Hydrogen from renewable power: a global perspective

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Webinar on Power-To-X as a Technology to Support the Energy Transition
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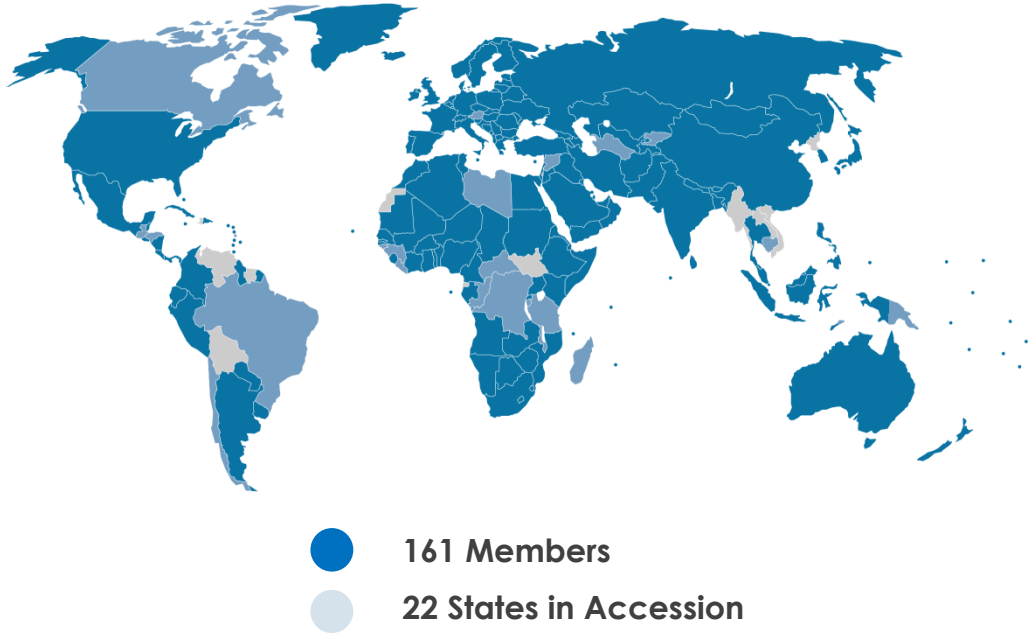
About IRENA

- Inter-governmental agency established in 2011
- Headquarters in **Abu Dhabi, UAE**
- IRENA Innovation and Technology Centre – **Bonn, Germany**
- Permanent Observer to the United Nations – **New York, USA**



Mandate: Assist countries to accelerate renewable energy deployment

IRENA's work on Green Hydrogen

"Hydrogen and electricity, as energy carriers, are complementary in a world dominated by renewable energy"

Knowledge

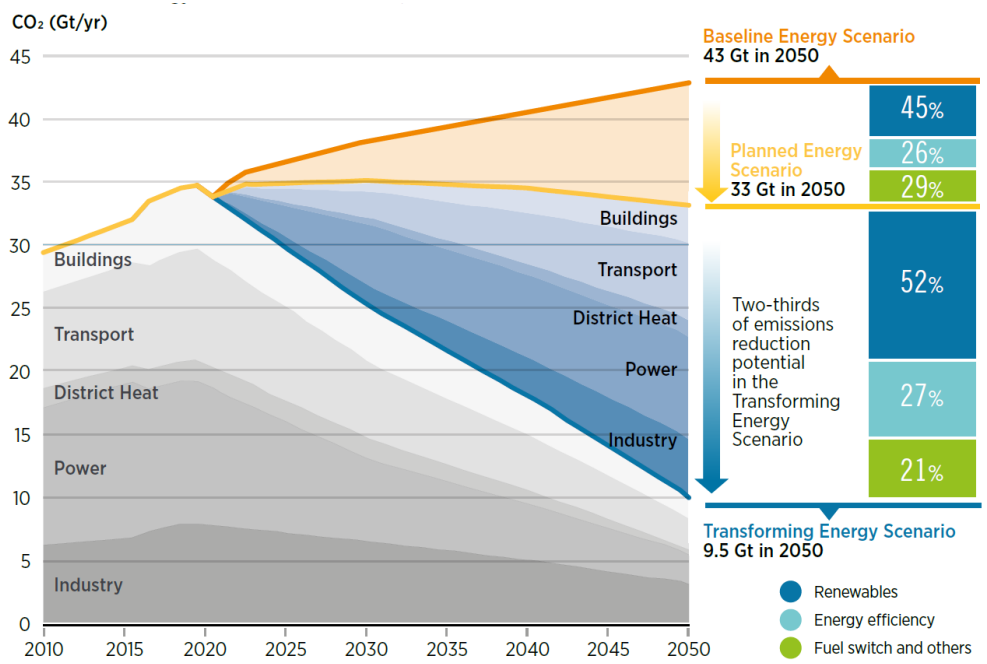
- **Hydrogen from renewable power: Technology outlook for the energy transition** (2018)
- **Hydrogen: A renewable energy perspective** (2019)
- **Reaching Zero with Renewables** (Q3 2020)
- **Technology Brief: Electrolyser Technologies** (Q4 2020)

Outreach

- **Session on "Electrification of Fuels: Hydrogen" at IRENA Innovation Week** (2018)
- **Thematic meeting "Decarbonizing complex sectors" at 18th Council** (2019)
- **Ministerial Roundtable on Green Hydrogen at 10th Assembly** (Jan 2020)
- **Collaborative Framework on Green Hydrogen** (Jun 2020)

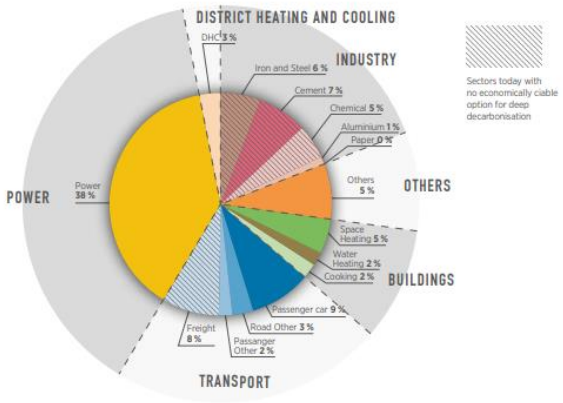
Context: the Global Energy Transformation

- Paris Agreement: Average global temperature to **“well below 2 degrees”**
- **Global Renewables Outlook 2020** (4 scenarios)
  - To achieve the Transforming Energy Scenario, **energy-related CO2 emissions need to fall** by 3.8% per year on average until 2050.
  - Annual energy-related CO2 emissions would need to **decline by 70% below today’s level by 2050.**



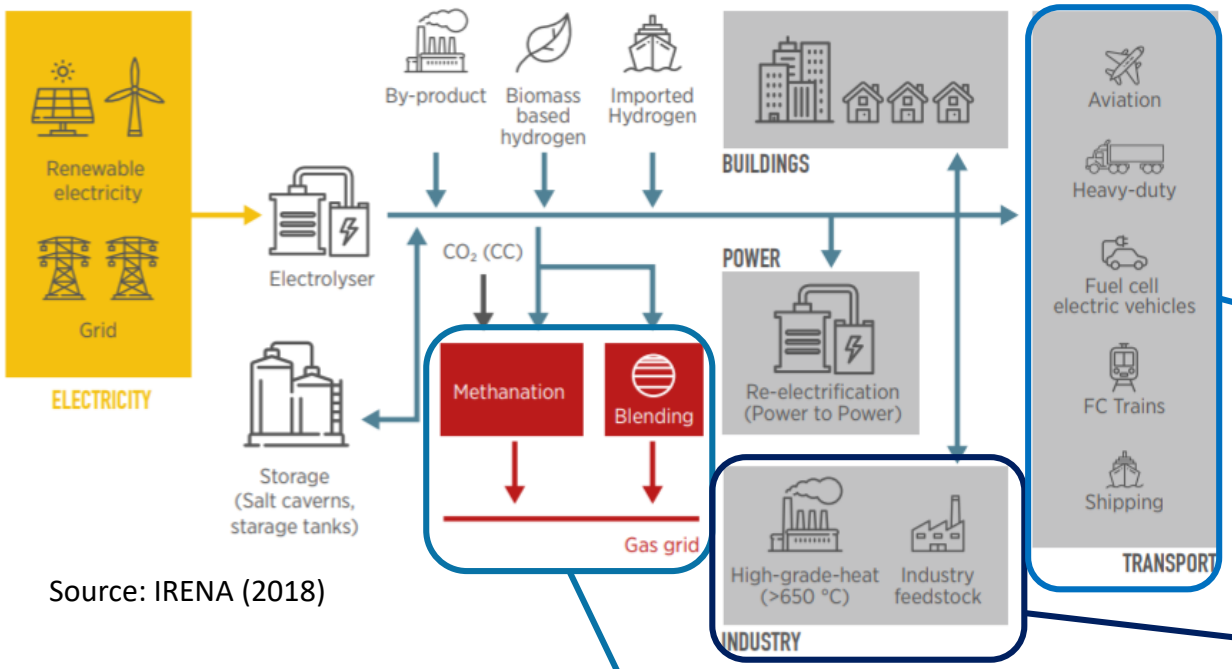
Source: IRENA (2020)

- **No economically-viable options** to decarbonize one third of energy-related emissions (mostly from the energy-intensive industry sectors and freight transport).
- **Hydrogen could be the “missing link”**: supply renewable energy to sectors for which electrification is otherwise difficult, such as transport, industry and processes that require high-grade heat



Source: IRENA (2018)

Hydrogen in the energy transition



Source: IRENA (2018)

Decarbonising Transport

- ✓ FCEVs: performances of conventional vehicles
- ✓ FCEVs are complementary to BEVs in decarbonising road transport
- ✓ FC/E-fuels for rail, aviation, maritime sector (deep decarbonization)

Decarbonising the gas grid

- ✓ Take advantage of low electricity prices
- ✓ Provide seasonal storage for solar and wind
- ✓ Provide grid services from electrolysers
- ✓ Distributed stationary fuel-cell for heat and power generation

Decarbonising Industry

- ✓ Replace fossil-fuel produced hydrogen
- ✓ Replace fossil-fuel based feedstocks
- ✓ New commodities e.g. iron pellets (DRI)

Decarbonisation

Deep Decarbonisation

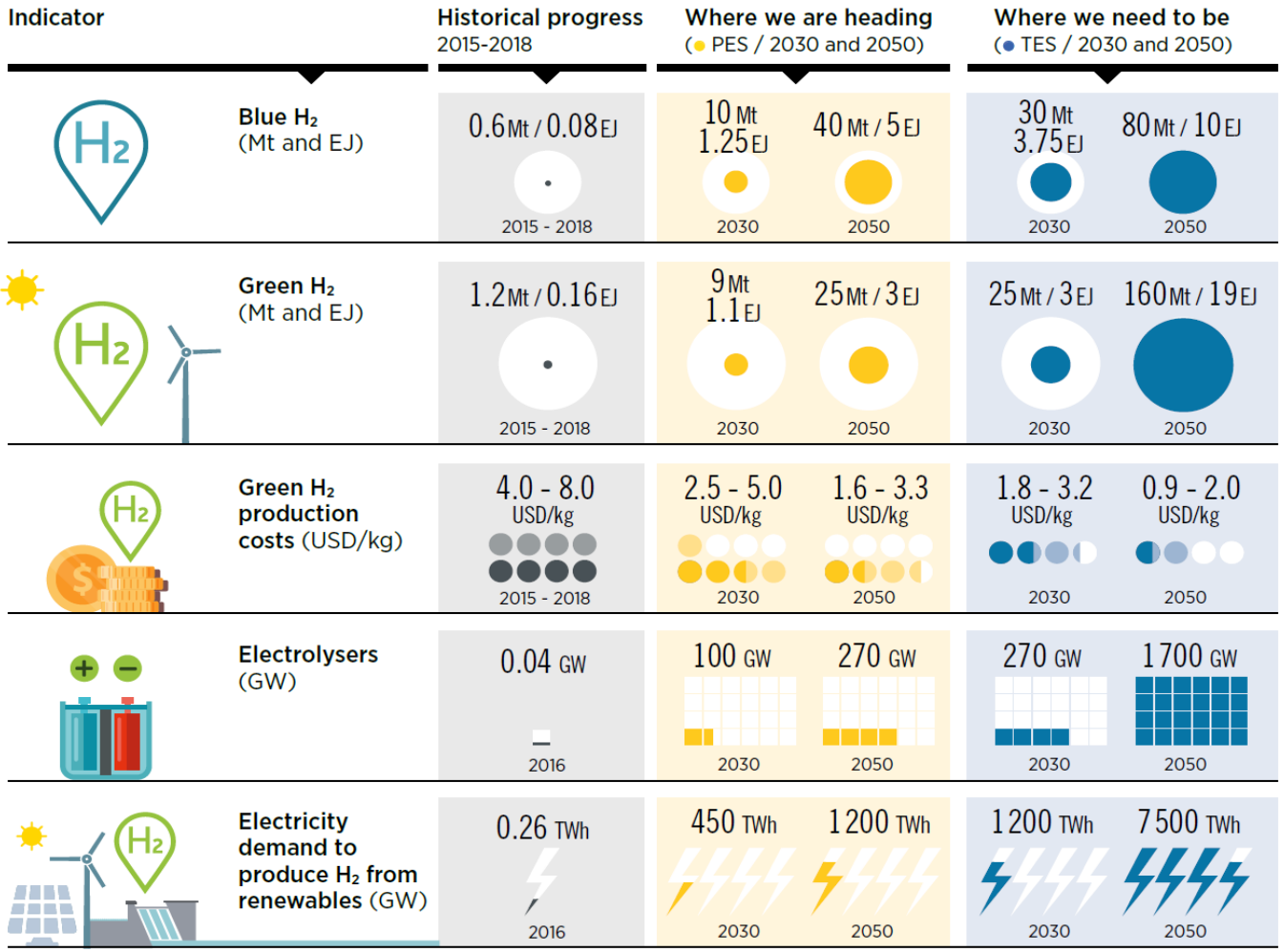
Hydrogen: A key part of future Energy Systems

Hydrogen's role

- **Solution for end-uses that are hard to directly electrify. Emission reduction (GRO 2050):**
  - **Green Hydrogen: 3%;** Blue Hydrogen: 3% (PES)*
  - **Green Hydrogen: 7%,** Blue Hydrogen: 1% (TES)**
- **Increase the flexibility of power systems** at all timescales

Key Points in 2050 (TES)

- **Hydrogen production costs:** 0.9-2.0 USD/kg H_2
- **Electrolyser capacity:** 1700 GW
- **Electricity to produce green hydrogen:** 7.5 PWh
- **Solar and Wind capacity:** at least 4 TW

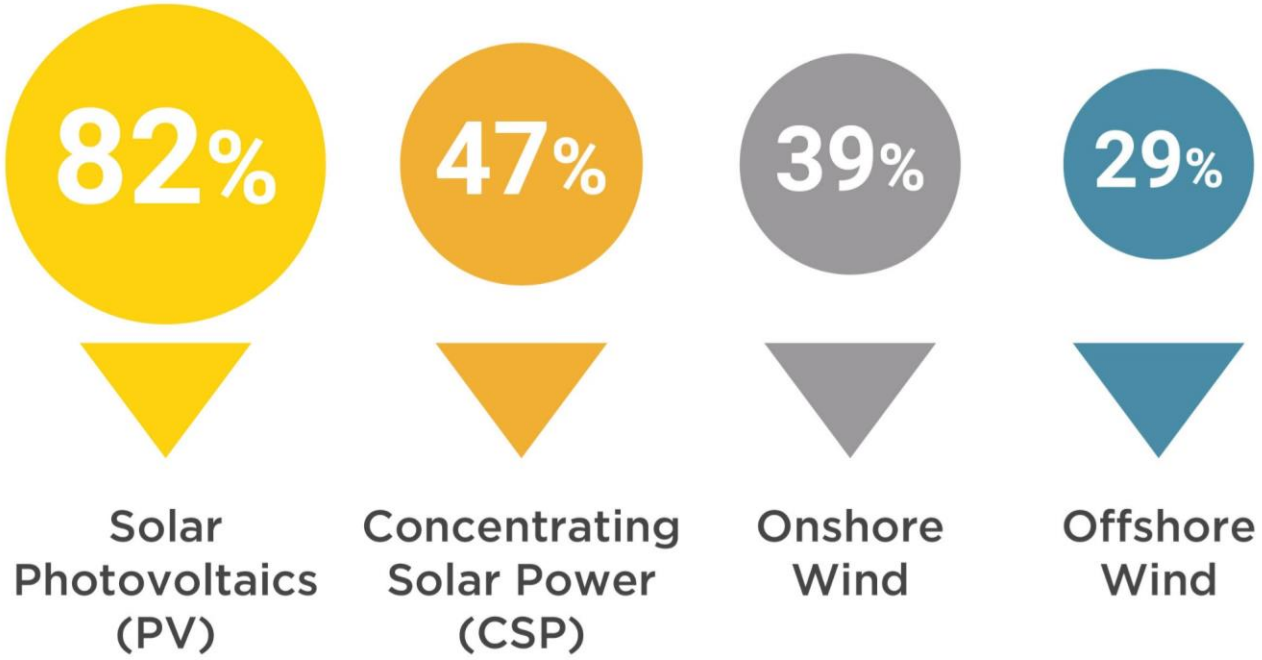


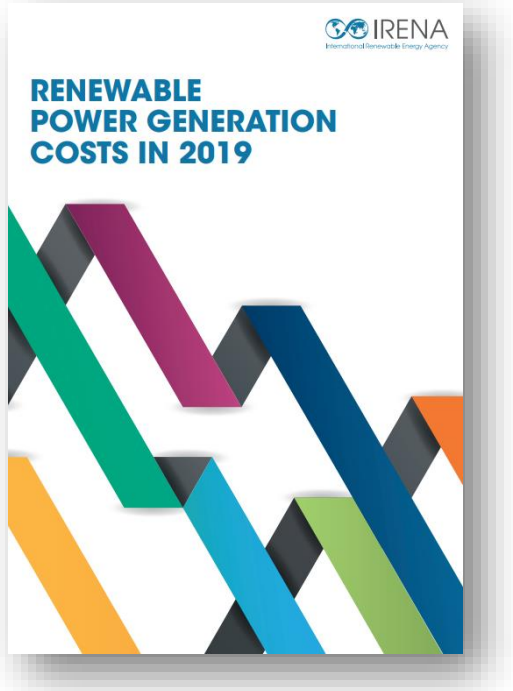
* Reduction in **Planned Energy Scenario (33 Gt in 2050)** in relation **to Baseline (43 Gt in 2050)**

** Additional reduction in **Transforming Energy Scenario (9.5 Gt in 2050**) in relation to **Planned Energy Scenario (33 Gt in 2050)**

Falling power generation costs

Renewable energy costs declined rapidly over the last 10 years (2010-2019)





June 2020

IRENA's Technology Brief on Green Hydrogen Electrolysers

- **Key drivers:**
  - Systems **integration challenges**
  - **Renewable costs** continue to fall
  - **Electrolyser costs** are projected to halve
  - **Key solution** to reaching net zero emissions by 2060

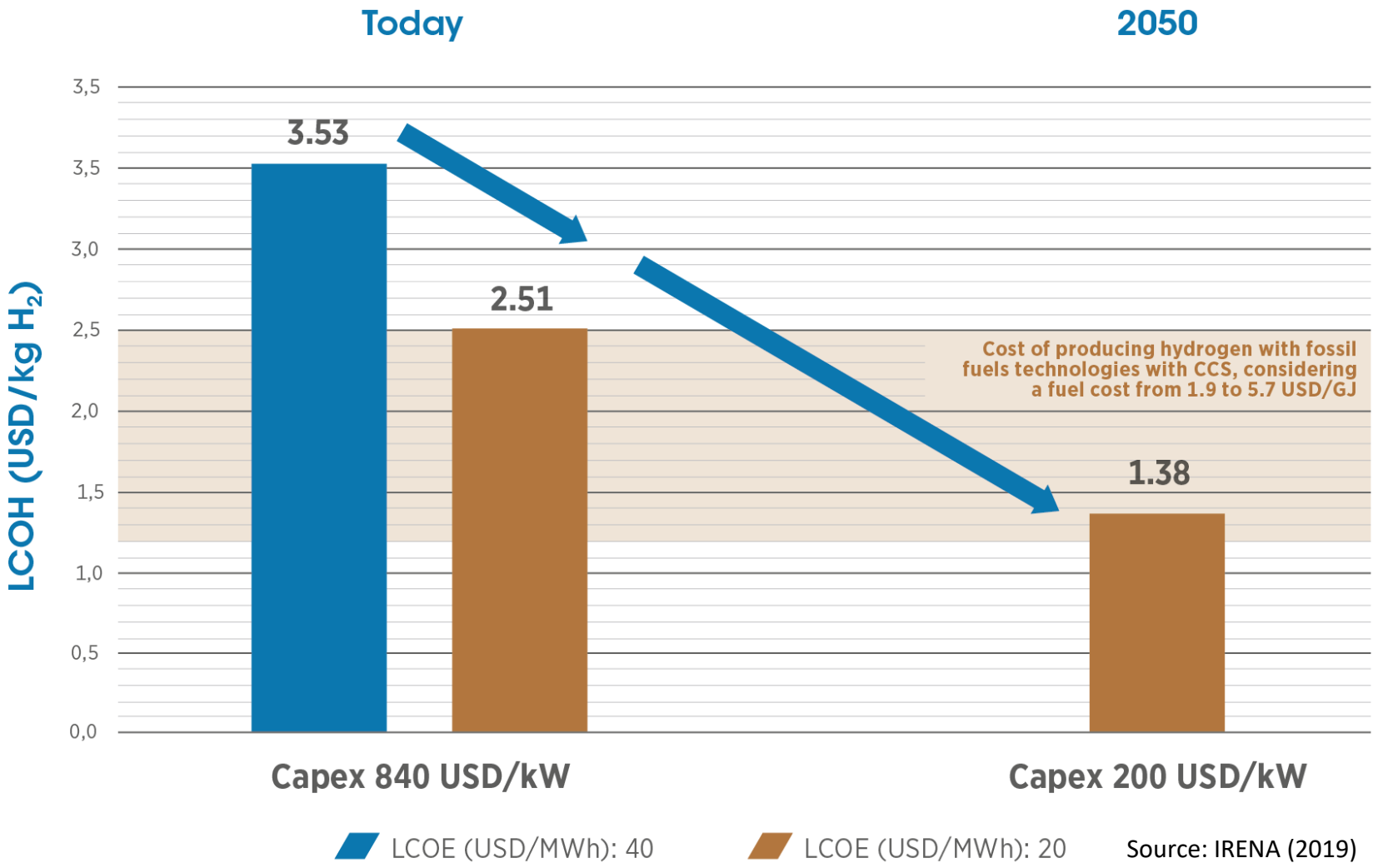
- **Main Objectives:**
  - Project cost and equipment **cost trends**
  - **Efficiency and lifetime**
  - Compressor and on-site storage linkages with operation and **capabilities to provide flexibility**
  - **Additional revenues** for electrolyser operators
  - Role of **upcoming technologies**

Electrolysers

- **Use electricity to split water into hydrogen and oxygen**
- Can provide **demand-side flexibility** by:
  - **Adjusting hydrogen production** to follow wind and solar generation profiles in periods of high resource availability
  - Store green electrons as green molecules
  - Provide grid **balancing services**

Hydrogen production costs

Hydrogen from renewables has a great potential but electrolyser costs need to further decrease



Source: IRENA (2019)

Key assumptions electrolyser: Load factor: 4200 hours (48%), conversion efficiency 65% (today), 75% (2050)

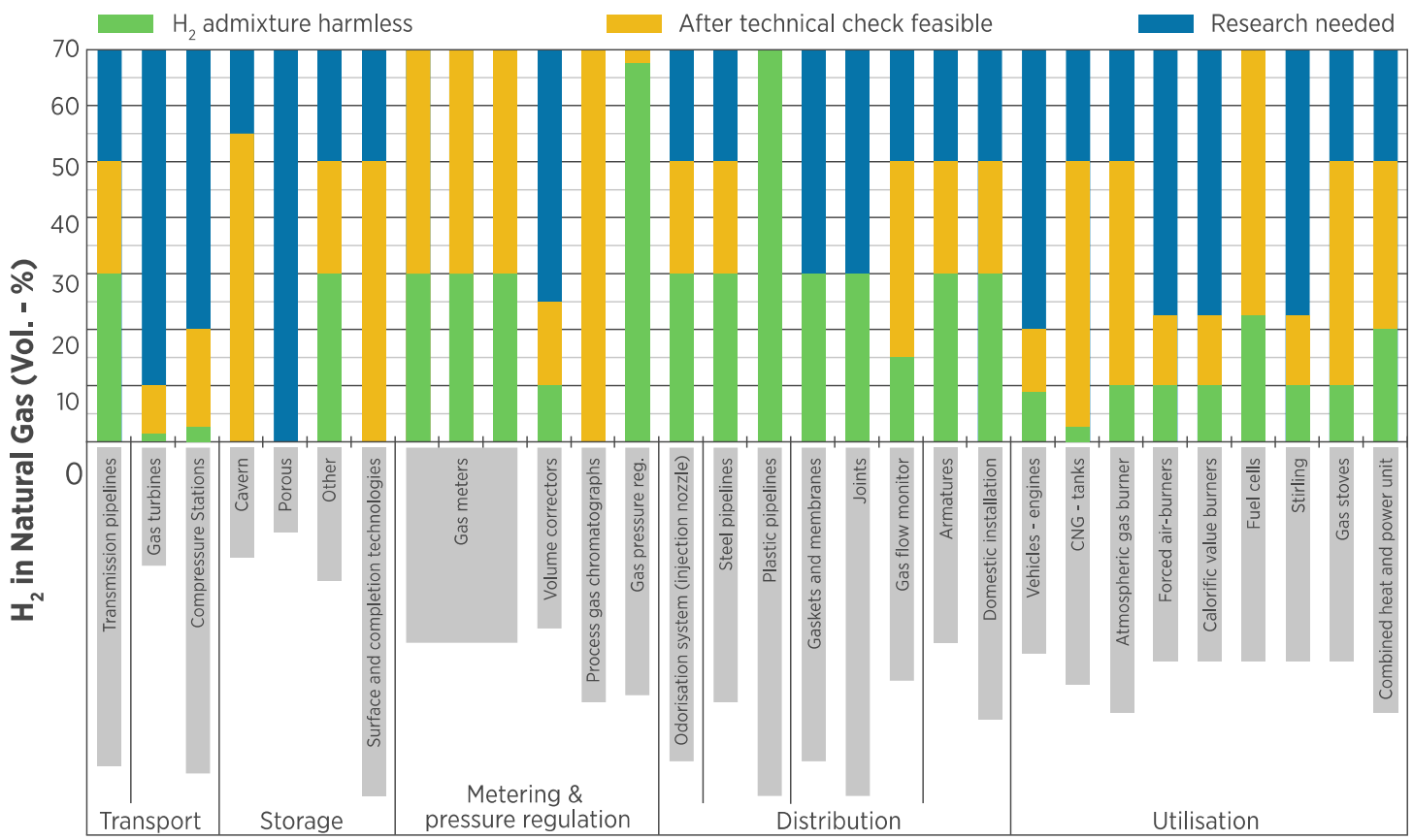
Decarbonizing the gas grid

Short-term: Injection could support early-stage development and economies of scale

- **Up to 10-20%** blend: minor Investments
- **Greater than 20%:** significant changes in Infrastructure and end-use applications

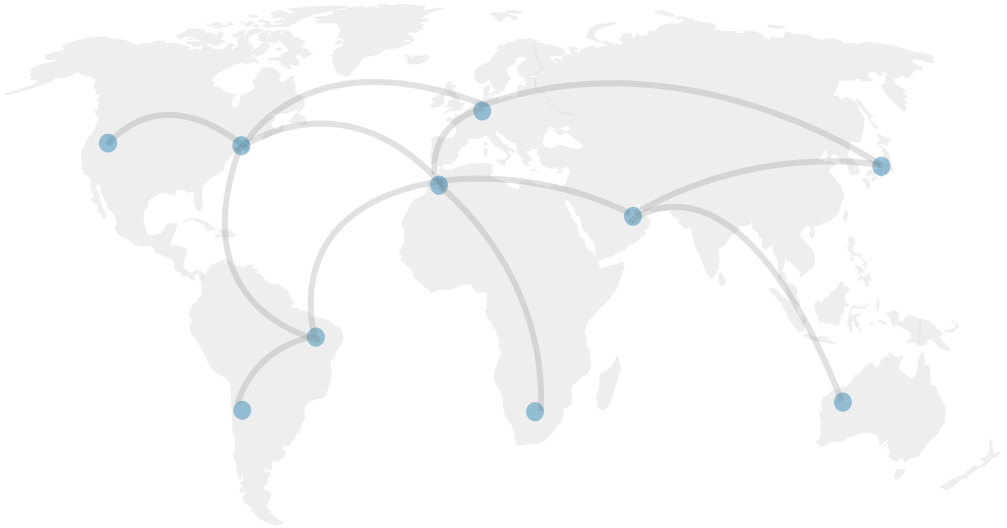
In the long-term: Store large amounts of renewables, while decarbonizing gas

- **Large capacity of gas network** EU natural gas grid stores around 1200 TWh of energy
- **Enable further deployment of solar and wind** into continental power grids
- **Possible creation of a global market** tapping into best remote/off-grid renewable resources



Collaborative Framework on Green Hydrogen

- **Green Hydrogen Ministerial Roundtable** at IRENA's 10th Assembly
  - Members called upon IRENA to **continue its work on hydrogen from renewable power**
- IRENA is establishing a **Collaborative Framework on Green Hydrogen**
- A virtual **meeting** was held on 18 June 2020 **to discuss the modalities and scope of work**



- **Strategic direction from Members on the Framework:**
  - Establish a **global knowledge database** for green hydrogen
  - Strengthen collaboration **with existing hydrogen initiatives** and other relevant stakeholders
  - Evaluate the **nexus between hydrogen and renewables** as well as the flexibility from coupling **power and hydrogen**
  - Disseminate **knowledge on transport and distribution** of hydrogen
  - Disseminate and coordinate **standards and regulatory frameworks**
  - **Sharing of best practices on financial mechanisms and practices**

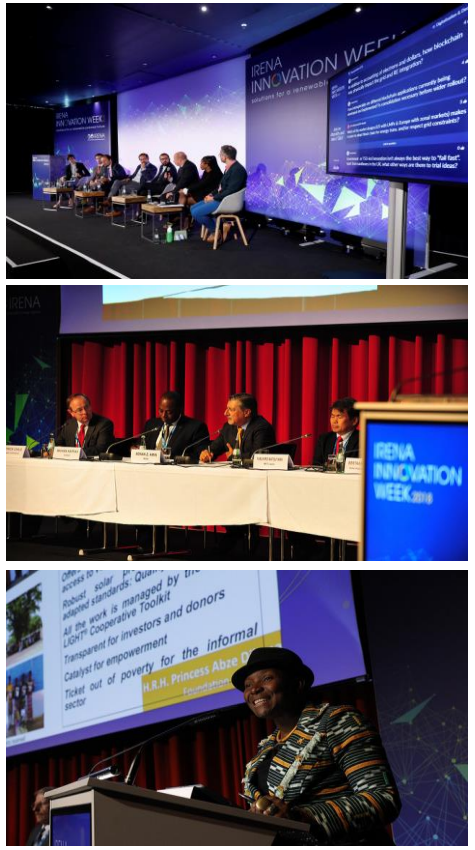
IRENA VIRTUAL EDITION INNOVATION WEEK 2020

5 - 8 October

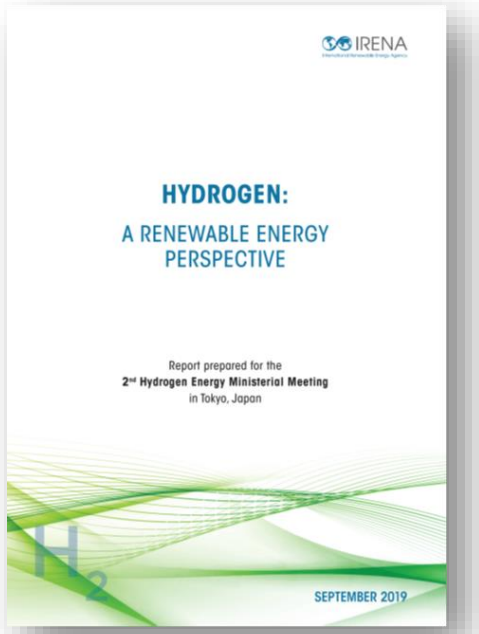
IRENA
International Renewable Energy Agency

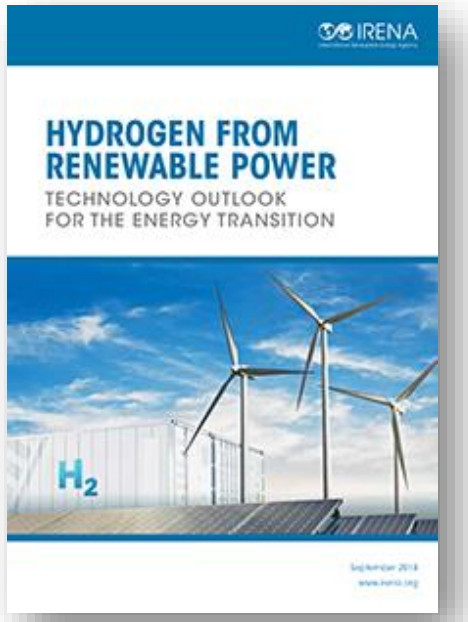
- A biennial series of IRENA Innovation Weeks
- Innovation Week 2020 builds on IRENA Innovation Weeks in 2016 & 2018 and regional Innovation Days in 2019. Key insights are available online at www.irena.org/innovation.
- Focus: **the use of renewables in the energy-end-use sectors of buildings, transport & industry**
- Aims to:
  - **Connect** experts and policy makers from IRENA's 161 member countries
  - **Showcase** emerging innovative solutions from around the world
  - **Inspire and inform** the transition to a renewable future
- Programme and speakers soon at innovationweek.irena.org
- Any questions, contact us at innovationweek@irena.org

INNOVATION WEEK 2018
solutions for a renewable-powered future



2018 event included over 80 expert speakers & 350 participants from over 70 countries





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Hydrogen production costs
Scale is needed for electrolysers' cost reduction

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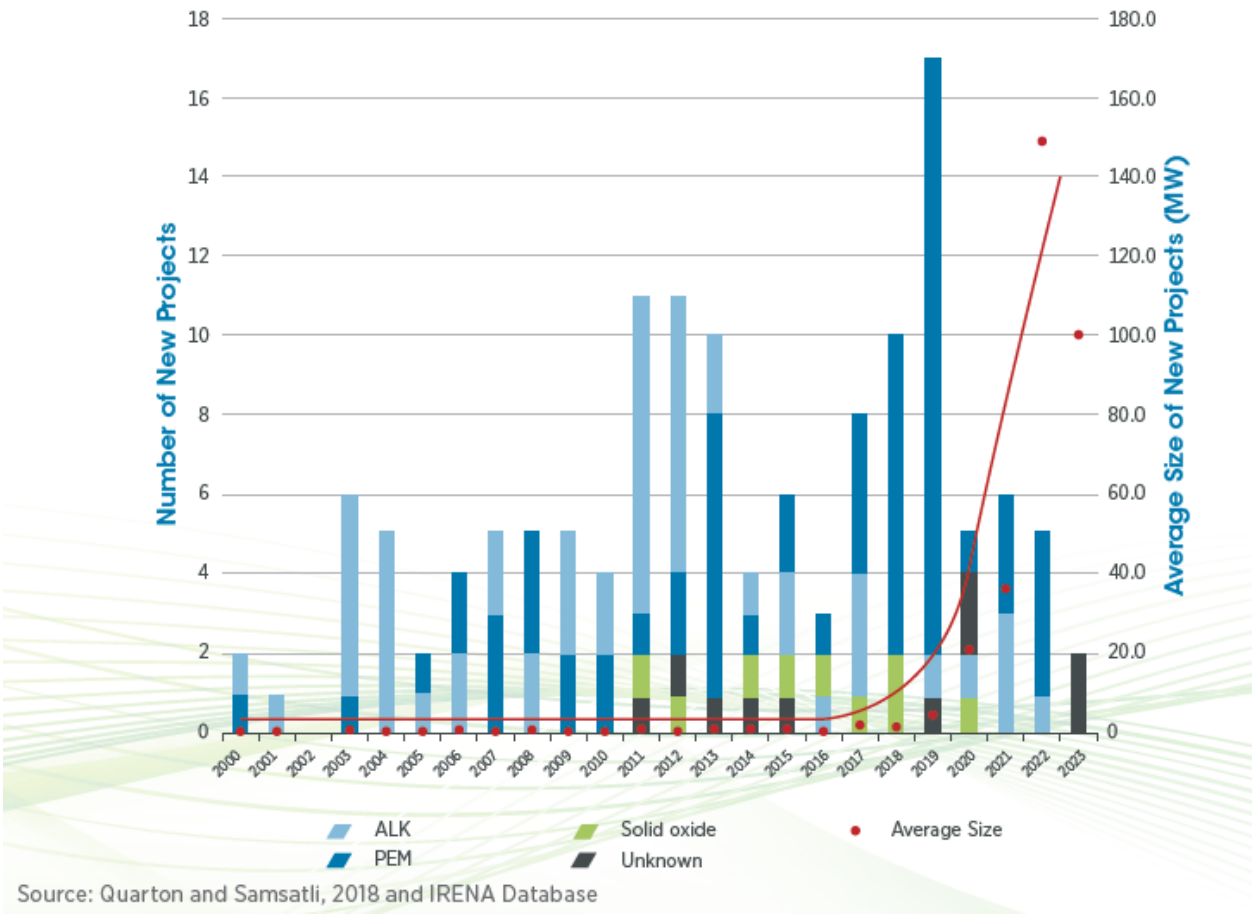
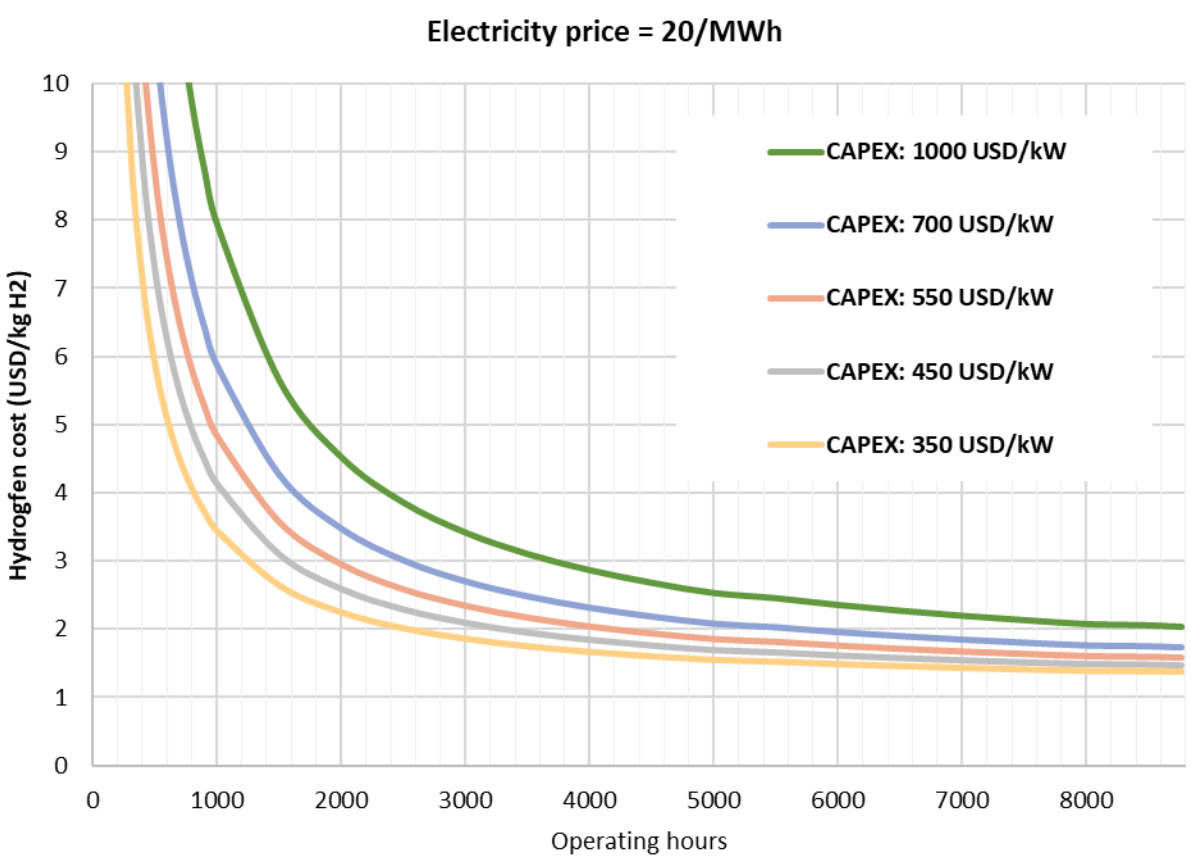
Rapid upscaling of electrolysers is key for green hydrogen

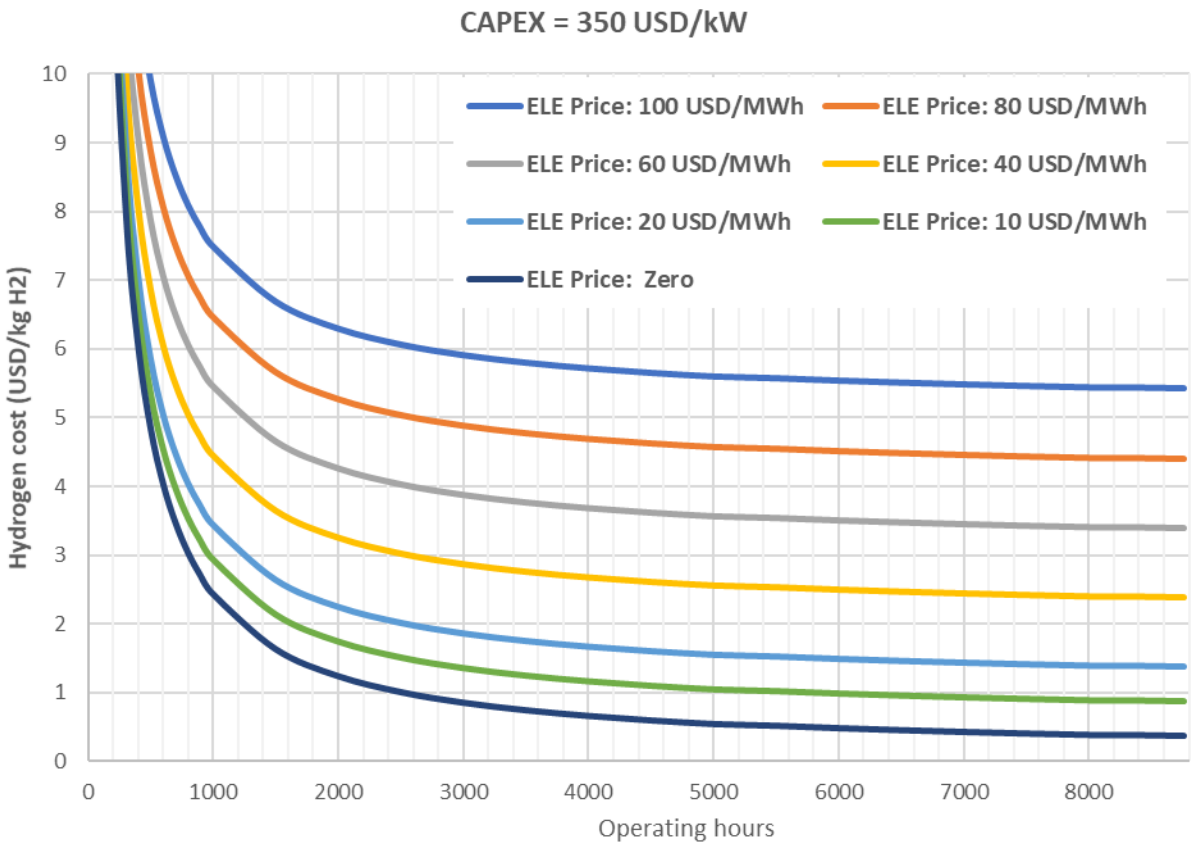


Source: Quarton and Samsatli, 2018 and IRENA Database

- **Present**
  - kW to few MW scale
  - Few hundred MW of c**umulative capacity**
- **Horizon 2021-2025**
  - **+ 100 MW scale** and ambitious projects targeting **GW scale**
  - **8.2 GW of projects** in the pipeline in Australia, France, Germany, the Netherlands, Paraguay, Portugal, the U.K. and the U.S
- **GRO's Transforming Energy Scenario target**
  - 2030: **270 GW**
  - 2050: **1700 GW**

Hydrogen production costs: renewable electricity, CAPEX of electrolysers and operating hours





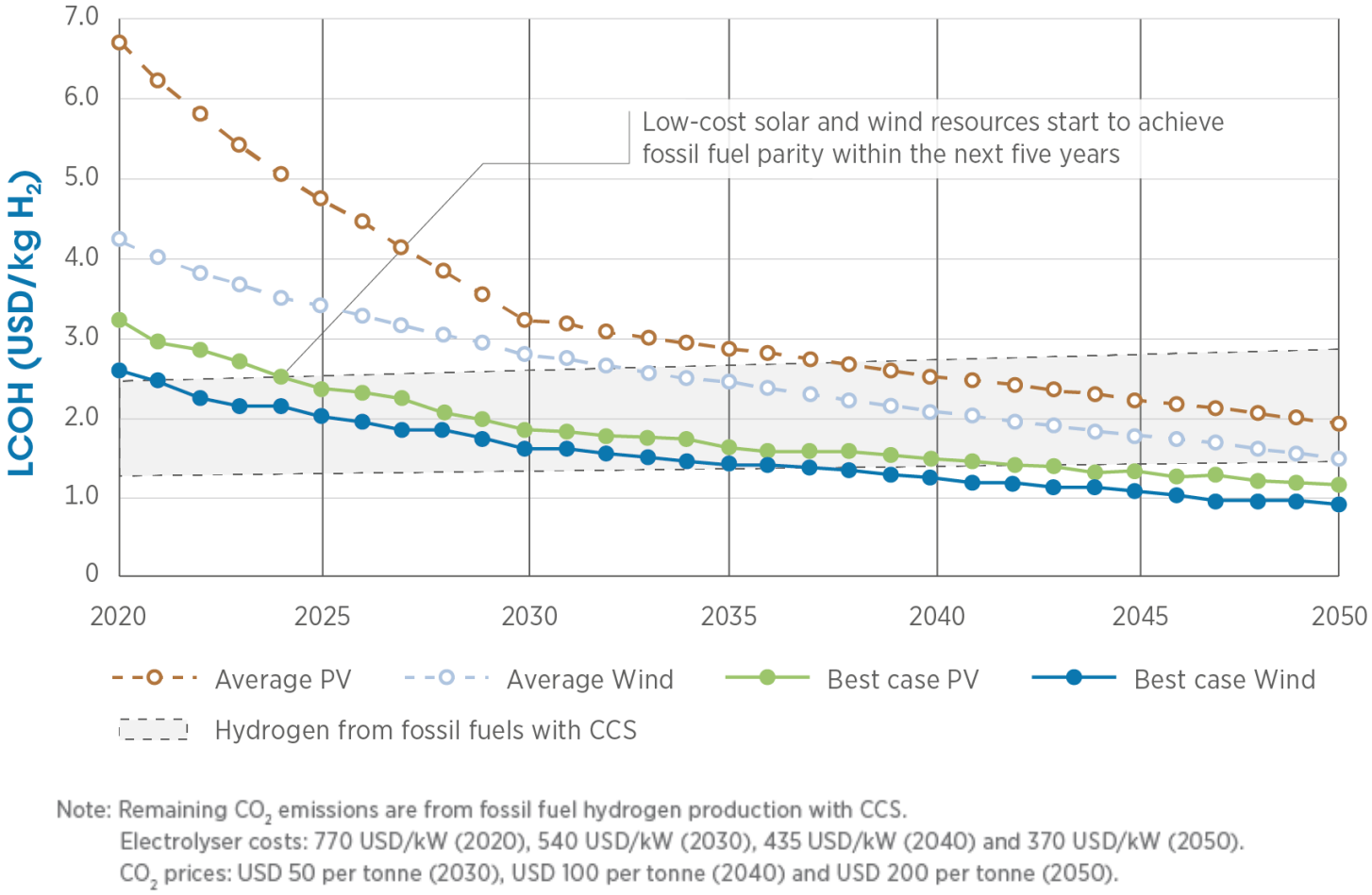
Hydrogen from renewables has a great potential but electrolyser costs need to further decrease

- **Electrolyser CAPEX and electricity price as well as operating hours are the main parameters determining the cost of producing Green Hydrogen**

Hydrogen production costs

Competitiveness in 3-5 years with low-cost solar and wind

- ✓ **Competitiveness of hydrogen from RE**
  - ✓ **Low-cost wind and solar PV projects** are expected to achieve competitiveness with fossil fuels **within the next five years** (SMR with CCS at 8 USD per million BTUs)
  - ✓ In the case of **average-cost solar and wind projects**, this would be achieved in **2030-2040**
  - ✓ Costs of Hydrogen from fossil fuels with **CCS is expected to increase due to CO2 prices**



Note: Remaining CO_2 emissions are from fossil fuel hydrogen production with CCS.
Electrolyser costs: 770 USD/kW (2020), 540 USD/kW (2030), 435 USD/kW (2040) and 370 USD/kW (2050).
CO_2 prices: USD 50 per tonne (2030), USD 100 per tonne (2040) and USD 200 per tonne (2050).

Source: IRENA (2019)

Hydrogen from renewables is close to competitiveness in regions with best solar and wind

Ministerial Roundtable on Green Hydrogen

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"In addition to power sector, there are other sectors which are very important, iron and steel, chemicals, and so on, and hydrogen can be very important there to decarbonize those so-called hard to abate sectors."

Fatih Birol

Executive-Director of IEA

"Green hydrogen is gaining unprecedented political and business momentum, with the number of policies and projects expanding rapidly around the world,"

Francesco La Camera

Director-General of IRENA

"The first thing which I feel is that costs of electrolyzers have to come down."

Claude Turmes, Minister of Energy of Luxembourg