STRATEGEN WEBINARS

FREE WEBINAR

RE-IMAGINING THE ENERGY ECOSYSTEM WITH GREEN HYDROGEN

APRIL 14

11:00 AM (PT)

Today's agenda

- Announcements
- Main Presentation (40 minutes):

  BEYOND POWER: Re-Imagining the Energy Ecosystem with Green Hydrogen

  - Co-presented by Janice Lin and Laura Nelson
  - Moderated by Melanie Davidson, Director of Marketing, Strategen

- Q&A
- Visit www.ghcoalition.org

Today's Webinar

Re-Imagining the Energy Ecosystem with Green Hydrogen	April 14, 2020

Upcoming Webinars

Perfect 50-State Storm: COVID-19 and the Utility Crisis	TOMORROW, April 15

Past Webinars

V-DER Tariffs: Encouraging Good Grid Citizenship	March 2020
Energy Storage on the Move	September 2019
Energy Storage in Emerging Markets	April 2019
Storage as a Peaker Replacement	October 2018
Winds of Change: Global Supply Chain Updates for Energy Storage	September 2018
Rate Design Trends for Behind-the-Meter Storage	July 2018

Recordings and slides available at https://www.strategen.com/webinars

Stay Tuned for More Webinars!

STRATEGEN

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.

Janice Lin

Founder, President
Green Hydrogen Coalition

Founder, CEO
Strategen

Dr. Laura Nelson

Executive Director,
Green Hydrogen Coalition

Vice President
Strategen

Beyond Power: Reimagining the Energy Ecosystem With Green Hydrogen

GREEN HYDROGEN COALITION

Prepared for
Strategen Webinar Series
April 14, 2020

STRATEGEN

Webinar Goals and Objectives

1. Introduce the Green Hydrogen Coalition
2. Explain why green hydrogen is a super gamechanger in our fight against climate change
3. Update on global green hydrogen progress
4. Introduce the GHC's first Initiative and 2020 Priorities
5. Open pathways for collaboration

GREEN HYDROGEN COALITION

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GREEN HYDROGEN COALITION

“Climate change is the defining issue of our time – and we are at a defining moment.”

Antonio Guterres
United Nations Secretary General

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 COALITION

*The GHC is a fiscally sponsored project of Community Initiatives, a 501c3 Tax Exempt Non Profit

What is so special about Green Hydrogen?

Our Thesis:

1. **Green hydrogen is a super gamechanger in our fight against climate change – 'fundamental building block'**
2. **Accelerated adoption is fundamentally a market design challenge: how to achieve production and use at scale**

We Believe:

1. **There are many commercial pathways to safely producing Green hydrogen**
2. **Today, green hydrogen can provide multi-day and seasonal energy storage for the power grid.**
3. **Scaling green hydrogen production will enable decarbonization of many sectors including shipping and aviation**

GREEN HYDROGEN COALITION

GHC Purpose and Core Values

Purpose:

Accelerate decarbonization to combat climate change

Core Values:

- **Technology and business model neutral**
- **Respectful and constructive collaboration with all stakeholders**
- **Integrity**
- **Safety**
- **Environmental justice**
- **Impact**

GHC will address key barriers…

- Build broad stakeholder support for green hydrogen use cases
- Establish evaluation & procurement framework for the costs/benefits of green hydrogen, including use cases that span jurisdictions
- Reduce the cost of physically moving green hydrogen from supply sources to demand centers
- Establish pricing, emissions benefits accounting and development of new market products for green hydrogen production and uses

…that span jurisdictions …

GHC has a different approach than other hydrogen-focused organizations…

1. The GHC is an educational and advocacy non-profit with a focus on building top-down momentum for Green Hydrogen
2. The GHC will leverage multi-sectoral opportunities to concurrently scale production and demand for Green Hydrogen.
3. The GHC will facilitate policies and practices to create compensation pathways and other market mechanisms to enable Green Hydrogen project development that spans multiple sectors
4. The GHC will have a global focus, demonstrating the technical and business feasibility of Green Hydrogen for domestic use and as a valuable export commodity

…and is committed to working collaboratively with all stakeholders

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GHC Membership

Leadership Circle

LA DWP Los Angeles Department of Water & Power

MINUTE SOLAR ENERGY

Intersect Power

Visionary Circle

SoCalGas
A Sempra Energy utility®

Champion Circle

Bloomenergy®

PHOTOSOL US

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GHC Advisory Committee

MARTIN ADAMS

- General Manager & Chief Engineer at the LADWP

TOM BUTTGENBACH

- President & CEO of 8minute Solar Energy

SHELDON KIMBER

- CEO & Founder of Intersect Power

ROB WEBSTER

- Co-Founder & Chief Strategy Officer of Magnum Development

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GHC Board: Proven Expertise & Impact

JANICE LIN

- Founder and President of the Green Hydrogen Coalition (GHC)
- Founder and CEO of Strategen Consulting
- Co-Founder of the California Energy Storage Alliance (CESA)

DON LIDDELL

- Board Chair of the GHC
- Founder and Partner of Douglass, Liddell & Klatt
- Co-Founder of the California Energy Storage Alliance (CESA)
- Board member and chairman of the Independent Energy Producers Association

THIERRY LEPERCQ

- Founder of Soladvent
- Founder of NetsCapital
- Co-founder of Solairedirect
- Author: *Hydrogen is the New Oil*

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Green Hydrogen is a super gamechanger

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Plants make fuel from water and sun… and so can we.

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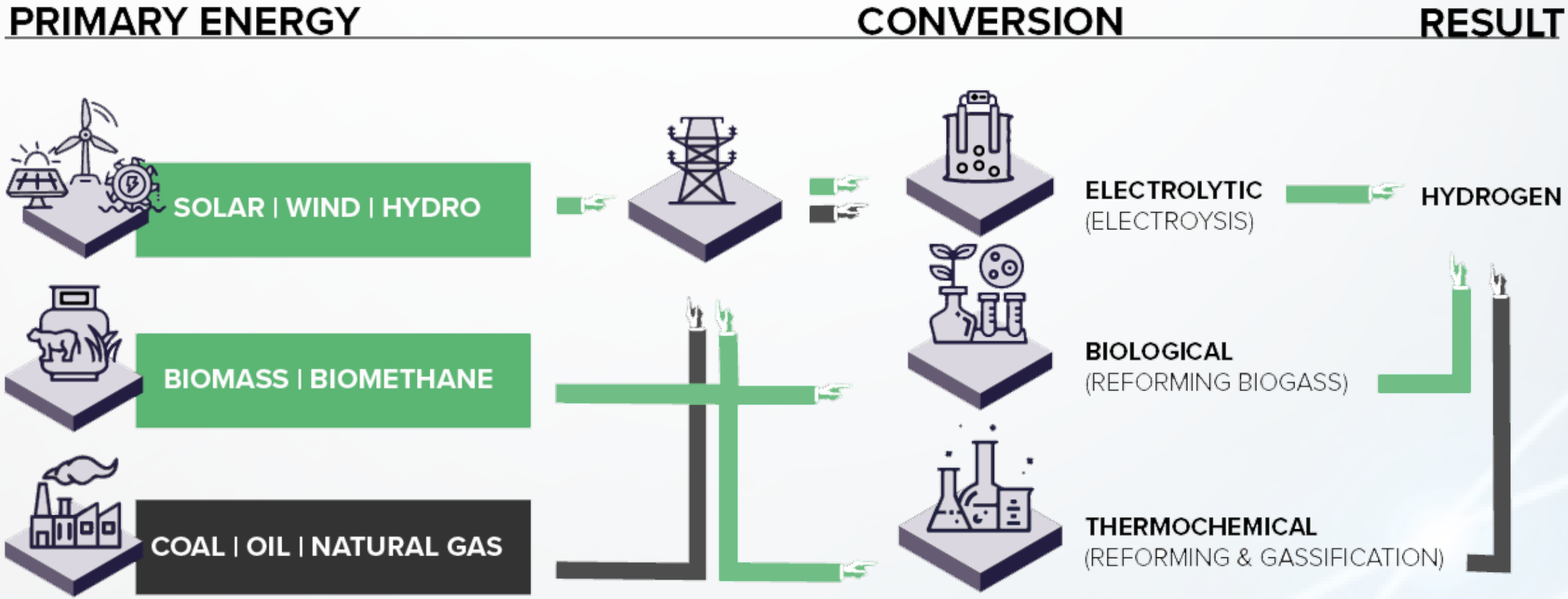
There are many ways to make Green Hydrogen...



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Green Hydrogen has versatile applications

TRANSPORT

POWER

INDUSTY

CHEMICAL

AGRICULTURE

Hydrogen has the potential to reduce emissions across many sectors

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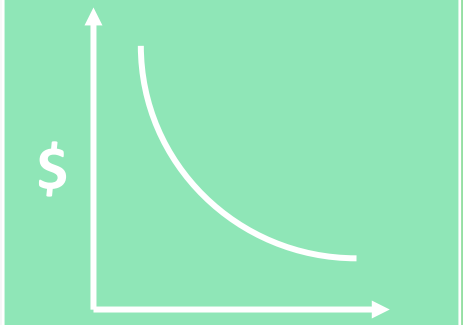
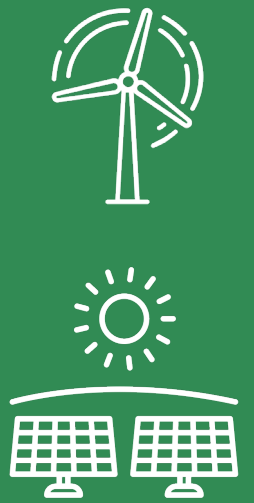
Why Green Hydrogen is a Super Gamechanger

Commercially Viable	Repurposes Infrastructure & Jobs	Decarbonizes Globally Traded Commodity	Decarbonizes Many Sectors	Achieves 100% Renewable Energy Affordably, Flexibly, & Reliably
				

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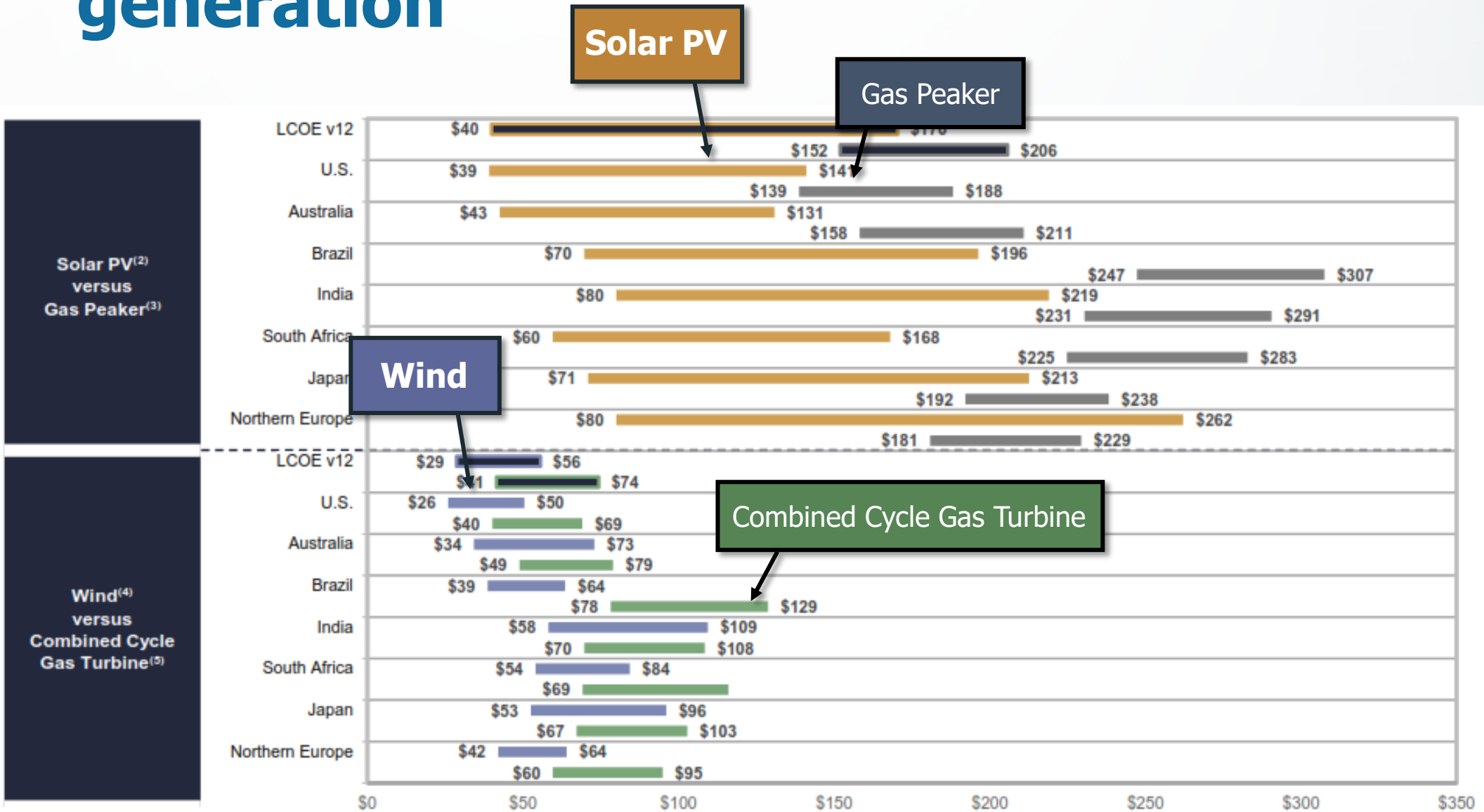
Commercially Viable

Renewables are now cheaper than fossil generation



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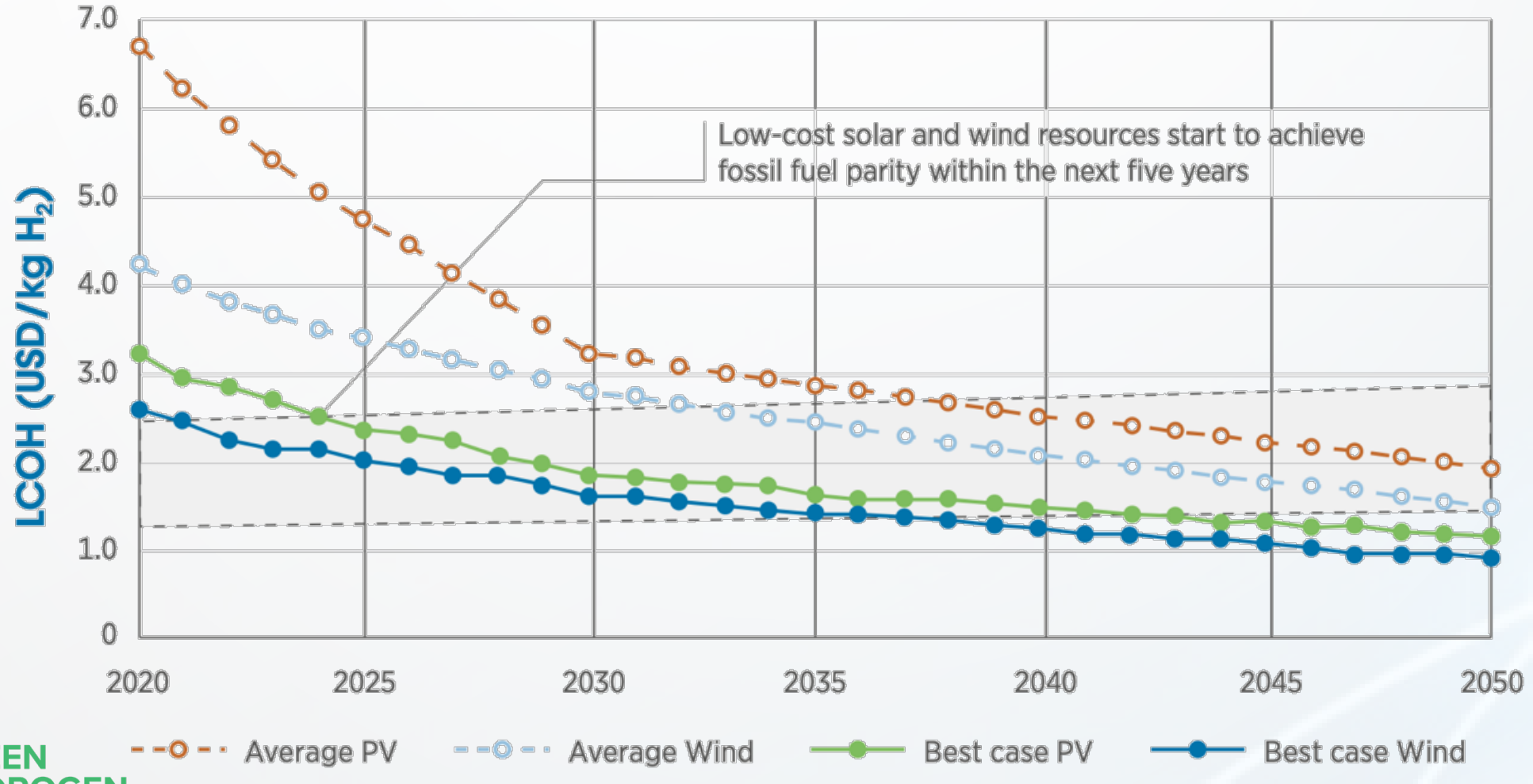
Source: Lazard

Commercially Viable

Green H_2 is commercially viable; on trajectory for lowest cost



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•*IRENA, 2019*: Dolf Gielen, Emanuele Taibi and Raul Miranda, 2019. *Hydrogen: A Renewable Energy Perspective.* International Renewable Energy Agency (IRENA). Report.

Repurposes Infrastructure & Jobs

Green Hydrogen (H_2) can repurpose existing infrastructure …

Source: LADWP

…Enabling an affordable & responsible transition

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Decarbonizes Traded Commodity

Green H_2 can decarbonize today's global hydrogen commodity markets …

Today's Global Hydrogen Value Chains

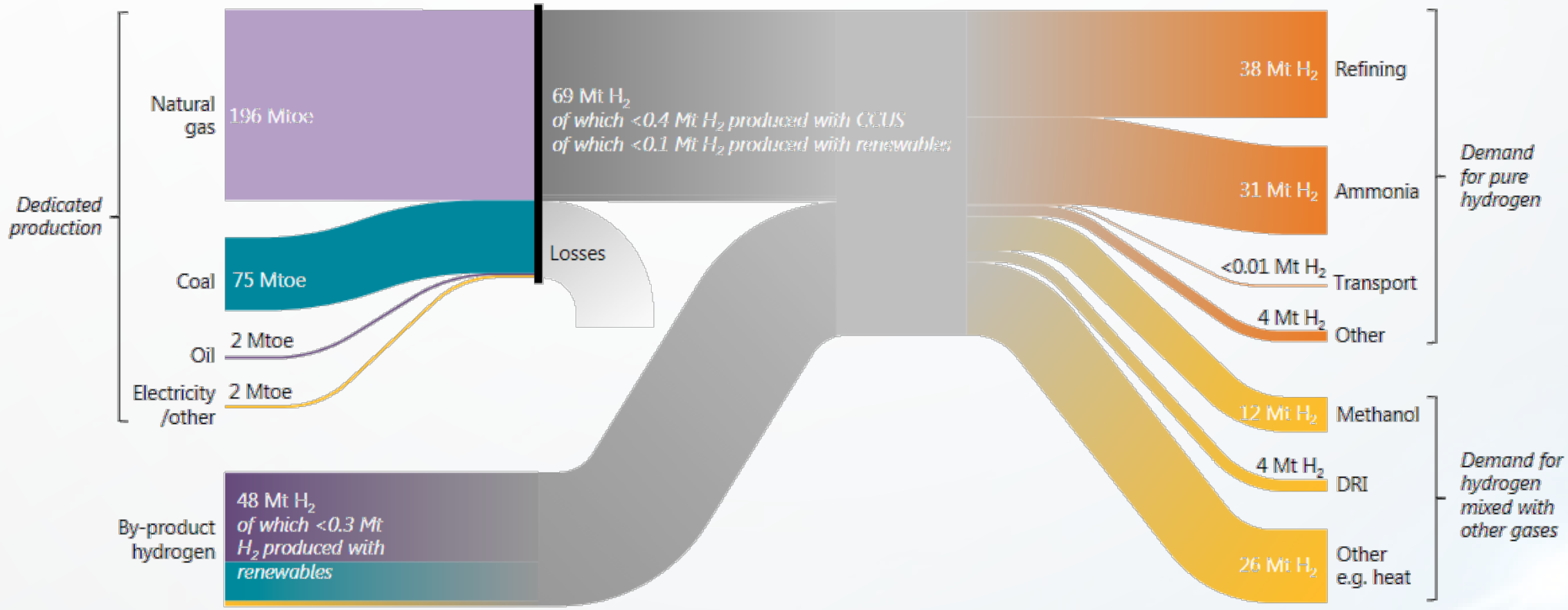

Image from "The Future of Hydrogen: Seizing today's opportunities" report prepared by IEA for the G20, Japan.
Mtoe=million tons of oil equivalent. Mt=million tons

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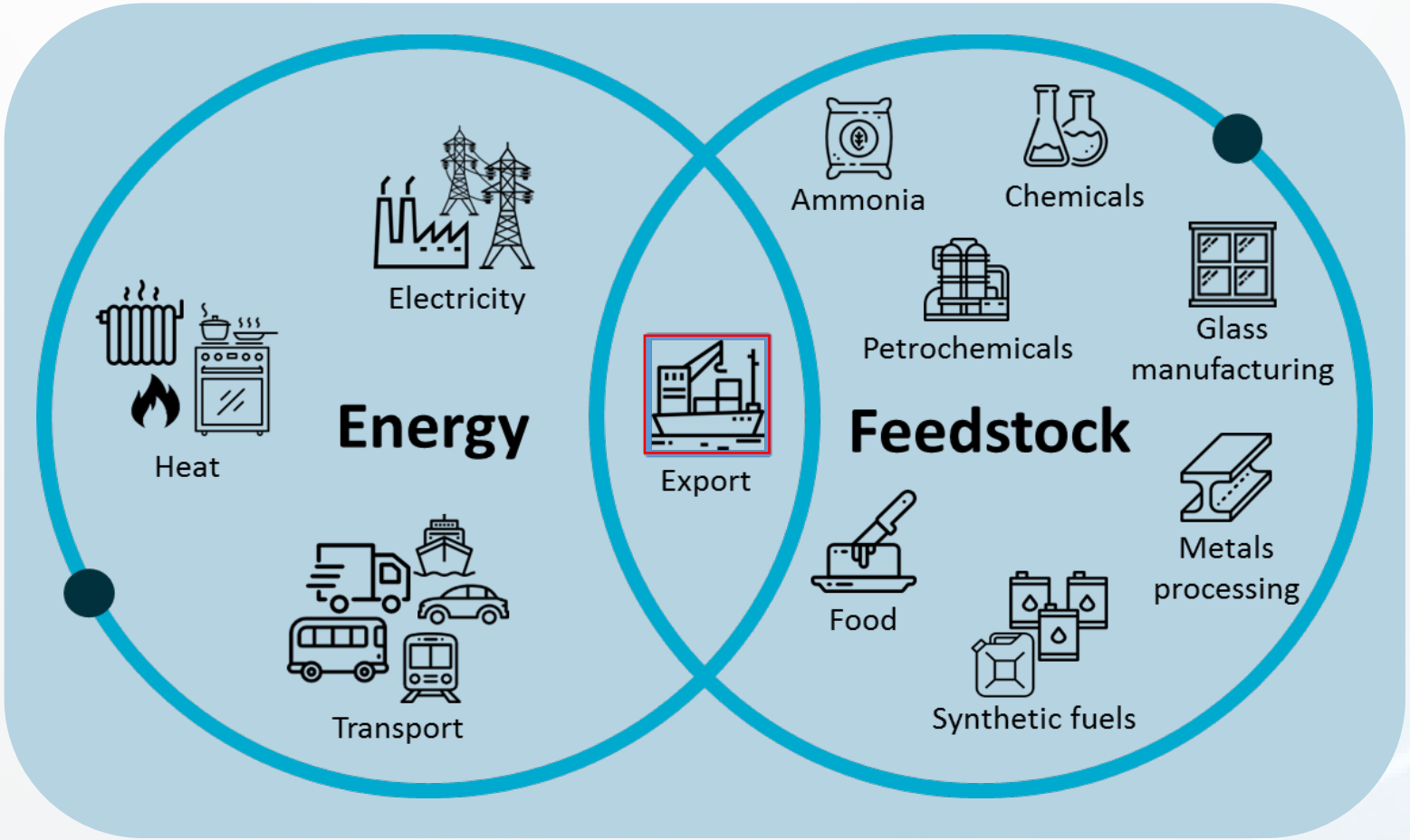
>99% is made from fossil fuels

Green H_2 can decarbonize many applications and sectors- even aviation



Source: CSIRO

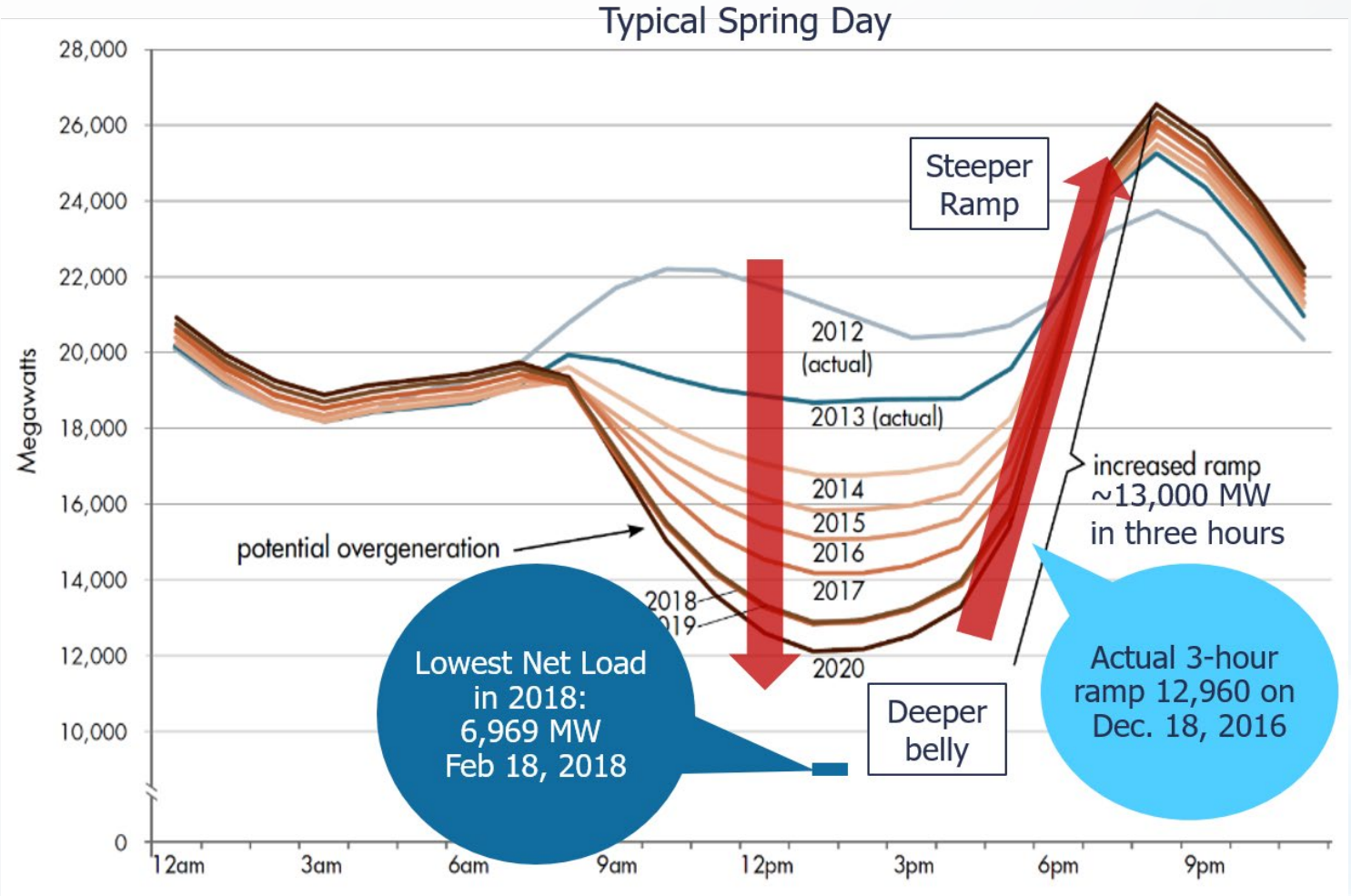
Green H_2 with fuel cells can be used as a clean alternative to diesel and gas backup generators today

Photo Credit: Altergy

Achieves 100% Renewables

Green H_2 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

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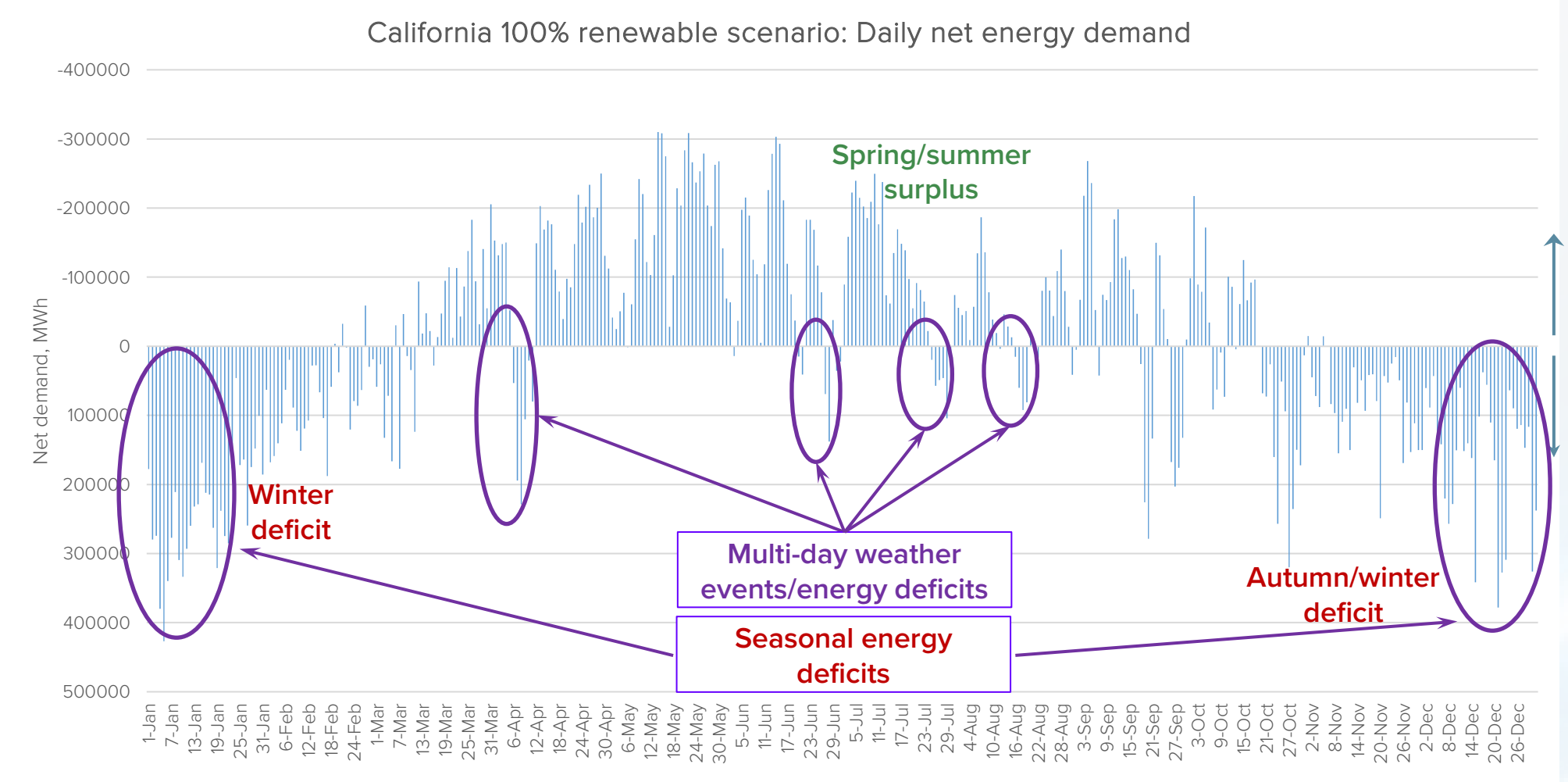
Achieves 100% Renewables

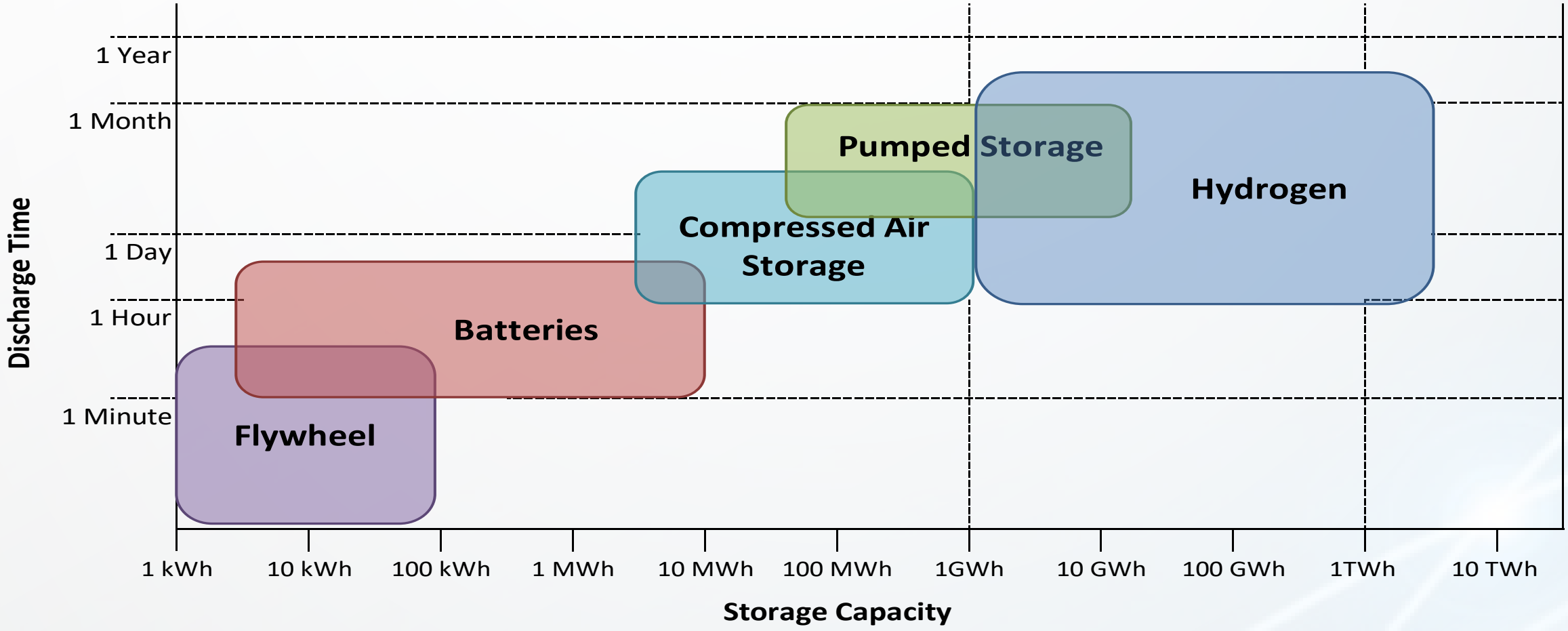
By uniquely providing low cost multi-day and seasonal energy storage



Source: CAISO and Strategen Analysis

Achieves 100% Renewables

Green H_2 is the only commercially viable seasonal storage solution available today



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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

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A NEW PARADIGM IS NEEDED

- System-wide transformation
- Planning across sectors
- Valuing benefits, not just costs!

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New Paradigm Is Needed:

Valuing and procuring for net benefits

NOT just cost

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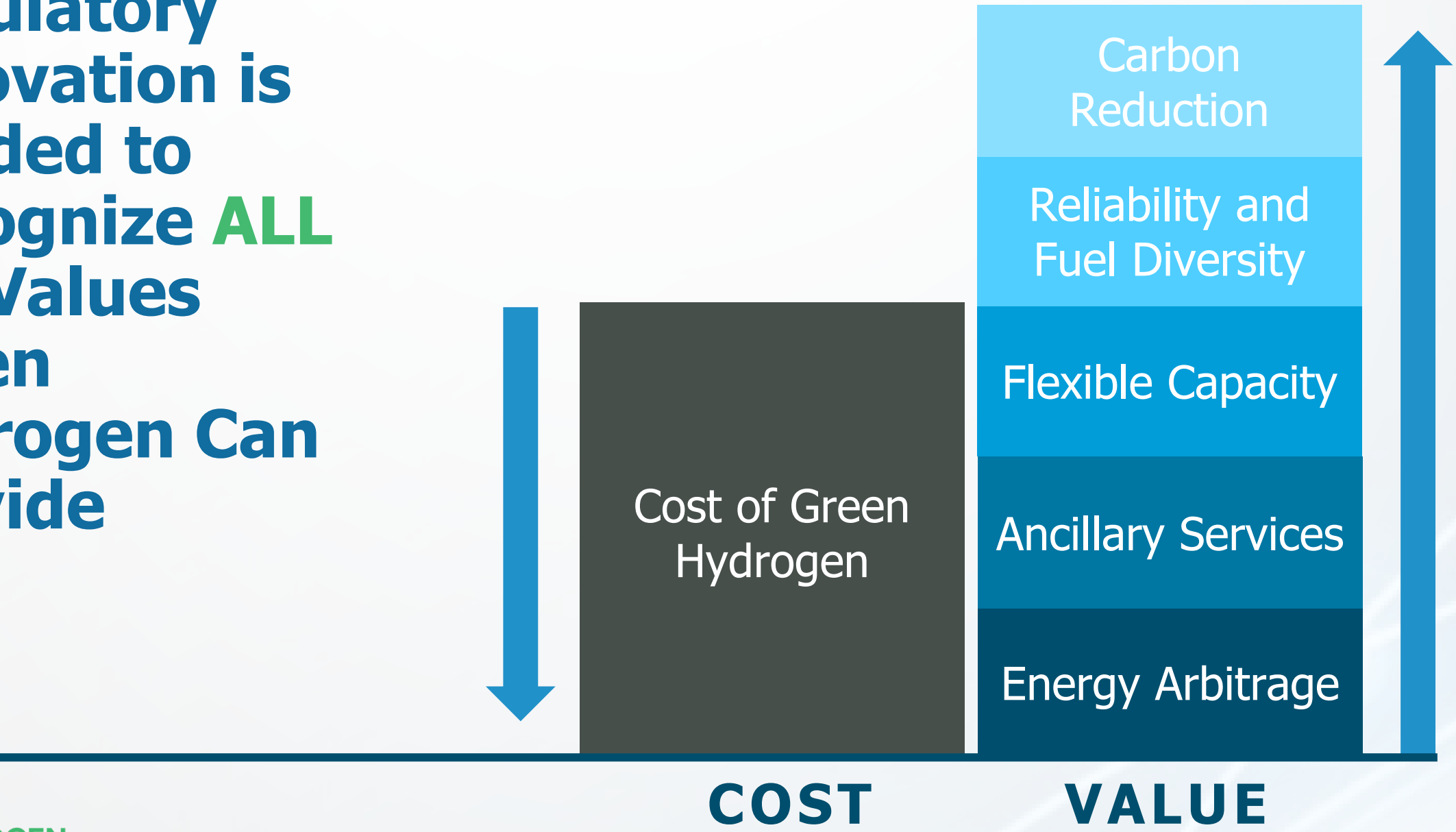
Regulatory Innovation is Needed to Recognize ALL the Values Green Hydrogen Can Provide



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Appropriate market design is necessary to scale up & accelerate progress

MARKET DESIGN

CAPITAL & INFRASTRUCTURE INVESTMENT

PROGRESS, IMPACT, & INNOVATION

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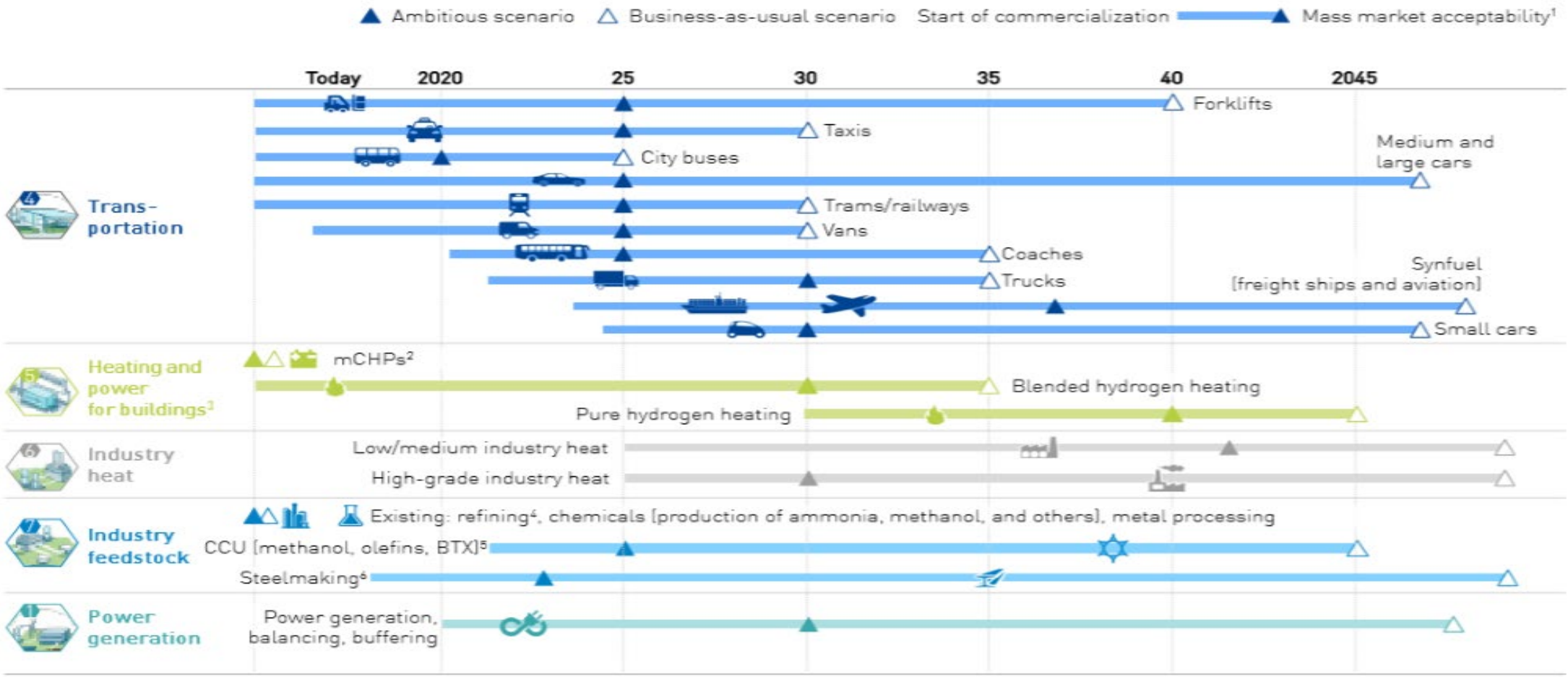
Global Drivers for Green Hydrogen:
A Roadmap to 100% Clean Energy

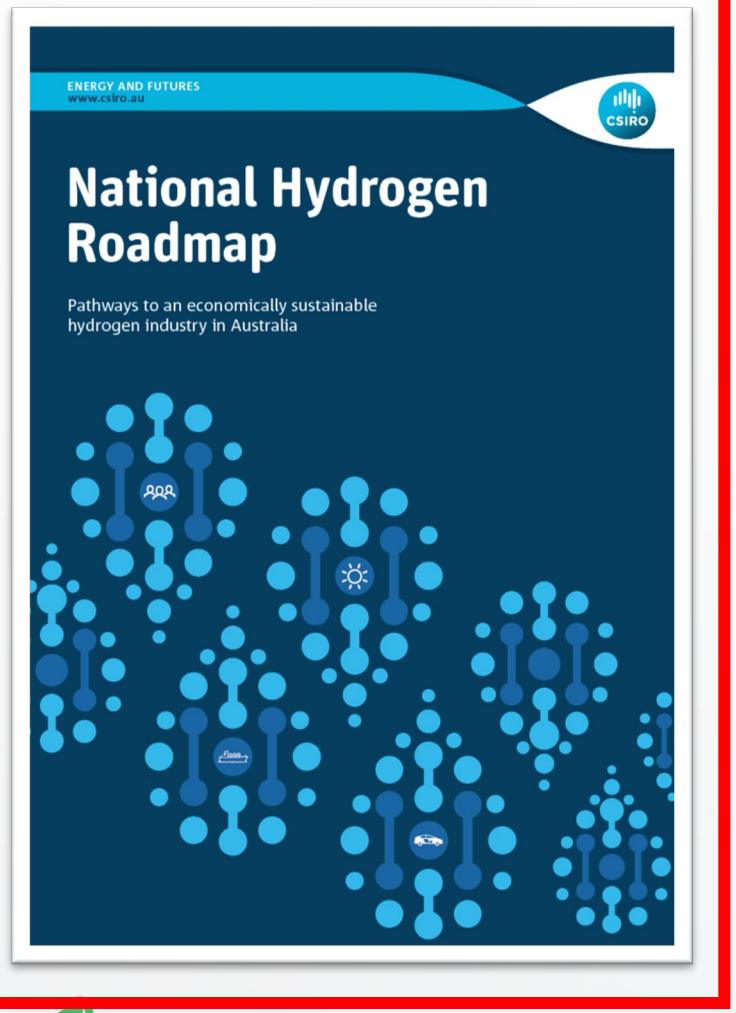
EXHIBIT 20: HYDROGEN TECHNOLOGY EXISTS AND IS READY FOR DEPLOYMENT

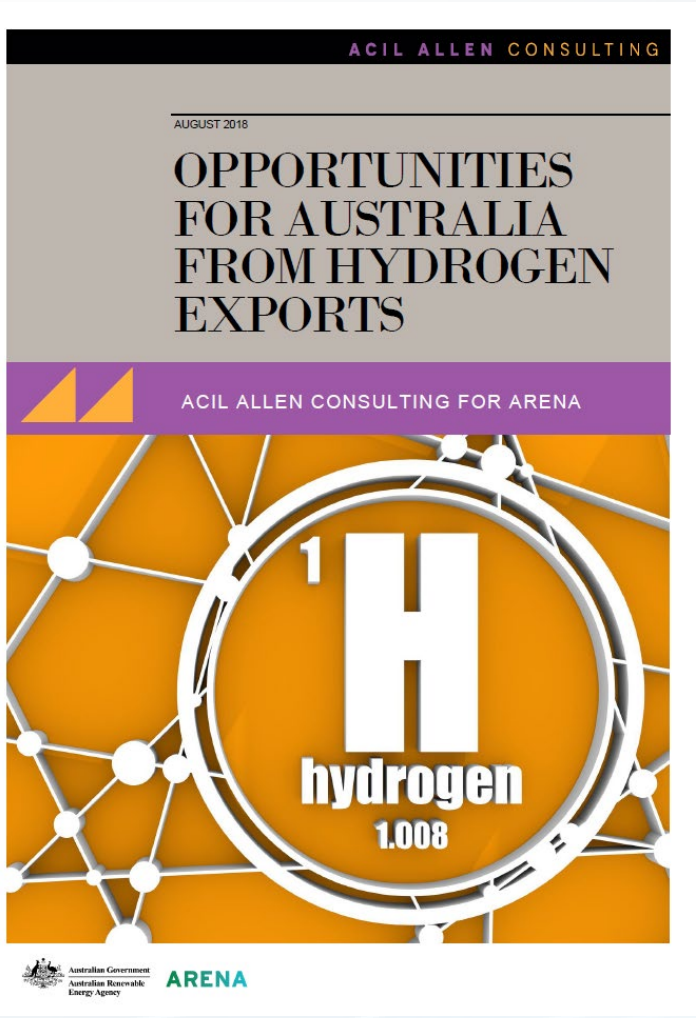


1 Defined as sales >1% within segment 2 mCHPs sales in EU independent of fuel type (NG or H_2) 3 Pure and blended H_2 refer to shares in total heating demand
4 Refining includes hydrocracking, hydrotreating, biorefinery 5 Market share refers to the amount of production that uses hydrogen and captured carbon to replace feedstock 6 CDA process and DRI with green H_2, iron reduction in blast furnaces, and other low-carbon steelmaking processes using H_2

Source: Hydrogen Roadmap Europe 2019

Global Drivers for Green Hydrogen:
Jobs and Economic Development Opportunity





Source: CSIRO Energy

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Austria: H2FUTURE 6 MW

- Description:
  - Researching the industrial production of green hydrogen as a means of replacing fossil fuels in steel production over the long term.
- Project Plan:
  - Built in 2019, currently in operation
- Goal:
  - Test whether green hydrogen is suitable for industrial-scale use in the steel industry, refineries, and other industrial sectors requiring large volumes of hydrogen

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https://www.powerengineeringint.com/2019/11/19/worlds-largest-green-hydrogen-pilot-begins-operation-in-austria/

Germany: Heide Oil Refinery 700 MW

- Description:
  - Green hydrogen production from offshore wind energy to produce aviation fuel
- Project Plan:
  - 2019 – Proposal to Federal Ministry of Economics
    - Initial: 30 MW electrolysis plant to gather information on operation, control
    - Scale-up: 700MW electrolysis plant
- Goal:
  - Continuous stream of green hydrogen for industrial use

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https://www.heiderefinery.com/en/press/press-detail/cross-sector-partnership-green-hydrogen-and-decarbonization-on-an-industrial-scale/

Netherlands: NorthH2 Project 10 GW

- Description:
  - Shell plans to have 10GW of turbines off the Netherlands coast to power green hydrogen production
- Project Plan:
  - 2027 – start with 3-4 GW
  - 2040 – 10 GW target
- Goal:
  - 800,000 tons of green H2 produced/year

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https://www.rechargenews.com/wind/shell-unveils-worlds-largest-offshore-wind-plan-to-power-green-hydrogen/2-1-763610

Belgium: Port of Oostende 4 GW

- Description:
  - Plant that produces green hydrogen from the electricity produced at Belgium's offshore wind farms
- Project Plan:
  - 2020 – Demonstration phase with shore-based power, 2.26 GW wind
  - 2025 – Commercial green hydrogen plant completed, 4MW off-shore wind
- Goal:
  - CO_2 reduction of 500,000-1,000,000 tons/year

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https://www.offshorewind.biz/2020/01/27/deme-oostende-port-and-pmv-launch-offshore-wind-to-hydrogen-project/

Canada: Chetwynd Hydrogen 3% pipeline injection

- Description:
  - Coupled electrolysis plant and wind farm to produce green hydrogen to inject into natural gas pipelines at 3% concentration
- Project Plan:
  - Build dedicated wind farm as well as the electrolysis plant
  - Negotiate agreement to inject hydrogen into natural gas pipeline
- Goal:
  - 22,000 tons green hydrogen produced/year

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https://fuelcellsworks.com/news/canada-macquarie-capital-to-finance-new-200-plus-million-renewable-hydrogen-plant-in-chetwynd

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GHC Priority #1:
Conversion of Intermountain Power Project (IPP)

IPP Overview: Convert Large-Scale Thermal Plant to 100% Green Hydrogen & Establish Regional Renewable Reliability Reserve

PROJECT OVERVIEW

Leverage curtailed and low-cost purpose-built wind and solar to produce Green Hydrogen at scale, displacing natural gas at IPP and providing renewable regional reliability (Green Hydrogen stored in purpose-built salt caverns on site)

PROJECT GOALS

1. **Demonstrate large-scale thermal plant conversion to 100% Green Hydrogen**
2. **Leverage IPP project to develop market products & contracting mechanisms to establish a scalable regional renewable reliability reserve for Western US**

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IPP History and Plan

- Located in Delta, Utah
- Two coal-fired units operating since 1986 with 1,800 MW net capacity
- Two Transmission Systems:
  - STS To Southern California
    2400 MW HVDC System
  - NTS To Utah & Nevada
  - Interconnected to 370MW of Wind Generation
- 35 Project Participants, 6 from Southern California
- Coal Units to be retired by 2025; IPP conversion to 840 MW natural gas combined cycle gas facility
- Day 1: run on 30% blend of green hydrogen ramping up to 100% over time

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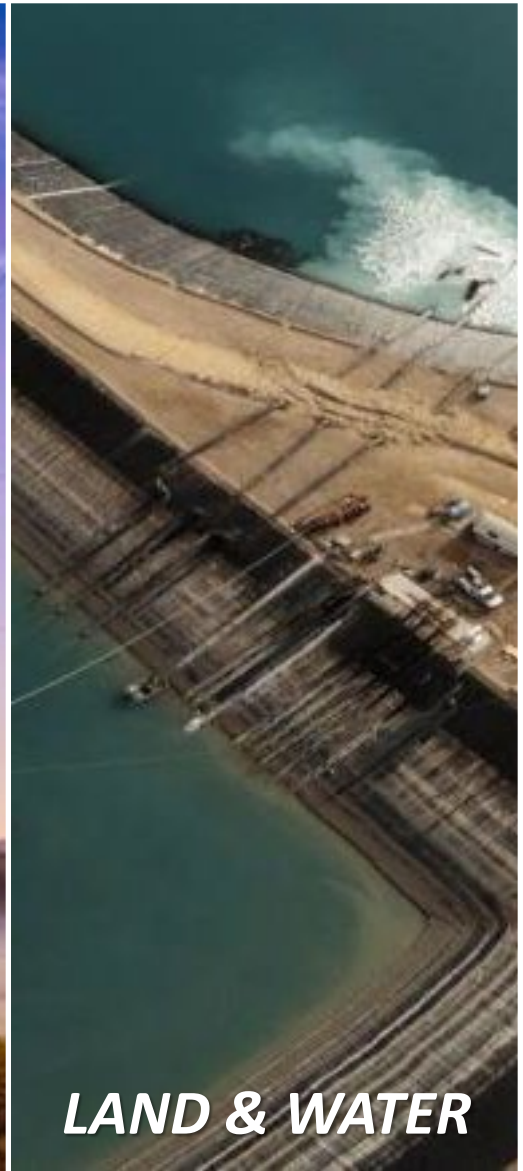
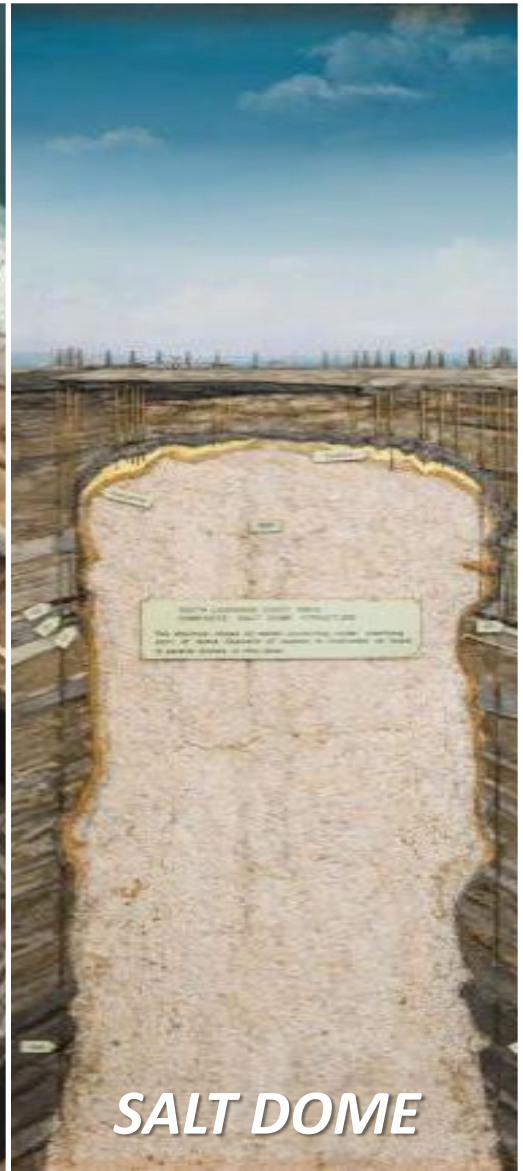
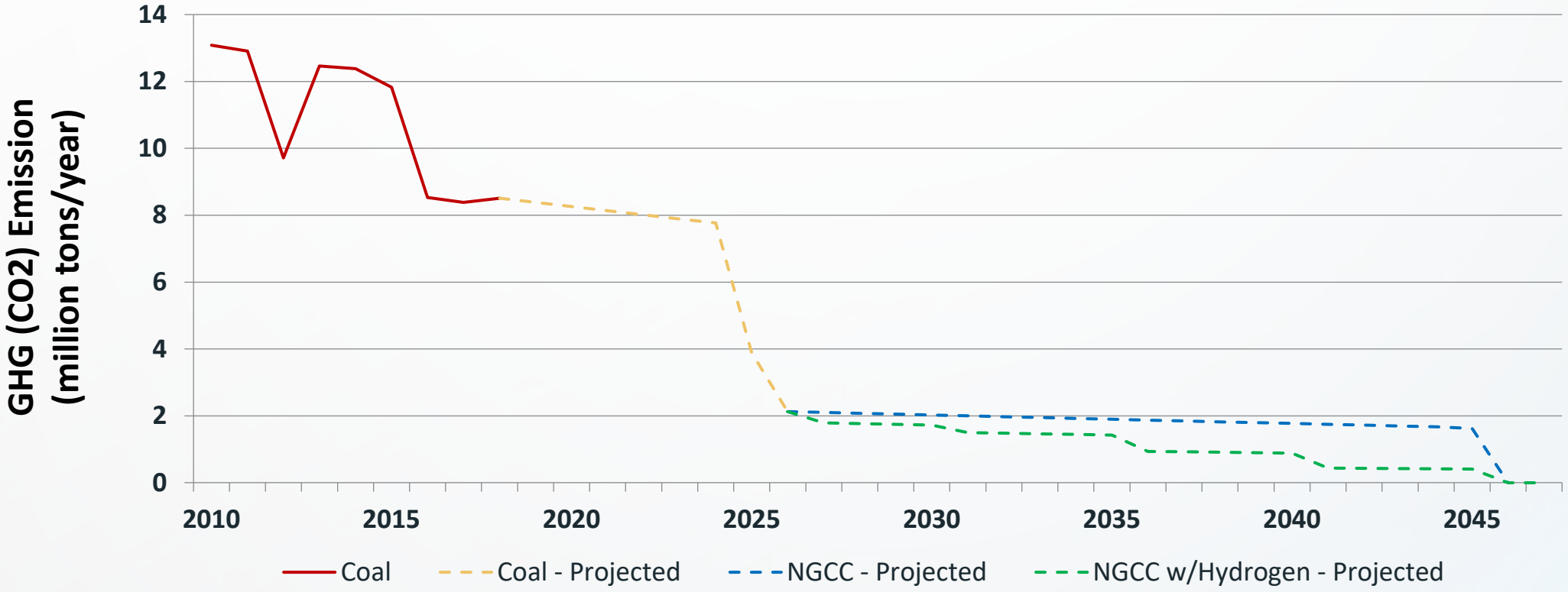
Unlocking IPP Green H_2 Potential





IPP Emissions Reduction Profile



%Hydrogen by Heat Rate	2026-2030	2031-2035	2036-2040	2041-2045	2046 -
	15%	25%	50%	75%	100%

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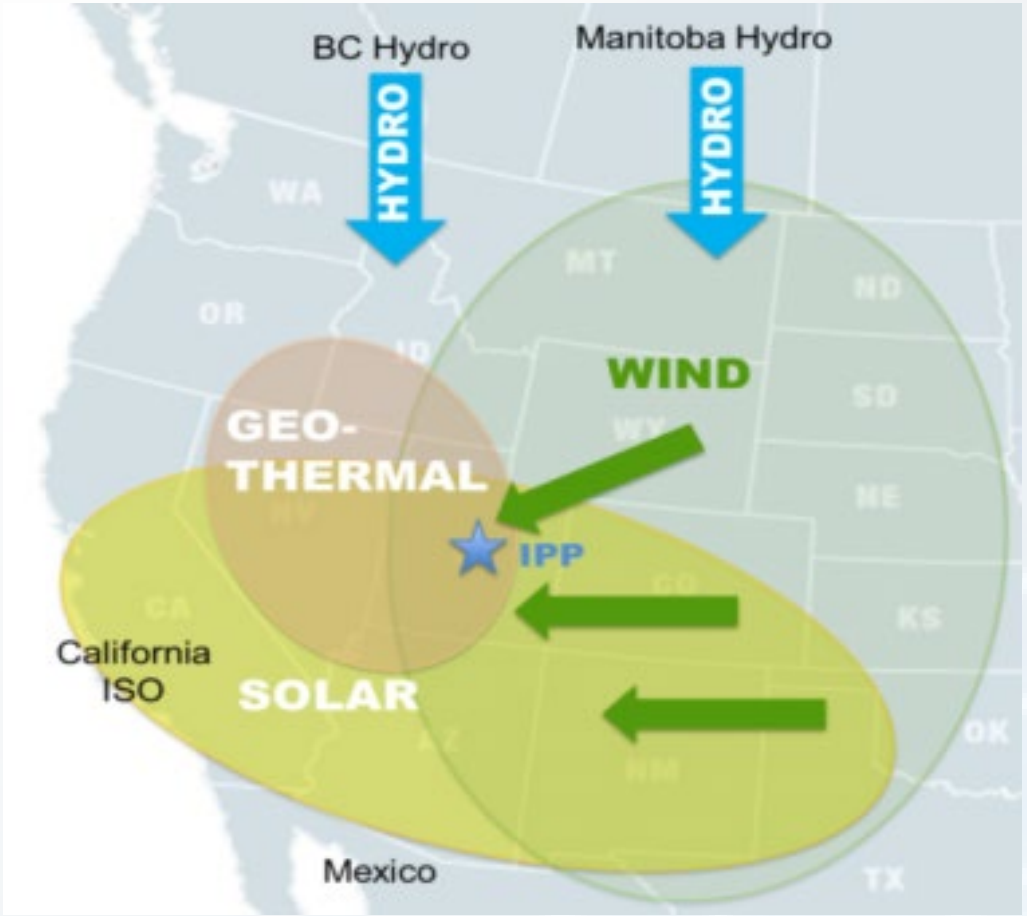
Utah's Renewable Hub

- IPP sits in a confluence of renewable resources
- Currently interconnected to 370 MW of wind generation
- Secondary Path for existing Geothermal Projects and potential for additional geothermal in the area
- 2,300 MW of current solar interconnection requests in queue
- 1500 MW of Wyoming wind interconnects currently being discussed



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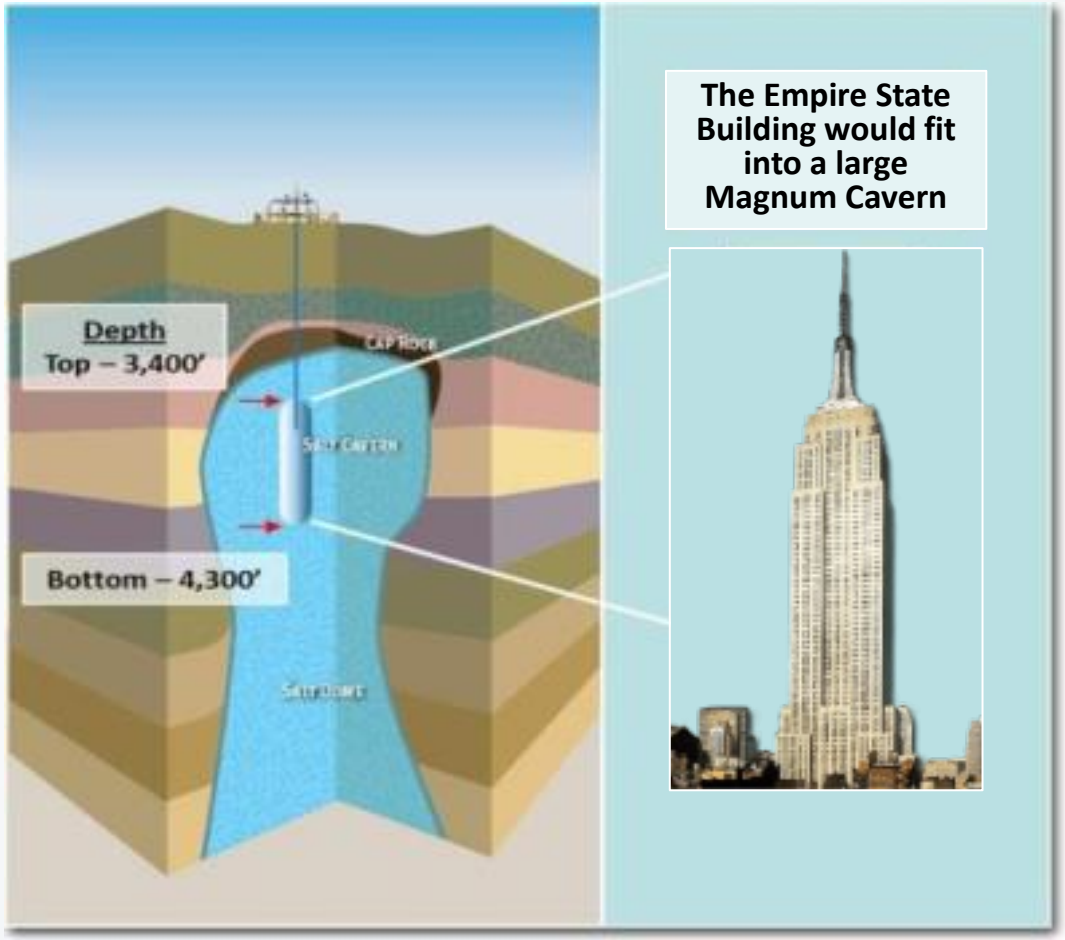
IPP Can Help Drive Global Reductions in Hydrogen Electrolyzer Capex & Operations

Source: BloombergNEF

IPP is Sited on Western US Strategic Renewable Reliability Reserve: Hydrogen Storage in Underground Salt Caverns

- A typical cavern size at IPP = 4,000,000 barrels
- 1 cavern = 5,512 tons of H_2 (operational limit)
- This is equivalent to:
  - 200,000 hydrogen buses
  - 1,000,000 fuel cell cars
  - 14,000 tube trailers used for delivery
- Over 100 caverns can be constructed in the IPP salt dome
- Storing H2 in salt caverns is already done commercially around the world



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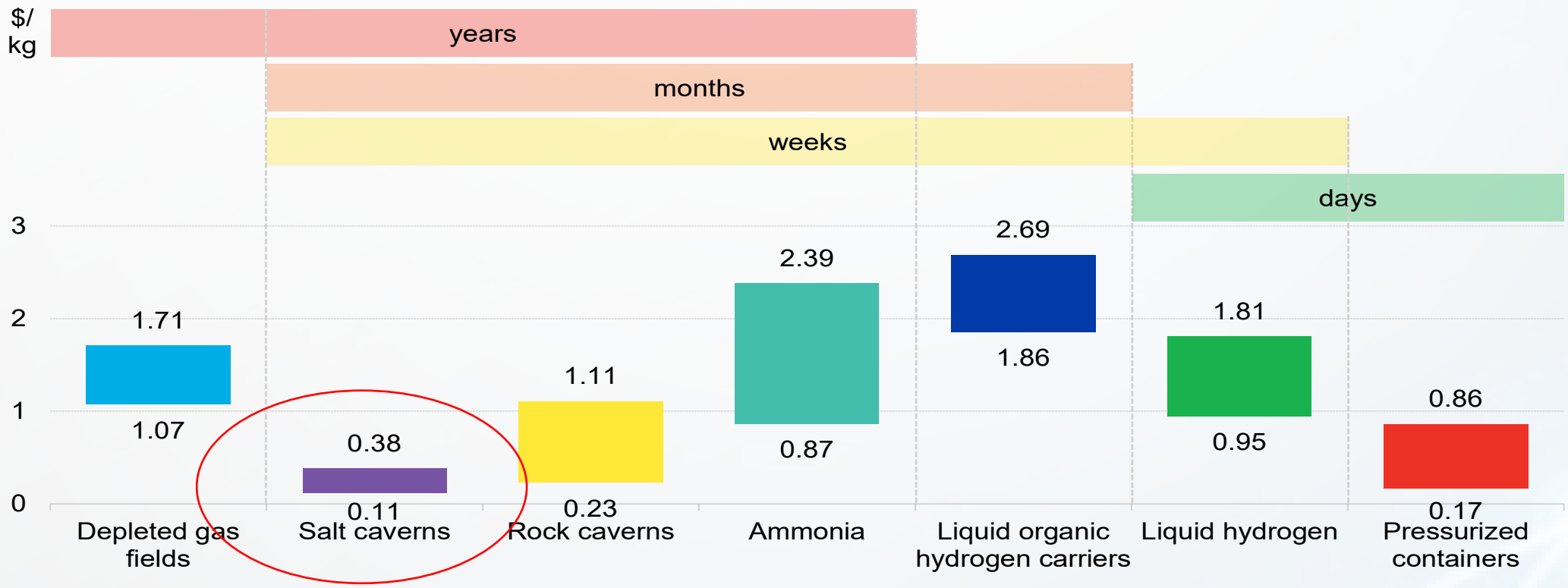
Levelized Cost of Hydrogen Storage
FUTURE BEST CASE



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Source: BloombergNEF

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GHC 2020 Priority Activities

- Build momentum, education and alignment with stakeholders
- Breakdown regulatory and policy barriers
- Facilitate Sharing of Best Practices
- Expand GHC networks

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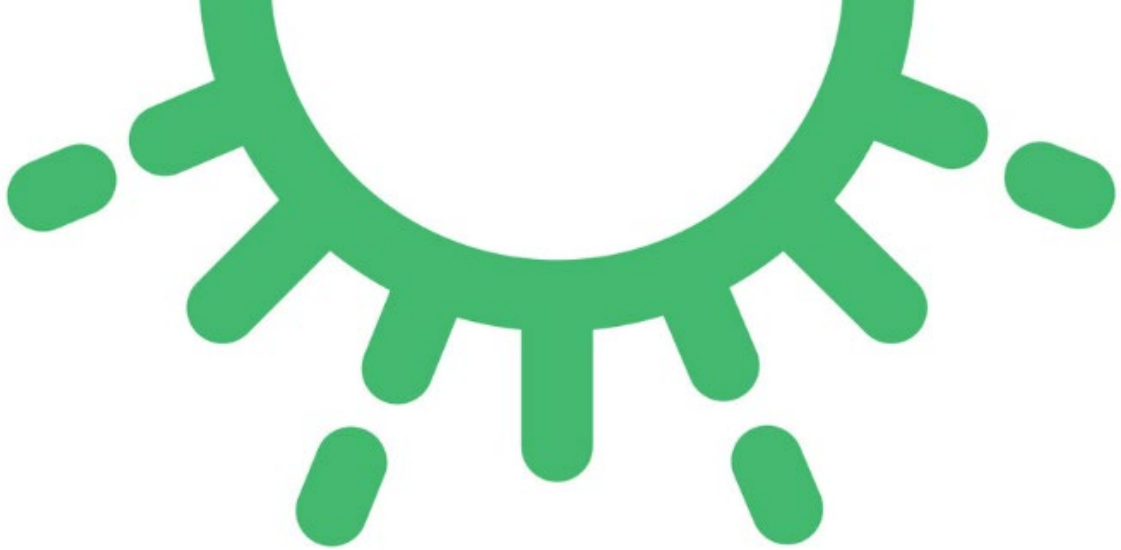
Goal: Efficient collaboration to accelerate progress and momentum for green hydrogen

Pathways for Collaboration

Objective	Pathway for Collaboration
• Shape market design for green hydrogen project development, obtain latest news, information and global best practices about green hydrogen market development	• Membership – join GHC!
• Non profit and government organizational collaboration – information sharing, messaging, events and networking	• Become a GHC Supporting Partner
• Learn about green hydrogen pathways and innovation. Stay informed, at a high, level on green hydrogen news and market developments	• Attend GHC events, sign up for newsletter

GREEN HYDROGEN COALITION

Goal: Efficient collaboration to accelerate progress and momentum for green hydrogen



"*We spend **1000x** more on global **fossil fuel** subsidies than on **natural-based solutions**.*"
-Greta Thunberg

Why Fund the GHC?

Funding matters in the fight for our climate and a clean energy future.

Visit ghcoalition.org/fund

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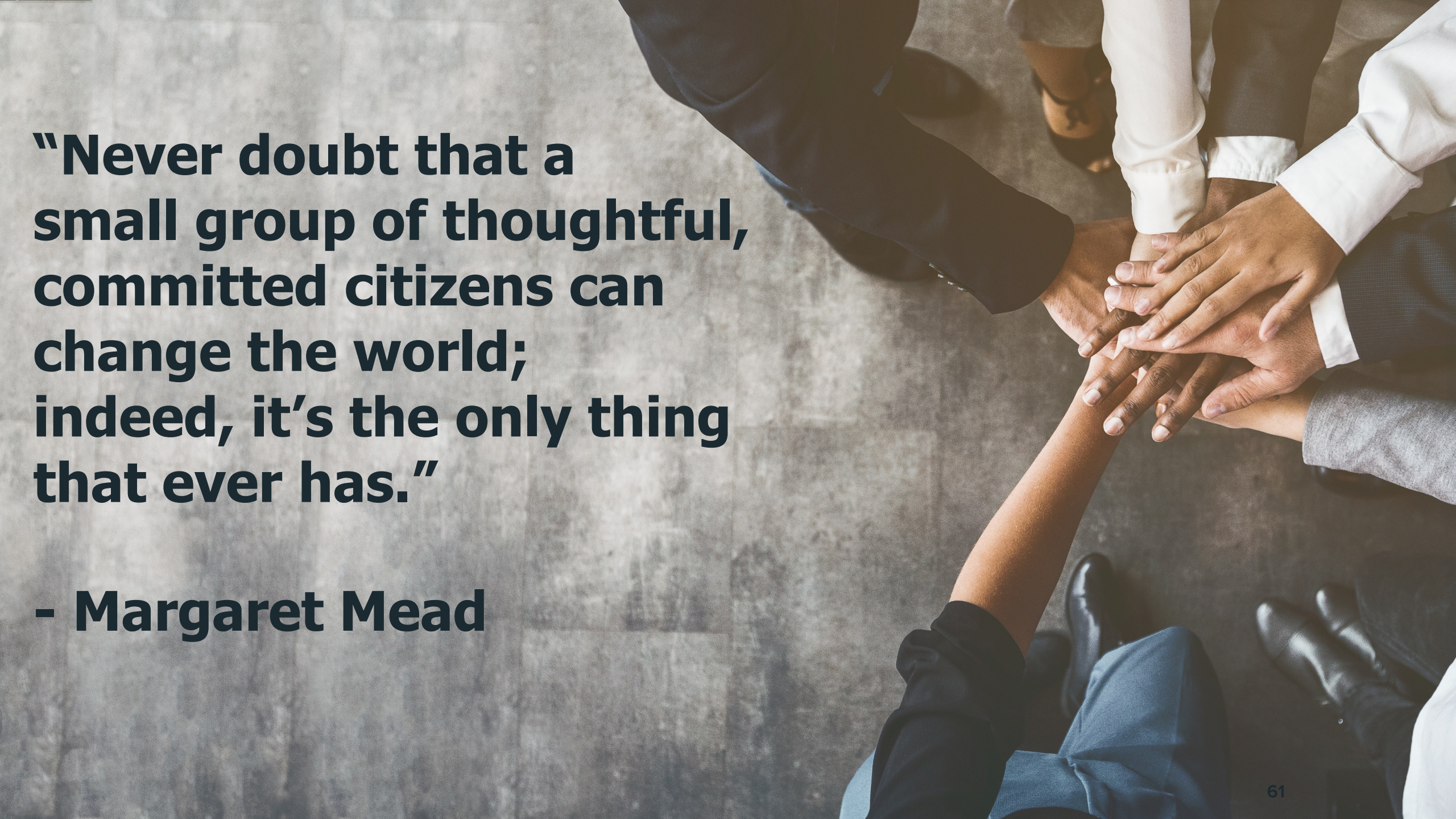
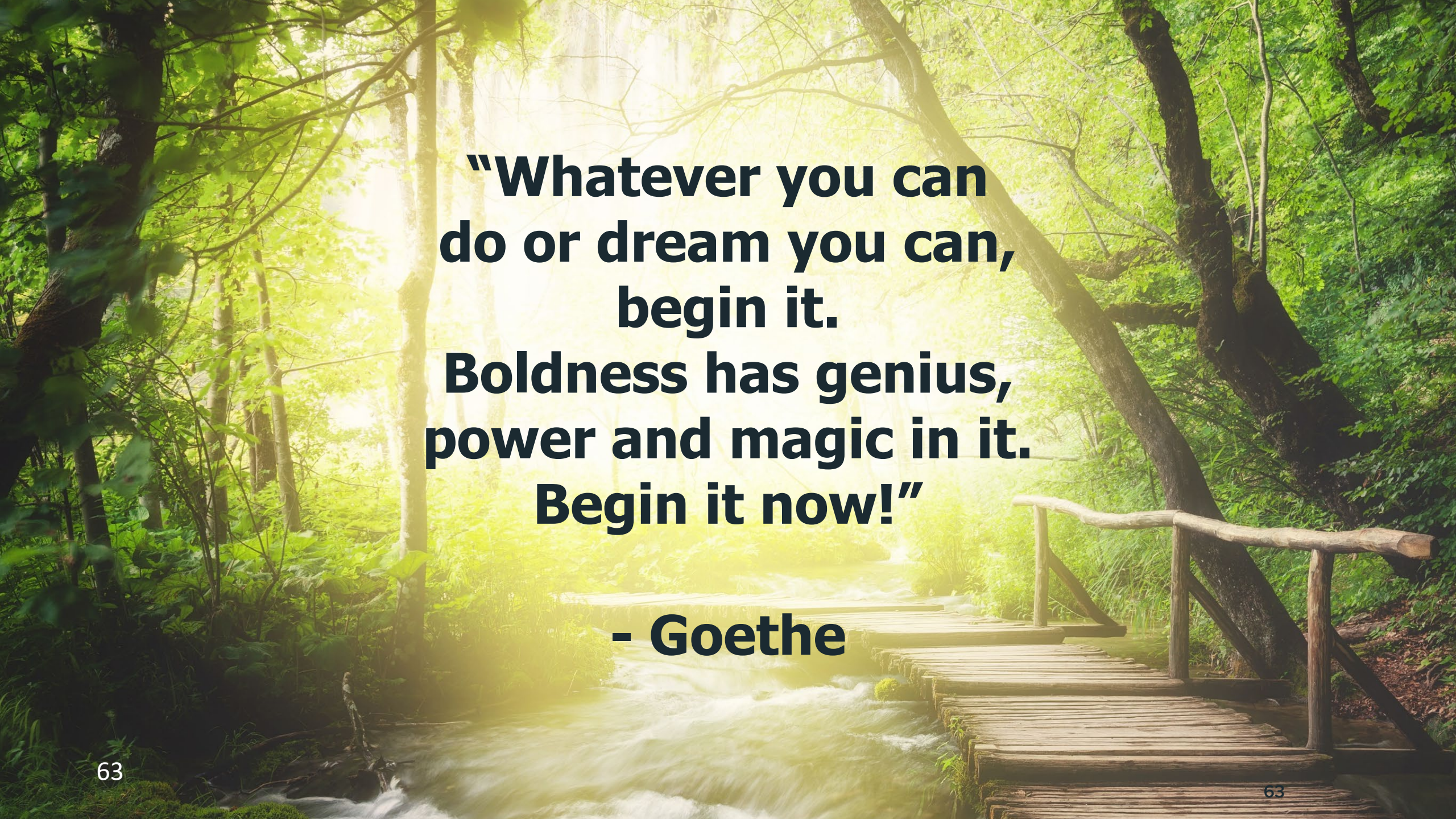

“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.”
- Margaret Mead

Green Hydrogen
is the gamechanger to fight climate change and provide a clean energy economy for everyone


“Whatever you can
do or dream you can,
begin it.
Boldness has genius,
power and magic in it.
Begin it now!”
- Goethe

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