

# Beyond Power: Opportunities and Challenges for Green Hydrogen



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Green Hydrogen Coalition  
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# About Green Hydrogen Coalition

## MISSION:

Facilitate policies and practices to advance the production and use of Green Hydrogen in all sectors where it will accelerate a carbon free energy future

## APPROACH:

Prioritize Green Hydrogen project deployment at scale; leverage multi-sector opportunities to simultaneously scale supply and demand





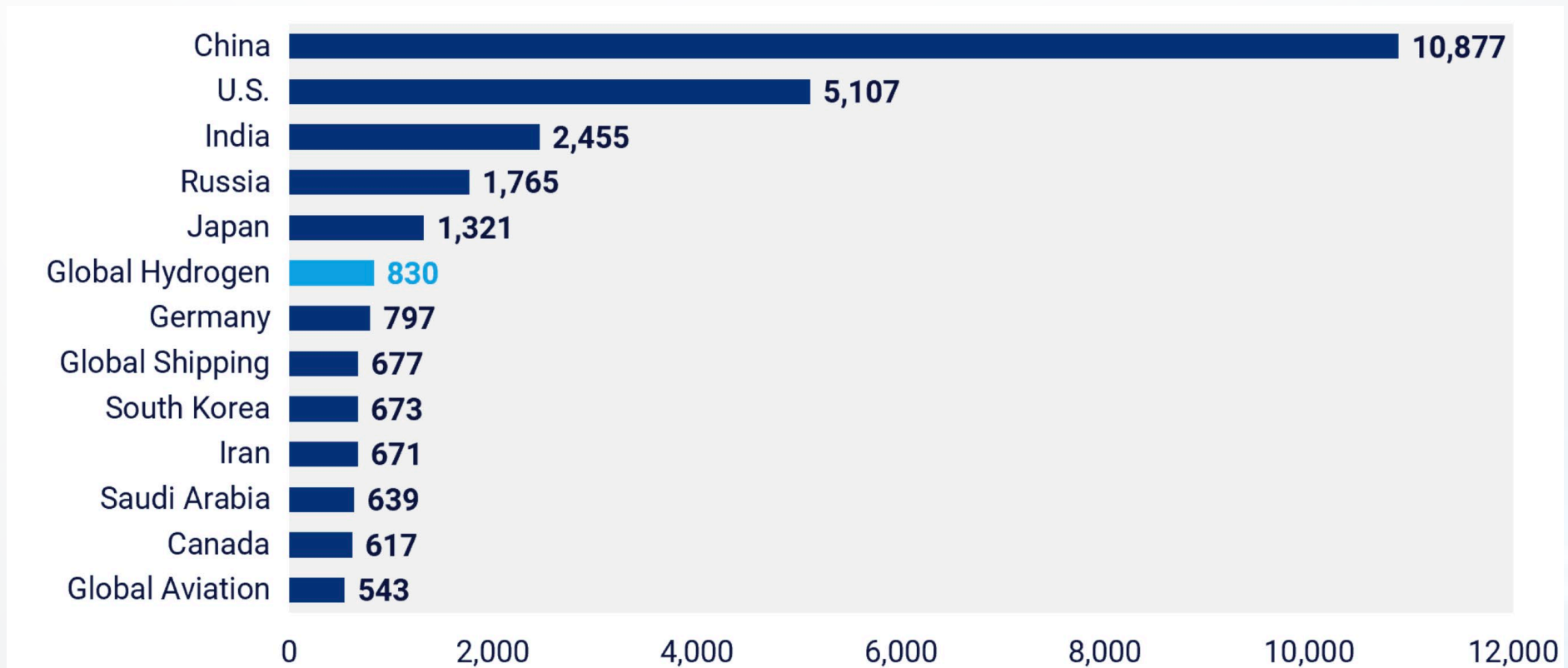
# Green Hydrogen is a super gamechanger



# GHG Emissions From Global Hydrogen Production Ranks Higher than Germany

2017 CO<sub>2</sub> emissions by country and sector (Mt Co<sub>2</sub>/year)

Source: Wood MacKenzie

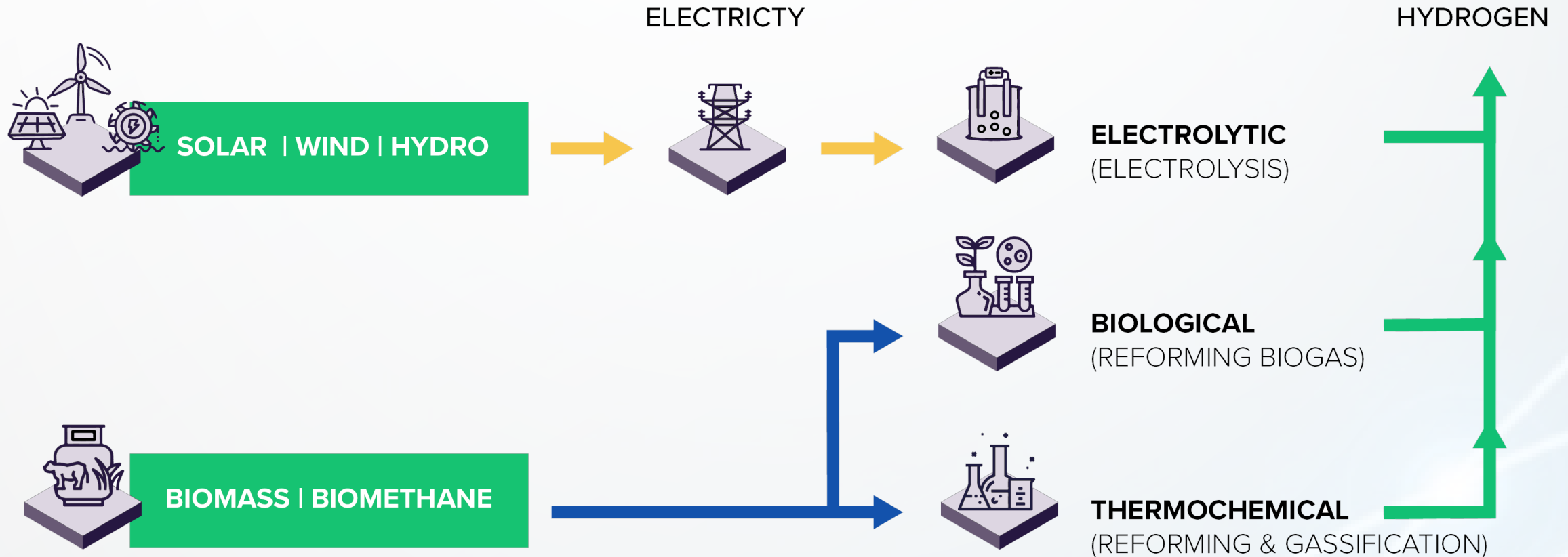


# There are many ways to make **Green Hydrogen**...

PRIMARY ENERGY

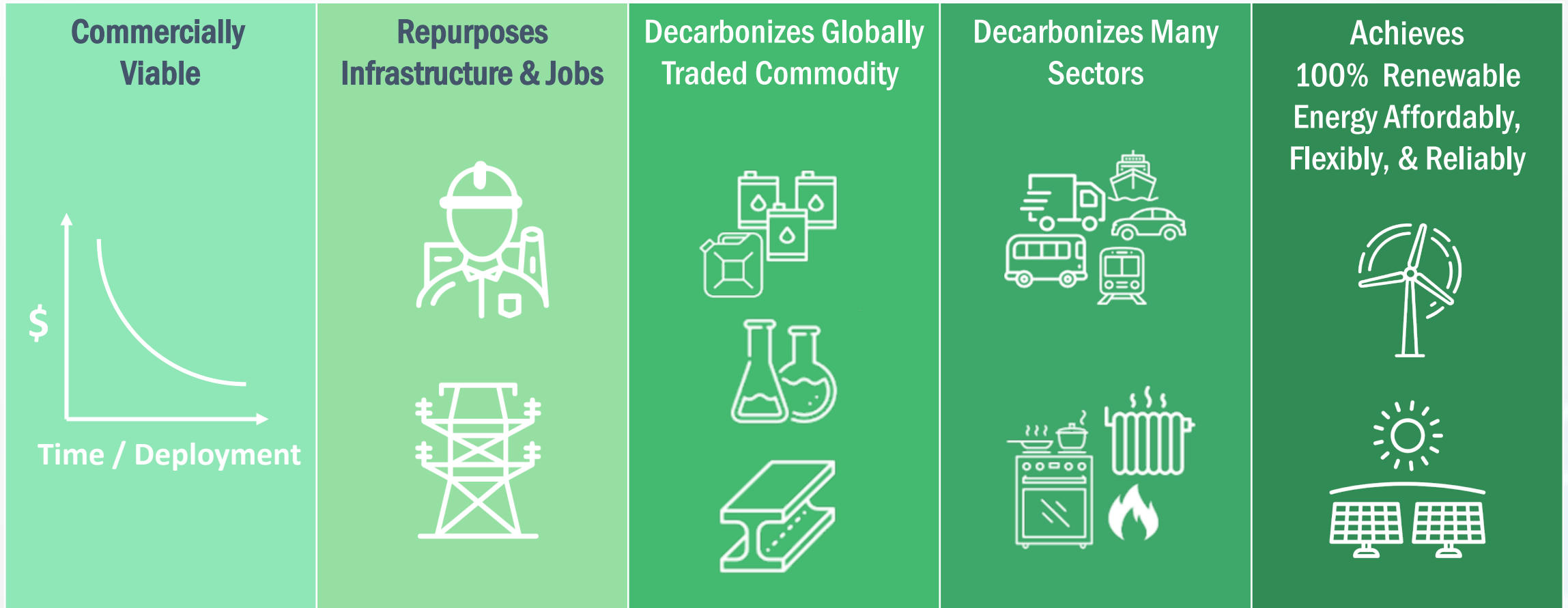
CONVERSION

RESULT



...which are zero net emission

# Why Green Hydrogen is a Super Gamechanger

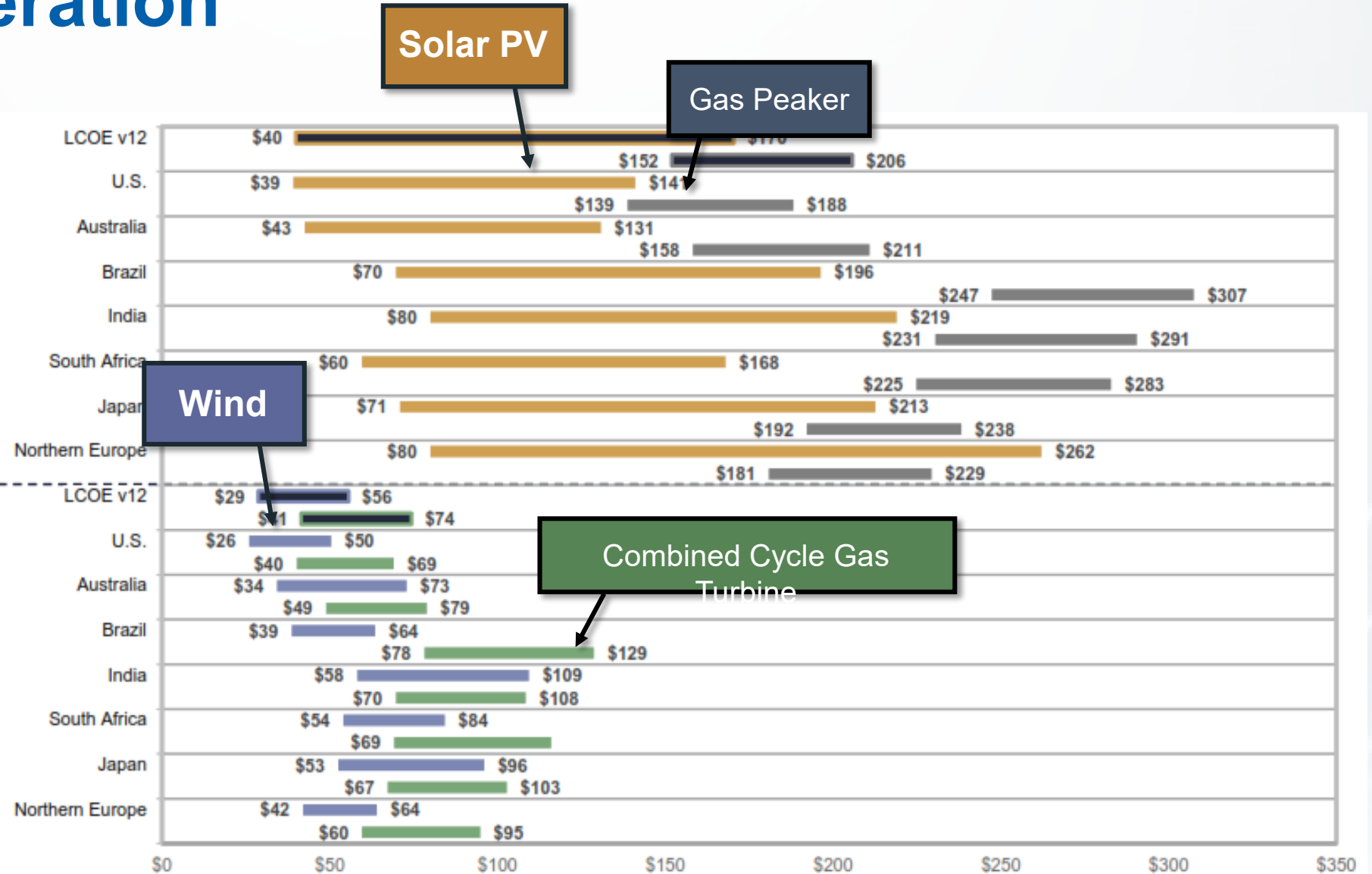


Commercially  
Viable

# Renewables are now cheaper than fossil generation

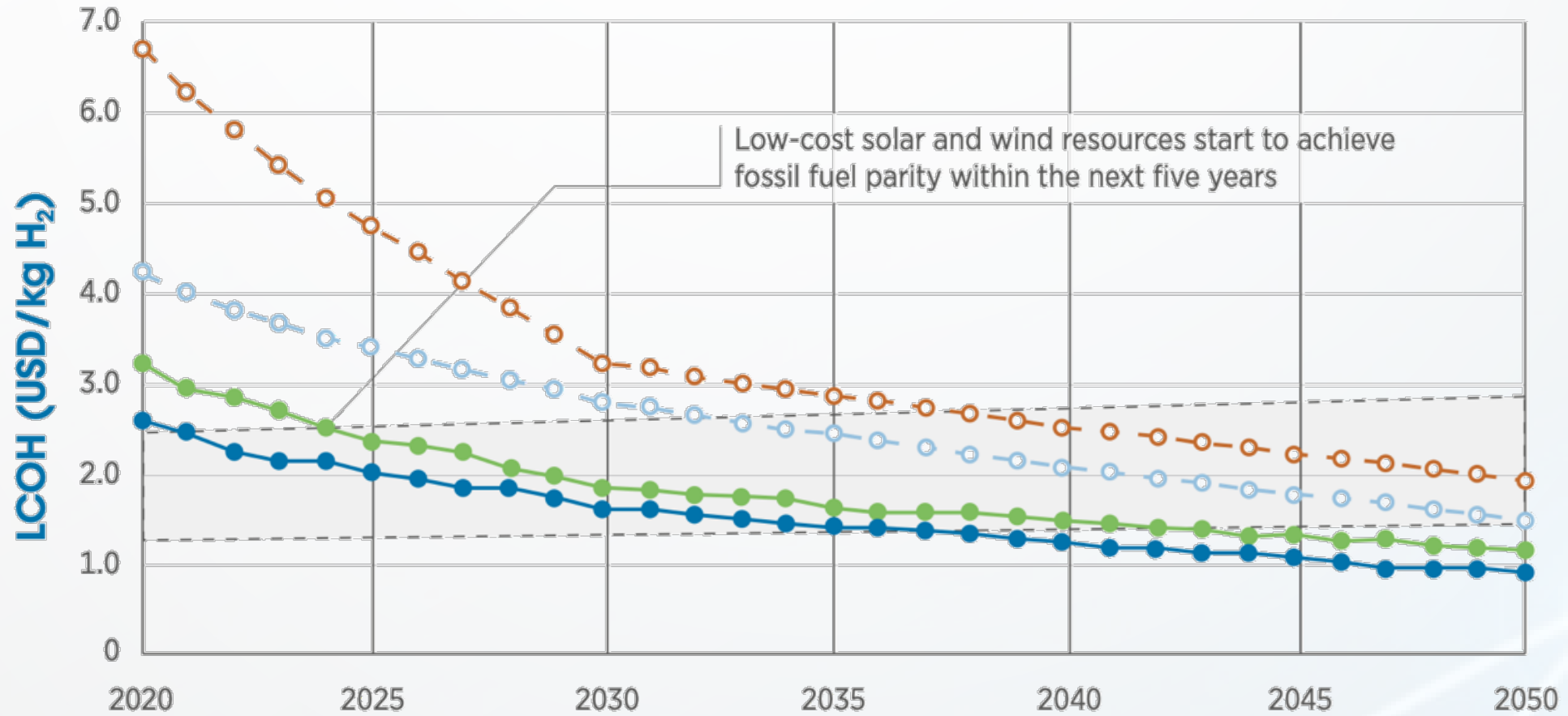
Solar PV<sup>(2)</sup>  
versus  
Gas Peaker<sup>(3)</sup>

Wind<sup>(4)</sup>  
versus  
Combined Cycle  
Gas Turbine<sup>(5)</sup>



Commercially  
Viable

# Green H<sub>2</sub> is commercially viable; on trajectory for lowest cost





# Green Hydrogen (H<sub>2</sub>) can repurpose existing infrastructure ...



Source: LADWP

## ...Enabling an affordable & responsible transition

# Green H<sub>2</sub> can decarbonize today's global hydrogen commodity markets...

Today's Global Hydrogen Value Chains

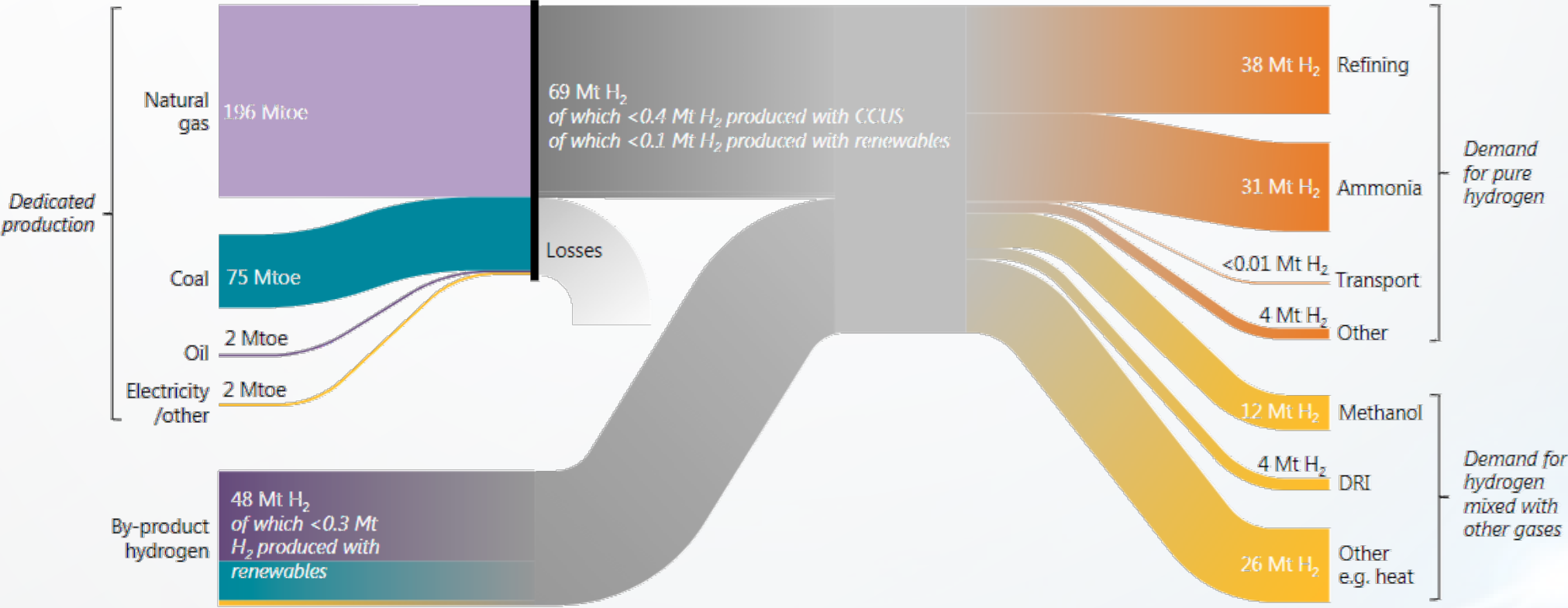


Image from "The Future of Hydrogen: Seizing today's opportunities" report prepared by IEA for the G20, Japan. Mtoe=million tons of oil equivalent. Mt=million tons



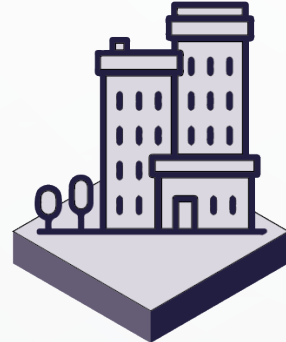
>99% is made from fossil fuels

# Green Hydrogen has versatile applications

TRANSPORT



POWER



INDUSTRY



CHEMICAL AGRICULTURE



**Hydrogen has the potential to reduce emissions across many sectors... even aviation**



# Green H<sub>2</sub> with fuel cells can be used as a clean alternative to diesel and gas backup generators today

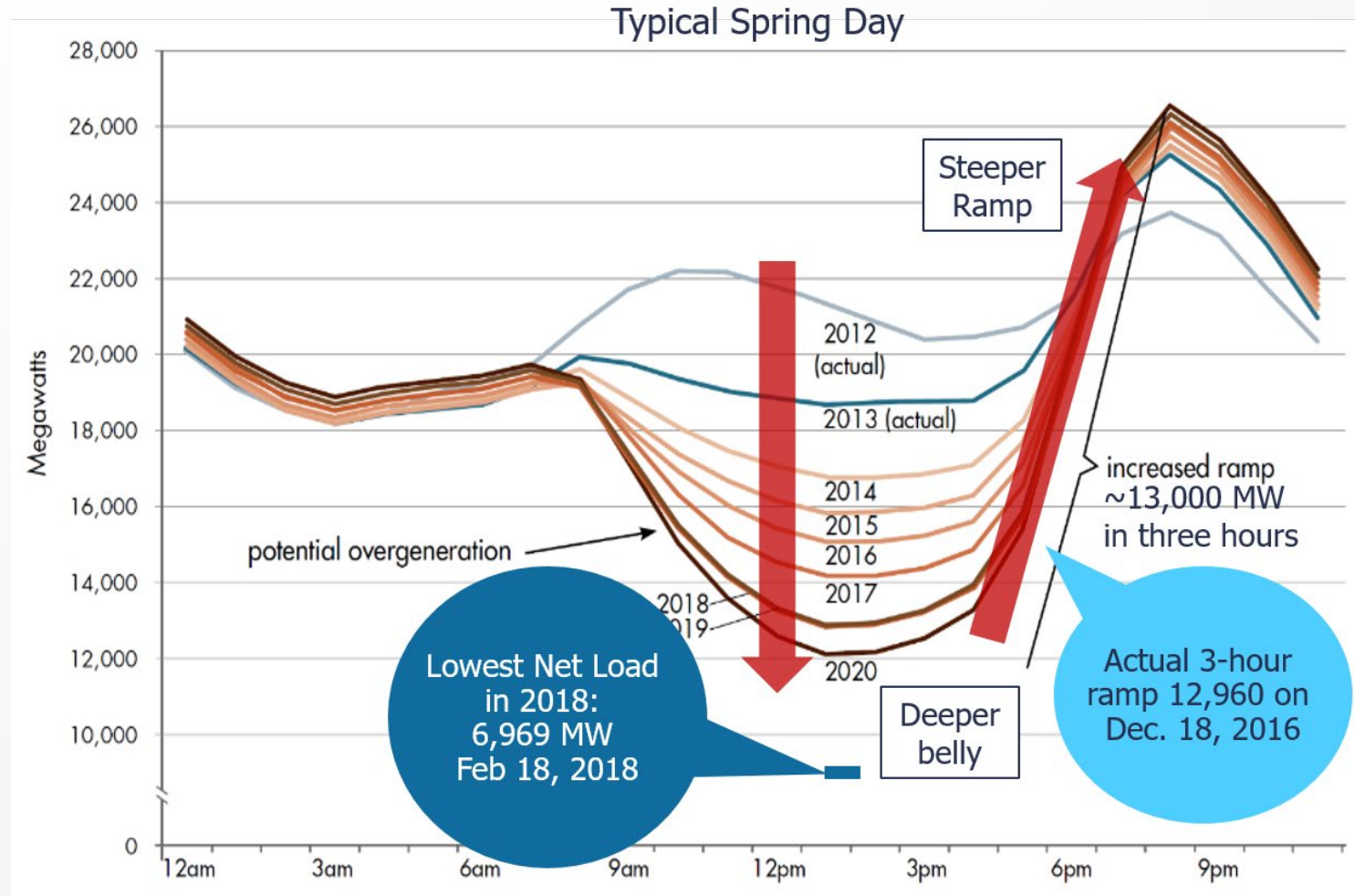


Photo Credit: Alteryg

Achieves 100% Renewables

# Green H<sub>2</sub> can help integrate low cost renewable energy

Storage-enabled grids are the catalyst for higher renewables investment and penetration

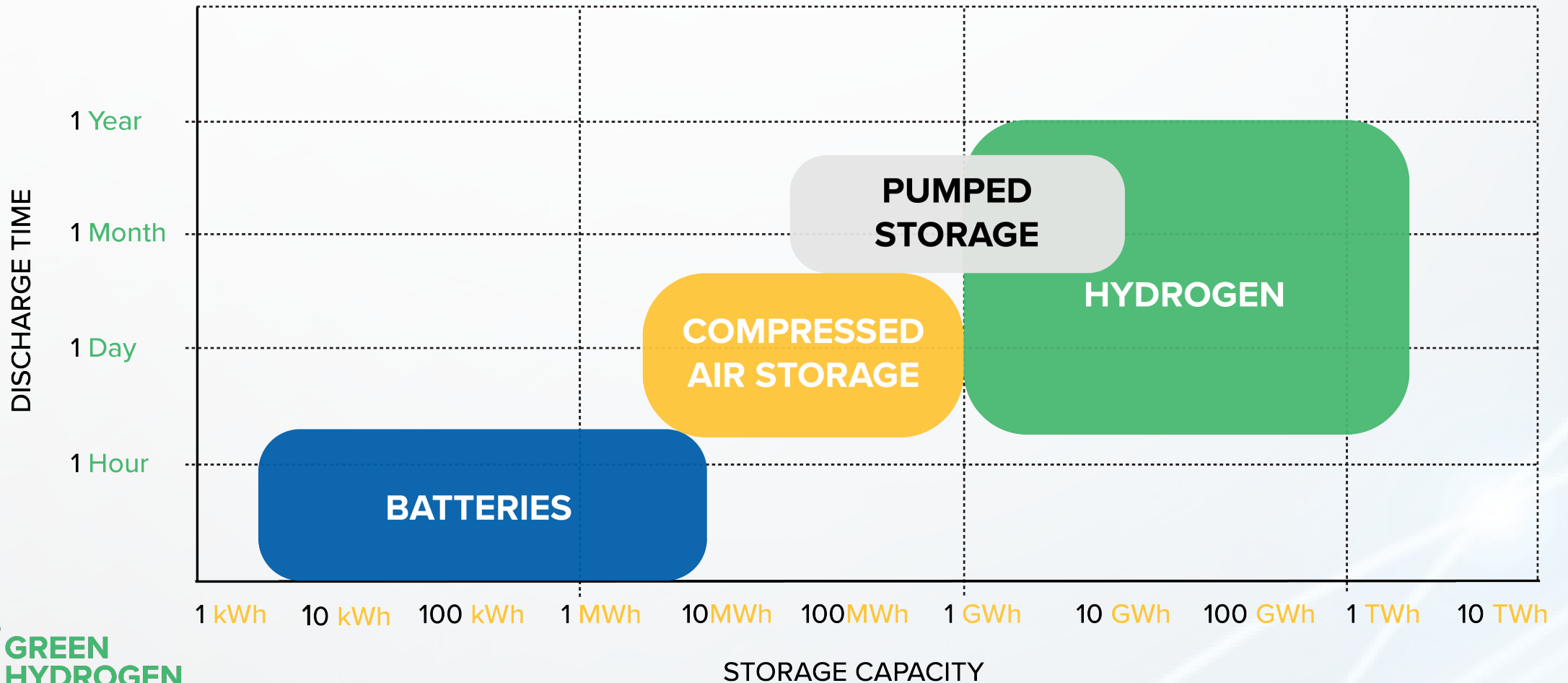


Example: California's net load, forecasted and actual 2016 & 2018

Achieves 100%  
Renewables

# Green H<sub>2</sub> is the only commercially viable seasonal storage solution available today

ENERGY STORAGE CAPACITY VS. DISCHARGE TIME FOR COMMERCIALY AVAILABLE SEASONAL STORAGE SOLUTIONS





# Green Hydrogen is Key to carbon-free energy supply **ACROSS** sectors

- **Green Hydrogen can help overcome difficult challenges**
  - Integrate more renewables
  - Decarbonize hard-to-abate sectors: steel, chemicals, trucks, ships, planes
  - Enhance energy security
- **Challenges for Green Hydrogen are fundamentally market design-related**
  - Achieving scale to reduce cost
  - Compensation for all benefits provided
  - Consideration of Green Hydrogen as part of planning tool kit
- **Multi-sectoral project opportunities to address challenges that exist today**



**Progress requires multi-jurisdictional focus**

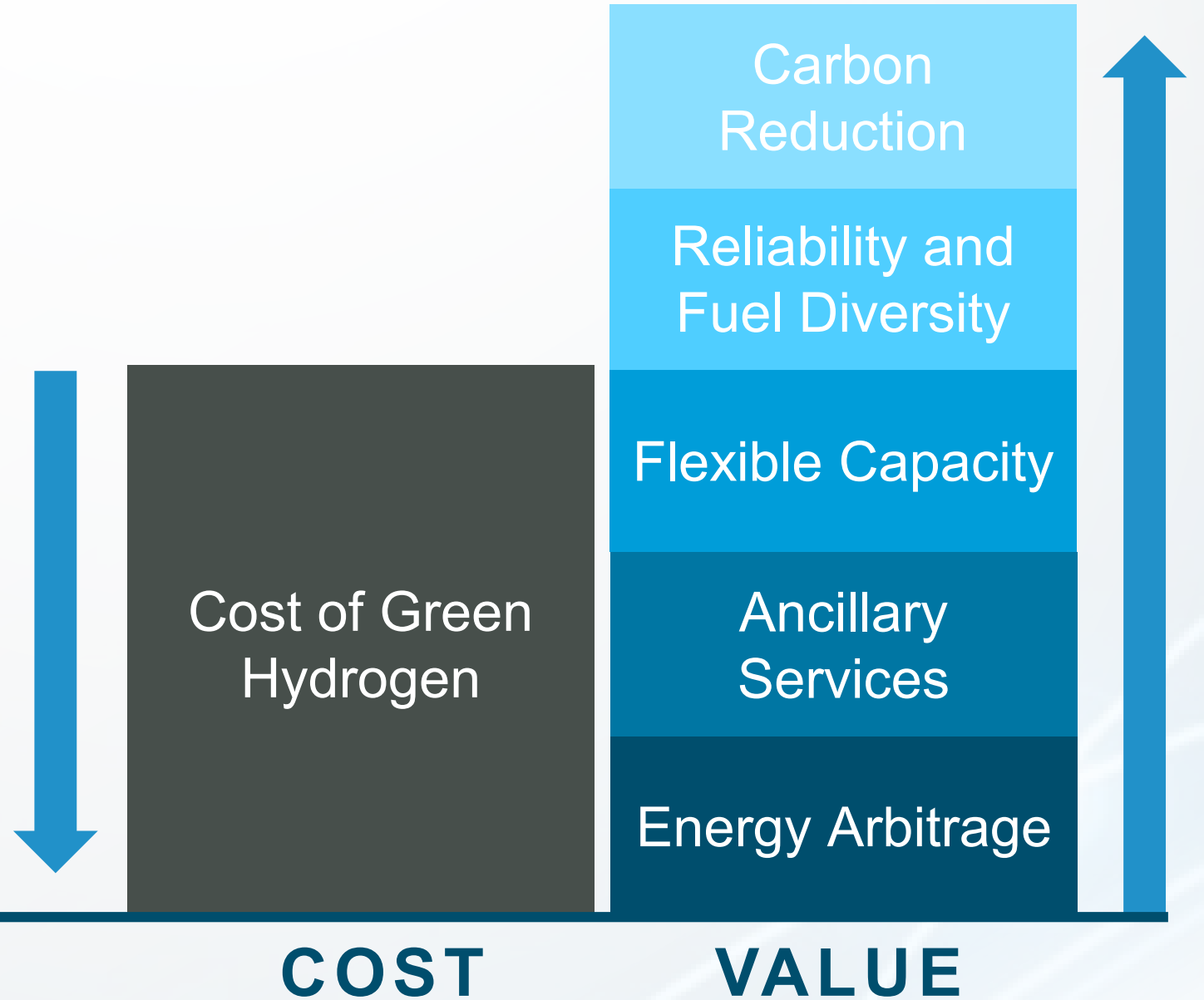
**New Paradigm  
Is Needed:**

**Valuing and  
procuring for  
net benefits**

**NOT just cost**



# Regulatory Innovation is Needed to Recognize ALL the Values Green Hydrogen Can Provide





# Appropriate market design is necessary to scale up & accelerate progress



MARKET DESIGN



CAPITAL &  
INFRASTRUCTURE  
INVESTMENT



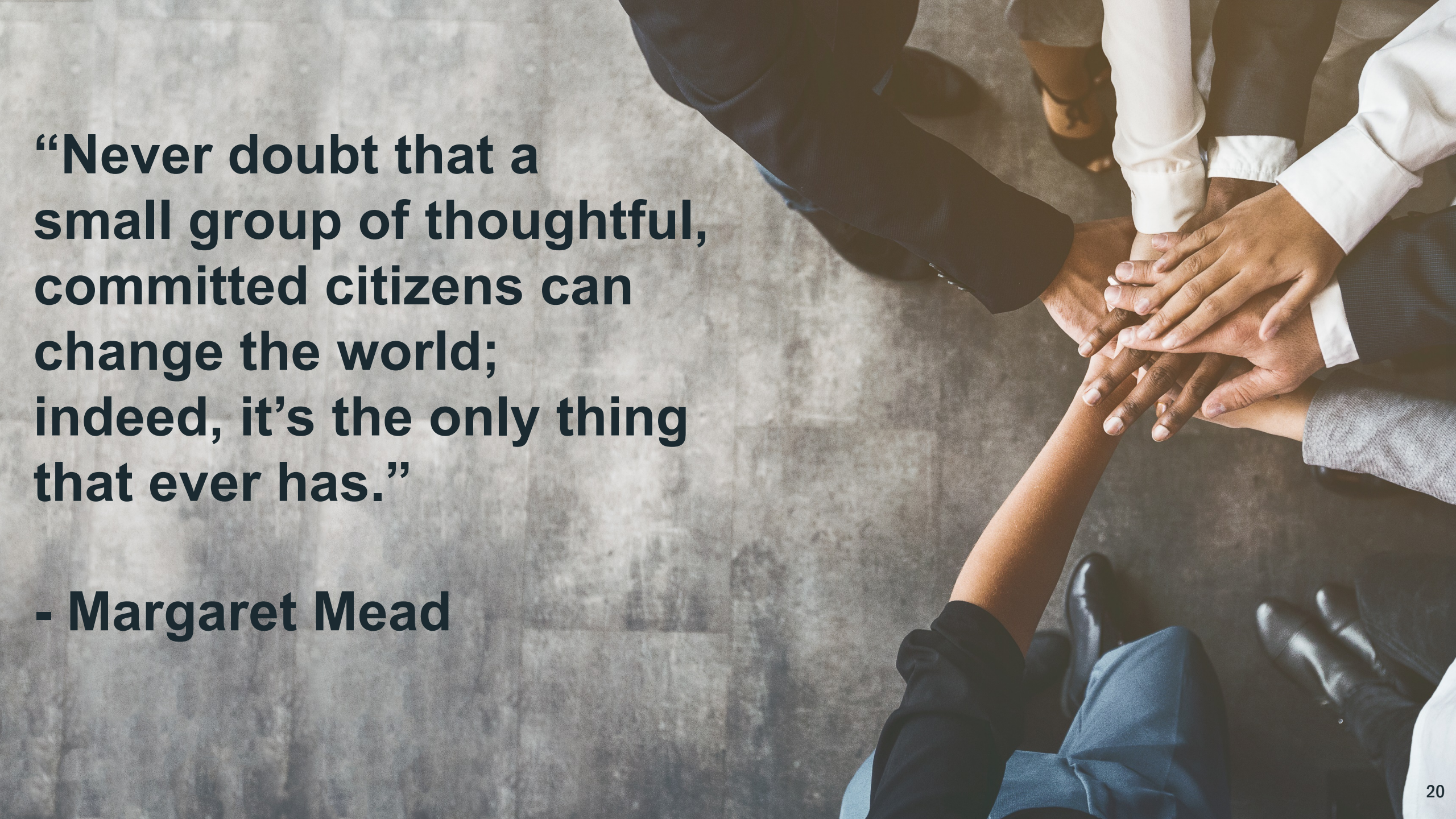
PROGRESS, IMPACT, &  
INNOVATION

# Recommendations

- **ARB-led multi jurisdictional task force (CEC, CPUC, CAISO, GoBiz)**
  - Define green hydrogen broadly – technology neutral
  - Identify opportunities to provide cross sector accounting for emissions benefits and eligibility toward SB 100 compliance
- **ARB can set decarbonization/procurement targets – can be economy wide!**
  - Green H2 in gas pipeline
  - Green H2 as alternative thermal electric generation fuel
  - Green H2 for fertilizer for agriculture
  - Green H2 for oil refining
- **ARB can coordinate development of new tariff design and market incentives**
  - Wholesale tariff design enabling curtailed and purpose built renewables for electrolysis
  - Interconnection – CAISO market participation and gas pipeline injection

**Progress requires multi-jurisdictional focus**





**“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.”**

**- Margaret Mead**



# CONTACT US

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# Strategen is a mission-driven professional services firm dedicated to decarbonizing energy systems

## ASSOCIATIONS

Strategen co-founded and manages the California Energy Storage Alliance (CESA), the Vehicle-Grid Integration Council, and the Green Hydrogen Coalition. Through these organizations, Strategen policy work has been pivotal in building the energy storage industry in California, the US, and around the world.

## CONSULTING

Since 2005, Strategen Consulting provides analysis and insight to governments, utilities, NGO's, and industry to help them achieve leading-edge market development and transformational clean energy strategies.

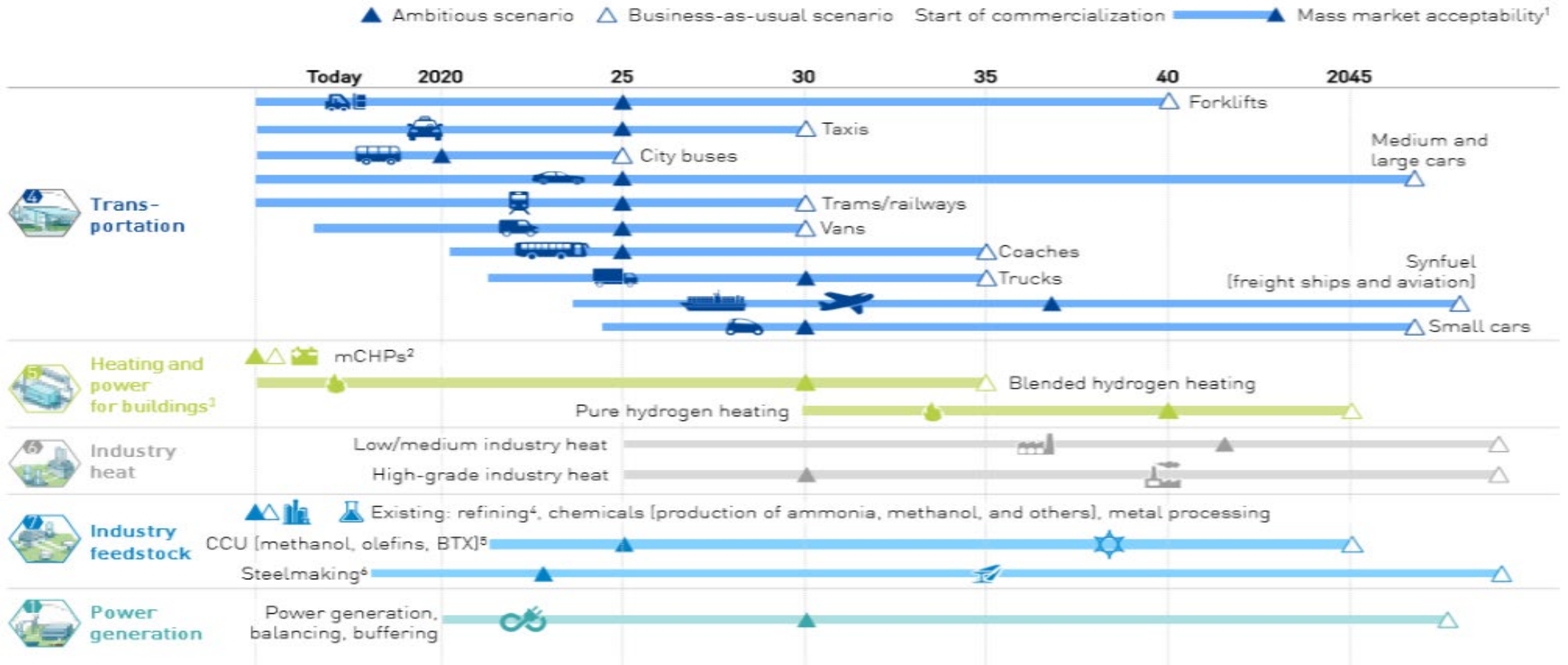
## CONVENINGS

Strategen excels in stakeholder engagement, via customized small and large events. Strategen founded Energy Storage North America (ESNA), the largest grid-connected storage conference in North America. ESNA 2021 is affiliated with Intersolar North America.

# Multi-sectoral roadmap example

## Europe's Roadmap to 100% Clean Energy

EXHIBIT 20: HYDROGEN TECHNOLOGY EXISTS AND IS READY FOR DEPLOYMENT



<sup>1</sup> Defined as sales >1% within segment    <sup>2</sup> mCHPs sales in EU independent of fuel type [NG or H<sub>2</sub>]    <sup>3</sup> Pure and blended H<sub>2</sub> refer to shares in total heating demand  
<sup>4</sup> Refining includes hydrocracking, hydrotreating, biorefinery    <sup>5</sup> Market share refers to the amount of production that uses hydrogen and captured carbon to replace feedstock    <sup>6</sup> CDA process and DRI with green H<sub>2</sub>, iron reduction in blast furnaces, and other low-carbon steelmaking processes using H<sub>2</sub>

