IEA H2 Today

Newest Members


Strategy Matters

The IEA Hydrogen Strategic Plan for 2020-2025 and End of Term Report 2015-2020 have been approved by the IEA Renewable Energy Working Party (REWP) and accepted by the IEA Committee on Energy Research and Technology (CERT).

The Strategic Plan 2020-2025 and End of Term Report 2015-2020 are featured in this issue’s Technology Spotlight.

See the Member Update Table as of February 2020 for a bullet points guide to our Members’ latest policy, R&D&D, and market/commercial news. See the Hydrogen and Fuel Cell Market Space and Diplotech sections in this newsletter for more information on member activities.

ExCo Meetings

The 81st IEA Hydrogen ExCo Meeting was held by webinar on 5 December 2019. The previously scheduled in-person meeting changed to a webinar because of the widespread Paris transport strike. Fortunately, the 82nd ExCo Meeting was held 4-5 February in Paris at IEA Headquarters just before the corona virus shutdown. This was the first IEA Hydrogen ExCo Meeting at IEA headquarters since October 2003.

Collaboration and Outreach

A full day workshop entitled “Hydrogen Production with CCS” was held on 6 November 2019 at EDF in Chatou, France thanks to a collaboration of the Carbon Sequestration Leadership Forum (CSLF), IEA GHG, Equinor and IEA Hydrogen. There were over a hundred participants in this day-long event that included a plenary and three sessions (The role of hydrogen in a low-carbon economy; Case studies; and Technology status of hydrogen production from fossil fuels with CCS followed by breakout discussions). Chairman Lucchese delivered a keynote on global perspectives on hydrogen and IEA Hydrogen activities while General Manager de Valladares gave an overview of hydrogen production today and tomorrow. Y. John Khalil, Operating Agent for Safety Task 37, spoke about safety considerations in the power to gas (P2G) conversion process, while Task 39 - Maritime expert Jacques Saint-Just, spoke about hydrogen in the maritime transport. See all presentations; see workshop report.

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**PUBLICATION ALERT**

The Task 32 Final Report entitled “Materials for hydrogen-based energy storage -- past, recent progress and future outlook” was published in a special issue of the Journal of Alloys and Compounds. This report, which is actually the first part of the Task 32 final report, covers the development of hydrogen storage materials, methods, and techniques - including electrochemical and thermal storage systems over the last 6 years. An overview is given on the background to the various methods, the current state of development, and the future prospects. The second part of this task’s final report is coming soon and will feature a two-page summary of each project and an annex of all publications.

The Task 36 Technology Brief - Life Cycle Sustainability Assessment of Hydrogen Energy Systems is available now. This brief complements the Task 36 Final Report.

The Task 35 Final Report summarizes the status of research in three prominent pathways of renewable hydrogen: water-splitting electrolysis; photoelectrochemical (PEC) hydrogen production; and solar thermochemical (STCH) hydrogen production.

**PRESENTATION ALERT**

<table>
<thead>
<tr>
<th>DATE</th>
<th>EVENT</th>
<th>PRESENTATION TITLE</th>
<th>IEA H₂ SPEAKER/AUTHOR</th>
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<tr>
<td>June 2019</td>
<td>WHTC 2910 in Japan</td>
<td>Previewing the Strategic Plan</td>
<td>Ohira/de Valladares</td>
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<td>July 2019</td>
<td>13th G&amp;O TCP Meeting</td>
<td>The Future of Hydrogen: Seizing Today’s Opportunities</td>
<td>de Valladares</td>
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<td>July 2019</td>
<td>Security &amp; Sustainability Webinar</td>
<td>Can Hydrogen close the Climate Emission Gap</td>
<td>de Valladares</td>
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<tr>
<td>August 2019</td>
<td>AREDAY</td>
<td>The Hydrogen Space: Update &amp; Overview</td>
<td>de Valladares</td>
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<tr>
<td>Oct 2019</td>
<td>Planet Philadelphia Radio Interview</td>
<td>The Challenges and Promises of Hydrogen for zero carbon power</td>
<td>de Valladares</td>
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<tr>
<td>Sept 2019</td>
<td>NEA Workshop Boulogne, France</td>
<td>The Role of H₂ in the Energy Transition</td>
<td>Lucchese</td>
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<tr>
<td>Nov 2019</td>
<td>Hydrogen Production with CCS</td>
<td><a href="#">keynote on global perspectives on hydrogen and IEA Hydrogen activities</a></td>
<td>Lucchese</td>
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<td></td>
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<td>Overview of hydrogen production today and tomorrow</td>
<td>de Valladares</td>
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<td>Safety considerations in the power to gas (P2G) conversion process</td>
<td>Khalil</td>
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<td>Hydrogen in the maritime transport</td>
<td>Saint Just</td>
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<td>Jan 2020</td>
<td>WKO AFCO Vienna, AUT</td>
<td>Viennese Chamber of Commerce H2B – Tapping Hydrogen’s Potential</td>
<td>de Valladares</td>
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</tbody>
</table>
HYDROGEN AND FUEL CELL MARKET SPACE

In 2019, a total of 83 Hydrogen Fueling Stations (HRS) went into operation: 36 in Europe (22 alone in German); 38 in Asia; 8 in North America; and one in the Arabic peninsula. By year end, 432 HRS were in operation worldwide, 330 of which are publicly accessible.

Shipments of hydrogen fuel cells grew by more than 40 % last year as companies delivered about 1.1GW of hydrogen fuel cells in 2019, up from 806 MW in 2018, according to energy consultant E4tech. Toyota and Hyundai accounted for 2/3 of the 1.1 GW capacity. The report noted the “burgeoning” market for hydrogen buses, trucks, and vans.

With the March 2020 launch of a renewable energy-powered 10MW hydrogen production unit at the Fukushima Hydrogen Energy Research Field (FH2R), Japan opened the largest hydrogen production unit on the globe.

Toyota Motor Corp is preparing to launch the 2nd generation of its Mirai FCEV next year. Toyota has also announced that it is using fuel-cell stacks developed for Mirai in a stationary generator system, which is undergoing testing and will soon be used inside Toyota’s Honsha (headquarters) plant—birthplace of the Toyota Production System for manufacturing.

South Korean automaker Hyundai told Autocar it sold 5,500 Nexo crossovers in-country alone. The company is prioritizing domestic orders, effectively hurting supply for the U.S. and Europe.

South Korea plans to install H2 charging stations for FCEVs without delay: 310 charging stations by 2022; 1,200 by 2040 according to the Ministry of Trade, Industry and Energy.

China, far and away the world’s biggest auto market with some 28 million vehicles sold annually, is aiming for more than 1 million FCEVs in service by 2030.

BMW Group expects to have one million EVs and PHEVs on the roads by 2021.

Toyota and its commercial vehicle subsidiary Hino Motors are developing a fuel cell truck based on the Hino Profia using technology Toyota developed for the next generation Mirai. Toyota is partnering with Paccar Inc.’s Kenworth Truck Co. to build 10 Class 8 fuel cell trucks for demonstration in Southern California. Toyota is also expanding its U.S. hydrogen fuel cell heavy-duty truck program with a utility tractor rig designed to pull cargo containers at ports. The prototype, “UNO,” made its first drive at the Fenix Marine Services container terminal at the Port of Los Angeles.

Hyundai Motor Company and Yeosu Gwangyang Port Corporation are partnering to commercialize H2 fuel-cell trucks for logistics and build an H2 fueling station. The port region is home to petrochemical complexes that produce hydrogen as a byproduct.

Norwegian wholesaler Asko is among the first to operate a goods vehicle that runs on H2 thanks to a collaboration between industry and Norway’s SINTEF, which has been working on emission reductions with Asko and hydrogen fuel for almost ten years.

Nikola Motor Co. has introduced the Badger, the most advanced electric & hydrogen pickup, to rival its Ford Raptor competitor. The Badger will output 906 HP, 980 ft. lbs., 4x4, torque vectoring, 15 kW of power export, with up to 600 miles (966 km) of range.

CNH Industrial’s truck unit Iveco unveiled its first electric vehicle (full electric and FCEV models), the Nikola Tre, built in partnership with Nikola. Electric model delivery expected in 2021; FCEV delivery targeted for 2023.
Cummins Inc. unveiled a heavy-duty truck with a 90K kW fuel cell and battery electric power at the 2019 North American Commercial Vehicle Show in Atlanta. It is scalable in 30 kW or 45 kW increments up to 180 kW, has a 100-kWh lithium-ion battery capacity and a 150-250 range. Hyundai Motor Company and Cummins Inc. are exploring opportunities to develop and commercialize electric and fuel cell powertrains, initially for the North American market.

Cummins Inc. closed its $290 million acquisition of Canadian fuel cell and hydrogen production technologies provider Hydrogenics Corp. on Sept. 9.

Swedish manufacturers ASKO Appliances and Scania (heavy duty vehicles) celebrate the start of operations in a pilot venture featuring four hydrogen gas trucks with electric drivetrain as well as ASKO’s hydrogen gas station in Trondheim, Norway.

Japan’s Honda Motor Co and Isuzu Motors Ltd said they would jointly research use of hydrogen fuel cells to power heavy-duty trucks with zero-emission technology.

AKASOL will supply battery systems for more than 40 Coradia iLint hydrogen trains that have been ordered from Alstom by the Lower Saxony Transit Authority and the Rhine/Main Regional Transport Association. This major order is in the low double-digit million-euro range.

The first zero-emission U.S. “hydrail” project will be in Southern California, where San Bernardino County Trans. Authority plans to operate a Swiss Stadler FLIRT H₂ train in 2024.

The city of Auxerre has commissioned the French manufacturer Safra to deliver five fuel cell buses (hybrids with a 30-kW Symbio fuel cell and 132-kWh battery pack) by year end.

Arriva, one of the largest bus operators in the Netherlands, has converted a diesel bus into a hydrogen bus that will run on one of the longest bus lines in the Netherlands.

Germany’s FlixMobility, parent company of coach firm FlixBus, is working with electromobility Freudenberg Sealing Technologies to test H₂ fuel cell buses on long-distance European trips.

Plug Power’s stock soared nearly 20% with the announcement that it had entered into a $172 million agreement with a Fortune 100 logistics company at the end of 2019 to deploy its Gen family of H₂ fuels cell across the customer’s distribution network over the next couple of years.

The green energy investment arm of Australia’s Macquarie Capital will finance a $200-plus million renewable H₂ plant for Renewable Hydrogen Canada (RH2C) in Chertwynd, British Columbia. The plant capacity will be 60 tonne/day.

Nel ASA received a purchase order from Everfuel Europe A/S (Everfuel) for the delivery of an H2Station® fueling solution for a fleet of taxis in Copenhagen, Denmark.

Following the first flight of the world’s first fully electric commercial aircraft in Vancouver, Canada, ZeroAvia plans to carve out a new niche in zero-carbon propulsion in the aviation industry with its hydrogen fuel cell powertrain.

Toshiba Energy Systems & Solutions Corporation (Toshiba ESS) has delivered a mobile 30kW hydrogen fuel cell system to a fuel cell ship. Due to its simplified design, the fuel cell system’s volume per unit power output is reduced to 1/3 compared to a stationary fuel cell system.

Japan’s Kawasaki Industries launched the world’s first ocean-going liquid H₂ carrier, the 8,000-tonne Hydrogen Frontier, to initiate a global supply chain for carbon-free fuel. This pilot project will ship H₂, produced from coal in Australia and then liquefied at -253°C, to Japan.
Norwegian shipbuilder Ulstein is developing an offshore construction support vessel, the Ulstein SX190 Zero Emission DP2 with H₂ propulsion, which will be tested on the high seas starting in 2022. The vessel can serve operations such as offshore wind turbine construction.

Hydrogène de France (HDF) inaugurated a high-powered fuel cell production plant in Bordeaux, with an annual production capacity of 50 MW. It will be the first in the world to mass produce high-powered PACs (>1 MW) using PEM (Proton Exchange Membrane) technology.

The Hydrogen Council, a global association of energy, transport, and industry CEOs are advocating for the accelerated deployment of hydrogen energy solutions. The European Investment Bank (EIB), one of the world’s largest climate financiers, signed a landmark agreement to collaborate on development of innovative financing for hydrogen projects to address climate change.

The world's largest green-H₂ production facility has begun operations in Austria. The 6MW H2Future plant at steel maker Voestalpine's site in Linz is running a Siemens Silyzer 300 PEM electrolyser using renewable electricity provided by Austrian utility Verbund.

If large vessels are to sail zero emission at high speed over long distances, battery solutions do not contain enough energy. The Havyard Group et al. and Norwegian Electric Systems (NES) are developing a hydrogen fuel cell system that will be the largest of its kind for ships.

At CES 2020, Toyota reported it will build a 175-acre H₂ fuel cell-powered city of the future at the foot of Japan's beloved Mount Fuji for employees and families, retirees and scientists.

The South Australia government approved a plan to build a green H₂ production facility that will blend H₂ with natural gas to lower the CO₂ in the distributed gas network. This year, a Queensland plant launched exports of renewable H₂ to Japan. South Korea has also been identified as a promising market for Australian H₂.

The UK’s Powerhouse Energy wants to make energy from non-recyclable plastics and other waste via its process to shred waste and then heat it to ~1,800 degrees F to produce syngas (H₂, methane, CO), for burning to produce electricity, or separation as H₂ to power fuel cells in vehicles and other applications.

Siemens AG is partnering on a 5,000 MW combined solar and wind farm in Western Australia, using Siemens' electrolyser to produce renewable hydrogen for potential export to Asia.

Sinot Yacht Architecture & Design and Lateral Naval Architects made waves at the Monaco Yacht Show with AQUA, their strikingly stylish, 376’ liquid H₂-powered superyacht concept.

The H2Haul project (H₂ fuel cell trucks for heavy-duty, zero-emission logistics) has been launched. Sixteen heavy goods vehicles will be tested in European locations. The consortium includes Air Liquide, Eoly, H2 Energy, H2 Europe, IRU Projects, ThinkStep and WaterstofNet.

The California Fuel Cell Partnership released its second bus road map, Fuel Cell Electric Buses Enable 100% Zero Emission Bus Procurement by 2029, calling for 11 essential actions and setting new industry targets needed to widely adopt FCEBs in the Golden State.

ISS Aerospace, the UK’s leading developer of autonomous aerial systems, has unveiled the Sensus, a pioneering, modular hydrogen fuel cell UAV (unmanned aerial vehicle) platform.

A coalition of major oil & gas, power, automotive, fuel cell, and hydrogen companies has developed and released a new report entitled “Road Map to a US Hydrogen Economy.”
There are varied approaches to strategic planning, a vital organizational function for over 50 years. The success of a strategic plan is ultimately measured by outcomes resulting from its implementation. One major strategic planning challenge, says IEA Hydrogen General Manager Mary-Rose de Valladares, is to engage key members of the organization in the planning process; the companion challenge is to retain their attention and commitment through its execution. In the case of the IEA Hydrogen TCP, a “bottom-up organization,” all members are “key” members with a voice, vote and interest in process and outcomes — and therefore in the success of

### TECHNOLOGY SPOTLIGHT

#### Strategic Plan and End of Term Report - at a Glance

Every five years IEA Hydrogen produces a Strategic Plan for the coming five years and an End of Term report for the preceding five years.

The [IEA Hydrogen Strategic Plan 2020-2025](#) contains the following elements:

- Strategic framework: Vision, Mission Strategy
- Overarching Objectives
- Themes and Portfolios – organizing principles for the Strategic Plan
- 2020-2020 Work Programme with R&D Themes and Portfolios

The [IEA Hydrogen End of Term Report 2015-2020](#) captures the history, results and achievements of the past five years. It contains the following elements:

- Overarching Objectives; Themes and Portfolios
- Activities and Outcomes; Key Task Findings/Results, Lessons Learned & Success Stories, Products
- Participation, Labor and Product Development
- Membership, Governance and Resources

#### IEA Hydrogen Strategic Plan 2020-2025

Excerpts from the **IEA Hydrogen Strategic Plan 2020-2025** appear below:

### Strategic Framework

**Vision**

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

**Mission**

Accelerate hydrogen implementation and widespread utilization – for production, storage, distribution, power, mobility, heating and industry – to optimize environmental protection, improve energy security, transform global energy systems and grid management, and promote international economic development – while sustaining Hydrogen TCP as the premier global resource for hydrogen expertise.

**Strategy**

Facilitate, coordinate and maintain innovative research, development and demonstration activities as a hub for international cooperation and knowledge exchange.
Overarching Objectives that inform Strategic Plan for 2020-2025 Term

| Special focus | Place special focus on the role of hydrogen as a facilitator for a smart, sustainable energy system based on renewables: hydrogen as an energy carrier; hydrogen as an energy storage medium; hydrogen as an intermediate for e-fuels and chemicals; hydrogen for smart cities. |
| Climate | Elaborate the role of hydrogen in deep decarbonization and sustainability of the energy system for transport, power, heating/cooling and industrial uses, highlighting hydrogen’s importance in sector-coupling and energy storage, as well as infrastructure. |
| Core | Sustain the focus on the Hydrogen TCP’s core business of R,D&D cooperation on production, storage, infrastructure, distribution, and safety—enlarging the spectrum of hydrogen applications. |
| Global analysis | Consolidate reference database and global sector analysis, maintaining a “living document” on technology development and learning experiences, including roadmaps and modeling results. |
| Outreach | Communicate Hydrogen TCP knowledge and results, as well as hydrogen information from governments, industries and academia to policy-makers, decision-makers, and the greater public. |
| Demand and trade | Grow global demand for hydrogen and power to gas, while paying special attention to high-growth economies and supporting development of a long-distance supply chain and hydrogen trade. |
| Hydrogen TCP role | Position Hydrogen TCP as a hub for international collaboration on hydrogen R,D&D within the IEA Technology Network, as well as in the greater energy community, while cooperating closely with the new IEA hydrogen initiative. |
| Hydrogen TCP capacity | Enlarge Hydrogen TCP expert network and grow Hydrogen TCP membership, thus enhancing resources and capabilities. |

**IEA Hydrogen End of Term Report 2015-2020 – Findings**

At the beginning of the term, there were 24 IEA Hydrogen members; by the end of the term, there were 31: 25 Contracting Parties and 6 Sponsors. The TCP is in excellent financial condition -- by adopting a conservative budgeting approach, the task-shared TCP built a financial reserve equal to a year+ of its operating budget. Some 365 experts, ~420 FTE person years contributed to the TCP’s work programme.

During the 2015-2020 term, 18 tasks were in some phase of their life cycle: 12 tasks were active, and six (6) were in definition or proposed. As the term ended, five (5) tasks were current and seven (7) tasks were completed, while six (6) were in definition or proposed. These tasks produced some 960 publications in high-value journals and 930 presentations. Moreover, the tasks held 58 task meetings and staged 40 topical workshops, as well as End of Task Workshops for closing tasks.

The IEA Hydrogen Secretariat produced the following materials, all of which may be found on the website at www.ieahydrogen.org: Annual Reports (redesigned in 2016); newsletters; press releases; and a regularly updated Executive Summary. In 2017, at the request of the Executive Committee (ExCo), the GM developed a special report, Global Trends and Outlook for Hydrogen, to inform policy and decision-makers about the status of hydrogen technology. During this term, the Hydrogen TCP expanded its marketing channels by building a robust social media presence on Twitter (@IEA_Hydrogen) and Facebook (@IEAHydrogen). Our Twitter account alone has more than 3,300 followers.

IEA Hydrogen supported the IEA’s development of the Japanese-funded report The Future of Hydrogen, which was presented at the G20 meeting in 2019. Notably, Chairman Paul Lucchese was seconded to the IEA part-time for several months to support report preparation.

External conference and event outreach was very fruitful at the ExCo and Secretariat level. It included participation in UNFCCC COPs, plenary appearances at WHEC, as well as conferences and events of community-wide stature. Our 2019 International Hydrogen Forum in New Zealand was a resounding success, attracting ~75 participants from every corner of this island country.

IEA Hydrogen’s strategic plan.

The IEA Hydrogen Strategic Plan 2020-2025 went into effect on 1 March 2020. However, the planning process began in the spring of 2018 with written Executive Committee and Operating Agent surveys. The first dedicated strategic planning session was held in May 2018; the second in February 2019. Ms. de Valladares spearheaded the planning process and prepared the reports and supporting documents on behalf of the IEA Hydrogen Executive Committee. The ExCo approved the Strategic Plan in June 2019. Final acceptance by the IEA Committee on Energy Research and Technology (CERT) occurred in early 2020. Implementation has just begun.

Ms. de Valladares has broad strategic planning expertise in the public, private and non-profit sectors. In her role as IEA Hydrogen General Manager, she has been an integral part of its strategic planning leadership team over the last 3 cycles, a 15-year period. See strategic plans for earlier periods 2015-2020 and 2009-2013. She also prepared End of Term Reports for these periods as well as the earlier 2004-2009 term.

Over Ms. de Valladares’ tenure, her strategic contributions to planning and management have facilitated successful outcomes: both the number of IEA Hydrogen tasks and the size of its membership have doubled. Beyond RD&D, IEA Hydrogen’s strategy has generated robust outreach and analysis efforts. Industry participation grew not only in terms of task experts but also in the number of IEA Hydrogen industry members. Moreover, IEA Hydrogen has had its own office, a key objective of the 2004-2009 Strategic Plan, since late 2005.

In its pursuit of competitive advantage, the Hydrogen TCP is now focused on sustaining its unique value proposition in the hydrogen space. With global interest in hydrogen at all-time high, the world stage is now set for implementation of the IEA Hydrogen Strategic Plan 2020-2025.
As well, the Hydrogen TCP co-sponsored the 2015 and 2017 International Conferences on Hydrogen Safety (ICHS), as well as the 2019 Hydrogen-Metal Systems Gordon Research Conference, providing financial, technical and marketing support for these events.

### Key Task Findings/Results, Lessons Learned & Success Stories, Products

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<th>PRODUCTS</th>
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<td>28</td>
<td>Large-Scale Hydrogen Delivery Infrastructure (2010-2013) H2 Integration in Existing Infrastructure</td>
<td>FCEVs are technically ready for market; there are no technical barriers to commercialization; no single blueprint for HRS. Market development is bottlenecked, necessitating involvement of all stakeholders.</td>
<td>FCEVs would be more cost-competitive if more financial value were ascribed to environmental benefits, particularly to climate change mitigation. Homer analysis of techno-economic aspects was performed for each project. Task was seriously disrupted by loss of OA but rescued by Japan's support of new OA. Task completion is success story, as is development of Market Readiness Level (MRL) template tool.</td>
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<tr>
<td>29</td>
<td>Distributed and Community Hydrogen (DISCO H2) (2010-2016) Integrated H2 Systems and Analysis</td>
<td>H2 would be more cost-competitive if more financial value were ascribed to environmental benefits, particularly to climate change mitigation. Homer analysis of techno-economic aspects was performed for each project. Task was seriously disrupted by loss of OA but rescued by Japan's support of new OA. Task completion is success story, as is development of Market Readiness Level (MRL) template tool.</td>
<td>Final reports (2017) - DISCO H2, Ito; Subtask 3 - Model Concept Development, Ito; Subtask 4 - Replicability and Market Readiness of the Six Case Study Technologies, Gardiner.</td>
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<tr>
<td>32</td>
<td>Hydrogen-Based Energy Storage (2013-2018) Storage</td>
<td>World’s largest R&amp;D collaboration in H2 storage: 52 experts from 17 Member countries organized in six working groups. Progress with adsorbent-based hydrogen storage; progress with Ni-MH batteries for energy storage as cheaper, safer and simpler than Li-ion batteries (in demo stage); modified Sodium hydride (NaH) shown to be reversible after four cycles. Ferroamp EnergyHub system (using Nilar Ni-MH battery packs) will enter into full-scale production, providing up to 200 kWh energy storage. Case study in efficiency of H2 storage concluded that 28,500 t molten salt could be replaced by 1,100 t MgH2 in Andasol, Spain’s concentrated solar thermal energy system. Prolific publication record is success story.</td>
<td>Final report - Part 1 - final public report organized by working group (in progress); Part 2 (special issue of IJHE) - Seven papers with 60 affiliations published February 2019. Special issue of Applied Physics, A Springer (April 2016) comprised 8 papers with 66 affiliations. Plus, Task 32 experts published &gt;600 other publications.</td>
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<tr>
<td>33</td>
<td>Local H2 Supply for Energy Applications (2013-2016) Production, Infrastructure</td>
<td>80% of participants from industry; created industry electrolyser network. Cooperated with AFC TCP. ELECTROLYZER findings/results - Industrial alkaline and PEM electrolyser systems commercially available in containerized units (ca.10-300 Nm3/h per unit), but capital costs for pressurized water-electrolyser systems in new local supply markets require cost reduction. Reduction in stack cost (42-47% of total) expected with mass manufacturing. REFORMER findings/results - New generation, small-to-medium (ca. 10-300Nm3/hr per unit) reformers demonstrate flexibility in design, scale-up, and dynamics, New RE system concepts using novel reforming and CO2 capture and/or water electrolysis in development, with 75-80% overall system efficiency. H2 supply to FCEVs requires high purity (&gt;99.97%H2). Existing HRS fueling protocols and H2 quality standard are strict, leading to extra costs, but do not represent technical barriers.</td>
<td>Close to 200 publications from H2 TCP Members Proposed successor task will focus on production and conversion of hydrogen for energy and chemicals.</td>
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<td>34</td>
<td>Biological Hydrogen for Energy and Environment (2014-2017) Production</td>
<td>Biohydrogen a viable prospect going forward. Will require consistent direct funding. Key drivers include not only renewable energy demand but also waste treatment, water recovery, and recovery of other valuable resources, such as phosphate. Biohydrogen production from wastes and low-grade biomasses will be important for waste and agro-industry. Progress in both basic and applied biohydrogen production in demonstrating biohydrogen production at larger scale in industrial environment. Dark fermentative hydrogen production by integrating extractive technologies is promising.</td>
<td>Close to 200 publications from H2 TCP Members Proposed successor task will focus on production and conversion of hydrogen for energy and chemicals.</td>
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### Hydrogen in Marine Applications (2017-2019)
**Infrastructure**
- Built maritime industry platform - vessels and ports; building “know-how” for sector that is primary means of transportation worldwide (responsible for 90% of all inter-country trade).
- Supporting development of regulatory framework for hydrogen in the maritime industry.
- Three white papers in progress: 1) “Realizing H₂ in the maritime - experience and knowledge gaps;” 2) H₂ safety, regulations, codes & standards;” 3) “H₂ logistics and ports.”

### Energy Storage and Conversion Based on H₂ (2019-2021)
**Storage**
- Eight working groups, including new working group on ammonia and reversible liquid carriers.
- IEA H₂ TCP sponsorship of MH Gordon conference.

## Analysis

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<td>36</td>
<td><strong>Life Cycle Sustainability Analysis (LCSA) 2015-2018</strong></td>
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<td>Developed life-cycle costing framework. LCSA is a convenient methodological solution to evaluate the performance of H₂ energy systems. LCSA concludes that different calculations associated with conventional LCC, as well as LCC with externalities, influence leveled cost of H₂.</td>
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<td>38</td>
<td><strong>Power-to-Hydrogen and Hydrogen-to-X 2016-2020</strong></td>
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<td></td>
<td>Provided comprehensive assessment of various technical and economic pathways to Power-to-H₂ applications in diverse situations as well as the existing legal frameworks. Performed extensive data collection and analysis on techno-economic studies and business cases as well as PtX demonstrations. Regularly held workshops on demonstrations, in conjunction with meetings. Organized WHEC2018 round table “The Role of Hydrogen in Energy Policies” and participated in other WHEC2018 and non-hydrogen conferences. Collaborating with ETSAP project, Task 41c.</td>
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<td>Three technology briefs: 1) “Electrolysis: what are the investment costs?” 2) “Incentives and Legal Barriers;” 3) “Services to the Grid.”</td>
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<td>41c</td>
<td><strong>Data and Modeling 2020-2023</strong></td>
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<td>Subtask 41c – Cooperation with ETSAP (via ETSAP project) – underway. Project aims to better understand and improve modeling of hydrogen, especially within IEA and the IEA network. It is also intended to inform other Task 41 subtasks, providing a sustainable data validation system and enhanced approach to hydrogen modeling. Longer term ambition is to incorporate database as Secretariat function.</td>
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## Awareness, Understanding and Acceptance (AUA)

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<td><strong>Safety 2015-2021</strong></td>
<td>Provided structural and quantitative contributions, including testbed, to HyRam quantitative risk assessment (QRA) platform in dedicated subtask. Held European workshop back-to-back with ICHS. Supported Sponsor Member HySafe on ICHS conferences. Launched Hydrogen Safety Journal.</td>
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<td><strong>HyRam QRA tool kit; Hydrogen Safety Journal; 2 joint publications in peer-reviewed journal, Process Safety and Environmental Protection.</strong></td>
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**CURRENT**

- **Task 37** 2015-2021  
  Hydrogen Safety
- **Task 38** 2015-2019  
  P2H and Hydrogen-to-X
- **Task 39** 2016-2019  
  Hydrogen in Maritime Transport
- **Task 40** 2019-2021  
  Energy storage and conversion based on Hydrogen
- **Task 41C** 2019-2021  
  Data and Modelling

**PAST**

- **Task 1** 1977-1988  
  Thermochemical Production
- **Task 2** 1977-1979  
  High Temperature Reactors
- **Task 3** 1977-1980  
  Assessment of Potential Future Markets
- **Task 4** 1979-1988  
  Electrolytic Production
- **Task 5** 1979-1983  
  Solid Oxide Water Electrolysis
- **Task 6** 1979-1988  
  Photocatalytic Water Electrolysis
- **Task 7** 1983-1992  
  Storage, Conversion and Safety
- **Task 8** 1986-1990  
  Technical & Economic Assessment of H2
- **Task 9** 1988-1993  
  Hydrogen Production
- **Task 10** 1995-1998  
  Photoproduction of Hydrogen

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**TASK INK**

**Collaborative R,D&D**

**Closing**

**Task 32 – Hydrogen-Based Energy Storage**

Operating Agent: Dr. Michael Hirsch

The first part of Task 32’s Final report, *Materials for hydrogen-based energy storage – past, recent progress and future outlook*, has been published in a Jubilee (open access) issue of the *Journal of Alloys and Compounds*. The second part, comprising a two-page summary of each project and an annex with all publications, will follow.

**Current**

**Task 40 – Energy Storage and Conversion Based on Hydrogen**

Operating Agent: Dr. Michael Hirsch

Since its May 2019 kick off meeting, eight Working Groups are exploring hydrogen storage and conversion options. The next task meeting is now scheduled for 19 July 2020 in Madrid, Spain.

**Coming Soon**

In definition: successor to Task 35 on renewable hydrogen production

Operating Agent: Dr. Luca Turchetti

A September 2019 webinar further clarified scope: electrochemical processes; hybrid processes; photoelectrochemical processes; thermochemical processes; and biological processes. Synergies/redundancies with other IEA H2 tasks, other TCPs and other initiatives being explored. ExCo guidance and participation sought. Expert recruiting continues. Finalization of proposal in progress.

**Analysis**

**Closing**

**Task 38 – Power to Hydrogen and Hydrogen-to-X**

Operating Agent: Dr. Olfa Tlilli

Task 38 will continue to valorize the results and findings of its successful collaboration and also prepare its final report. The final task meeting has been postponed due to the pandemic.

**Task 39 – Hydrogen in Maritime Transport**

Operating Agent: Dr. Ingrid Schjølberg

Task 39 has postponed its final meeting due to the pandemic. Experts are now completing their white papers: $\text{H}_2$ Supply in ports; $\text{H}_2$ safety; and Realizing hydrogen in the maritime - experiences and knowledge gaps. The task will also make recommendations about a successor.
**Current**

**Task 41c of Data and Modeling Task**
Operating Agent: Dr. Arne Lind

Activity continues on subtask 41c and in cooperation with the ETSAP TCP. As well, the third task definition meeting for subtasks a, b, and d took place in Brussels in August 2019. A webinar will take place May/June 2020.

**Coming Soon**

In definition: successor to Task 39 on hydrogen in maritime transport
Successor task under discussion.

In definition: Task 41 a, b, d of Data and Modeling Task
Complete and submit final proposal for ExCo approval of subtasks a, b, and d. A webinar will be scheduled for the May/June timeframe. Final ExCo approval is also expected in this timeframe.

In definition: Hydrogen Export Supply Chain
Activity has global visibility. Task definition meetings expected shortly.

In definition: Hydrogen Applications in Primary Sectors (Agriculture, mining and resource)
Task definition meetings expected shortly.

**Hydrogen Understanding, Awareness and Acceptance**

**Current**

**Task 37 – Hydrogen Safety**
Operating Agent: Dr. Y. John Khalil

Scope expanded beyond deterministic and probabilistic studies to includ safety associated with other hydrogen-based technologies such as hybrid-electric and all-electric commercial aircraft; power-to-gas (P2G) applications (viz blending H\(_2\) with methane for domestic heating); tunnels; and maritime applications. Strategy enlarged to include collaboration with other IEA Hydrogen tasks and IEA TCPs.
DIPOTECH

**New IEA Hydrogen Members**

**CANADA**

Early and strategic investments have placed Canadian companies at the forefront of global fuel cell activity for more than two decades. Investments include: 1st Bus (Vancouver, 1995); 1st Bus Fleet Demo (Chicago, 1998); 1st Vehicle Fleet (Vancouver 2005); 1st Train (Germany 2018); 1st bus fleet in regular service (Whistler 2010); Medium Heavy-Duty Trucks China; 1st National Installation Code (Canada); and 1st Waste H2 Facility (Vancouver).

Currently, Canada is taking actions domestically to foster the growth of H₂ technologies. First, they are developing policies which include: zero emission vehicle sales targets; a clean fuel standard; carbon pricing; analyzing optimal end-use for H₂; and federal and provincial strategies. Second, they are investing in programs which include building stations; supporting vehicle purchase; greening the freight sector; ensuring consumers and fleets have information; aligning codes & standards; deploying vehicles in our fleets; and mining. Lastly, they are partnering with industry to produce a 5MW power to gas facility; 20 MW PEM electrolysis; manufacturing; 80+ MW Alkaline; 1000s fuel cell forklifts; long-haul trucks; mining applications; and 100s of cars.

In the production area, Canada is investigating: Carbon capture & storage (CCUS); electrolyser cost reduction; techno-economic resource potential (clean electricity, biomass, nuclear); and business models for clean H₂ production. For distribution, Canada is working on blending natural gas (NG) in the infrastructure; for storage -Tank size, pressure and storage potential. In the end use sector (power), Canada is exploring grid regulation and energy storage. End use for transport interests are vehicle and infrastructure demonstrations, and codes and standards for refueling infrastructure. For buildings and communities, Canada is researching diesel replacement in remote locations; H₂ blending impacts in NG appliances; industry CCUS at various scales; fuel cell vehicle use in industry; demonstrations (mines); and H₂ blending impacts in industrial engines.

The CEM Hydrogen Initiative (H2I) is a cornerstone of international activities. It aims to advance commercial scale H₂ and fuel cell deployment globally across all sectors of the economy via analysis, policies, programs and projects.

**PORTUGAL**

By using energy analysis and comprehensive Life Cycle Assessment (LCA), the Portuguese Roadmap for Hydrogen is adopting a value chain approach developed by DGEG (Directorate General for Energy and Geology (PT)). The roadmap proposal will be submitted to the government for approval end of March 2020 and next submitted to public consultation. Roadmap for Carbon Neutrality (RNC) 2050: Portugal has committed internationally to reduce its GHG emissions so that the balance between emissions and removals from the atmosphere will exhibit a net zero carbon footprint by 2050. Achieving net-zero carbon emissions will present both a significant opportunity and an enormous challenge – both economically and socially — as a successful transition will require close cooperation between policy, technology and capital, as well as effective engagement of public and private sector.

The National Energy and Climate Plan (PNEC) 2030 states that energy priorities are closely aligned with the RNC 2050, including the following: (i) Decarbonize the economy; (ii) Improve EE; (iii) Reinforce investments in RES; (iv) Ensure security of supply; (v) Promote an innovative and competitive national industry. With respect to clean energy, priority is placed on promoting the national energy system, largely assisted by renewable and sustainable sources, innovative storage solutions, and greater the investment in energy infrastructures and interconnectivity. Approximately 70% of the national gas grid is able to carry H₂, indicating massive potential of renewable energy integration in the future.

Currently there are no HRS or FCEV in Portugal. However, approximately 200 HRS and 300,000 FCEs are anticipated by 2050. CaetanoBus H2.CITY GOLD had its prototype test in 2019. Commercialization is expected in 2020. It holds up to 87 passengers and employs a Siemens permanent-magnet synchronous (180 kW) engine.
Member Updates

AUSTRIA

The new Austrian Governmental Programme 2020 – 2024 has set the following goals: 100% renewable electricity by 2030; 45-50% share of renewables by 2030; carbon-neutrality by 2040; high share of energy-intensive industry (e.g. steel) and feedstock for industry; seasonal storage and flexibility in electricity system; and green gas grid. On 18/09/2018 at Linz Conference, the Austrian Ministry for Sustainability and Tourism signed “The Hydrogen Initiative,” a policy document to support the development of sustainable H2. Signatory states and companies/organizations (25 EU Member States plus 86 companies/organizations) committed themselves to continue research and investment in the production and use of H2 as a future oriented technology.

DENMARK

On Friday 6th of December 2019, 8 out of the 10 parties in the Danish Parliament agreed on a national Climate Act with a legally binding target to reduce greenhouse gas emissions by 70 percent by 2030 (compared to the 1990 level). The Act will entirely overhaul Denmark’s climate policy: every year, the Danish Government will present Climate Action Programmes with concrete political initiatives to decarbonize every sector from transport to agriculture and energy. In December 2019, €27 million in public funding were allocated to two large-scale P2X demonstrations which include a collaboration between Danish Shell and Everfuel, as well as a project consisting of a wide partner-circle under the industrial business park GreenLab Skive. As well Denmark has committed €3 million funding to ACT: an international initiative to facilitate RD&D and innovation for CO2 capture, utilization and storage.

BELGIUM

In Belgium, the off-shore wind targets for 2020/2030 are 2,3 / 4 GW (world’s top 5). The Port of Zeebruges is employing 25 MW electrolyser (P2G) and the Port of Ostend (HYPORI) is employing a 50 MW electrolyser (P2X); the world’s first commercial green H2 project powered by surplus renewables. Air Liquide’s Northern Europe pipeline network is 3000km long and includes 870km of H2 pipeline, 600 km of which are in Belgium. There are currently 3 HRS with another 4 planned in 2021 and 3 projected for 2022. Highlights in Flanders include manufacturing and demonstration of an H2 garbage truck by E-Trucks and a WaterstofNet owned mobile H2 refueling station for demonstrations. The last phase of development trucks on H2 (27 ton, 40 ton) will be demonstrated in early 2020 at Colruyt. Van Hool is manufacturing H2 buses for Pau. Project Green Octopus is focused on large scale H2 production, making ports more sustainable and organizing a H2 backbone network to supply end-users with clean H2. As well, a new major manufacturer in Belgium (Liège region) has developed the world’s largest single-stack alkaline electrolyser (7.5 MW).

EC

The European Green Deal aims to make the EC the world’s first climate neutral continent by 2050. Hydrogen will be a key instrument for meeting the Green Deal. “Clean H2 can play a pivotal role for EU energy transition,” according to European Commission First Vice President Frans Timmermans. Download the full communication. The Commission has also set up an informal group of experts called Hydrogen Energy Network (HyENet), composed of representatives from ministries in charge of energy policy in EU Member States. This expert group aims to support national authorities in charge of energy policy to develop on the opportunities offered by H2 as an energy carrier. Plans for an EU-wide “Clean H2 alliance” were confirmed on 10 March when the EU commission unveiled its new industrial strategy. The alliance is slated to launch this summer.
The Commission is completing its agenda for a low-emission mobility system called Clean Mobility by putting forward the first ever CO\textsubscript{2} emissions standards for heavy-duty vehicles. In 2025, average CO\textsubscript{2} emissions from new trucks will have to be 15% lower than in 2019. For 2030, an indicative reduction target of at least 30% compared to 2019 is proposed. Currently there are 185 HRS in operation, out of which 66 are deployed by FCH JU. 136 HRS are publicly available (https://h2-map.eu/). There are 78 FC buses in operation of which 50 were funded by FCH JU; another 308 FCB in planning (mainly via FCH JU’s JIVE1 and JIVE2). There are 1730 FCEV in the EC (including range extenders) of which 726 are deployed by the FCH JU. There are currently 922 vehicles registered (357 in 2019). 3900 µCHPs have been contracted via FCH JU of which around 1920 have already been deployed.

**HYDROGEN COUNCIL**

Founded at the World Economic Forum in Davos in 2017, the CEO-led Hydrogen Council now has 81 industry members representing 6 million jobs in 13 countries on 4 continents and €18.7 T in revenues. Members participate in large-scale deployment projects globally. The Hydrogen Council’s 2019 engagement with the investment community featured a collaboration agreement with the European Investment Bank (EIB). In early 2020, the Council’s new publication *Path to hydrogen competitiveness – a cost perspective* predicted a cost reduction up to 20% by 2030. As well, the Council is investigating H\textsubscript{2} safety with an emphasis on codes and standards. It has agreed to launch a roadmap on decarbonization of H\textsubscript{2} pathways in 2020 and is also focusing on presenting a clear vision to government on the prospects for H\textsubscript{2}. The Hydrogen Council strategy features communications that support all advocacy efforts.

**ISRAEL**

Israel plans to introduce a H\textsubscript{2} roadmap in 2020, including a techno-economic assessment for Hydrogen in Israel. They hosted a late Dec. 2019 H\textsubscript{2} Round table that began with a Kickoff meeting for stakeholders (Companies, Academy and Regulators). The mission of this Round table is: to review global status of H\textsubscript{2} market, regulation and standards; to create a central knowledge base; and to map expected barriers in Israel.

Research Planning and Programs in Israel include the continuing support of R&D on production, storage and fuel cells. They will examine the need for a governmental H\textsubscript{2} research center. In total there is support in the amount of 12.3M NIS for 12 H\textsubscript{2} related Projects in 2019. There is currently 1 HRS project under way.

**ITALY**

In October 2019, the Italian Prime Minister delivered a speech at “the Hydrogen Challenge” Conference where he confirmed the endorsement of H\textsubscript{2} by the Italian Government. A “Hydrogen Working Table” was opened by the Ministry for the Economic Development in June 2019, gathering industries, institutions, stakeholders, suppliers and developers to enable H\textsubscript{2} technologies. Italy is one of the leading EU countries in terms of number and funding of H\textsubscript{2} & FC R&D projects, with 139 projects (29 coordinated) financed by the European Commission under the FCH 2 JU in the period 2008-2018, involving over 121 Italian beneficiaries and mobilizing over 90 M€ funding. In 2019, Italy produced about 480,000 ton of H\textsubscript{2}. Today less than 2% is distributed (in pipelines or gas/liquid vessels), while the remainder is used on-site for oil refinery.

The Italian Association on Hydrogen and Fuel Cells (H2IT) has developed the “National Plan for Hydrogen Mobility”. This targets the installation of 197 HRS (141 for cars + 56 for busses) large enough to sustain the circulation of 27,000 FC cars and 1,100 busses over the country by the end of 2025. Trucks and H\textsubscript{2} trains are included in the H\textsubscript{2} mobility plan. Currently, there are eight HRS in Italy (with 3 in operation). There is one HRS coming soon in Venice where Toyota Motor Italia will supply a FCEVs fleet with 10 Mirai as well.

**JAPAN**

Japan aims to complete construction of a large-scale demo project in 2019. This includes a 10MW Electrolysis Power to Gas project in Fukushima and H\textsubscript{2} supply chain between Japan/Australia (LH2) and Japan/Brunei (MCH). Japan will also continue a 1MW H\textsubscript{2} gas turbine demo project in 2019 and start an international collaboration on regulations, codes and standards (RCS) for HRS and FCEVs. The budget in JFY 2020 (Apr-Mar, in million US$) includes: subsidy for stationary FC of $36; subsidy for FCV of $120; subsidy, R&D, RCS for HRS of $136; basic research of $61; and demonstration of $128.

Tokyo Metropolitan Government has increased the number of FC-Bus. Kyocera has released 0.4kW SOFC Ene-Farm for installation. Toyota unveiled a new Mirai prototype. And the JOC announced plans to use H\textsubscript{2} as the fuel for its Olympic flame. As of Dec 2019, Japan boasts 22 FCEB; 3,500 FCEV; approx. 300K (0.7 kW) stationary residential FC and approximately 35 (3kW, 4.2kW, 250 kW) commercial stationary FC. HRS Infrastructure wise there are 112 open HRS and 160 projected for 2020.
KOREA

Korea introduced their “Hydrogen Economy Roadmap” in January 2019 and the “Hydrogen Economy Standard Roadmap” in May 2019. These include plans to harmonize domestic standards with international standards, build certification schemes and propose a H₂ related international standard. Korea introduced “Strategy on Future vehicle industries” in October 2019; this announcement included a strategy on future mobility with connectivity, autonomous, sharing and electrification. A “Measure for Hydrogen Infrastructure and Hydrogen Refueling Station” (Oct 2019) was introduced to meet the increasing demand of H₂, diversify H₂ resources, increase H₂ transportation infrastructure and stabilize the price of H₂ “Promotion of Hydrogen Economy and Hydrogen safety Act” passed at National Assembly (Jan. 2020) and will be published soon.

Korea currently boasts 17 FCEBS and 5,080 of FCEV (of 9,177,517 registered vehicles). There are 34 HRS total: 26 early market stations and 8 private research lab and/or company sites. There are 20 HRS under construction and they are preparing for construction of another 100. They’ve set the target of 6.2M FCV, 1,200 HRS and 15GW capacity of Fuel Cell power plant by 2040. As well, Ulsan city will be home to the “Regulation‐Free Area on Hydrogen Green Mobility” (Nov. 2019) project, which includes 1,420,000 and 4.7 M US$ of investment in 2020. The project will feature demonstrations on H₂ logistics machineries (forklift, unmanned luggage vehicle and etc.), H₂ ships and large-scale tube trailers in 2021.

NETHERLANDS

In the Netherlands, a Dutch Climate Agreement was signed in June 2019. Its main elements include: a 49% CO₂ reduction by 2030; 84 TWh of renewable electricity by 2030 (70% of the mix); a subsidy scheme for CO₂ reduction techniques; a phasing out of coal in power plants by 2030; a CO₂ levy in industry above ETS; and an agreement that all new cars in 2030 will be electric. The Climate Agreement will also include a National Hydrogen Programme; a green H₂ ambition of 500 MW 2025 and 3-4 GW in 2030; and 40 million euro/year subsidies for innovation.

The Hydrogen Government Vision (March 2020) features the following H₂ goals: renewable gases as indispensable in 2050; H₂ as 30-50% final energe use (350-750 PJ); H₂ produced and used on large quantities in NL (175 PJ in 2019) and concentrated mainly in the five industrial clusters. Current H₂ programs include: 1) Innovation program on H₂; 2) Demonstration energy innovation (DEI), 2019-2020; 3) arrangement demonstration climate technologies and innovations for transport; 4) fiscal incentive programs (rebate on investments); 5) electrochemical conversion and Materials; 6) MOOI (Mission driven Research, Development and Innovation), 2020; 7) Netherlands Energy Research Alliance (NERA). The Netherlands has 5 HRS and 28 projected by 2021; 6 FCEBs: 215 FCEVs and 3 garbage trucks. They anticipate 50 HRS, 15,000 FCEV cars and 3,000 heavy vehicles by 2025; 200+ HRS and 300,000 FCVs by 2030.

NEW ZEALAND

In December 2018, the newly established NZ Hydrogen Association was accepted as one of 7 global associations to work with the Hydrogen Council. The NZHA has 35 members and growing. In Nov 2019 a letter of intent was signed with South Korea to investigate the feasibility and core technology required to develop a liquid H₂ supply chain for green H₂. In Sep 2019 the green paper “A Vision for Hydrogen in New Zealand” was launched by government seeking feedback on the potential for H₂ production, export, and utilization in the N economy.

In September 2019, First Gas received a government Provincial Growth Fund (PGF) grant to assess whether H₂ can be transported via the existing gas pipe network, together with its application in heating, transport, power generation and integration with other renewable generation sources. As well, New Zealand has introduced a number energy EV focused policy incentives. This includes setting a target of doubling the number of electric vehicles every year to 2021 or about 2% of the fleet; setting exemptions on electric vehicles until they make up two percent of the fleet; and US$700k annually for a nation-wide electric vehicle information and promotion campaign. Ports of Auckland have called tenders for NZ’s first H₂ refilling station with project partners Auckland Transport, Auckland Council and KiwiRail, and have been awarded a 14% subsidy for the purchase of a H₂ fuel cell (HFC) bus and three HFC cars.

INDIA

India’s supreme court has directed the Indian Government to explore H₂-based fuel technology to mitigate pollution issues in the country (13 November 2019). The Ministry of petroleum and natural gas has instructed oil-and-gas public sector companies to explore the feasibility of H₂ fuel for India (6 Dec. 2019). Ministry of new and renewable energy (MNRE) has invited proposals to run four H₂ fuel cell buses in Delhi NCR area (2019).
India has started a Polymer exchange membrane Fuel cell (PEMFC) technology development (CSIR / RIL) program. It is developed in-house low- and high-temperature fuel cell technologies for stationary applications. Hyundai Motor India limited is currently evaluating the feasibility of bringing fuel cell electric vehicles for India. IOC and Tata motors have launched the trial demonstration of India’s first H₂ fuel cell bus. Indian railways are planning to install H₂ powered engines for select passenger trains by end of 2021. There are two HRS deployed in India. H₂ blended CNG (up to 18% v/v H-CNG) stations deployed by Indian Oil corporation (IOC) in select locations around Delhi area. India is also planning to spend ~ $10 bn to expand natural gas pipeline network to promote gas-based economy with potential H₂ blend (2019).

SPAIN

The Spanish Government recently published the “Energy and Climate Integrated National Plan (PNIEC)” intended for 2021-2030. It defines the global objectives in energy efficiency, greenhouse gases emission reduction and renewable energies implementation. The law RD 639/2016 published in December 2016 regulates the specifications of alternative fuels refill stations, in which H₂ is included. According to official data on 2019, Spain has participated in 27 projects funded by FCH JU, among a total of 92 projects, during 2014-2018. 32 institutions were involved with a budget of $102,763,718.

In Spain there are 2 lab site HRS (Puertollano and Walqa in Huesca), 4 privates HRS (Albacete, Hues and 2 in Sevilla). In 2020 there are 3 HRS under construction (Madrid, Zaragoza and Mallorca). There are currently (January 2020) only 2 FCEV registered in Spain: one Toyota Mirai and one Hyundai Nexo. Enagas has announced the acquisition of 12 FC cars, which will use the first HRS in the capital open to the public.

SWITZERLAND

Switzerland has eight energy research competence centers (SCCERs) focused on H₂ and fuel cells. H2 Mobility Switzerland is establishing a nationwide network of HRS thru 2023 which focus on a pay per use model for H₂ trucks across the country. It has 15 members with a goal of 2000 filling stations and 4000 trucks. The Swiss Association for Standardization has developed HRS development guidelines (available at https://www.snv.ch/de/). Hyundai & H2E have partnered in a plan called Hyundai Hydrogen Mobility to deliver 1600 FC powered heavy trucks from 2019 to 2025. The first 50 4x2 FC electric rigid Hyundai trucks arrived in February 2020 with 5X2 electric rigid trucks coming in 2021.

There is currently one HRS (https://hydrospider.ch/en/filling-stations/) in operation in Hunzenschwil and six HRS under construction/planned. Gösgen 2 MW electrolysis plant, located at Alpiq’s Gösgen run-of-river hydroelectric power station (https://hydrospider.ch/en/locations/), produces 300 tons of H₂ per year, sufficient for approximately 40-50 trucks or 1700 cars. Nel ASA has been awarded a purchase order for 2 MW PEM electrolyzers in Switzerland and has entered into a 30 MW framework contract.

UK

The UK government has currently allocated £108m for innovation in low carbon H₂. This includes the following arenas: up to £20m for industrial fuel switching to low carbon fuels; up to £20m for novel clean H₂ supply methods; £25m to develop the safety case of using 100% H₂ through Hy4Heat; and £23m for deployment of H₂ vehicles and to grow HRS infrastructure. The UK government has announced an additional £100m for Low Carbon H₂ Production in August 2019. H21 project has been granted £6.8m of Ofgem funding for phase 2. Hy4Heat hydrogen fired appliances are showing promising results.

Infrastructure is still growing in the UK with 11 public HRS operating and an additional 8 planned for this year. The largest has a capacity of 360kg/day though one with a capacity of 1200kg/day is planned. Currently, there are a total of 260 FCV: 20 FCEB, 179 FCEVs; and 61 commercial vehicles. In January, Worchester Bosch made a strong push for H₂ ready boilers to be required from 2025 in the UK media. A growing number of local councils are announcing climate emergencies requiring them to become carbon neutral by a commitment date.
MESSAGE FROM THE CHAIR

Over the past year or so, hydrogen has realized an impressive number of milestones on the road to its adoption and use in the energy system.

The Future of Hydrogen — a landmark report funded by Japan and prepared by the International Energy Agency (IEA) — was released during the June 2019 G20 meeting of energy and environment ministers in Japan. Having contributed to development of this report, IEA Hydrogen shares in its success.

The European Green Deal, announced in December 2019, aims to make Europe the world’s first climate-neutral continent by 2050. In March 2020, the European Commission (EC) then announced that hydrogen would be “pillar of Europe’s new industrial strategy.”

There is everywhere an increased level of understanding about hydrogen’s benefits for sector coupling and storage.

IEA Hydrogen has marked its own strategic milestones with approval of our Strategic Plan 2020-2025 and End Of Term Report 2015-2020, together with the 1 March launch of our new five-year cycle.

As well, we now feature a Member Table Update (http://ieahydrogen.org/pdfs/Member-Update-Table-2020-v7.aspx) on our website that conveys recent in-country developments, policy alerts, RD&D highlights and business news for each member.

Since energy is essential to the global economy, and clean energy is key to decarbonization for climate change, recovery from COVID-19 will doubtless impact the evolution of hydrogen. IEA Hydrogen is working with its members and allies to support the best possible outcomes.