Introduction to the Hydrogen TCP
In a nutshell

- **Members**
  - 24 Member Countries
  - 9 Sponsors
  - European Commission + UNIDO

- **Tasks**
  - 4 Ongoing
  - 39 Finished
  - ≥ 8 in definition

- **Experts involved**
  - In collaborative research on hydrogen and hydrogen technologies

- **In a nutshell**
  - 35
  - 40+
  - 250+
What is the Hydrogen TCP?

• The Hydrogen Technology Collaboration Programme was established in 1977 to pursue international collaborative research in the hydrogen field under the auspices of the International Energy Agency.

• It carries out R,D&D activities through projects focused on specific topics called Tasks.

• Its Executive Committee is formed by representatives and alternates of its 24 Member Countries, the European Commission, UNIDO and 6 Sponsors.
How does it work?

• Members pay an annual fee contribution of 11 350 €*. These common funds are used for maintenance and strategic activities

  *Countries with GDP < 300 billion USD and GDP per capita < 20,000 USD can request a 50% reduced rate*

• Tasks are managed with in-kind contributions from participants

• Overall objectives can be found on the Strategic Plan, updated every 5 years

• Updates and findings are brought together at the ExCo Meetings (about 3 per year)
Strategic Plan 2020 - 2025

A future where **hydrogen plays a key, cross-cutting role** for the world economy in a sustainable, global, integrated & flexible energy system.

Facilitate, coordinate and maintain innovative RD&D activities as a **hub for international cooperation and Knowledge exchange**.

**Vision**

**Mission**

Accelerate the implementation and widespread **efficient use of hydrogen** to minimize global warming, optimize environmental protection, improve energy security and contribute to sustainable economic development - and preserving the hydrogen TCP as a **leading global source for hydrogen expertise**.

**Strategy**

**Collaborative R&D & D**

- H₂ storage
- Integrated H₂ systems
- H₂ integration in existing infrastructure
- H₂ production

**Analysis that positions hydrogen**

- Technical
- Market
- Policy support & Political will

**H₂ awareness, understanding & acceptance**

- Information & Dissemination
- Safety
- Outreach
Activities

- **Events** (organization + participation)
  - Workshops, conferences, plenary sessions, and webinars

- **Meetings** (at ExCo and Task level)

- Document review for other organizations (IEA, other TCPs, international groups...)

- Dissemination through website and social media
  - Blog
  - Twitter
  - LinkedIn

- Planned strategic activities: hydrogen production projects Database, Technology Observatory...
Hydrogen TCP website
Hydrogen TCP website

Tasks in Definition information

Live calendar with relevant events

www.ieahydrogen.org

Relevant hydrogen-related documents repository

and much more!
Other dissemination

IEA Hydrogen TCP
Global collaboration for research and innovation in hydrogen
Research - Trees Center - Madrid 
Newsletter (biannual)

@IEA_Hydrogen

IEA Hydrogen TCP

Recently posted videos
Today, February 11th, we celebrate the International Day of Women and Girls in Science. We would like to give recognition to all those initiatives working for equal opportunities for women in science, more specifically in the field of hydrogen. Women in Clean Hydrogen As part of the 2022 Strategic Plan implementation, the hydrogen TCP will encourage the wider participation of women both at the Task and TCP’s levels. Let’s keep working for equality in all spheres of our lives! #womeninhydro.
Members

Representatives and alternates at the Hydrogen TCP Executive Committee (ExCo) level
Members’ Responsibilities

• Maintain management oversight of the Hydrogen TCP to ensure the overall quality and effectiveness of the various elements of the program

• Ensure effective participation by their national/entity experts in the Hydrogen TCP Tasks and other activities

• Act as a link between their national strategies (or entities strategies) and the Hydrogen TCP Strategic Plan
Why should you become a Contracting Party?

✓ **Collaborate** with other members on cutting-edge hydrogen R,D&D

✓ **Access** an archive of over 40 years of research

✓ **Increase** and share your hydrogen expertise

✓ **Connect** with scientists, and national leaders committed to reliable, sustainable, and clean energy

✓ **Open doors** to all national companies, entities, and individuals to participate in Tasks
How to become a member

1. When a new Member shows interest in joining, we invite them to present their interest formally in our next Executive Committee Meeting, we allocate a slot of 10-15 min presentation + 10 min Q&A to discuss on current status on hydrogen, main priorities and areas of interest

2. A written procedure is launched to invite this new member to join the ExCo

3. If no opposition is received, the TCP Chair sends a letter to the entity/country formally inviting it to join the TCP

4. The potential new member sends back a letter of acceptance with copy to the IEA Secretariat

5. On receipt of the acceptance letter, the IEA Legal Office sends a TCP Signature Page to be signed and dated

The Technical Secretariat will issue the invoice with the proportional contribution to the Common Funds based on the month the new member joins (standard contribution fee 11 350€/year)

Specific information on procedures can be found on our website and the Procedures Manual are available here.
Tasks
Main Hydrogen TCP activities
What is a Task?

- Collaborative research **project** among parties related to hydrogen
- Usually **3-year** duration
- Led by one or more **Task Manager(s)**
- Each one has a different scope, framework and is structured in **Subtasks**
- Any member can propose a **Task**
- Participation in is indicated by submittal of a **Letter of Participation**
- Task’s **Work Plan** includes scope, goals, milestones, participation requirements, structure, deliverables...
- When approved by the Executive Committee, the Task is assigned the next consecutive number and becomes part of the Hydrogen Implementing Agreement (HIA) as an **Annex**
Types of Tasks

Closed
Tasks that already finished. List and related reports can be found here.

Open
Tasks that are currently active. Information about them and related documents can be found here.

In definition
Potential Tasks in the process of defining scope and terms of their work. Information and requirements to join can be found here.
Task portfolio status

- **International H₂ Supply Chains**
  - H₂ for Marine Applications + Ports
  - H₂ in Islands
  - H₂ in the Mining, Mineral Processing, and Resource Sectors

- **H₂ LCA, societal and environmental impact**
- **H₂ Certification**
- **Renewable H₂**
- **Off-shore H₂ Production**
- **Natural H₂**
- **H₂ in Industry**

- **Preliminary Idea**
- **Project Definition Phase**
- **Kick-off**
- **Active**
- **Closing Steps**
- **End**

- **Task 40 – Energy Storage and Conversion**
- **Task 41 – Analysis and Modelling of H₂ Technologies**
- **Task 42 – Underground H₂ Storage**
- **Task 43 – Safety and RCS of Large-Scale H₂ Energy Applications**
- **Task 44 – HYNE**
- **Task 37 – H₂ Safety**
- **Task 38 – PtH & HtX**
- **Task 39 – H₂ in the Maritime**

March 2023
Task 40

Energy storage and conversion based on hydrogen

I. Develop reversible or regenerative H$_2$ storage materials (solid or liquid) fulfilling the technical targets for mobile and stationary applications

II. Develop fundamental and engineering of H$_2$ storage materials and systems that fulfil Target I

III. Develop materials and systems including H$_2$ storage for use in stationary, mobile and portable applications, electrochemical storage, and solar thermal heat storage.

- Porous materials as cryo-adsorbents for hydrogen (coordination polymer framework compounds, MOFs, ZIFs, COFs, and carbon-based compounds)
- Magnesium- and intermetallic alloy-based hydrides for energy storage
- Complex hydrides (borohydrides, alanates, amides/imides-systems, magnesium-based compounds, reactive hydride composites)
- Ammonia and reversible liquid hydrogen carriers
- Catalysis
- Electrochemical storage of energy (MH-batteries, ion-conduction)
- Hydride-based thermal energy storage
- Research and development for hydrogen storage and compression
Task 40

Energy storage and conversion based on hydrogen

7 recently published papers
- Metallic and complex hydride-based electrochemical storage of energy
- Magnesium- and intermetallic alloys-based hydrides for energy storage: modelling, synthesis and properties
- Hydrogen storage in complex hydrides: past activities and new trends
- Fundamentals of hydrogen storage in nanoporous materials
- Hydrogen storage in liquid hydrogen carriers: recent activities and new trends
- Hydride-based thermal energy storage
- Research and development of hydrogen carrier-based solutions for hydrogen compression and storage

Deliverables

Meetings and activities

2 in-person meetings in 2022
- 15-18 May, Louvaine-la-Neuve, Belgium
- 18-21 Sept Madrid, Spain

Next in-person meeting planned
- 9-12 May 2023, Nottingham, UK
Task 41

Analysis and Modelling of Hydrogen Technologies

I. Develop an updated and updatable long-lasting database on hydrogen technologies.

II. Develop an improved appreciation of hydrogen energy modelling.

III. Support decision-making.

IV. Closer collaboration between the Hydrogen TCP and the ETSAP analysis community.

Data consolidation of parameters describing H₂ technologies: during and since the definition of this Task, the growth of the H₂ industry accelerated exponentially. To keep up with the frenetic pace of industry growth, the originally envisioned database would have had to evolve too quickly to be established and maintained as a mere TCP Task. In the meantime, IEA launched its Global Hydrogen Review series, which reports annually on H₂ technology.

Develop knowledge of how to model hydrogen in the value chain and improve current methods: as reported in RSER (Blanco et al. 2022), we classified H₂ models based on 29 studies. 9 model archetypes were identified, each with associated challenges. The Task considered potential solutions to those challenges and suggested future work. There is a need for international collaboration among countries with a high proportion of VRE. Engagement with commercially successful leading modelling firms is paramount.

Collaboration with analysts in IEA HQ Analytics and the ETSAP community: final report for this sub-task is available here. Suggested future work includes modelling the impact of inherited CO₂ emissions along the paths from production to end products.

Review reports from IEA
Task 41
Analysis and Modelling of Hydrogen Technologies


- ✓ Modelling H₂ is complex because no single archetype covers all the features and applications of H₂.
- ✓ Soft-linking or modelling suites can overcome this challenge.
- ✓ The Task developed a comprehensive reference energy system (RES) for hydrogen in ETSAP models.
- ✓ Best-practice guidelines for representing H₂ in energy system models, focusing on TIMES, were developed.
- ✓ In general, H₂ modelling applications are new relative to legacy applications. Some developers are progressing well, including TIMES / ETSAP and Energy Exemplar’s PLEXOS.
- ✓ No existing models adequately deal with electricity markets in regions with very high VRE proportions. Hence further work in this area is highly recommended.
- ✓ Extending this work to model the flow of inherited CO₂-e emissions would lead to a productive collaboration with certification scheme development.
Task 42

Underground Hydrogen Storage

I. Solve R&D challenges which establish the technical, economic, and societal viability of underground hydrogen storage

II. Prepare for responsible demonstration and upscaling.

III. Covering porous reservoirs, salt caverns, and lined-rock caverns.

While salt caverns are already being deployed for static storage of H₂, there is a need to test the technical feasibility of fast-cyclic and high-performance injection, production, and optimal management of dense clusters of them. The technical viability of UHS in porous reservoirs is relatively less established, and still under more fundamental scientific and technological investigations.

H₂ Conversion & Contamination: how H₂ interacts with the rock matrix, fluids and micro-organisms. Microbial and geochemical processes may lead to H₂ conversion and impact the safety, efficiency, quality and recoverability of UHS.

Storage Integrity: will determine the safety and efficiency of the storage projects (e.g., recoverability) and impacts on nearby subsurface activities and resources. Subsurface processes and properties determine integrity, sealing capacity, and geomechanical behaviour to (fast) cyclic H₂ injection and production.

Storage performance: determining and improving the performance of storage operations as well as the criteria and methods to select, rank and validate potential storage sites.

Surface facilities & wells: safety and performance of a storage site strongly depend on a proper well design and materials that withstand the impacts of H₂. Engineering and safe design of top-side facilities and wells.

Economics & system integration: evaluate and determine drivers, boundary conditions, pathways for system integration and general economic parameters for demonstration and development of UHS.

Planning, regulation, safety & society: compile and share recommendations, guidelines, best practices and decision support info with policymakers, regulators, operators, NGOs.... Address public participation and educational events.
Task 42

Underground Hydrogen Storage

Activities in 2022

- TRL Assessment Report for IEA, July
- 3 events co-organized: first UHS Summer School (11-14 July, with TU Delft), in-person Task Workshop (17-18 Nov, with Clean Hydrogen Partnership), and UHS Workshop Perth (2 Dec, WITH Curtin Univ)
- Presented at 4 events: UHS Workshop/Webinar (10 Feb, US DOE), Living on H₂ (4 May, Norce), EHEC2022 (20 May, AeH2), GeoHydrogen (23 Nov, BGR)
- 12 online Task meetings/workshops
- First Task Report: Technology Monitor for UHS (expected to be out in March 2023), with recommended actions for industry, research organizations and other stakeholders for a safe and responsible demonstration and implementation of UHS.

Key messages

✓ **Increase technological confidence in UHS based on lab and pilot tests:** there is insufficient information and experience from real subsurface H₂ injection and extraction activities to reliably predict and monitor the H₂ behaviour and impacts in porous reservoirs.

✓ **Develop a market for UHS:** there is often a lack of reliable information on cost aspects, revenues and the long-term economic viability to justify the high investments associated with the development of UHS projects.

✓ **Risk assessment and uncertainty reduction:** there is a lack of basic information and models to support an integrated assessment and quantification of risks.

✓ **Increase Societal Embeddedness Factors:** support governments, stakeholders and public in defining the framework and criteria for establishing a social license to operate.
Task 43
Hydrogen Safety and RCS of large-scale hydrogen energy applications

I. Large-scale compressed and liquid H₂ energy systems and applications.
II. Horizontal safety & regulatory attributes of large-scale H₂ energy systems and applications.
III. Developing uniform methodologies via case studies, available PNR, results’ synthesis and analysis.
IV. Practical recommendations and solutions for industry and standardization and regulatory bodies:
   a. Inform relevant international and national RCS development activities.
   b. Help the H₂ industry with market deployment and establishment of best practices.
V. Development of joint products, peer-reviewed publications, educational and training materials, conference papers, white papers, reports, new work item proposals for standard development, etc.

Subtask A: social comprehensive risk.

Subtask B: safety culture & Management system.

Subtask C: to harmonize consequence models, harm criteria, assumptions, and QRA database.

Subtask D: various standard requirements posing harmonization challenges for hazardous areas classification.

Subtask E: data for future analysis for industry recommendations to improve hydrogen system safety.

Subtask F: Inform RCS; ISO, IEC, CEN/CLC, Global SDOs, global government bodies, IMO, ICAO, Rail. Inform industry; Hydrogen council, EIGA/CGA, Ammonia/LOHC stakeholders, others.
Task 43

Hydrogen Safety and RCS of large-scale hydrogen energy applications

- 1st in-person meeting in Buxton, UK, HSE, October 17-21, 2022.
- **Next in-person meeting**: February 27 – March 3, 2023 at NREL, USA
- Develop joint papers for peer-reviewed journals (like IJHE) and relevant conferences (like ICHS)
- Develop recommendations to RCS, ISO, IEC, CEN / CLC, Global SDOs, Global government bodies, IMO, ICAO, Rail
- Develop recommendations to Industry: Hydrogen Council, EIGA / CGA, Ammonia / LOHC stakeholders, and others.

- The first IEA Hydrogen TCP Task on Hydrogen Safety was launched in Oct 2004. The focus being on enriching the knowledge and closing gaps on H₂ properties and risk analysis.
- There has been a significant change of pace of RES-based clean energy technologies that have significant H₂ content changes the narrative around safety. Global regulatory bodies have set aggressive targets to reduce pollution and carbon footprint to protect international environment.
- Common topics to be addressed as hydrogen energy applications deploy at large-scale include compressed and liquid H₂ systems, safety culture and management system, uniform methodologies for safety distances and hazardous areas classification, large scale electrolysis and confined environment.
**Task 44**

Energy storage and conversión based on hydrogen

This Task aims to identify and provide analysis on the development of Hydrogen production from Nuclear Energy. This Task will serve as a platform and framework for sharing and contributing information one the different possibilities of Hydrogen production from Nuclear Energy by:
- Identifying the on-going and planned activities in this subject
- Providing a holistic analysis of the situation, context and constraints to identify all conditions to fulfill for this technology to be deployed.

**Task structure**

Subtask 1: State of the art / Data and Knowledge Acquisition
Subtask 2: Process of hydrogen production systems from nuclear energy
Subtask 3: Hydrogen production for high value products and services
Subtask 4: Business case model analysis & scenarios
Subtask 5: Recommendations, stakeholder engagement, communication & dissemination
Subtask 6: Task management and coordination
Tasks’ Participants Responsibilities

• Each Task will specify its requirements to join, scope of work and activities to be carried out on its Work Plan

• In general terms:
  • Attend to Task Meetings
  • Provide knowledge and research capacity
  • Keep national/company Executive Committee (ExCo) representative informed
  • Comply to the specific requirements detailed in the Participation Letter

• Participation is in-kind and it is estimated to be ≈ 0.1 person/annum

• For information on how to join a Task, visit the Procedures Manual available here
Why should you join a Task?

✓ **Join** a network of international experts

✓ **Participate** on cutting-edge hydrogen R,D&D

✓ **Visit** facilities and laboratories from other Task participants

✓ **Set the ground** for joint demonstration projects

✓ **Contribute** to defining the state-of-the-art for hydrogen technologies
Collaboration
Joint activities with entities within the IEA Network and external
Collaboration within the IEA Network
Some examples of our collaboration within the IEA Network

More Workshops being planned:
- H2 + CCUS with IEAGHG
- Electrolysis with Advanced Fuel Cells TCP
- Hydrogen combustion in ICEs and turbines with Advanced Combustion TCP

Peer reviewers for IEA strategic reports on hydrogen:
TRL Assessment on H₂ technologies

**STRATEGIC ACTIVITY**

IEA is updating its Clean Energy Technology Guide (CETG). TRL Assessment is critical, IEA wants to contrast estimated TRL values, description of technologies and current projects, with experts worldwide to be able to achieve the most accurate result. They have asked the Hydrogen TCP for advice/help regarding their TRL assessment activities in new emerging H₂ technologies. Hydrogen TCP has proposed to transform this IEA-TCP’s collaboration into a strategic activity.

**Objectives (general)**

- Strengthen our collaboration with IEA
- Strengthen our collaboration with synergic TCPs
- Position the Hydrogen TCP as a reference for technical knowledge

**Analysis**

Hydrogen TCP Technical Secretariat has analyzed IEA’s CETG hydrogen-related technologies (94): 30 TRL GROUPS have been identified.

**Collaboration**

- TRL Assessment 1st Phase
- 40+ technologies assessed
- 30+ experts mobilized

**Next steps**

- Tasks in definition
- Open Tasks
TRL Assessment on H₂ technologies

STRATEGIC ACTIVITY

Our Goal...

✓ Produce **Hydrogen TCP-centered initiatives/outputs**

✓ Strategic activity, **constant and updatable**

✓ Several tasks are involved, and produce relevant inputs for the TRL Assessment strategic activity

✓ Own database for hydrogen technologies which feeds IEAs CTEG publication periodically

✓ New Tasks are launched within the TRL Assessment framework

Main conclusions:

- We should develop this activity to the maximum quality and coverage of technologies possible, focusing not only on providing the required info by the IEA but also on creating TCP’s products (Technology Briefs).

- The Work would be done in three main phases:
  - Phase 0: identifying missing technologies and completing the list, identifying experts (from TCP network and external collaborators), defining the methodology (Q1 2023)
  - Phase 1: gathering info and providing results to the IEA (Q2 2023)
  - Phase 2: creating TCP results, Technology Briefs (from Q3 2023 onwards)
Collaboration with other organizations

- IRENA: International Renewable Energy Agency
- Hydrogen Council
- IPHE
- World Economic Forum
- MI
- International Transport Forum
- Hydrogen TCP
- IAEA
- Clean Energy Ministerial

Accelerating the Global Clean Energy Transition
Some examples of our collaboration with other organizations

Clean Hydrogen – A Call for Action

2 September 2022, 13.45-16.00 (EDT) – Pittsburgh – Room 407

Keynote speakers:

- Alexander Voigt CEO, HH2E
- Tudor Costantinescu Principal Adviser to the Director General for Energy, European Commission
- Capella Festa COO, Genivia
- Timur Gul Head of Energy Technology Policies Division, International Energy Agency
- Kurt-Christoph von Knobelsdorff CEO, NOW GmbH
- Janice Lin Founder and President, Green Hydrogen Coalition

- David Turk Secretary of Energy United States
- Paul Lucchesi Chair, Hydrogen TCP
- Demetrios Papathanasiou Global Director for the Energy and Extractives Global Practice, World Bank
- Elizabeth Press Director of the Planning and Programme Support, IRENA
- Matthias Soede, M2G Clean Hydrogen Mission Director, European Commission
- Patrick Verhoeven Managing Director, International Association of Ports and Harbors
- Natascha Viljmen CEO, Anglo American Platinum

Moderator:

- Bart Biebuyck Executive Director, Clean Hydrogen Partnership

INTERNATIONAL WORKSHOP

The Role of Low Carbon Hydrogen for a Net Zero Energy System

Organized by:

IAEA International Atomic Energy Agency
CEA Commissariat à l’Énergie Atomique
Hydrogen TCP

22 to 24 June 2022

Hôtel Renaissance, Aix-en-Provence, France
Hydrogen TCP Awards of Excellence

STRATEGIC ACTIVITY

✓ To recognize excellence in international collaboration in research, development, and application of H₂ technologies.
✓ To leverage innovation in H₂ technologies and applications.
✓ To promote and increase the outreach for winning and finalist projects.
✓ Public/private energy companies, start-ups, universities, and research institutions can participate

2022 Topic: “Integrating electrolysis with wind, solar and/or nuclear energy”
Winner: project nuGen™ Zero Emissions Haulage Solution

This project not only succeeded in integrating electrolysis with solar energy but also in demonstrating full integration of the hydrogen value chain from production to final use.
Set at Anglo American Mogalakwena Platinum mine in South Africa, it is a fully integrated, end-to-end green hydrogen system, consisting of hydrogen production (demonstrating solar PV plant (340kW) and 3.5MW electrolyser), refuelling station and haulage system (2MW hybrid fuel cell-battery truck).
Natascha Viljoen, CEO of Anglo American Platinum and Jan Klawitter, Head of International Policy for Anglo American received the Award. Engie and Bright Minds partnered in this project.
“This project is a symbol of what is possible when we work together collaboratively. One truck will take the equivalent emissions to 1000 cars on the road. Anglo American has currently 400 trucks in use and the ambition to retrofit them to use hydrogen” – Natascha Viljoen, CEO of Anglo American Platinum.
Thank You!

For more information, contact the Technical Secretariat:

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