# RD20 Task Force: Hydrogen Life Cycle and Sustainability Analysis

**Reporting on behalf of $H_2$ LCA Task Force:**

**Presented by Co-Chair: Dr Nawshad Haque, CSIRO Energy, Australia**

**Chair: Dr. Amgad Elgowainy, Argonne National Laboratory, USA**

**October 3, 2025**

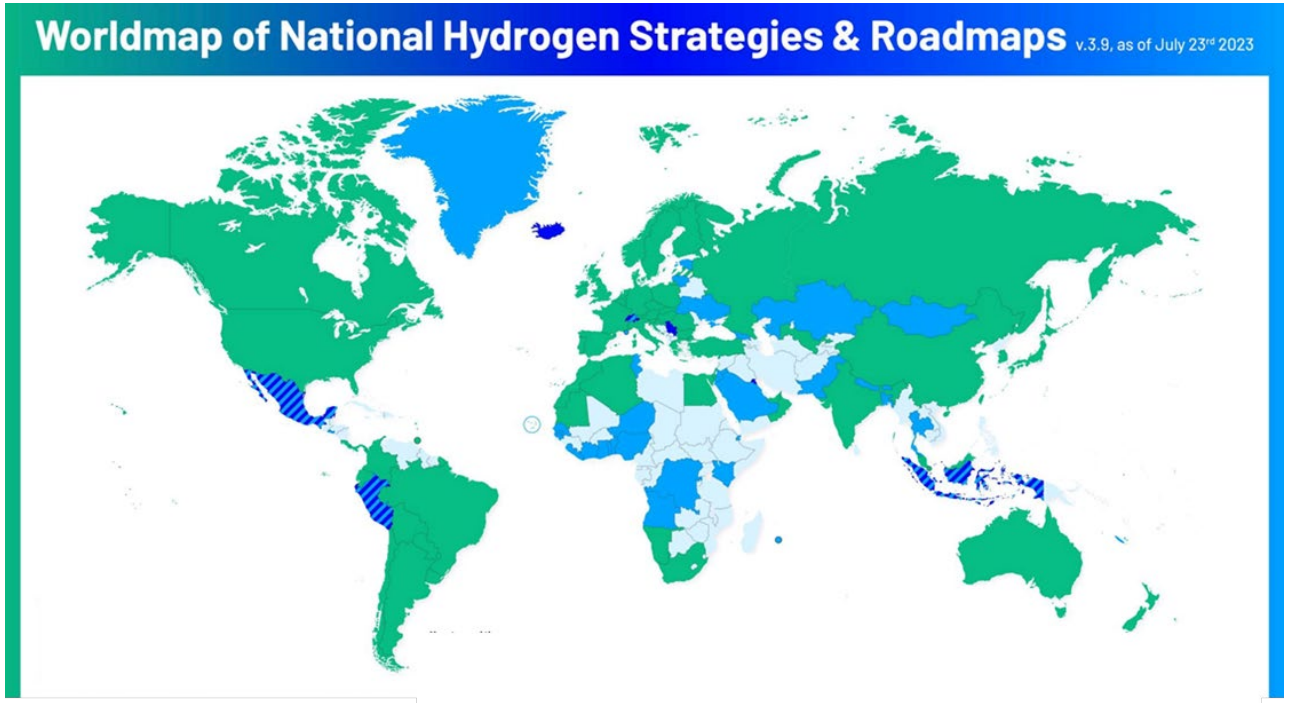
# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Motivation for a Life Cycle and Sustainability Analysis (LCSA) Task force:

**Hydrogen** is considered worldwide as **an important energy carrier for decarbonization**

**Most countries have national $H_2$ strategies**

- industry decarbonization (petrochemical, steel, cement, manufacturing….)
- For transport sector via direct or indirect electrification

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for the French Hydrogen Task Force

(May 2022 - July 2023, ongoing)
www.taskforcehydrogene.fr

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## → Consensus to form a task force on broad area of LCSA

- **provide general overviews of national situations, priorities and roadmaps**
- **propose priorities at international level for R&D, demonstration or experimentation at large scale**
- **provide sound advice, with a common voice, to G20 countries**

Chair: **Dr. Amgad Elgowainy**
Argonne National Lab, USA

Co-chair: **Dr. Nawshad Haque**
CSIRO, Australia


Participants:

**Dr. Myriam Merad** - CNRS-Paris Dauphine, France
**Dr. Laurent Antoni** – CEA-Liten, France
**Dr. Yuki Kudoh** - GZR, AIST, Japan
**Mr. William Stafford**- CSIR, South Africa
**Dr. Souvik Bhattacharjya** - TERI, India
**Dr. Eniya Listiani Dewi** – BRIN, Indonesia
**Dr. André Steinberg**– Fraunhofer ISE – Germany
**Dr Farid Bensebaa** – CNRC, Canada
**Dr. Pietro Moretto** – JRC - EU

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Motivation for a Life Cycle and Sustainability Analysis Task force:

### Common expression of current needs during 4th RD 20 Technical Workshop :

- For **common metrics and harmonized methodologies** to evaluate **Carbon Intensity** of **$H_2$** or **$H_2$ carriers** and also for evaluating other risks/benefits,
- For sharing **assumptions** and **boundary conditions** that determine the analysis with **performance** requirements
- For **sharing data** to enhance LCA inventory

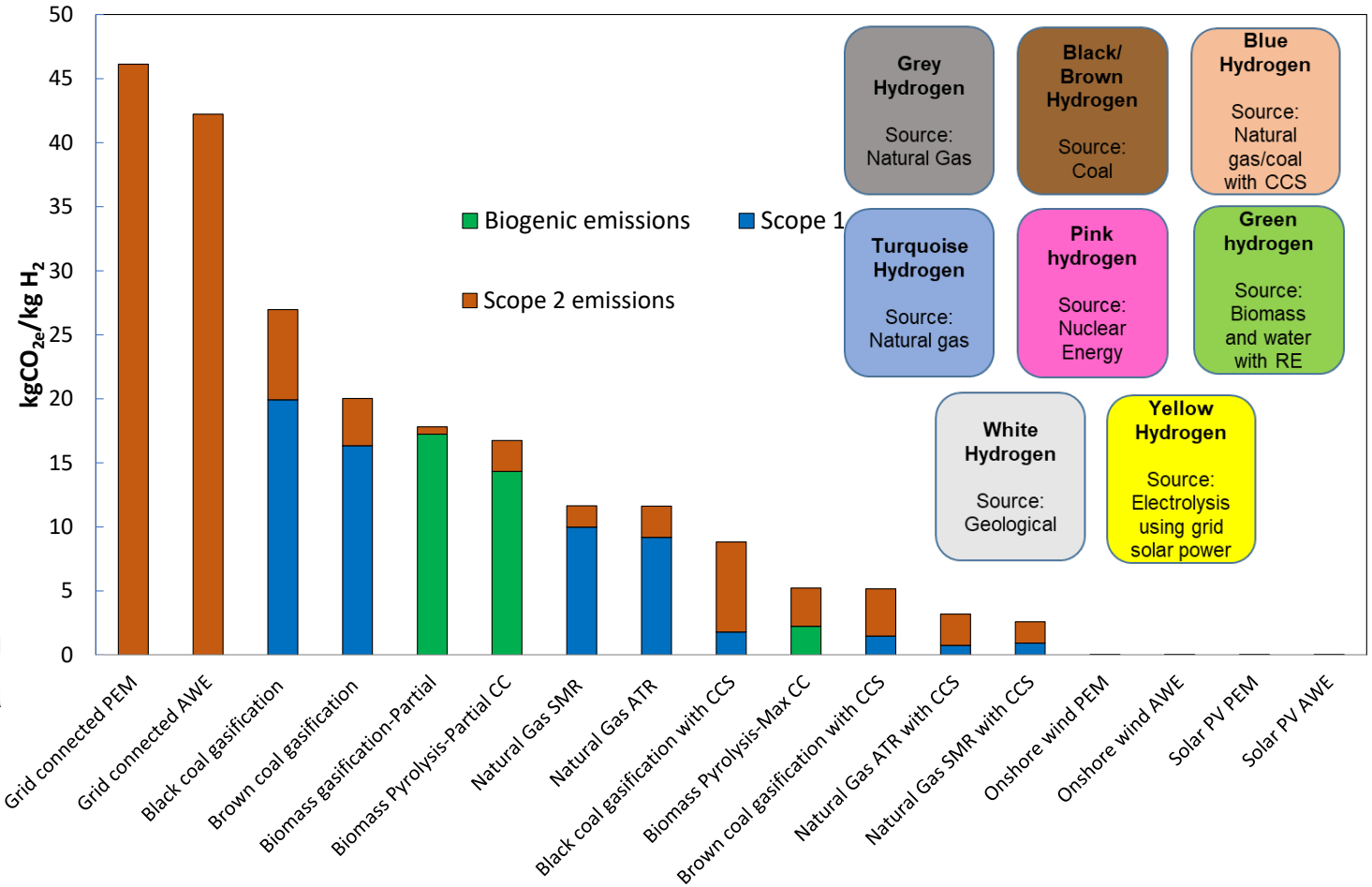
### Additional consensual remarks:

- Incorporate **sustainability** and **social acceptance**,
- Incorporate **safety** aspects, **recycling** possibilities
- Consider local specificities and **environmental justice**
- Coordination with **IPHE** running **task force** (focused on C Content of $H_2$ produced/transported) as well as other initiatives, and possibly expand their approaches to $H_2$ carriers & e-fuels
- Analyze **practical scenarios and solutions** that could help, not only “ideal” cases

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Current status and trends of Life Cycle and Sustainability analysis of Hydrogen Deployment in Australia

- Definition of “greenness”
- Various pathways for $H_2$
- Carbon footprints of hydrogen vary widely

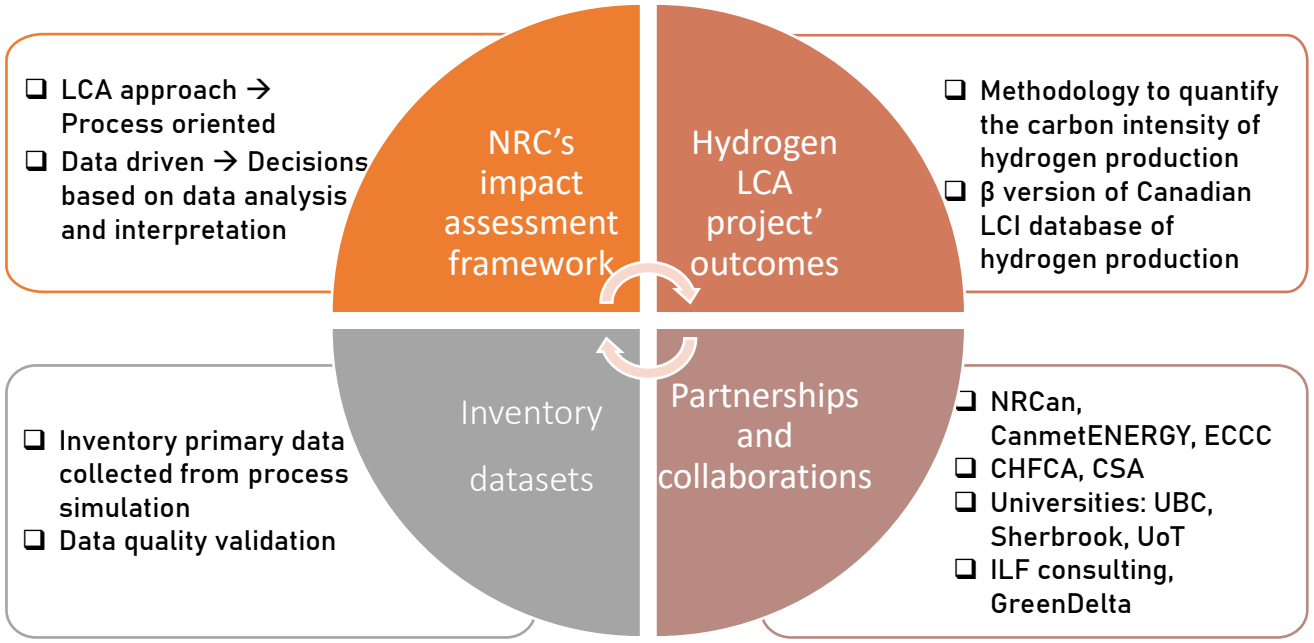


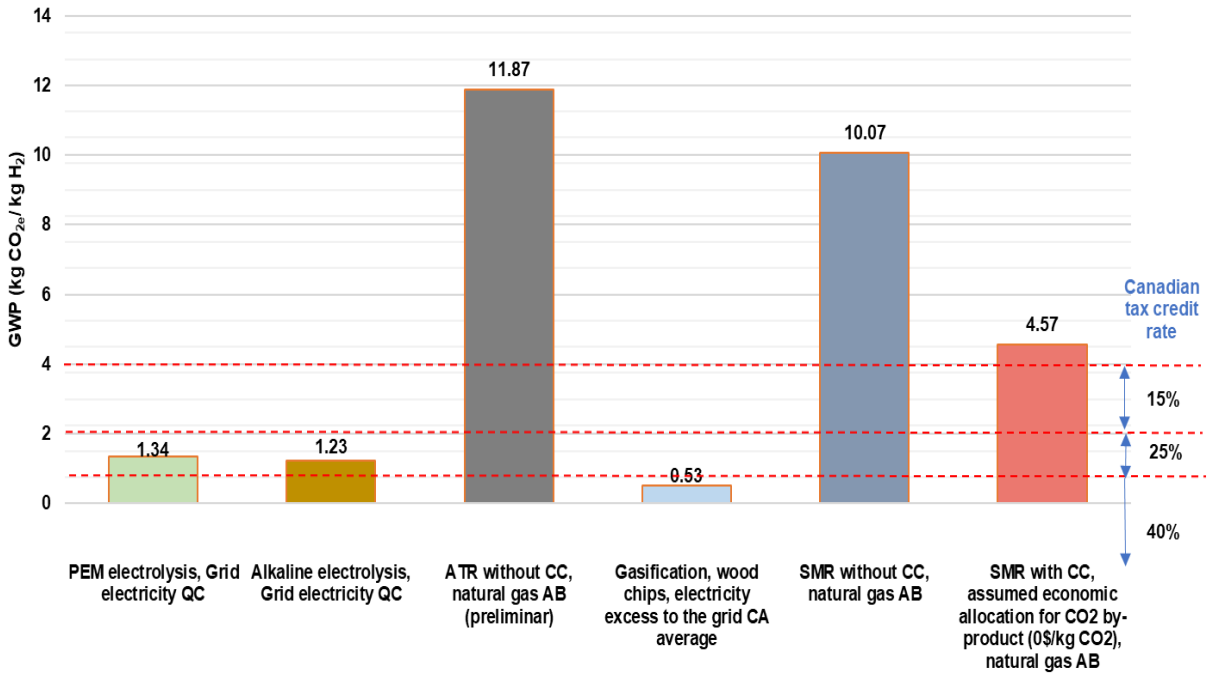

Evaluated life cycle impact of hydrogen production processes in Australia

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Current status and trends of Life Cycle and Sustainability analysis of Hydrogen Deployment in Canada

### LCA framework of $H_2$ in Canada



# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Current status and trends of Life Cycle and Sustainability analysis of Hydrogen Deployment in France

- **European Context of Green Deal**: 10 million tons of annual domestic production of decarbonized $H_2$ + 10 million tons of annual $H_2$ imports by 2050
- **France 2030 and the national $H_2$ strategy**:
  1. **Decarbonising industry** by developing a French electrolysis industry. The French ambition to reduce $CO_2$ emissions by 81% by 2050 compared with 2015. Target of 6.5 GW electrolysis installed by 2030
  2. Develop **heavy-duty mobility** using low-carbon hydrogen
  3. Supporting **research and innovation**
- **Development of a LCSA methodology to support $H_2$ deployment:**
  - Quantification of Green House Gas emission and Carbon intensity using *Base Empreinte®* - *ADEME*
  - Quantification of other environmental impacts: water consumption
  - A multi-criteria approach for the quantification and the qualification of Hydrogen based energy systems

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Goals and policy measures in Germany

### Goals

- Expected hydrogen demand in 2030: 95 to 130 TWh
- Electrolysis capacity in 2030: 10 GW
- Import of remaining hydrogen (about 50-70%)
- Infrastructure until 2030: 1.800 km hydrogen pipeline

### Policy measures

- Ensuring sufficient hydrogen supply
  - Ramp up of generation in Germany
  - Import of hydrogen
- Establishing hydrogen infrastructure
  - National infrastructure and European $H_2$ backbone
  - Import infrastructure
- Establishing hydrogen applications
  - Industry, transport, electricity supply and residential heat supply
- Creating good business conditions
  - Planning permission
  - Sustainability standards and certification
  - Research, innovation and education

Hydrogen includes also hydrogen derivatives



Reference: Update of National Hydrogen Strategy, 2023

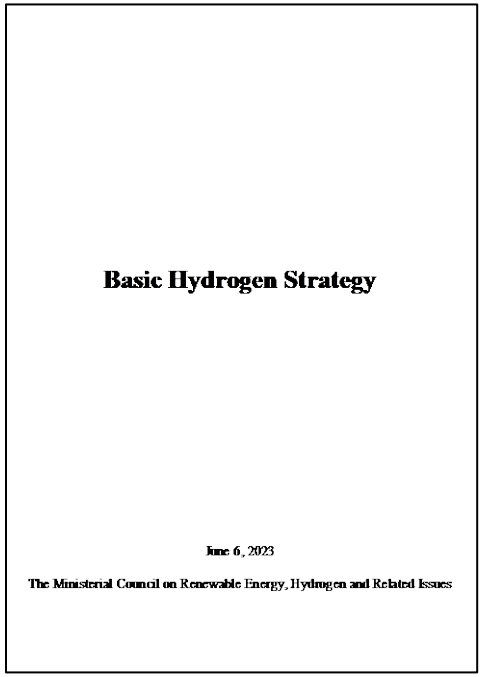
# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Policies for hydrogen economy in Japan

- Basic Hydrogen Strategy (December 2017):
  The world's first national strategy for hydrogen
- 2050 Carbon Neutral Declaration (October 2020)
- Green Growth Strategy Through Achieving Carbon Neutrality in 2050 (Revised June 2020)
  - An industrial policy to create a positive cycle of economic growth and environmental protection
  - Hydrogen-related projects conducted under the 2 trillion JPY Green Innovation Fund
- Revised Basic Hydrogen Strategy (June 2023): Four goals
  - 2 Mt in 2030, 12 Mt in 2040, 20 Mt in 2050 ($H_2$ and $NH_3$)
  - 30 JPY/$Nm^3$-$H_2$ in 2030, 20 JPY/$Nm^3$-$H_2$ in 2050
  - 15 GW electrolyser capacity by Japanese companies in the global market
  - 15 tn. JPY investments over the next 15 years






Basic Hydrogen Strategy

June 6, 2023

The Ministerial Council on Renewable Energy, Hydrogen and Related Issues

Sources: METI and NEDO

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Current status and trends of Life Cycle and Sustainability analysis of Hydrogen Deployment in South Africa

- **Transition to low-carbon fuels** critical to mitigate climate change
- **Abundant sources of solar and wind resources** in **South Africa** are well positioned to help fulfil growing global demands.
- **Just Energy Transition Partnership** (JETP) Political Declaration of South Africa, France, Germany, United Kingdom, United States, and the European Union that aims to accelerate the decarbonization; with initial mobilization of US$8.5 billion between 2023 and 2027.

- **Hydrogen** fuel is a promising alternative to the carbon-intensive fossil fuels used for power and transport, but there are **challenges in hydrogen storage and distribution.**
  - ✓ A solution is to **convert hydrogen into ammonia as an energy carrier (low-carbon) fuel**

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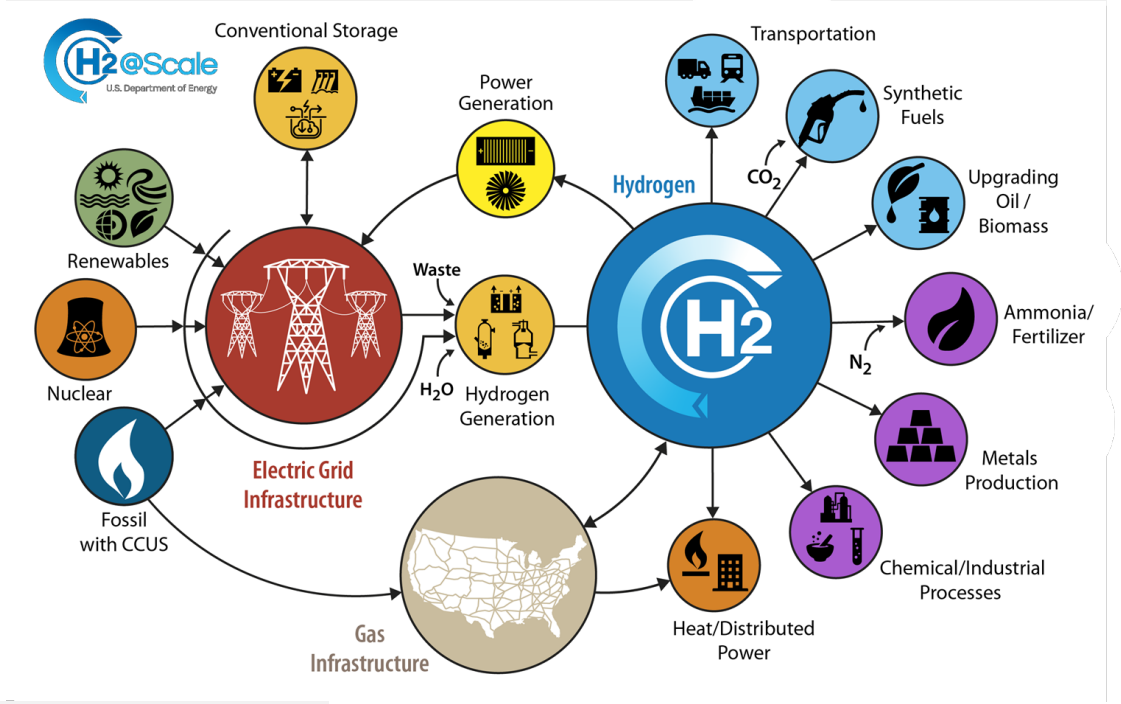
H2Global Advisory

# Hydrogen Life Cycle and Sustainability Assessment
# Outcome of the Task force 2023

## Current status and trends of Life Cycle and Sustainability analysis of Hydrogen Deployment in the USA




**Hydrogen Program**

**Coordinated across DOE** on **research, development, demonstration, and deployment (RDD&D)** to address:

- **The entire $H_2$ value chain** from production through end use
- **$H_2$ production from all resources** (renewables, nuclear, and fossil + CCS)

– **$8B** for at least 4 regional hydrogen hubs

– **$1.5B** for electrolysis RD&D, commercialization and deployment

– **<4 $kgCO_{2e}/kg_{H2}$** defined for clean $H_2$ production

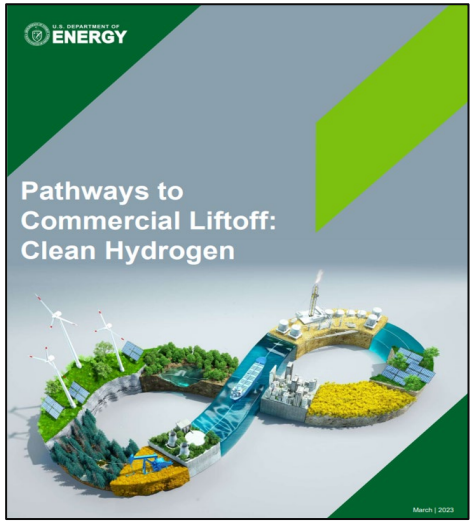
– Up to **$3/kg** Tax Credits for clean $H_2$ production

U.S. clean hydrogen market is poised for rapid growth

Annual clean hydrogen production for domestic demand has the potential to scale from < 1 to ~10 M metric tons by 2030

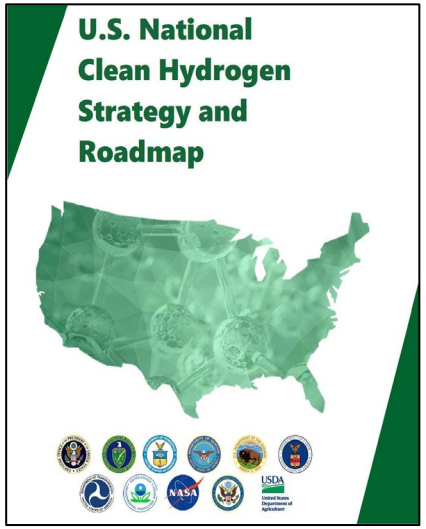
Scaling the market will require continuing work to address demand-side challenges

**March 2023: Market Liftoff of Clean Hydrogen**



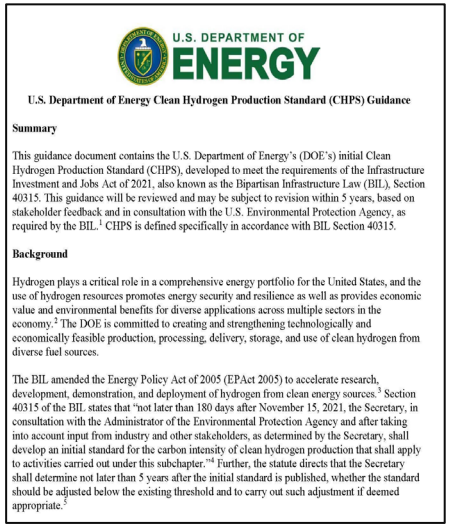

https://liftoff.energy.gov/clean-hydrogen/

**June 2023: Multiagency strategy and roadmap**




https://www.hydrogen.energy.gov/clean-hydrogen-strategy-roadmap.html

**June 2023: DOE Production standard guidance**


U.S. DEPARTMENT OF ENERGY

U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Guidance

**Summary**

This guidance document contains the U.S. Department of Energy's (DOE's) initial Clean Hydrogen Production Standard (CHPS), developed to meet the requirements of the Infrastructure Investment and Jobs Act of 2021, also known as the Bipartisan Infrastructure Law (BIL), Section 40315. This guidance will be reviewed and may be subject to revision within 5 years, based on stakeholder feedback and in consultation with the U.S. Environmental Protection Agency, as required by the BIL.[1] CHPS is defined specifically in accordance with BIL Section 40315.

**Background**

Hydrogen plays a critical role in a comprehensive energy portfolio for the United States, and the use of hydrogen resources promotes energy security and resilience as well as provides economic value and environmental benefits for diverse applications across multiple sectors in the economy.[2] The DOE is committed to creating and strengthening technologically and economically feasible production, processing, delivery, storage, and use of clean hydrogen from diverse fuel sources.

The BIL amended the Energy Policy Act of 2005 (EPAct 2005) to accelerate research, development, demonstration, and deployment of hydrogen from clean energy sources.[3] Section 40315 of the BIL states that "not later than 180 days after November 15, 2021, the Secretary, in consultation with the Administrator of the Environmental Protection Agency and after taking into account input from industry and other stakeholders, as determined by the Secretary, shall develop an initial standard for the carbon intensity of clean hydrogen production that shall apply to activities carried out under this subchapter."[4] Further, the statute directs that the Secretary shall determine not later than 5 years after the initial standard is published, whether the standard should be adjusted below the existing threshold and to carry out such adjustment if deemed appropriate.[5]

https://www.energy.gov/eere/fuelcells/articles/clean-hydrogen-production-standard

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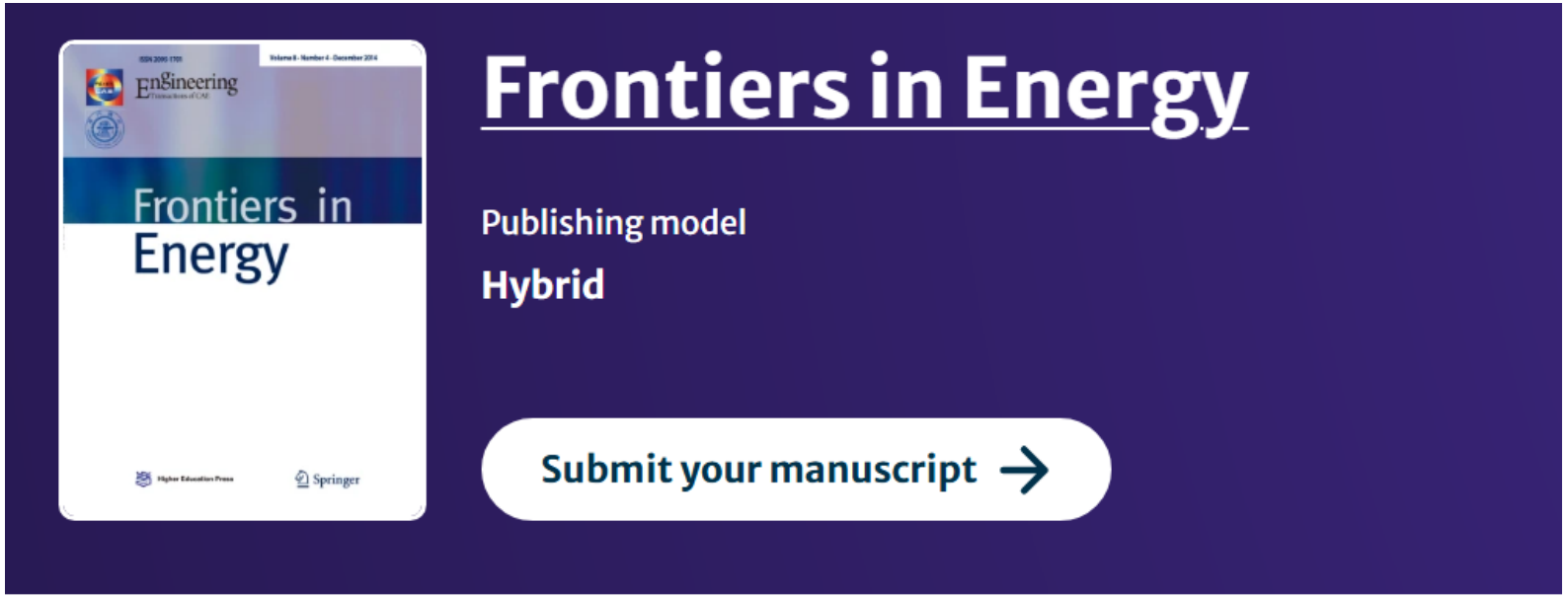


- **8 papers published in the Frontiers in Energy submitted by representatives from G20 countries where papers were available**

## Call for Papers: "Special Issue on Life Cycle Sustainability Assessment of Hydrogen Energy Systems: Global Perspective "

# What Next

- Use one methodology and undertake analysis for cases presented in each paper
- Compare results and present in one RD20 event
- Continue to build consensus for more unified standard methodology
- Keep country-specific context where appropriate
- Consider to offer a summer school course on life cycle assessment for hydrogen energy systems

Research and Development 20
for Clean Energy Technologies

# Thank you!

Nawshad.Haque@csiro.au