

General Information	
Preliminary title of the European Partnerships	European Partnership for Clean Hydrogen.
Short description of the partnership	Creating a strong, innovative and competitive European Clean Hydrogen sector, fully capable of underpinning the European energy transition by accelerating the market entry of nearly-zero carbon hydrogen-based technologies.
Services directly involved	RTD (chef de file), ENER, MOVE, CLIMA
Context and problem definition	<p>Hydrogen and associated technologies such as fuel cells are an important decarbonisation pathway that can be applied in a wide range of end-use sectors, in particular the hard-to-abate ones such as industry (steel, chemical, refining etc.), heating, or heavy-duty transport (trucks, ships and rail) where alternatives are scarce or non-existent.</p> <p>With the agreed 32% renewable energy target by 2030, it is expected that the share of renewables in the electricity grid will reach 55%. These high shares of variable renewable energy require much higher flexibility of the power system. Hydrogen produced from renewable electricity is a versatile energy carrier that can respond to these needs through large-scale/long-term energy storage capability, also increasing the entire energy system efficiency through sectoral integration. These benefits are acknowledged in the Communication “A Clean Planet for All” (COM(2018) 773), which identifies hydrogen as one of most promising options for achieving carbon-neutrality and recommends this technology (together with fuel cells) is duly address through EU research. Although the outlook for the entire near-zero carbon hydrogen sector has positively evolved over the last years, the sector still faces two main challenges:</p> <ul style="list-style-type: none"> <li>• high cost compared to fossil-based or more mature alternatives</li> <li>• lack of hydrogen distribution/storage infrastructure.</li> </ul> <p>The underlying problem drivers include market failure for first movers, fragmentation among players and lack of critical mass. Massive cost reductions and technology improvements are still necessary for commercial deployment at a scale that would correspond to the decarbonisation needs at the energy system level. A coordinated pan-European approach is needed to pull together private and public resources to bring down the costs, to develop European supply chains, to increase the maturity of hydrogen-based solutions and, finally, to validate them in full-scale industrial settings. This is needed to ensure that Europe becomes the world leader at a time when major geographies (Japan, Korea, China, USA, Australia etc.) are investing heavily in this emerging sector.</p>
Objectives and expected impacts	<p>The overall objective of the initiative is to create a strong, innovative and competitive European Clean Hydrogen sector, fully capable of underpinning the European energy transition by accelerating the market entry of nearly-zero carbon hydrogen-based technologies and delivering a wide range of socio-economic benefits to the European society.</p> <p>The partnership should constitute a significant <b>upscaling</b> of activities in priority applications where expected environmental impact is high, but alternatives for decarbonisation are scarce - such as industry (steel, chemical, petrochemical etc.), heavy duty transport (incl. shipping and rail) and built environment (heating and cooling). It should help the sector overcome the “valley-of-death” by de-risking the technology through demonstration and pilot deployments at a meaningful scale.</p> <p>The partnership shall address the following 3 key R&amp;I areas:</p> <ul style="list-style-type: none"> <li>• Near-zero carbon <b>hydrogen production</b> pathways, particularly renewable based and including energy system integration aspects (e.g. linking electricity and gas sectors, support decarbonisation of industry). The</li> </ul>

	<p>objective is to produce near-zero carbon hydrogen at a cost of ~€1.5-3/kg by 2030, allowing penetration into mass markets.</p> <ul style="list-style-type: none"> <li>• <b>Technologies</b> for safe and cost-efficient distribution and storage of hydrogen and hydrogen-rich energy carriers, incl. long-term, large-scale storage of hydrogen as energy buffer. The objective is to reduce the distribution costs to less than €1/kg of hydrogen at scale by 2030.</li> <li>• <b>Demand side technologies</b> (including fuel cells) to produce power and/or heat for mobile and stationary applications. In the transport sector, focus will be on heavy-duty road freight, rail, and water-borne. The objective is to deliver hydrogen based solutions at a price equivalent to the alternatives by 2030.</li> </ul> <p>The proposed partnership will therefore contribute to the three objectives of the Horizon Europe programme:</p> <ul style="list-style-type: none"> <li>• <b>Scientific:</b> By supporting the creation and diffusion of high-quality knowledge as a backbone for the new generation of products.</li> <li>• <b>Societal:</b> By providing innovative solutions for the integration of renewables in economic sectors traditionally difficult to decarbonise. It is estimated that ambitious<sup>1</sup> deployment of hydrogen could reduce annual CO<sub>2</sub> emissions by approx. 560Mt by 2050<sup>2</sup>. Beyond decarbonisation, the targeted technologies will also improve the energy security and European trade balance.</li> <li>• <b>Technological/Economic:</b> By fostering innovation and enabling market uptake through strengthening the European supply chain for hydrogen and fuel cells technologies, with positive impacts on jobs and growth. It is estimated that an ambitious roll-out of hydrogen technologies in Europe could create a market worth EUR 85 Billion by 2030, directly employing approximately 1 million people and 5.4 million by 2050<sup>3</sup>.</li> </ul>
Necessity test: rationale for a European Partnership	<p>Decarbonisation is one of the key drivers for hydrogen uptake at scale. Making the technology available for large-scale deployment is in the interest of the entire EU, and the benefits of reduced GHG emissions surpass national borders, justifying EU level action.</p> <p>The scale and scope of research and development needs to bring near-zero carbon hydrogen sector to the level where deployment at scale is feasible goes well beyond the capacity not only of individual companies, but also those of single Member States. The associated risk levels to technology take-off are enormous and call for intensified cooperation across all European actors and Member States to focus research and innovation efforts around key priorities and to create the right framework conditions for commercialisation in a synchronised manner.</p> <p>In addition, the European interest in near-zero carbon hydrogen as an energy vector is driven by its ability to optimise the European energy system through “sectorial integration”. Harnessing its full benefits requires close collaboration among Member States along the entire technology value chain, not only to make near-zero carbon hydrogen technologies cheaper and more efficient, but also to remove market-based barriers through preparation of harmonised regulations, codes and standards.</p> <p>The proposed EU partnership responds to “The Hydrogen Initiative” endorsed by 26 EU Member States and the European Commission in 2018, which calls for intensification of hydrogen R&amp;I to promote the supply of efficient, safe and clean energy for all users throughout Europe and</p>

<sup>1</sup> Where the annual demand for hydrogen is estimated at ~ 665 TWh in 2030 and increases **sevenfold** by 2050 - from about 325TWh in 2015 to ~ 2250 TWh in 2050.

<sup>2</sup> Hydrogen Roadmap Europe – A sustainable pathway for the European energy transition, FCH 2 JU 2019. The reduction corresponds to ~ 50% of the gap between the existing energy and climate related commitments by European countries and what is necessary to achieve the 2 degrees target as estimated in the Reference Technology Scenario of the IEA.

<sup>3</sup> Hydrogen Roadmap Europe – A sustainable pathway for the European energy transition, FCH 2 JU 2019

	multilateral cooperation regarding the exchange of technological expertise, data, results and best practices.
Relevant for the following parts of Horizon Europe	Pillar II 'Global Challenges and European Industrial Competitiveness' <input checked="" type="checkbox"/> Cluster Digital, Industry and Space <input checked="" type="checkbox"/> Cluster Climate, Energy and Mobility
Currently identified links with other partnership candidates / Union programmes	<p>The goal of this partnership is to produce leading European hydrogen-based solutions that can be applied in a variety of areas, for example in electro mobility and energy storage (potential partnership 2ZERO, Batteries) or in buildings (potential partnership on the built environment). The Clean Hydrogen partnership would focus on development of hydrogen and its associated technologies whereas the other partnerships would address the implementation/validation. This would be the case for the potential partnership on Rail, and, to a lesser extent, the one on Aviation.</p> <p>The similar relationship can be expected with Missions, where hydrogen technologies could play a role in Mission Areas 1 (Adaptation to Climate Change and Societal Transformation), 3 (Healthy Oceans, Seas, Coastal and Inland Waters) and 4 (Climate-Neutral and Smart-Cities).</p> <p>Synergies with other EU programmes are also expected with the work under the Strategic Forum for Important Projects of Common European Interest, the next Connecting Europe Facility, the future Innovation Fund and EIBs loans such as those provided by InnovFin EDP.</p>
Does the proposed partnership build on currently active ones?	<p>The partnership builds on the results of the currently active FCH 2 JU, which has been instrumental in developing key technology bricks and bringing the first generation of products to the market.</p> <p>Compared to the existing JU, the new structure moves away from the current 2 pillars, Transport and Energy, giving more prominence to hydrogen production, distribution and storage, as enablers for hydrogen uptake at scale. In end-use application the priority will be given to applications where alternatives are scarce and expected impacts high.</p>
Expected type and composition of partners	<p>As of today, the private partners in the FCH JU consist of industry and research stakeholders (also including academia), represented through associations – Hydrogen Europe (100+ members) and Hydrogen Europe Research (~ 70 members). The current partnership is already entirely open and involves stakeholders from across the entire technology value chain – from basic research up to close-to-market activities. The versatility of hydrogen is fully reflected in the diversity of the industrial association's membership, with actors representing a broad variety of sectors and disciplines – from hydrogen production via different pathways, through fuel cell community, up to end-use across various sectors (energy, transport, industry etc.).</p> <p>This open set-up should be further reinforced under the new partnership, which should include more energy companies (e.g. transmission and distribution system operators, operators of power plants, utilities), waterborne and rail transport industry as well as more representatives of the industrial sectors that could benefit from the use of near-zero carbon hydrogen (chemical, steel, refineries...) in order to better reflect the revised strategic orientation and incentivise further uptake of hydrogen technologies in the broader energy system.</p> <p>Given the need to address the acceptance of hydrogen technologies, it will also be important to establish a dialogue with representatives of civil society and NGOs.</p>

Contributions and commitments expected from partners	<p>It is expected that in-kind contributions (in projects) from partners, possibly through lower funding rates compared to Horizon Europe, will account for the bulk of the contribution from the private stakeholders and should at least match the Union's contribution. Financial contributions are expected to play a rather limited role.</p> <p>In addition, the partnership should trigger private partners' investments beyond the Joint Undertaking itself in areas related to technology commercialisation and deployment, in particular in areas such as pilot plants, lines and hydrogen infrastructure. These investments will contribute to the overall leverage. It is also expected that private stakeholders will actively contribute to the development of the Regulations, Codes and Standards that need to be put in place to allow for mass-commercialisation of near-zero carbon hydrogen.</p>
Currently envisaged implementation mode(s).	<p><input type="checkbox"/> Co-programmed European Partnership</p> <p><input type="checkbox"/> Co-funded European Partnership</p> <p><input checked="" type="checkbox"/> Institutionalised European Partnership</p> <p style="padding-left: 40px;"><input type="checkbox"/> Article 185</p> <p style="padding-left: 40px;"><input checked="" type="checkbox"/> Article 187</p> <p style="padding-left: 40px;"><input checked="" type="checkbox"/> EIT-KIC</p>
Justification of the implementation mode	<p>An institutionalised partnership, with its effective coordination and collaboration mechanisms, is likely to be more successful in federating and structuring the stakeholders around a long-term European hydrogen R&amp;I agenda shared by the industry, research and the European Commission than the other types of partnerships.</p> <p>An institutionalised partnership gives the strongest signal of EU commitment and is likely to be much more impactful in terms of safeguarding long-term industry commitment to effectuate investments that are necessary for hydrogen technologies to play a major role in the EU clean energy transition. While the existing FCH JU has been instrumental in creating a well-structured innovation ecosystem where public and private actors work together, it is unlikely that this ecosystem will survive without a uniting umbrella. This is because the sector is not yet profitable and as SMEs are its core<sup>4</sup>, it not only relies on public funding, but it also requires long-term stability and vision.</p> <p>The conclusions of the Interim Evaluation of the FCH 2 JU confirm the relevance of the instrument: "[...] The FCH sector is still in a pre-deployment stage, implying that the first-mover risk is still very present for the industrial partners. The choice of a Joint Undertaking as instrument continues to ensure good alignment with both policy and industrial objectives and [...] Europe's competitive position would be less favourable without the activities of the FCH 2 JU [...]"</p> <p>An institutionalised partnership also offers a unique platform for an in-depth dialogue between public and private stakeholders and for better alignment with Member States and other EU programmes.</p>
Proposed starting year	2021

<sup>4</sup> more than 30% of the FCH JU's funding goes to SMEs