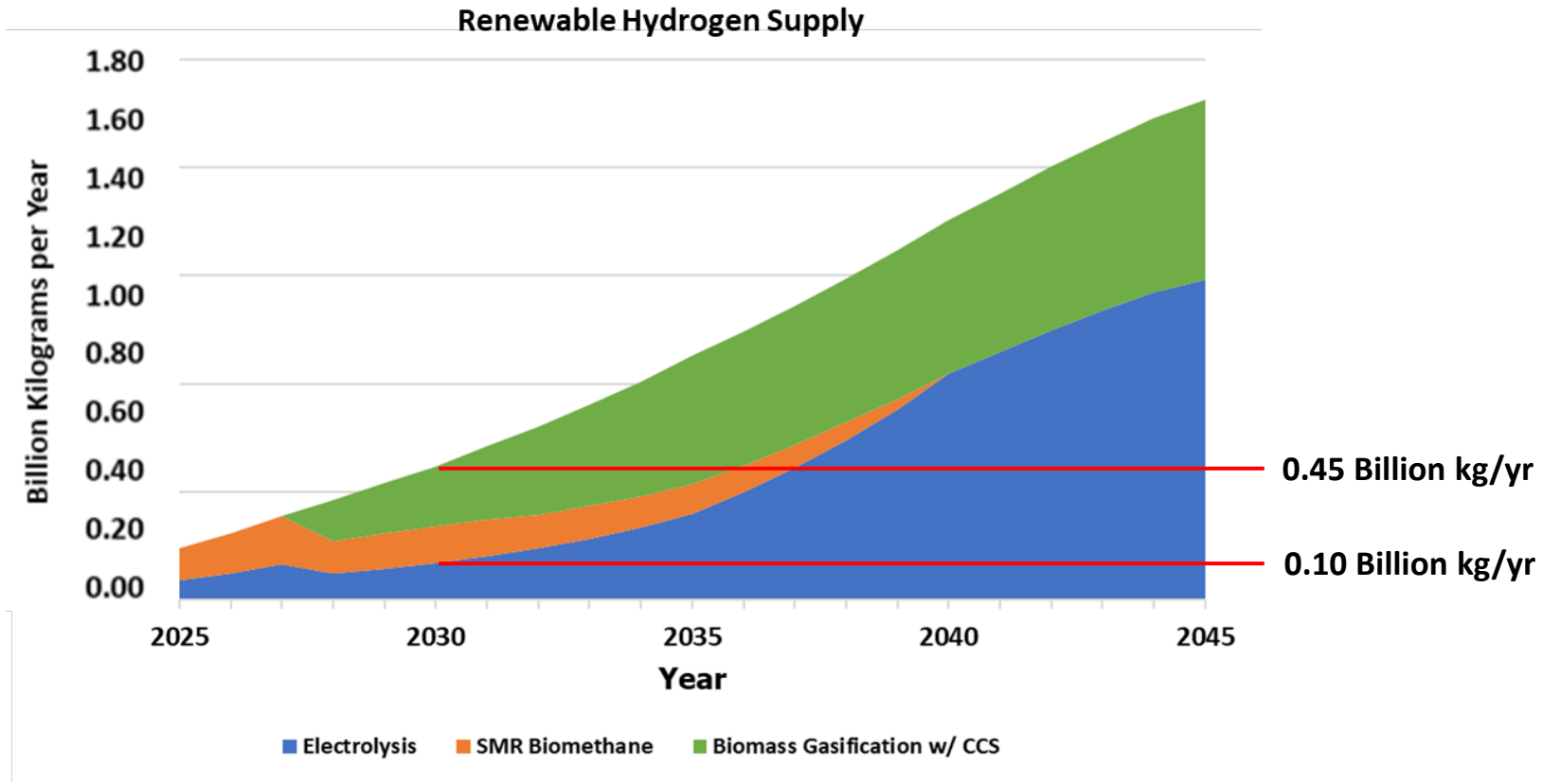




Keys to Hitting <$3/kg within Next 5 Years

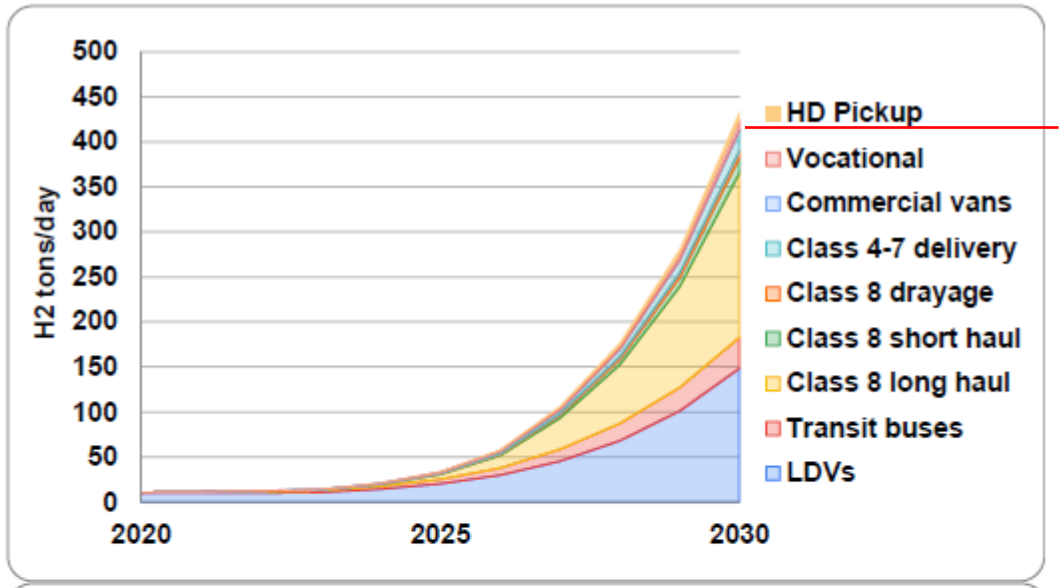
- Near-term incentives:
  - Qualification for IRS Section 45V tax credits
  - Certifying hydrogen pathways in federal Renewable Fuel Standard
  - LCFS pathway certifications and continued use of book and claim
- Electrolytic Hydrogen
  - Successful scaling of clean hydrogen sectors in the U.S. and E.U. to fill new electrolyzer factory capacity
  - Establishment of cost-reflective electric rates for grid connected electrolyzers as dispatchable load (cost to serve based on short-run marginal cost) + ability to directly contract for renewables
- Thermochemical
  - Concentrate state support to allow deployment of first systems at 150 MW_{th} scale and above
  - Apply rigorous up-front technical and commercial risk assessment to ensure that beachhead projects fully address project financier concerns

2022 CARB Scoping Plan Hydrogen Forecast

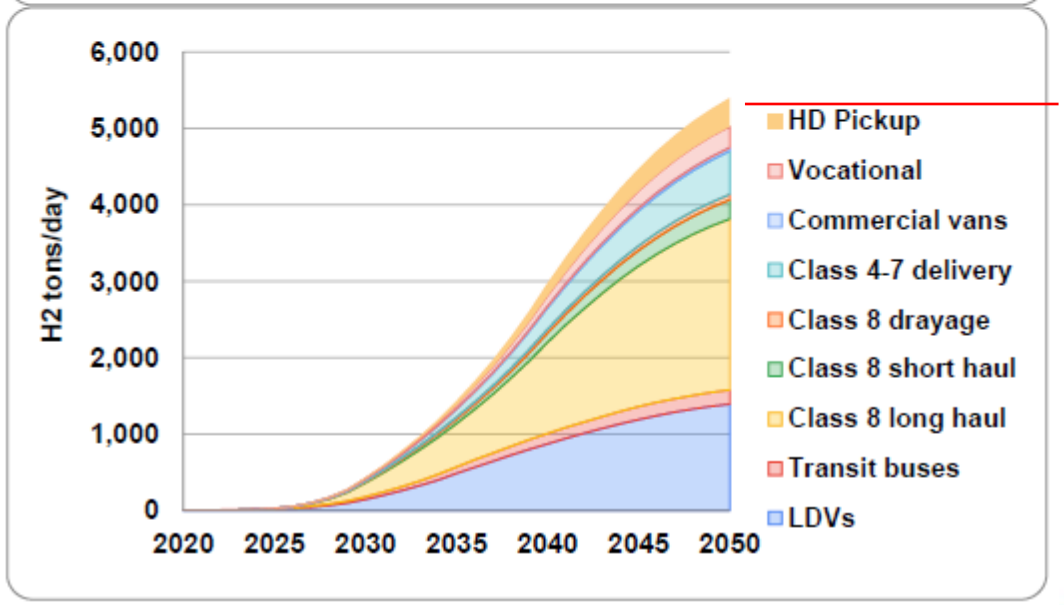


Source: California Air Resources Board

UC Davis Forecast for Transportation Demand for Hydrogen

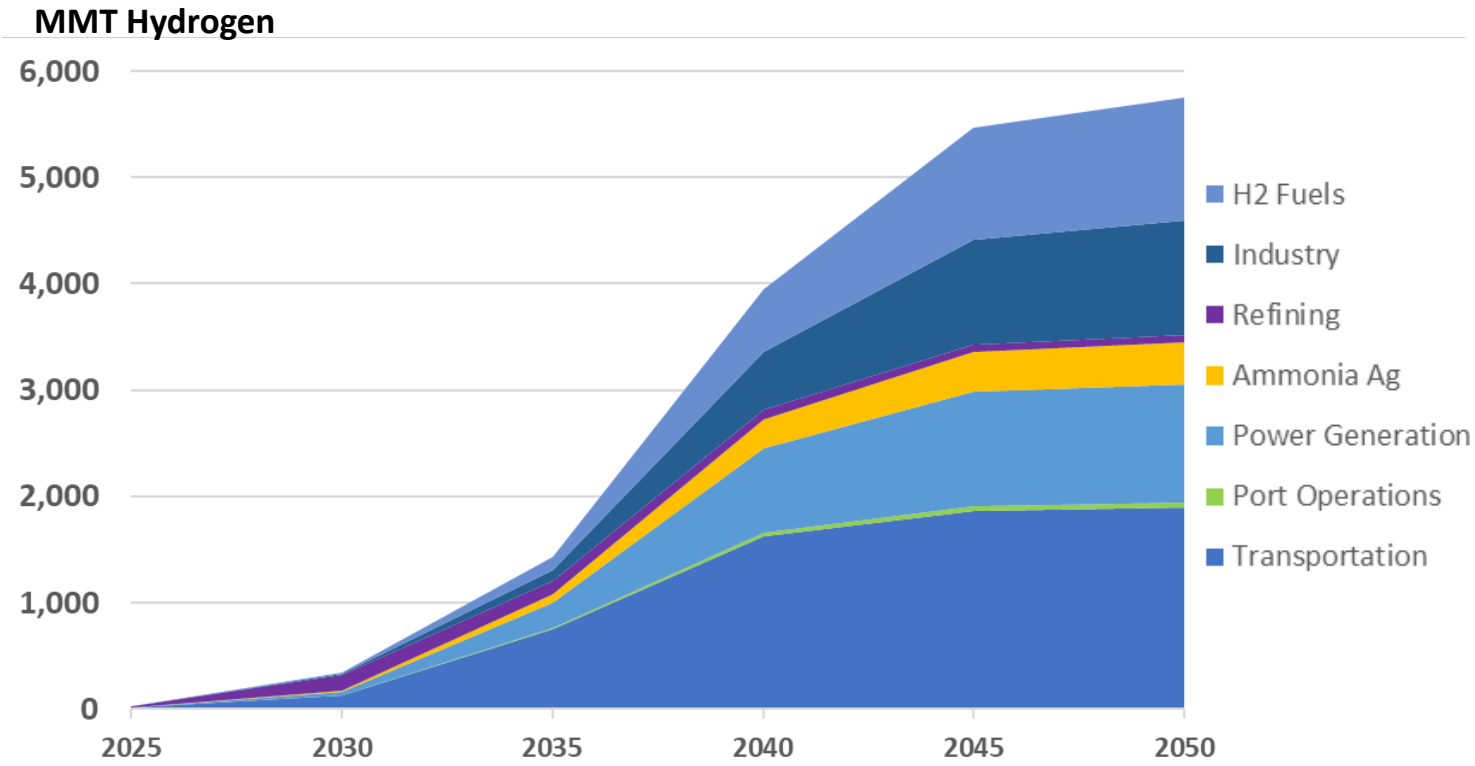


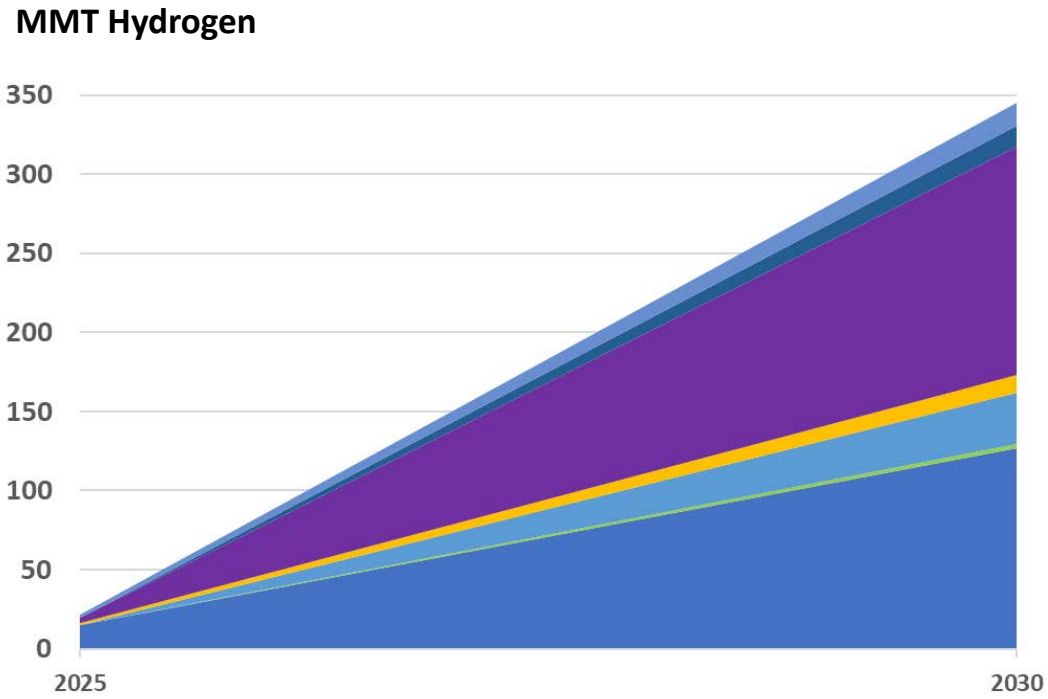
0.155 Billion kg/yr



1.9 Billion kg/yr

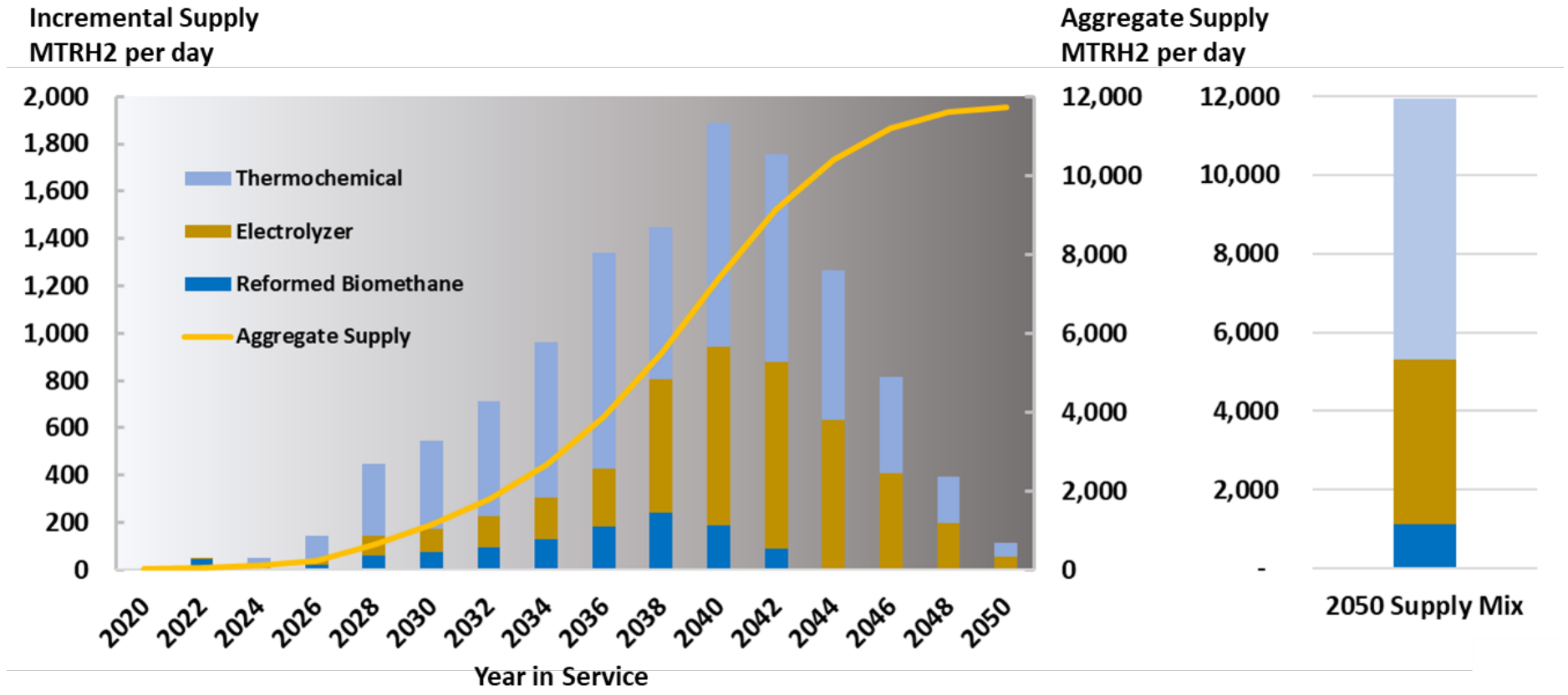
UCI Non-Transportation Forecast with UC Davis Transportation Forecast



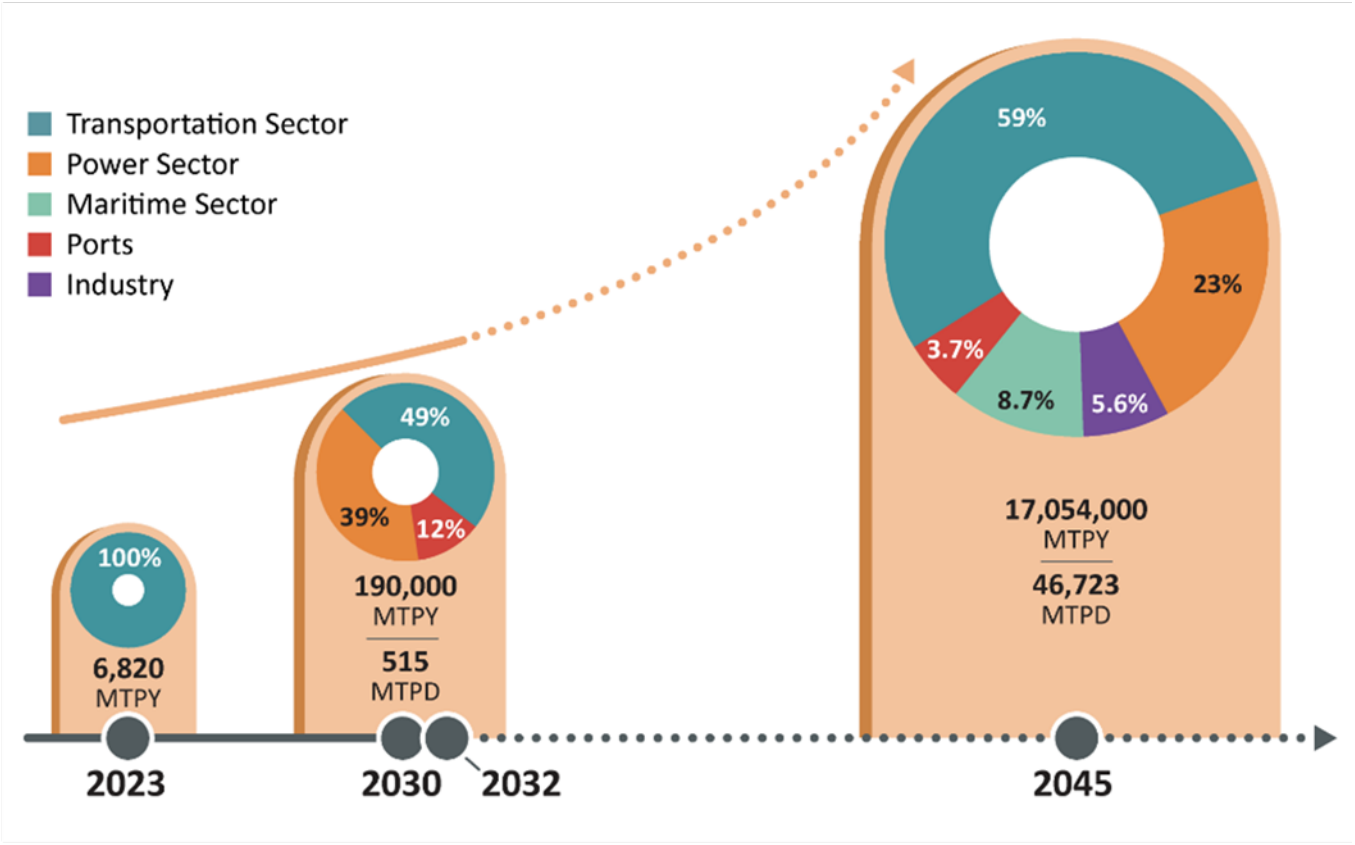


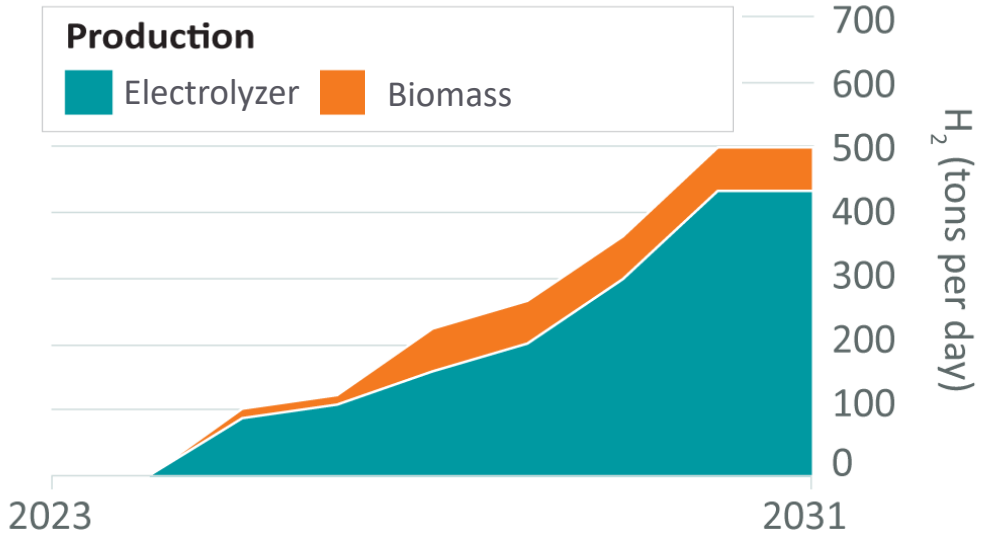
Technology Shares from 2020 RH2 Roadmap

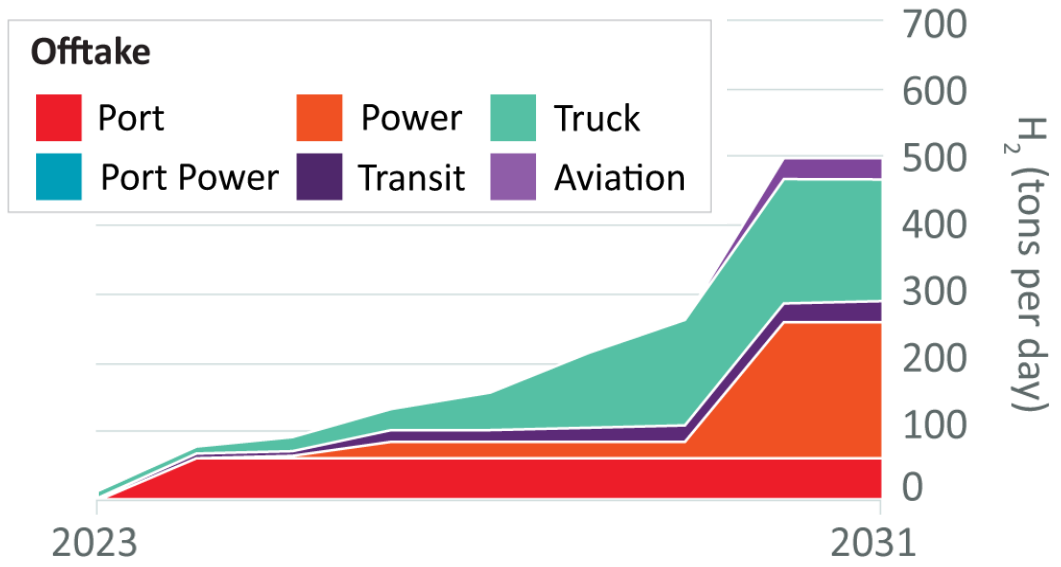
- Early market is predominantly reformed biomethane but longer-term bio-SMR will be supply-limited and substantially higher-cost than alternatives
- Electrolytic and thermochemical RH2 costs are projected to be similar beyond 2030 and are projected to have equal shares of new supply



ARCHES Demand and Production Estimates

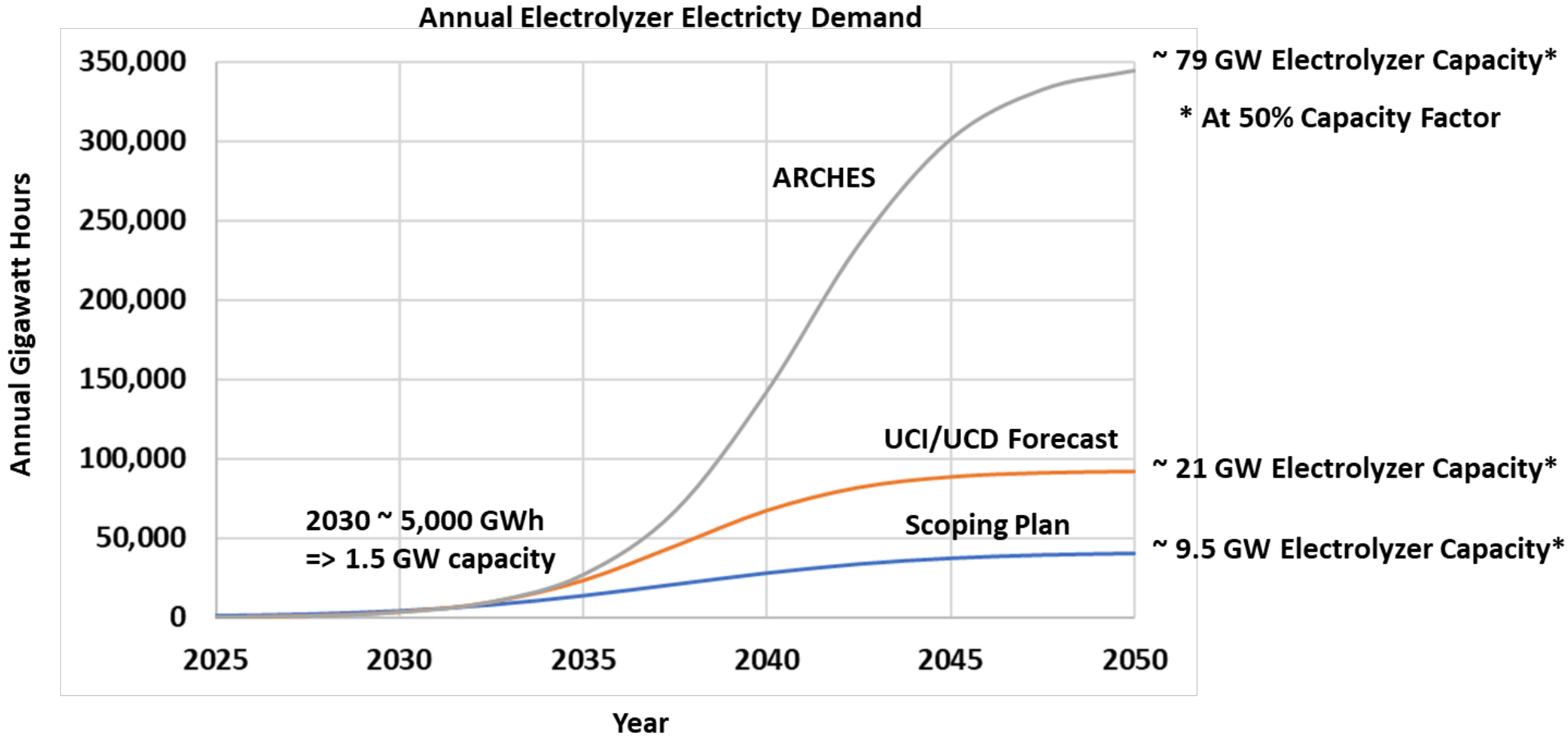






Electrolytic Load Forecast (Grid + Self-Gen) – Various Cases

- Electrolyzer electricity demand
  - Near term: 55 kWh/kg
  - 2035+: 48 kwh/kg (PEM) ; 42 kwh/kg SOEC



Hydrogen Electricity Demand Estimates

IEPR Workshop (16 May 2024)

Prof. Jack Brouwer, Director
Clean Energy Institute, UC Irvine