Clean Hydrogen Partnership

ANNEX to GB decision no CleanHydrogen-GB-2025-06

CONSOLIDATED ANNUAL ACTIVITY REPORT

YEAR 2024

In accordance with Article 26 of Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Clean Hydrogen Joint Undertaking and with Article 23 of the Financial Rules of the Fuel Cells and Hydrogen 2 Joint Undertaking as re-adopted by the Clean Hydrogen Governing Board on 17 December 2021 (Decision reference number CleanHydrogen-GB-2021-02).

The consolidated annual activity report will be made publicly available after its approval by the Governing Board.

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(FACTSHEET)

Name of the JU	CLEAN HYDROGEN JOINT UNDERTAKING (CLEAN HYDROGEN JU)
Objectives	The Clean Hydrogen JU, through the involvement and commitment of its partners, will enhance cooperation between the diverse stakeholders along the whole hydrogen value-chain and mobilise them to increase the leverage effect of investments in R&I, with the main objectives to: • Contribute to the EU ambitious 2030 and 2050 climate ambition • Support the implementation of the Commission's Hydrogen Strategy • Strengthen the competitiveness of the Union clean hydrogen value chain • Stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications The Clean Hydrogen JU has the following specific objectives: a) improve through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union; b) strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills; c) carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications; d) increase public and private awareness, acceptance and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe. Moreover, the Clean Hydrogen Joint Undertaking shall carry out the following specific JU tasks: a) assess and monitor technological progress and technological, economic and societal barriers to market entry, including in emerging hydrogen markets; b) notwithstanding the Commission's policy prerogatives, under the

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	Commission's policy guidance and supervision, contribute to the development of regulations and standards with the view to eliminating barriers to market entry and to supporting interchangeability, inter-operability and trade across the internal market and globally; c) support the Commission, including through technical expertise, in its international initiatives on hydrogen, such as the International Partnership on the Hydrogen Economy (IPHE), Mission Innovation and the Clean Energy Ministerial Hydrogen Initiative
Legal Basis	Established under article 187 of the Treaty on the Functioning of the European Union and Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014]
Executive Director	Valérie Bouillon-Delporte
Governing Board	Governing Board (3 representatives of the European Commission, 6 representatives of the Industry Grouping and 1 representative of the Research Grouping) Chair: Ms Melissa Verykios until 22 October 2024, followed by Ms Danica Maljković as of 23 October 2024 (Industry Grouping) Vice-chair: Ms Rosalinde van der Vlies (European Commission) Current composition: https://www.clean-hydrogen.europa.eu/about-us/organisation/governing-board_en
Other bodies	States Representatives Group Stakeholders Group
Staff number	27 temporary agents, 2 contract agents and 2 seconded national experts
Total Budget [2024][1]	Commitment appropriations([2]): EUR 215.01 million, of which EUR 206.6 million for operational activities and EUR 8.5 million for administrative expenditure

[1] Total budget includes operational budget (used for funding selected projects) & administrative (used for funding Programme Office activities)

[2] Voted commitment appropriations were EUR 185.9 million, subsequently amended to include unused appropriations from prior years and additional appropriations due to UK contribution.

[3] Voted payment appropriations were EUR 147.6 million, subsequently amended to include unused appropriations from prior years.

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	Payment appropriations([3]): EUR 150.7 million, of which EUR 141.6 million for operational activities and EUR 9.1 million for administrative expenditure
Budget implementation/execution	Commitments: EUR 210,933,875 (98% of appropriations): • Title 1: EUR 3,992,867 (83%) • Title 2: EUR 3,194,985 (87%) • Title 3: EUR 203,746,023 (98.6%) Payments: EUR 126,994,237 (84 % of appropriations) • Title 1: EUR 3,758,472 (73%) • Title 2: EUR 2,287,747 (58%) • Title 3: EUR 120,948,018 (85%)
Grants/Tenders/Prizes	22 grants signed in 2024 (incl. those remaining from call 2023) for a total value of EUR 143,592,970.66 Two specific contracts under operational tenders for a total value of EUR 13.6 million and administrative tenders for a total value of EUR 1.053 million
Strategic Research & Innovation Agenda	Strategic Research and Innovation Agenda 2022–2027 (https://www.clean-hydrogen.europa.eu/about-us/key-documents/strategic-research-and-innovation-agenda_en)
Call implementation	Number of calls launched in 2024: 1 Number of proposals submitted: 151 Number of admissible and eligible proposals: 140 Number of proposals granted: 29 Deadline model: Single stage Number of global project portfolio as of end of 2024 (since the setting up; signed grant only; for evolution overview): 115
Participation, including SMEs	Total of 755 beneficiaries in funded projects of the Clean Hydrogen JU (Calls 2022, 2023 and 2024), securing EUR 642.58 million of funding. Of these beneficiaries: • 19 % were SMEs, receiving 18 % of total EU funding; • 51 % were private for profit/large companies, receiving 48 % of total EU funding; • 5 % were non-EU, non-associated members' entities (openness); • 40 % were newcomer entities; 21% were members of the Clean Hydrogen JU's private members, receiving 43% of the total funding.

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FOREWORD

Advancing Europe’s Hydrogen Ecosystem

In 2024, Europe made significant strides in advancing its hydrogen economy towards building a strong European value chain, and the Clean Hydrogen Partnership followed course, advancing the European hydrogen value chain by fostering innovation, supporting infrastructure development, and enhancing regional collaboration.

"The Future of European Competitiveness," published in September 2024, underscored the critical role of hydrogen in Europe's green transition and industrial competitiveness. The newly elected European Commission also reinforced its commitment to hydrogen as a key element of Europe's green transition. Through strategic investments, regulatory frameworks, international partnerships, and support for innovation and skills, Europe is striving to establish a competitive and sustainable hydrogen economy by 2030 and beyond.

2024 proved to be a pivotal year for Europe's hydrogen sector, characterized by substantial investments, major policy initiatives, and growing international collaborations. Yet, challenges remain: accelerating infrastructure development, achieving cost competitiveness, and building resilient supply chains will be crucial for realizing the EU's hydrogen ambitions. However, challenges remain: electrolyser deployment is much slower than expected; renewable hydrogen production costs remain well above those of hydrogen from natural gas, hindering widespread adoption.

The Clean Hydrogen Partnership (CHP) plays a vital role in tackling these challenges. An independent Partnership Evaluation Report published this year confirmed the significant progress made by the Clean Hydrogen Partnership and its predecessor, the FCH 2 JU, highlighting the Partnership’s contribution to Europe’s green energy transition and its ability to drive innovation through collaboration.

Our projects achievements clearly demonstrate our ongoing commitment and impactful progress in advancing the European hydrogen sector:

- Significant progress was made across several electrolyser technologies. Notably, Low Temperature (LT) electrolysis projects demonstrated robust performance in challenging environments, improving electrolyser efficiency and reducing electricity consumption significantly. The Clean Hydrogen JU’s support helped achieve remarkable reductions in Levelized Cost of Hydrogen (LCOH), thanks to electricity consumption reduction, both on AEL (from 65 to 50 kWh/kg) and PEMEL (from 60 to 52 kWh/kg), which contributed up to a 10% reduction of LCOH for AEL and up to a 6% reduction for PEMEL . Over the last 10 years, thanks to our programs, the capacity of electrolysers in the projects being funded increased 200 times (from 150kW to 30MW) while JU support reduced by 40 times, per installed MW (from EUR 20 million/MW to EUR 0.5 million/MW).
- Our projects demonstrated enhanced hydrogen storage and distribution capabilities, successfully demonstrating cyclic testing in salt caverns, or ability to scale this storage substantially. Innovative solutions in liquid organic hydrogen carriers (LOHC) and hydrogen liquefaction processes were developed, significantly improving the technology’s practicality and scalability.

- On hydrogen-powered mobility notable demonstrations were performed in 2024 in inland waterway vessels, port machinery, and heavy-duty road transport vehicles. These demonstrations not only validate technological feasibility but also help establish a dedicated European supply chain for fuel cell systems, enhancing the EU’s competitive edge globally.
- In 2024 Hydrogen Valleys clearly confirmed their role of “Regional Powerhouses for Green Growth”**.** Hydrogen Valleys are game changers in Europe’s hydrogen journey. These regional ecosystems serve as testbeds for scaling up hydrogen technologies and fostering new value chains. By the end of 2024, 18 H2 Valleys (including BIG HIT) had been approved, with total JU’s funding of €215.8 million, across 18 countries. The first edition of the Hydrogen Valley Days, held in Brussels on 17 and 18 June 2024, marked a new milestone in our efforts to further develop Europe’s green hydrogen regions, with the signing of the first 10 memoranda of co-operation with national and regional authorities.

The 2024 call or proposals allocated EUR 132.5 million (including UK contribution) to support projects across the entire hydrogen value chain. An additional EUR 60 million from the REPowerEU plan was earmarked to accelerate the development of Hydrogen Valleys, including the H2 Valleys facility.

Hydrogen is also a sector where SMEs are particularly dynamic: in 2024, 61 SMEs benefited from the Clean Hydrogen JU grants, representing 21% of all beneficiaries, and receiving 20% of the total EU contribution. Under Horizon Europe, SMEs now account for nearly 300 participations in Clean Hydrogen JU-funded projects. Public and private investment remained strong in 2024, enhancing the true value of the public private partnership. Under Horizon Europe, industry investment—net of the EU contribution—totalled almost EUR 1.16 billion, alongside an EU contribution of EUR 734 million. This represents a leverage effect of 1.58 for every euro invested by the EU in hydrogen research and innovation—reaching 1.65 in 2024 alone.

Cooperation between industry, research and policy was ever more prominent at the 2024 edition of the European Hydrogen Week. The Clean Hydrogen Partnership launched a new Innovation Hub showcasing cutting-edge hydrogen projects with sessions on research and innovation, EU competitiveness, skills development, and Hydrogen Valleys. At its annual awards, the Partnership recognised outstanding projects and, for the first time, introduced the *Women in Hydrogen Research* award, reflecting its commitment to promoting gender diversity in research and innovation.

Europe’s hydrogen ambitions are also global. In 2024, the Partnership signed its first cooperation agreement with Japan’s NEDO (New Energy and Industrial Technology Development Organization). This milestone agreement aims to accelerate the deployment of hydrogen technologies, contribute to the creation of a global hydrogen market, and support broader decarbonisation goals. Strengthening the international cooperation, the Clean Hydrogen Partnership also signed a Memorandum of cooperation with the Clean Hydrogen Mission - Mission Innovation, committing to continue advancing clean hydrogen technologies through key initiatives such as creating an enabling environment through global events, expanding Hydrogen Valleys with strategic tools or enhancing knowledge management with shared platforms.

In October 2024, our Governing Board appointed a new Chair, Danica Maljković, also a Board member of Hydrogen Europe shortly after my own appointment as Executive Director of the Partnership. Under my leadership, our committed team continues to support the development of innovative, cutting-edge projects that contribute to a resilient and sustainable hydrogen economy.

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This 2024 annual activity report will provide you with extensive details and information on our different projects and activities , again demonstrating that the Clean Hydrogen Partnership is instrumental in advancing the European hydrogen value chain, driving innovation, fostering regional collaboration, and positioning Europe as a leader in the global hydrogen economy.

Valerie BOUILLON-DELPORTE

Clean Hydrogen JU Executive Director

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EXECUTIVE SUMMARY

The year 2024 was a year of important developments for the Clean Hydrogen JU, continuing the achievements of the previous years and intensifying the efforts on hydrogen valleys. With a total amount of operational commitment of EUR 203 million, and the launch of 22 new projects, the overall portfolio has reached a total number of 147 projects under active management towards the end of the year. The budget execution reached the outstanding level of 98% in commitments and 84% in payments, in line with previous year, showing the continued effort to use the available credits.

In 2024, the JU launched a call for proposals with a budget of EUR 113.5 million covering R&I activities across the whole hydrogen value chain, to which was added an amount of EUR 60 million from the RePowerEU plan focusing on hydrogen valleys. That amount served for valleys-related grants and the "Hydrogen Valleys Facility" tender designed for project development assistance that will support Hydrogen Valleys at different levels of maturity. The Hydrogen Valleys concept has become a key instrument for the European Commission to scale up hydrogen technology deployment and establish interconnections between hydrogen ecosystems. At the end of 2024, the Clean Hydrogen JU has already funded 20 hydrogen valleys. This support was complemented with additional credits from third countries and the optimal used of leftover credits from previous years, allowing the award of 29 new grants from the call for 2024.

Further to the call for proposals, the JU worked on synergies with managing authorities at the national and regional levels, notably through the signature of 10 Memoranda of Understanding (MoUs)([3]).

Furthermore, in 2024, the SRIA of the Clean Hydrogen JU was amended for the first time([4]). This amendment was the result of the joint effort of the public and private members of the JU, under the coordination of the Programme Office. The revision of the Key Performance Indicators of the Strategic Research Agenda is ongoing and the second amendment of the SRIA, initiated in 2024, has not been completed

Regarding international relations, a cooperation agreement was signed in June with the New Energy and Industrial Technology Development Organization (NEDO) in Japan. A first Joint workshop focusing on electrolysis took place in Brussels during the European Hydrogen Week.

In addition, the JU continued its dissemination and communication actions with the European Hydrogen Week launching the Innovation Forum (a series of high-level conference devoted to Research and Innovation) organised in November. During the European Hydrogen Week, the Clean Hydrogen JU and Mission Innovation signed a Joint Declaration to strengthen collaboration in advancing hydrogen technologies and solutions. These major events were complemented with a new flagship event on hydrogen valleys, the Hydrogen Valleys Days, which was organised for the first time in June at the occasion of the publication by the European Commission of the Hydrogen Valleys Road Map. Due to the success of this initiative, it will become a yearly JU flagship event.

The European Hydrogen Sustainability and Circularity Panel, set-up in February 2024, conducted analysis at the Programme and projects level, supporting the Clean Hydrogen JU Programme and the

([3]) The 5 main MoU are between the Clean Hydrogen JU and Scientific and Technological research council of Turkey, Friuli Venezia Giulia Region, Croatian Hydrocarbon Agency, Ministry of Innovation and Growth of the Republic of Bulgaria and New Energy and Industrial Technology Development Organization towards social implementation of hydrogen technologies.

([4]) https://www.clean-hydrogen.europa.eu/about-us/key-documents/strategic-research-and-innovation-agenda_en

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overall transition of the European hydrogen sector towards a sustainable and circular hydrogen economy, while also promoted and disseminated the relevant knowledge and culture within and beyond the Programme.

Continuing on the efforts undertaken over the past years to strengthen synergies, collaboration and efficiency also in the administrative area, - the JU led the development of the back-office arrangements for ICT (BOA ICT), the new form of inter-JU collaboration in the area of Information and Communication Technologies, materialised by a signature of a Service Level Agreement between the 10 Joint Undertakings at the end of 2024. This SLA builds on a pre-existing collaboration and complements the already existing back-office arrangements established in the previous years.

In terms of operations and HR, the JU continued to fill its establishment plan with seven recruitments including the one of the new Executive Director who joined in June 2024. A committed staff, under the guidance of Mirela Atanasiu, acting as executive director ad interim, allowed JU operations to be successful and to meet the sector's ambitious expectations until the arrival of the new Executive Director in June.

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1 Implementation of the Annual Work Programme 2024

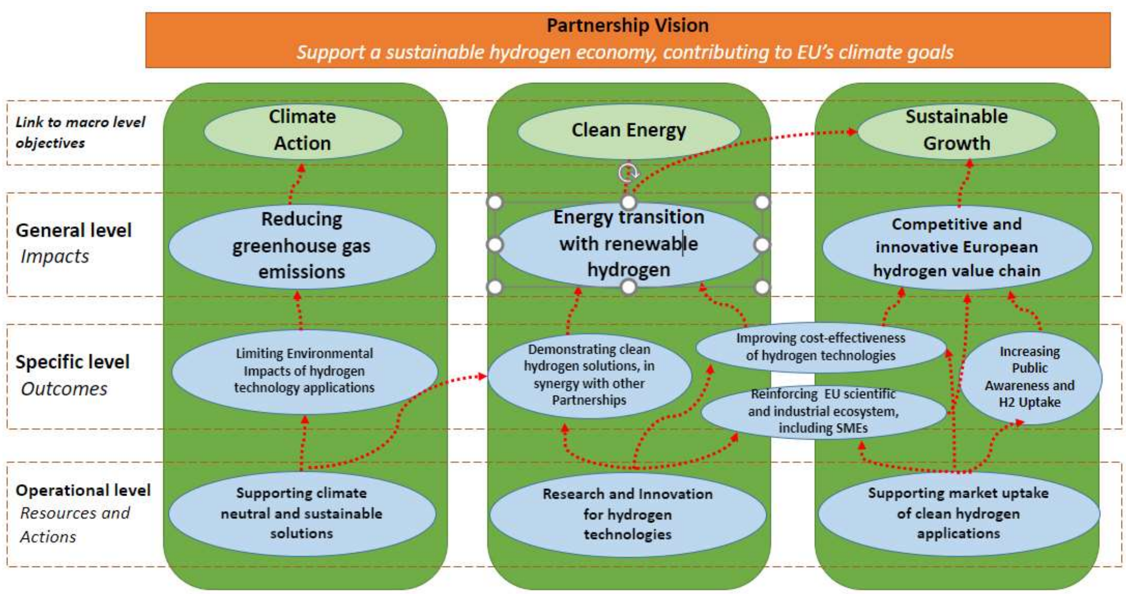
1.1 Key objectives 2024, associated risks and corrective measures

1.1.1 Progress towards achieving the Clean Hydrogen JU objectives

The European Green Deal aims to transform the Union into a fair and prosperous society with a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases by 2050 at the latest. Priority areas include clean hydrogen and fuel cells, together with other alternative fuels and energy storage. The Clean Hydrogen JU aims to accelerate the development and deployment of advanced clean hydrogen applications ready for market, across energy, transport, building and industrial end-uses for a European value chain, strengthening its competitiveness and with a view to supporting notably SMEs, accelerating the market entry of innovative competitive clean solutions. The final goal is to contribute to a sustainable, decarbonised and fully integrated EU energy system, and to the EU's Hydrogen Strategy, thereby playing an important role in the implementation of its roadmap towards climate neutrality.

The Clean Hydrogen JU outlined a Strategy Map to facilitate the implementation of the Programme, underscoring its large number of objectives, some of them high-level, to more specific ones([5]). This allowed the identification of the necessary actions across the lifetime of the Clean Hydrogen JU, necessary to meet its objectives. The Strategy Map, presented in Figure 1, links the resources of the Clean Hydrogen JU and the actions taken (operational objectives / indicators) to concrete outcomes (specific objectives / indicators) and directly to one (or more) of the general objectives and intended impacts of the Clean Hydrogen JU, which in turn contribute to one or more high-level objectives of the European Union.

FIGURE 1. STRATEGY MAP OF THE CLEAN HYDROGEN JU



Source: Clean Hydrogen JU.

([5]) See Section 7 of the Clean Hydrogen JU SRIA

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Therefore, the programme's progress towards its objectives can be assessed based on the progress of its KPIs towards achieving the targets associated with the Clean Hydrogen JU Strategy Map, as described above.

All projects support climate neutral and sustainable solutions, while many of them make a step forward the market uptake of clean hydrogen -technologies. Significant support is given both to SMEs (19% of the total beneficiaries) and to Research and Innovation Actions type of projects (almost 44% of the total projects) and to Innovation Actions type of projects (56% of its budget). The Clean Hydrogen JU activities are fully in line with its objectives, strengthening the knowledge and capacity of scientific and industrial actors, improving the hydrogen technologies and thus contributing to the implementation of the European Commission's Hydrogen Strategy and the achievement of the objectives set out in the European Green Deal and the 2030 Climate Target Plan.

In particular, looking at the 2022, 2023 and 2024([6]) calls, close to EUR 642.5 million([7]) have been used to support projects across the whole hydrogen value chain, covering different technology readiness levels including research actions up to the demonstration of specific technologies as well as projects aiming to demonstrate hydrogen ecosystems or Hydrogen Valleys. In addition, a number of projects have been supported looking at cross-cutting issues such as skills, pre-normative research and sustainability of hydrogen technologies.

Out of the EUR 642.5 million, a share of 9% (EUR 57.5 million) corresponds to the Hydrogen Valleys funded through the "REPowerEU Plan ([8])".

The figures below show the share of funding per Pillar and sub-pillar, as well as by type of action. These figures exclude the grants (Hydrogen Valleys) supported by the RePowerEU budget. The figure below shows the breakdown of the support provided under these calls per pillar in the SRIA, with the largest share used to support clean hydrogen production.

([6]) Considering grants in the Call 2024 signed before end of 2024

([7]) Figures for the 2024 Call do not include the 13 grants that were signed early 2025 or are still under preparation.

([8]) The European Commission (EC) in its communication "REPowerEU Plan" announced an additional investment. of EUR 200 million available for the Clean Hydrogen JU for doubling the number of Hydrogen Valleys in the EU by 2025

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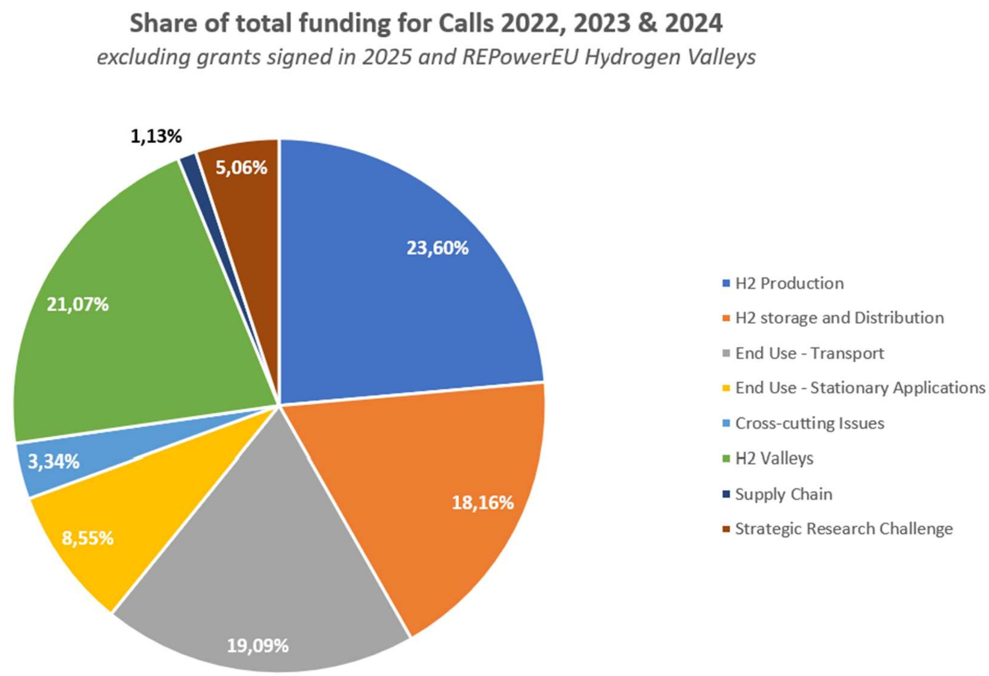
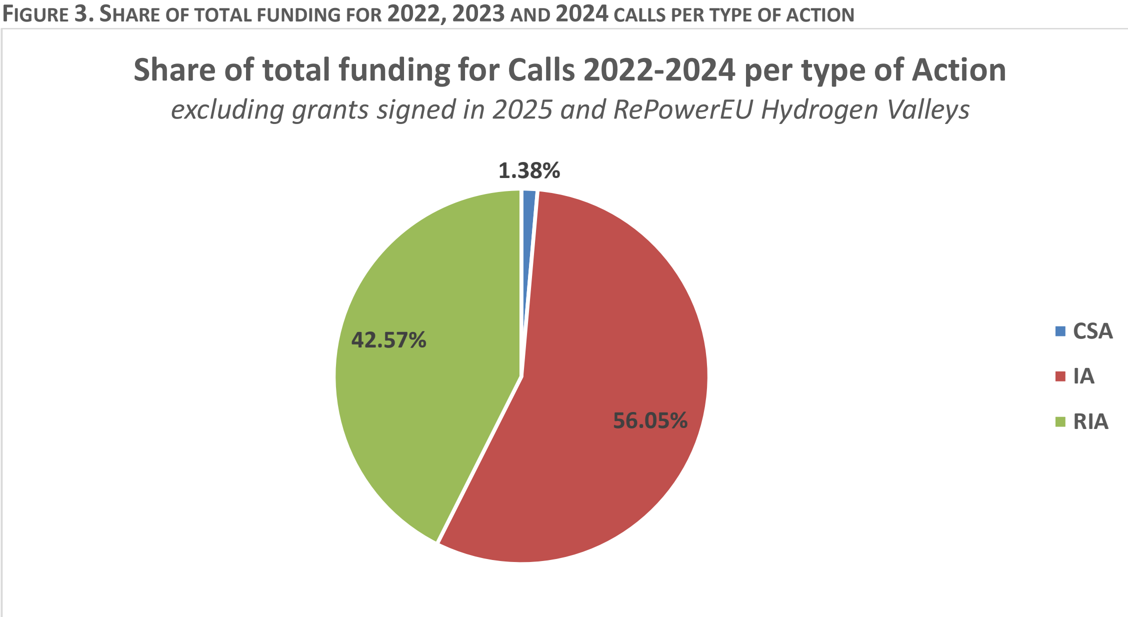
FIGURE 2. SHARE OF TOTAL FUNDING FOR 2022, 2023 AND 2024 CALLS



Source: Clean Hydrogen JU.

In addition, the breakdown per type of action is shown in the figure below. A good balance between Research and Innovation actions and Innovation Actions (demonstrations) is observed.

FIGURE 3. SHARE OF TOTAL FUNDING FOR 2022, 2023 AND 2024 CALLS PER TYPE OF ACTION



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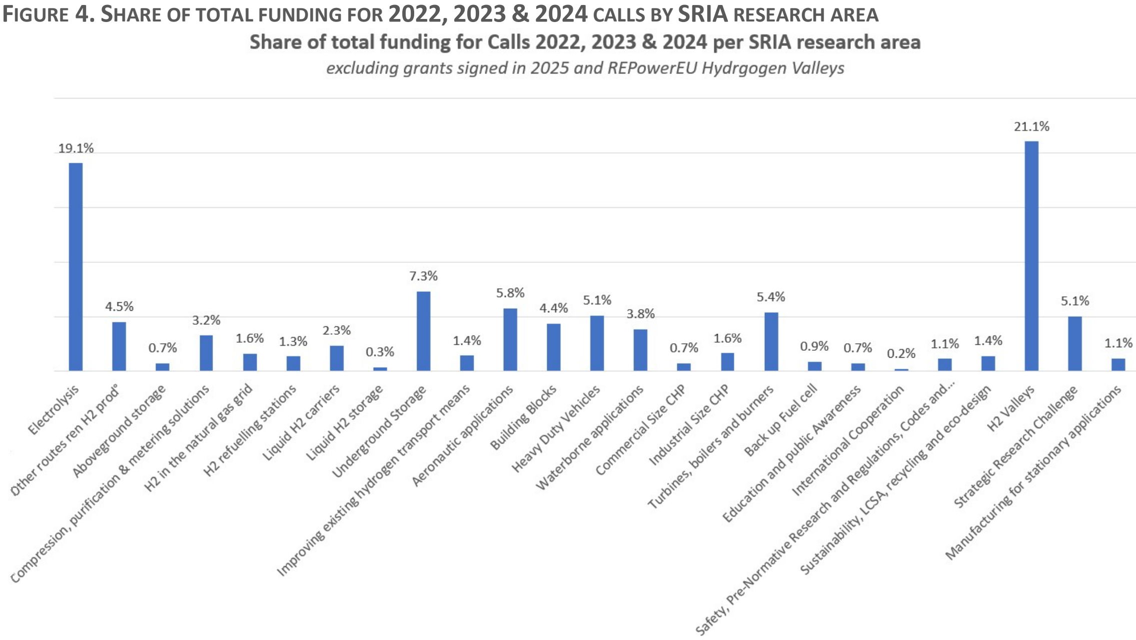
Source: Clean Hydrogen JU.

NB: CSA, coordination and support action; IA, innovation action; RIA, research and innovation action. At a deeper level of granularity, the Figure 4 below shows the funding per type of sub-pillar. This helps to identify where most efforts have been channelled.

FIGURE 4. SHARE OF TOTAL FUNDING FOR 2022, 2023 & 2024 CALLS BY SRIA RESEARCH AREA



Source: Clean Hydrogen JU.

NB: LCSA, life cycle sustainability assessment.

Hydrogen Valleys

The Clean Hydrogen JU has supported a total of 15 Hydrogen Valleys under Horizon Europe by the end of 2024([9]). These- include- funded-under the budget included in the main JU calls (EUR 123.5 mill) and the dedicated budget under RePowerEU (EUR 57.6 mill). The location of these Hydrogen Valleys as well as the three Hydrogen Valleys supported under H2020 (EUR 35 mill budget) are shown in the map below. All in all, these 18 Hydrogen Valleys represent project costs of close to 1,200 mill.

([9]) Including H2 Valleys supported with RePowerEU budget

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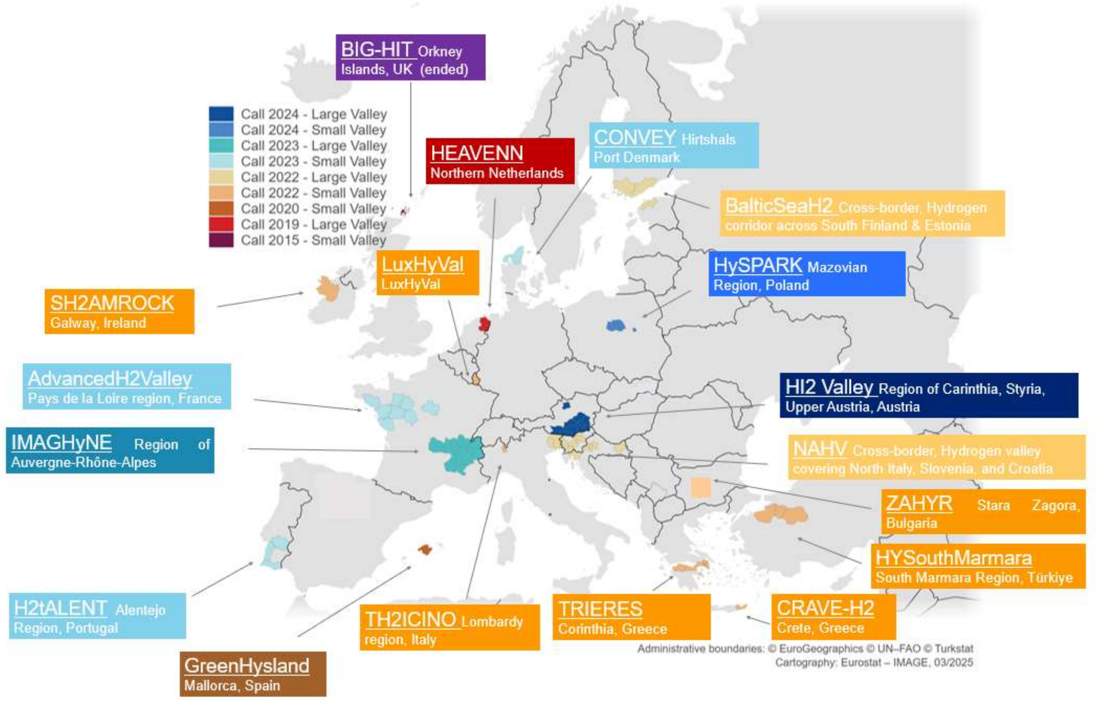
FIGURE 5. HYDROGEN VALLEYS SUPPORTED BY THE CLEAN HYDROGEN PARTNERSHIP (INCLUDING FUNDING UNDER H2020 AND HORIZON EUROPE, EXCLUDING GRANTS SIGNED IN 2025)



Source: Clean Hydrogen JU.

More **information on all the Clean Hydrogen JU projects** supported by the Clean Hydrogen Partnership can be found in the Clean Hydrogen JU website([10]).

1.1.2 Operational risks, mitigation and corrective measures

Risk assessment in 2024

Risk management is a crucial part of the strategic decision-making process and is essential for ensuring the effective and efficient use of the EU budget. Robust risk management ensures timely identification of risks and allows for the implementation of appropriate mitigating actions to address them. Every member of the staff of the Clean Hydrogen JU has a role to play in identifying and managing risks. The Executive Director is directly accountable to the Governing Board, is ultimately responsible for the management of the Clean Hydrogen JU's activities and achievement of objectives and must ensure that the Clean Hydrogen JU's critical risks are known and appropriately managed([11]).

As a continuation of the established practices, an annual risk assessment exercise was conducted in October 2024, with the aim to identify, analyse and respond to key risks (including fraud risks) across all the areas of responsibility of the Clean Hydrogen JU's Programme Office (PO). In this context, a risk management workshop was organised to (i) reassess the relevance of the risks identified in the

([10]) https://www.clean-hydrogen.europa.eu/projects-dashboard_en

([11]) Ref to. COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021, Article 19, 4

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previous risk-assessment exercises (i.e. in the scope of the risk assessment for the 2024 AWP) and (ii) identify and assess any relevant new risks (e.g. new risks related to the new mandate and new objectives of the Clean Hydrogen JU under the Horizon Europe Framework Programme) that could hinder achieving the objectives of the Clean Hydrogen JU, including operational, financial and compliance risks.

To reassess the already identified risks, the following aspects of each risk were assessed:

- Relevance of the risk: Is the risk still present? Is it well described? How probable is the risk to materialize in the upcoming year?
- Rating of the risk: Has the rating (in terms of impact/likelihood) increased or decreased over the period?
- Relevance and fulfilment of the action plan: Should we continue/expand/reduce action plans?

The exercise ensured that the new and reassessed risks were identified, and incorporated into the 2025 Annual Work Programme (AWP), facilitating a proactive and comprehensive risk management strategy for the year ahead.

The Table 1 provides a summary of the outcomes of the risk assessment exercise on the main risks and the fulfilment of the action plans, up to 31 December 2024.

TABLE 1. FULFILMENT OF THE ACTION PLANS UP TO DECEMBER 2024

RISK LEVEL	OBJECTIVE	INDICATOR	RISK IDENTIFIED in AWP 2024	ACTION PLAN - identified for 2024 and implemented
HIGH	All	All	**Insufficient Manpower** Risk of not meeting H2020 and Horizon Europe objectives due to insufficient manpower. The Programme Office is running two framework programmes simultaneously, H2020 and Horizon Europe with increased 50% of the budget and additional budget from the RePowerEU (approx. one half to be committed in the first two years), with only two additional FTEs for 2022 - 2027. Additional interconnected risks could result from high staff turnover. Back-office arrangements are helping to harmonize the working processes but have revealed that they do not represent a solution for the headcount issue. External service providers are hired for the operations and communication activities, but areas are restricted by the Project Technical Assistant (PTA) contract.	Several actions are in place to mitigate the risk. Clean Hydrogen JU: - implemented simplification models (e.g. Call 2024 and future Calls are fully lump sum grants); - used service contracts for support activities in the operations and communication activities. Clean Hydrogen JU will continue to: - use service contracts for support activities in the operations and communication activities and to explore synergies with other joint undertakings on administrative activities; - analyse and monitor tasks allocated among staff members to measure the staff workload and take appropriate measures; - explore best ways to shorten recruitment time for staff by using other JUs reserve list; - publish, on an ad-hoc basis, vacancy posts to get a reserve list at disposal to prevent the gap between the arrival and departure of a staff member. - discuss with the Governing Board (GB)

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				on the adequacy of the current staff establishment plan supported with a real workload analysis for the entire organization. The Governing Board should be continuously informed on the manpower situation and should provide guidance accordingly.
MEDIUM	Synergies	#9	**Synergies** Risk of missing opportunities for synergies with other partnerships and other EC programmes or Member States/regional funds for hydrogen technologies due to lack of strategic guidance and consequently Clean Hydrogen JU proper involvement in programming activities.	The JU shall, based on the results of the Internal Audit Service (IAS) audit on operational synergies, develop and implement an overall synergies' strategy including a systemic approach to the three levels of synergies listed in the Single Basic Act (SBA) (i.e. with other partnerships, other programmes and at national/regional level), under the orientation and guidance of its Governing Board, with input from the JU's advisory bodies, and taking into account the experience gained so far. In the meantime, the Programme Office will continue to plan, implement and report on already identified synergies. The JU will continue to report to the Governing Board and will continue to seek strategical guidance and orientation.
MEDIUM	Operational& Financial reporting	#1-#5 #9 #12 #13	**Membership Data** Risk that in-kind contributions in projects are not timely and fully recognised, due to lack of clear identification and timely update of private members membership (of Hydrogen Europe and Hydrogen Europe Research) status within JU projects. In addition, there is a risk that beneficiaries (non-members) could be indirectly contributing to JU administrative expenses, which could result in non-compliance of the JU financing rules. This can result in a potentially high negative impact on the JU reputation.	To mitigate the risk, the JU implements a process to ensure the eligibility criteria are met and in-kind contribution are continuously monitored throughout lifetime of the projects. The JU will continue: - an active dialogue with the private members and with the Commission central services to further develop the information technology (IT) tools for sufficient data accuracy. - reminding the stakeholders the provision of the JU Financial Rules, in particular article 32.
MEDIUM	Operational	#1 #4 #5 #9	**Projects Execution** Risk that program objectives will not be achieved fully and timely due to delays in project execution attributed to COVID-19, geopolitical instability, inflation situation and due to hydrogen market changes. Due to war in Ukraine and Middle East, there is an increased disruption in value chain and a general economic impact of the war (increase prices and scarcity of raw materials and energy resources).	Mitigating actions are in place for monitoring any delays in the projects, restructuring of the projects, if necessary, granting project extension via the amendment process.

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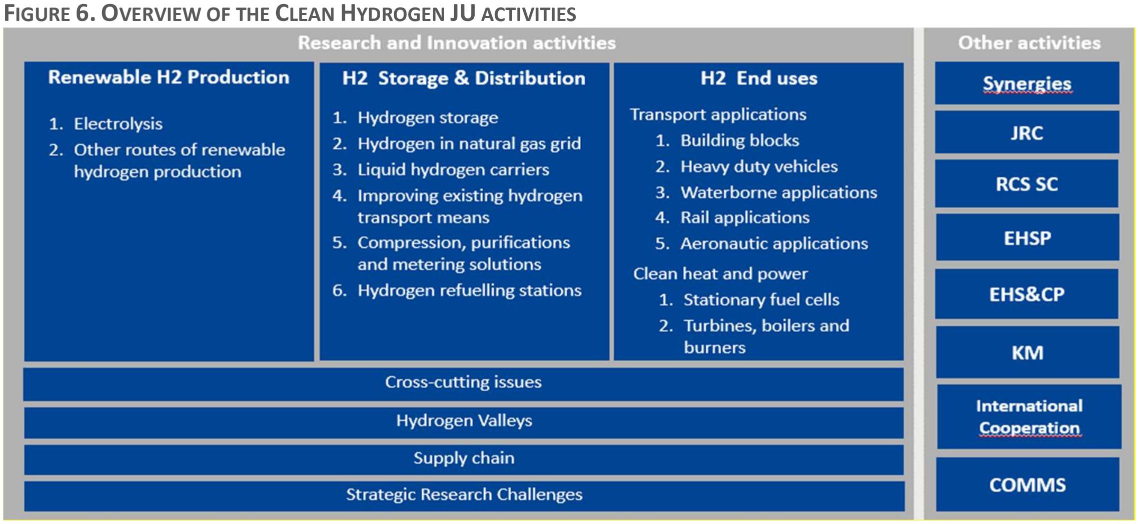
			Co-funded demonstration projects have a negative impact on the duration of the projects, including FIDs ("Final Investment Decision"), and consequently on budget execution and programme reaching its objectives.	

1.2 *Research & Innovation activities/achievements*

1.2.1 Overview of R&I Activities

The Programme of the Clean Hydrogen JU has been structured to cover all aspects of the hydrogen value chain, as shown in Figure 6. Its main focus will remain on the research and innovation actions on renewable hydrogen production, transmission, distribution and storage, alongside with stationary and transport end-use technologies and a strong emphasis on "circularity and safety by design".

FIGURE 6. OVERVIEW OF THE CLEAN HYDROGEN JU ACTIVITIES



NB: EHS&CP, European Hydrogen Sustainability and Circularity Panel; EHSP, European Hydrogen Safety Panel; RCS SC, regulations, codes and standards strategy coordination

In line with the new programme structure of the Clean Hydrogen JU explained in the SRIA ([12]), projects on-going in 2024, including those from H2020 managed by the Clean Hydrogen JU predecessor, have been assigned to eight Pillars:

- Pillar 1: Renewable Hydrogen Production
- Pillar 2: Hydrogen Storage and Distribution
- Pillar 3: Hydrogen End Uses: Transport Applications
- Pillar 4: Hydrogen End Uses – Clean Heat and Power
- Pillar 5: Cross-Cutting Issues

([12]) https://www.clean-hydrogen.europa.eu/about-us/key-documents/strategic-research-and-innovation-agenda_en

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- Pillar 6: Hydrogen Valleys
- Pillar 7: Supply Chain
- Pillar 8: Strategic Research Challenges

Each SRIA Pillar includes a wide range of activities and applications. Moreover, as part of the legacy projects under H2020, the Clean Hydrogen JU continues certain activities and applications of its predecessor. To better map the different current and possible future activities of the Clean Hydrogen JU, its Programme (including on-going legacy projects) can be further mapped into a set of Research Areas ([13]), which group projects covering related topics. This split in research areas is presented in Table 2, providing also a short summary of the topics of ongoing projects in 2024.

TABLE 2. PILLARS OF R&I ACTIVITIES

PILLARS	RESEARCH AREAS	RESEARCH TOPICS
1) Renewable Hydrogen Production	1 – Low temperature electrolysis	Projects targeting AEL, PEMEL and AEMEL
	2 – High-temperature electrolysis (incl. co-electrolysis)	Projects targeting SOEL and PCCEL
	3 – Other hydrogen production methods	Projects covering other production routes, including solar driven thermochemical hydrogen production and waste-to-hydrogen production
2) Hydrogen Storage and Distribution	4 – Hydrogen storage	Projects targeting the feasibility, risks and impact of H_2 underground storage
	5 – Hydrogen in the natural gas grid	Projects assessing the effect of H_2 on transmission and distribution of Natural Gas (NG) pipelines
	6 – Hydrogen carriers and liquid hydrogen	Projects focusing on the improvement of the roundtrip efficiency of conversion and system cost
	7 – Improving existing hydrogen transport means	Projects aiming to develop long-term storage and long-distance transportation of Liquid Hydrogen (LH2) for commercial vessels
	8 – Compression, purification and metering solutions	Projects demonstrating scale-up of existing compression concepts, material research on proton conducting ceramic electrochemical cells (PCC and purification concepts), quality assurance of hydrogen fuel
	9 – H_2 refuelling stations	Projects scaling up and demonstrating innovative hydrogen compression technology and liquid hydrogen refuelling stations for heavy-duty applications
3) Hydrogen End Uses: Transport Applications	10 – Building Blocks	Projects focusing on PEMFC MEA components, durability, development and optimisation of versatile PEMFC stacks, hydrogen tanks and demonstration of Non-Road Mobile Machinery
	11 – Heavy Duty Vehicles	Projects demonstrating Heavy-Duty Vehicles (HDV) in large scale

([13]) These Research Areas are the basis of the annual programme technical assessment performed by JRC. For more information see Section 1.5.1.1.

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	12 – Waterborne Applications	Projects focusing on FC applications for ports/harbours ecosystems, scaling-up and demonstrating multi-MW FC systems for shipping and demonstration of ships, including inland waterway vessels
	13 – Rail Applications	Projects with the objective of enabling hydrogen to be recognised as the leading option for trains on non-electrified or partially electrified routes Do
	14 – Aeronautic Applications	Projects addressing development and optimisation of a dedicated FC for aviation
	15 – Bus/Coaches	Large-scale demonstration projects, including refuelling infrastructure
4) Hydrogen End Uses: Clean Heat and Power	16 – Commercial Size CHP	Demonstration projects for commercial size SOFC CHP, including ammonia-powered
	17 – Industrial Size CHP	Projects focusing on SOFC, including reversible SOC systems, and PEMFC
	18 – Next generation degradation and performance & Diagnostic	Projects exploring diagnostic and control tools to enhance durability and reliability of stationary PEM and SOFC systems
	19 – Turbines, boilers and burners	Research projects to allow low NOx combustion of hydrogen-enriched fuels (up to 100%) at high-pressure conditions for new or existing gas turbine combustion systems
5) Cross-Cutting	20 – Sustainability, Life Cycle Sustainability Assessment, recycling and eco-design	Projects addressing the needs to define guidelines for sustainability assessment
	21 – Education and Public Awareness	Projects aiming to increase public understanding of hydrogen and FC technologies
	22 – Safety, Pre-Normative Research and Regulations, Codes and Standards	Projects focusing on improving knowledge of risks of hydrogen utilisation and the definition of a protocol for permitting and measuring
	23 – International Cooperation	Research & Innovation co-operation with Africa on hydrogen
6) Hydrogen Valleys	24 – Small-scale Valley	Projects aiming to develop island and micro-hydrogen integrated systems, to showcase the potential of hydrogen technologies
	25 – Large-scale Valley	Projects aiming to demonstrate a cross-border or interregional hydrogen integrated system when favourable conditions at industrial or geographical point of view
7) Supply Chain	26 – Manufacturing for stationary applications	Projects aiming to advance high-volume production techniques and quality control measures for manufacturing SOFC components and stacks
8) Strategic Research Challenges	27 – Strategic Research Challenges	Projects aiming in the development a sustainable European supply chain of materials, components and cells, less reliant on CRM, with lower environmental footprint and costs, and higher performance and durability.

NB: CHP, combined heat and power; m-CHP, micro-scale combined heat and power; PEMFC, proton exchange membrane fuel cell; SOFC, solid oxide fuel cell.

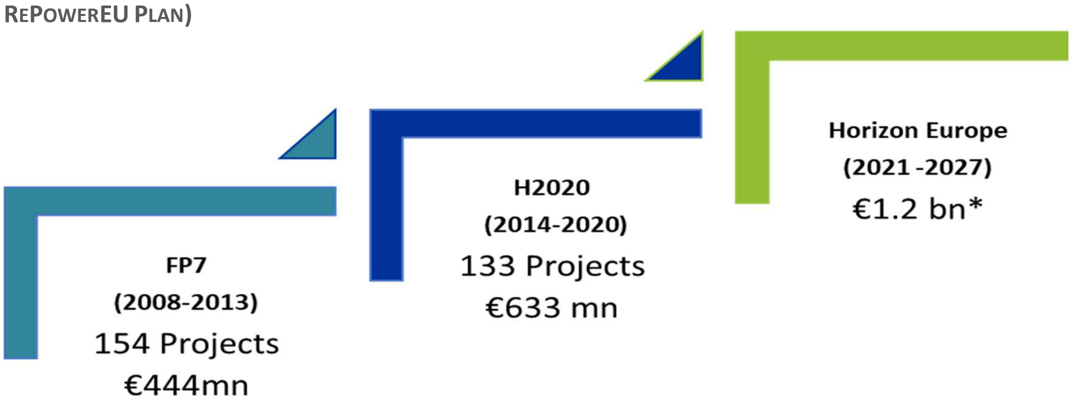
1.2.2 Financial Support

1.2.2.1 Overview of the financial support from 2008 to 2024

Before the establishment of the Clean Hydrogen JU, its predecessors, the FCH JU (2008-2013, funded under the FP7 programme) and the FCH 2 JU (2014-2020, funded under the H2020 programme), have supported 287 projects in total, with a combined budget of EUR 1.08 billion, complemented by equivalent funding from non-EU sources (e.g.: regional, national or private).

In line with the ambition to drive research and innovation of hydrogen technologies and achieve the objectives set for the Clean Hydrogen JU, the EU almost doubled its budget in comparison with that of its predecessor the FCH2 JU, supporting the JU with another EUR 1 billion for 2021-2027. As a result, under the Horizon Europe programme, the overall Clean Hydrogen JU programme funding, including investment from the private members of the Clean Hydrogen JU, it is expected to go beyond EUR 2 billion. Moreover, the EC has topped up the Clean Hydrogen JU budget with an additional EUR 200 million, to be matched by the same amount from industry, with the goal of doubling the number of Hydrogen Valleys and accelerating hydrogen projects under the REPower EU Plan ([14]).

FIGURE 7. SEQUENCE OF DEPLOYED EU BUDGET (*INCLUDING EXPECTED FUNDING FOR HYDROGEN VALLEYS FROM THE REPOWEREU PLAN)



Source: Clean Hydrogen JU.

Under the Horizon Europe Framework Programme, the Clean Hydrogen JU inherited the technological achievements and funding of the previous programmes and started to implement a new one. Based on the updated data from E-Grants, Figure 8 shows the cumulative number of projects supported by the FCH, FCH 2 and Clean Hydrogen JUs programmes (respectively, 154 projects under FP7, 133 projects under H2020 and 102 projects so far under Horizon Europe) and the annual and cumulative JU financial support given to the projects per year and per fund origin.

([14]) Communication from the Commission on REPowerEU Plan

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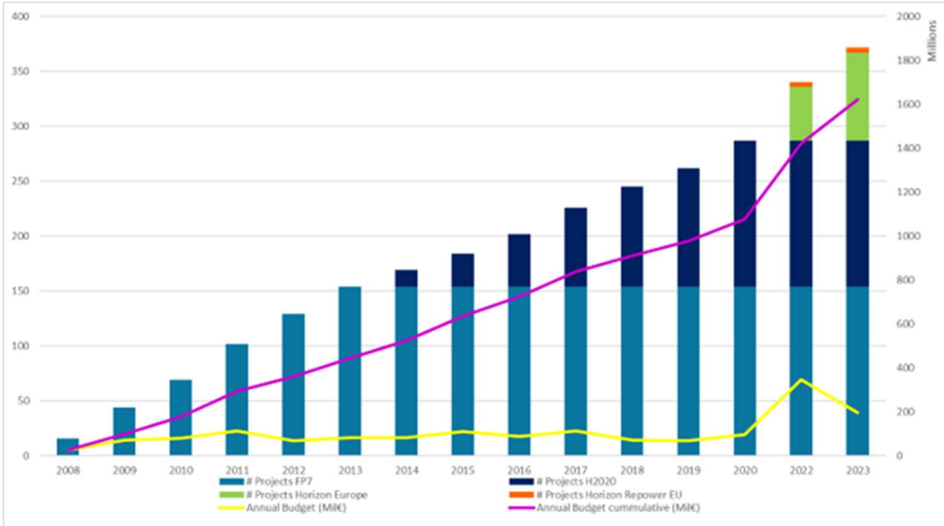
FIGURE 8. CUMULATIVE NUMBER OF PROJECTS SUPPORTED BY THE CLEAN HYDROGEN JU AND ANNUAL COMMITMENTS OF CALLS 2008-2024

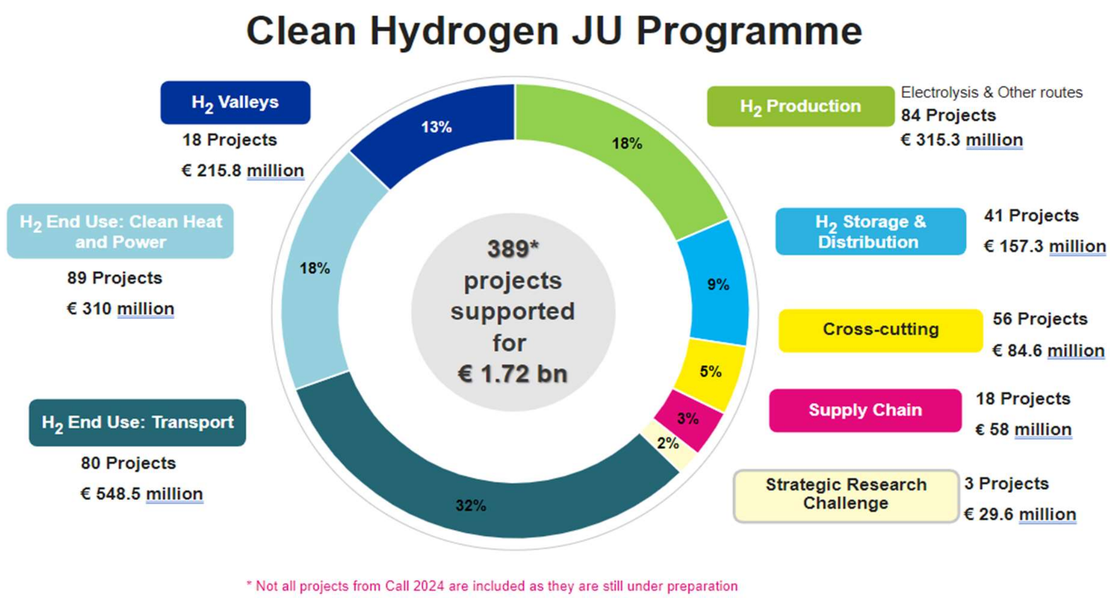


Source: Clean Hydrogen JU.

The bars show the cumulative number of the projects supported by the Clean Hydrogen JU since 2008. The yellow line shows the annual commitments undertaken by the Clean Hydrogen JU against the new projects signed under the call of each year. The purple line shows the cumulative amount of Clean Hydrogen JU funding, including the commitments undertaken for ongoing projects, taking into account any amendments, and the final amount of funding per finished project. Projects suspended or terminated with ongoing recovery processes are not included.

The overall split of the Clean Hydrogen JU funding is summarised in Figure 9.

FIGURE 9: TOTAL FUNDING OF THE CLEAN HYDROGEN JU PROGRAMME (2008 – 2024 PROJECT CALL YEARS)



Source: Clean Hydrogen JU.

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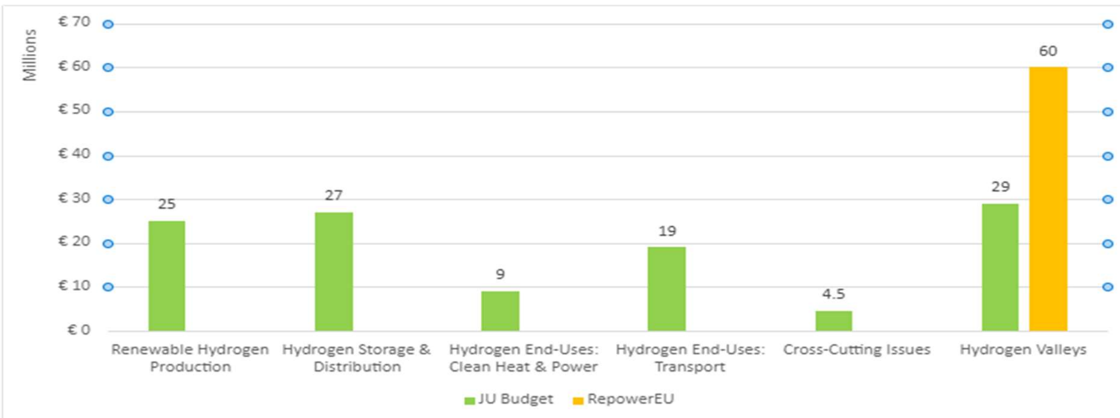
1.2.2.2 Financial support in 2022 - 2024 (Horizon Europe programme)

The third call for proposals under the Horizon Europe programme was launched in 2024. Following the evaluation results of Call 2024, 16 grant agreements (out of 29 proposals invited to prepare the grant, GAP phase) were signed for funding under Horizon Europe by December 2024, for a total funding of EUR 88.4 million([15]) ([16]). Figure 10 shows the distribution of Call 2024 total amount across the SRIA Pillars.

FIGURE 10. CLEAN HYDROGEN JU CALL 2024 MAXIMUM BUDGET ALLOCATION PER SRIA PILLAR



Source: Clean Hydrogen JU.

The Call 2024 projects have been added to the 86 projects signed following the Calls 2022 and 2023 under Horizon Europe, leading to a total of 102 projects which have signed grant agreements with the Clean Hydrogen JU by the end of 2024, with a total EU funding of EUR 643 million. Figure 11 shows the distribution of the budgets for projects funded in the 2022, 2023 and 2024 calls per pillar.

FIGURE 11. SOURCE OF FUNDING OF CLEAN HYDROGEN JU CALLS 2022, 2023 AND 2024

([15]) There are still 2 successful projects of Call 2024 in the final stages of grant preparation, not included in the figures above

([16]) https://www.clean-hydrogen.europa.eu/system/files/2022-05/Hydrogen-Valley_Facsheet_18.05.2022.pdfCommunication from the Communication on REPowerEU Plan

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Source: Clean Hydrogen JU.

For the purpose of programme review and analysis below, and due to the evolving structure of the Clean Hydrogen JU Programme compared with those of its predecessors, all previous projects under FP7 and H2020 were redistributed to the seven Pillars of the new Programme. The eighth Pillar on Strategic Research Challenges will include only projects funded under the current Programme.

1.2.3 Achievements and impact of funded projects

The projects funded under the previous programmes are continuously contributing to hydrogen technology development, as also highlighted in the *Programme Review Report 2024* ([17]). Under the Clean Hydrogen JU programme, for which the first projects from Call 2022 started only during 2023, and only in 2024 to gradually achieve results contributing to the overall programme impact, paving the way for further advancements. The overview of the main achievements of the on-going projects (only from H2020) per pillar is as follows:

Pillar 1 - Hydrogen Production: The main technology funded under this Pillar is electrolysis. Higher-TRL technologies such as Alkaline Electrolysers (AEL), Proton Exchange Membrane Electrolysers (PEMEL) and Solid Oxide Electrolysers (SOEL) are supported, along with newer lower-TRL technologies such as Anion Exchange Membrane Electrolysers (AEMEL) and Proton Conducting Ceramic Electrolysers (PCCEL).

In Low Temperature (LT) electrolysis, there are a number of high-TRL demonstration projects, validating electrolyser solutions for a range of environments and applications. These projects achieved very high visibility. In particular, demonstrations in an industrial environment or in remote areas were challenging, but overall, the projects were successful in overcoming the various hurdles such as additional safety measures, permitting and harsh environments. For **Alkaline electrolysis (AEL)**, 11 projects within the Hydrogen Production Pillar have been classified as contributing to the development

([17]) https://www.clean-hydrogen.europa.eu/document/download/6b6584d0-f259-436a-8fe8-3a6bf9d0761c_en?filename=20242823_PDF_EGAA24001ENN_002.pdf

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of AEL technology considering the whole project portfolio of the Clean Hydrogen JU (although some of these have worked on both Alkaline and PEM electrolysers).

Proton Exchange Membrane electrolyser (PEMEL) technology has been investigated in total by 18 JU projects, some of them working on both PEM and Alkaline. In addition, projects under other pillars have also contributed to this research area, including renewable hydrogen production workstreams (e.g. hydrogen valleys or HRSs)-.

For **Anion Exchange Membrane Electrolysis (AEMEL),** 3 projects (CHANNEL, ANIONE and NEWELY) were funded under the 2019 Call and the reported KPIs were estimated from single-cell tests only, with promising results against the SRIA 2024 targets. Four more projects in the same research area started in 2023-24.

The three AEMEL projects were instrumental in maturing AEMEL technology, up to higher TRL, also triggering new projects aiming for either PFAS-free membranes or to lower CAPEX. Research projects on AEMEL show good progress, when it comes to the development of components, but should consider the potential for mass manufacturing and quality of stack assembly at earlier stage in the project.

The JU is also still playing a leading role in the development of PEMEL technologies, contributing significantly towards SoA improvements regarding KPIs such as efficiency.

In terms of reducing the LCOH, the Clean Hydrogen JU has contributed to 1. decreasing CAPEX and 2. increasing electrolyser efficiency, thus lowering electricity consumption. In fact, over the last 15 years, electricity consumption for AEL dropped from 65 to 50 kWh/kg, while for PEMEL it went from 60 to 52 kWh/kg. This is equivalent to a **10% reduction of LCOH** - from 7.94 to 7.2 Euro/kg - for a grid connected electrolyser and a 9% reduction of LCOH for a renewable connected one - from 6.6 to 6 Euro/kg. For PEMEL the respective figures would be a **6% reduction of LCOH** from 7.94 to 7.48 Euro/kg for grid connected and 4% reduction from 6.6 to 6.3 Euro/kg for renewables connected one. For a grid-connected alkaline electrolyser, electricity and CAPEX costs account for approximately 30-40% and 25-45% of LCOH, respectively. On the other hand, for a RES connected alkaline electx²rolyser that does not entail grid fees and taxes, electricity and CAPEX costs account for approximately 26-27% and 57-59% of LCOH, respectively. Similar ranges are observed for a grid connected or RES connected PEM electrolyser. It should be noted here that these values change with respect to the location (country) of the electrolyser. Moreover, the difference between the RES and grid-connected cases is not as high as it might be expected because of the lower operational hours that a RES connected electrolyser generates green H2.

Regarding High Temperature (HT) electrolysis, **Solid Oxide Electrolyser (SOEL) technology** has been developed by 14 JU projects so far. The technology is less advanced than AEL or PEMEL, with fewer projects at higher TRL levels. However, the increase in capacity to the MW scale helps establishing SOE as a competitor for the large-scale production of clean hydrogen from renewable energy sources, including waste heat utilisation (at system level) for higher efficiencies. Also, there is clear progress regarding the durability of SOE, to the extent that the targets made more ambitious.

Proton-conducting ceramic electrolysers (PCCEL), although still a low TRL technology, can be highly efficient, even compared to ion-conducting SOEL. PCCEL has great potential for increasing the overall efficiency of hydrogen generation systems when integrated into industrial processes. Furthermore, as it was emphasised by the WINNER project (see below), PCCEL technology is capable to extract

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hydrogen from different gas mixtures ([18]) and has a role for purification and compression of hydrogen, enhancing process efficiency at the system level.

Other Routes of Renewable Hydrogen Production are finally being investigated by 4 ongoing projects. The routes covered are hydrogen production by solar thermochemical water splitting, gasification of biomass and photocatalysis. Compared to electrolysis, all other renewable hydrogen production technologies are of lower TRL. The objectives of such projects seem to be more challenging than anticipated, highlighting possible fundamental bottlenecks at reactor design and operational regime level. In particular, the high temperatures involved and the complexity of the processes have led to numerous problems, at the level of the materials, the reactors and the integration of the plant, while maintenance has also been flagged as major difficulties. As a result, achievements are under-reported and targets have mainly not been met yet, with the exception of System Energy use of biogas reaching a value of 41.7 kWh/Kg therefore exceeding the 2030 target of 57 kWh/Kg. It should be noted here that projects working on the White Hydrogen route are expected to start in following years.

Pillar 2 - Hydrogen Storage and Distribution: There are various options to transport and store hydrogen, and the SRIA calls for a pluralistic approach with respect to the technologies to be investigated and supported. These technologies can then serve as building blocks for an EU-wide logistical infrastructure in its multifaceted complexity.

Aboveground storage: This research area currently consists of one finished project, HYCARE. Clean Hydrogen JU is putting effort to improve and advance innovative technological solutions for solid state hydrogen storage at an unprecedented scale. The hydrogen storage solution developed by the project HyCare has well-defined advantages against other hydrogen storage solutions for relatively small-scale applications and certain use cases due to its lower footprint and reduced electricity consumption.

Underground Hydrogen Storage: Two new projects were launched in 2024, following the path of four earlier projects completed in 2023 or early 2024. These new initiatives are advancing the SoA in both depleted gas fields and salt caverns as well as supporting the replication of these activities in other sites across Europe. In particular, the finished project Hypster advanced the state of the art by conducting cyclic testing of renewable hydrogen storage in a small salt cavern. Project Frynge aims at larger scale, testing hydrogen storage in two adjacent salt caverns in Manosque, France and demonstrate H2 storage and cyclability in a 3000 tons potential cavern with 100 cycles from 1 hour to 1 week. Regarding depleted gas fields, while Hystories and HyusPre focused more on-site screening, techno-economic assessments and feasibility studies, EUH2STARS is aiming at demonstrating the storage of Hydrogen at TRL 8 by the end of the decade.

H_2 in the natural gas grid: Two projects are funded under this Research Area and are complemented by actions described in Pillar 5. Synergies are present at programme level between the HIGGS and CANDHY projects and other projects related to admixture such as THYGA, SHIMMER and THOTH2 (Pillar 5). This will support regulatory and standardisation progress in this area. Also, useful results have come from the experimental campaign on the potential issues of injecting hydrogen into the gas grid, with no critical gas losses, embrittlement or other kind of damage found.

Liquid H_2 carriers: Three LOHC projects are funded to investigate chemical carriers (HYSTOC, SHERLOHCK, and UnLOHCked). Also cracking of ammonia is a well-established technology for small-scale local hydrogen production. The two projects ANDREAH and SINGLE reviewed this year, are developing innovative solutions for ammonia cracking and purification and aim at scaling up their TRL from 3 to 5. Also, project HYLICAL is addressing hydrogen liquefaction.

([18]) The SINGLE project (see PILLAR 2) also uses PCCEL technology to extract hydrogen from Ammonia.

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For LOHC, good progress has been made by the HYSTOC project in terms of demonstrating the concept, and SHERLOHCK and UnLOHCked are working on improving the technology at a more fundamental level. Also, innovative solutions for liquid hydrogen storage and liquefaction are being developed for the first time.

Compression, purification and metering solutions: COSMHYC DEMO is likely to bring the technology of metal hydride compression up to TRL 7. Also, WINNER paves the way for the development of innovative and low-carbon technology to extract hydrogen from gas streams through the use of proton conducting ceramics, showing promising results in the development of tubular PCC cells to be used for the ammonia cracking and reverse electrolysis process.

Finally, synergies across several projects in the Programme are observed. RHEADHY, which will build HRS for the refuelling of heavy-duty vehicles and will validate the high-flow refuelling protocols developed by project PRHYDE. H2REF-DEMO aims to further develop and scale up the bladder accumulator-based compression concept developed in H2020-funded H2REF project, which finalised in 2019. COSMHYC DEMO, which began in February 2021, serves as a continuation of the COSMHYC XL project, with both initiatives being closely interconnected. COSMHYC XL has integrated the latest findings from COSMHYC DEMO, particularly in the selection of materials. Both projects are part of a cluster that also collaborates with other European initiatives like HECTOR (pillar 3) and SWITCH (pillar 4).

Hydrogen refuelling stations: The deployment of HRSs is expanding globally. HRS operators with experience of operating multiple HRS for several years have observed improvements in station availability for new stations (compared to previous models from the same supplier), suggesting that design and operational improvements are being implemented as a result of the experiences of early stations. Best practices should be widely shared and continued wherever possible, to ensure that hydrogen refuelling stations (HRS) from new suppliers and operators also maintain high availability (19).

Pillar 3 - Hydrogen End Uses – Transport:

Solutions for sectors such as heavy-duty road transport, off-road and industrial vehicles, rail, shipping, and aviation require further development and demonstration. These solutions leverage technical knowledge already acquired through FCEVs and FCEBs. Cost reductions and efficiency improvements can be achieved through scaling up and integrating processes more effectively (e.g. by combining manufacturing steps, optimizing supply chains, or aligning component and system designs for higher efficiency). Research in this pillar has been therefore carried on by both developing building blocks and working on more vertical applications and demonstrations.

Heavy Duty Vehicles (Building Blocks) - Fuel cell stack and fuel cell system technology: More efforts are necessary to understand degradation mechanisms and their causes, and to define mitigation strategies to improve PEMFC durability. Another -limiting -factor for a broad adoption of PEMFC technology is the usage of rare and expensive materials, most importantly Platinum Group Metals (PGM).

The use of non-PGM for electro-catalysis is studied in the JU projects with encouraging results and is providing the basis to potentially reduce the use of EU -critical raw materials. -Besides, several projects

(19) https://h2me.eu/wp-content/uploads/2023/01/H2ME2-D7.19-Public-FV-Emerging-conclusions-document-%E2%80%A6.pdf

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(i. e. IMMORTAL, DOLPHIN, MORELIFE, FURTHER-FC, RealHyFC and other) are developing knowledge including testing protocols and tools to improve fuel cell designs and adapt their features to fit the requirements of automotive applications, both light and heavy duty.

At present there are different alternatives for the placement of -hydrogen storage on-board heavy-duty vehicles. One of them is to store the hydrogen in vertical vessels installed behind the cabin. Another is having several vessels interconnected by long pipelines or using conformable tanks. **Heavy Duty Vehicles (Building Blocks) - On-board vehicle hydrogen storage:** A key requirement is decreasing the tanks cost by reducing the amount of used carbon fibre, while keeping storage performance and safety. The projects COPERNIC, TAHYA and THOR developed a complete compressed hydrogen storage system.

Heavy-duty vehicles: FCETs are potentially best-suited for longer-range missions and the heaviest goods, enabling connectivity to more remote areas than other solutions such as battery or catenary trucks.

As it was the case for busses, heavy-duty/trucks projects will help to establish a dedicated EU supply chain for FC and FC systems--. Likewise, trucks projects can provide valuable feedback to compressed hydrogen storage tanks manufacturers (e. g. storage requirements and sizes, locations for tanks and configuration of the system, number of fills, activation of temperature and pressure release devices, etc.). Furthermore, there is a certain potential to extrapolate results coming from buses projects JIVE refuelling operations in support of future flagship projects on heavy duty trucks, in particular, the handling of large quantities of hydrogen, using large capacity HRS- and requiring the delivery of large amounts of hydrogen on site (800 - 1 000 kg/day).

Waterborne applications: building blocks were developed for example in the project MARANDA ([20]), finished in 2022, while now the Clean Hydrogen JU waterborne projects are gaining visibility as the demonstration activities of H2PORTS and FLAGSHIPS are starting, with H2PORTS showcasing hydrogen-powered port machinery and FLAGSHIPS deploying fuel cell vessels for inland waterway transport. The RH2IWER project started in 2023, will demonstrate six inland waterway cargo, tanker and bulk vessels, further demonstrating the use of hydrogen in inland navigation. The Clean Hydrogen JU waterborne projects are gaining visibility as the demonstration activities of H2PORTS and FLAGSHIPS are starting.

Aeronautical applications: new projects have started in 2023: BRAVA - Breakthrough Fuel Cell Technologies for Aviation ([21]) (started in 12/2022) and NIMPHEA - Next generation of improved High Temperature Membrane Electrode Assembly for Aviation (started in 01/2023).

Buses and cars: Clean Hydrogen JU demo projects (CHIC, HIGHVLOCITY, HYTRANSIT, 3EMOTION, JIVE and JIVE2) contributed to improving the technical specifications of the buses (fuel cell power capability, storage capacity, range, and hydrogen consumption). An additional major contribution of the Clean Hydrogen JU projects on cars, such as ZEFER, H2ME and H2ME2, is the achievement of a large-scale deployment of fuel cells cars compared to the current fleets in Europe, in parallel to the refuelling infrastructure. The achievements of these demonstrations over the years, and their implications for

([20]) MARANDA (Marine Application of a New Fuel Cell Powertrain Validated in Demanding Arctic Conditions) aimed at developing and validating a hydrogen fuel cell-based hybrid powertrain for marine applications.

([21]) https://www.clean-hydrogen.europa.eu/projects-repository/brava_en

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the wider rollout of hydrogen mobility across the EU, are discussed in a new technical report authored by the JRC and the Clean Hydrogen JU ([22]).

Pillar 4: Hydrogen End Uses – Clean Heat and Power:

Turbines, Boilers and Burners: a new research area was introduced in the Programme in 2022, with six projects focusing on hydrogen, ammonia and natural gas combustion in gas turbine combustors and boiler burners. a new area aligned with the SRIA goals. Gas turbine and burner technologies present a valuable opportunity to repurpose existing infrastructure, thereby minimizing expenses for new investments and ensuring a cost-effective transition to renewable gases and zero-carbon power generation. These technologies do not demand high purity levels in fuel gas and can tolerate trace amounts of other substances, allowing for cost- and energy-efficient production and promoting large-scale hydrogen conversion technologies. By 2030, the goal is to have 100% hydrogen-ready European gas turbines and burners meeting emissions standards, providing zero-carbon, sustainable dispatchable power and high-temperature heat. Concerning PEMFC, 35 projects of this Pillar have contributed and continue contributing to the development of the technology: 11 projects are addressing CHP technologies, 10 projects concern next generation research area, 8 projects address off-grid applications and 6 projects - other research areas. On the other hand, 34 projects of this Pillar have contributed and continue contributing to the development of SOFC technology, and 10 projects under review are targeting this technology too.

m-CHP: For small stationary applications the only on-going project is PACE, exploring the possibility of deploying both PEMFC and SOFC fuelled with natural gas for fuel cell micro-Cogeneration for small stationary applications.

Commercial Size Systems: This Research Area contains two demonstration projects focused on fuel cell-based systems for power and heat solutions in the mid-sized power ranges of up to 60 kW, namely COMSOS and E2P2, both exploring SOFC technology. In addition, 3 other projects, i.e. SO-FREE and AMON using SOFC technology for commercial size systems and EMPOWER using high temperature PEMFC technology, are included in the 2024 Programme Review.

Industrial Size Systems: The industrial size CHP research area includes projects usually dealing with the MW scale. 3 projects are considered for the 2024 Programme Review, namely SWITCH, 24_7 ZEN and CLEANER.

Off-grid/back up/gensets: This Research Area contains the demonstration projects focused on off-grid applications, both in remote locations as well as in temporarily powered event areas. The current assessment period includes three projects: REMOTE, RoRePower and EVERYWH2ERE. The projects are exploring the application of PEM, SO and Alkaline hydrogen technologies (FC and electrolysers) for off-grid applications, but also urban areas.

Other research areas: This research area includes two projects assessed in 2024, WASTE2WATTS and RUBY. Both projects are exploring the use of SOFC technology; RUBY considers also PEMFC.

Pillar 5 - Cross-Cutting Issues: The cross-cutting activity area contains specific supporting activities, structured around three research areas: (i) Sustainability, life cycle sustainability assessment (LCSA),

([22]) https://publications.jrc.ec.europa.eu/repository/handle/JRC137101

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recycling and eco-design, (ii) Education and public awareness, and (iii) Safety, Pre-Normative Research (PNR) and Regulations, Codes and Standards (RCS).

Sustainability, life cycle sustainability assessment (LCSA), recycling and eco-design: The projects in this area aim to provide a significant contribution to the environmental impact mitigation of the design, production, use, and end-of-life phases of -hydrogen technologies. The tailored LCA guidelines for -technologies developed by SH2E are the first step needed to accurately assess their environmental impact. The work HYPEF will perform is crucial to creating a benchmark for the environmental impact of hydrogen technologies and for allowing EU sustainability policies targeting this category. At the same time, the work done by EGHOST and BEST4HY is important to provide guidance on how to improve the design and end-of-life phases of -technologies. Finally, the NHYRA project will provide essential information on hydrogen releases to better understand the potential climate impact of hydrogen technologies. It is positive the collaboration that NHYRA has initiated with the other EU-funded project (HyDRA) focusing on a complementary topic: the climate implications of hydrogen emissions.

Education and public awareness: The Clean Hydrogen JU has so far developed tools and methods addressing the needs in specialised knowledge and skills of a broad range of users, from technicians and professional operators, to universities, local and national authorities and public safety officials, and including introductory knowledge in schools. Among recent achievements, the first university master (MSc) programme dedicated in its entirety to fuel cells and hydrogen themes has been accredited and started in 2021-2022. Also, the project HyAcademy. EU and eventually the establishment of a European Hydrogen Academy represent the implementation of one of the provisions contained in the REpowerEU and Net-Zero Industry Academy (NZIA), addressing the gap in skilled workforce.

A recent Clean Hydrogen JU report measured the awareness of Europeans about hydrogen technologies through a survey conducted on a sample of approximately 1,000 citizens in each EU Member State. The results showed that a large majority of respondents are aware of hydrogen as energy carrier/source and have a positive perception of its environmental impact. A fair majority also considers hydrogen to be safe ([23]). On top of that, the new project HYPOP specifically targets policy stakeholders by exploring effective ways to involve them, including tailored communication strategies and engagement activities.

Safety, Pre-Normative Research (PNR) and Regulations, Codes and Standards (RCS): a mature liquid hydrogen technology is considered an enabler for the delivery and storage of large quantities of hydrogen. Project PRESLHY has set an important step forward in our understanding of the behaviour of liquid and cryogenic hydrogen during its release to the environment. Project ELVHYS, just starting and is dedicated to transfer of liquid hydrogen, will further support progress in technical knowledge and possibly handling skills. The protocols for the refuelling of heavy-duty vehicles developed by project PRHYDE will be validated at a high-flow refuelling station to be deployed under the project RHEADHY. It is expected that RHEADHY will also provide recommendations for the improvement of the high-flow refuelling protocols. This is a good example of mutual reinforcement between Pillars.

Pillar 6 - Hydrogen Valleys:

The high number of Valleys initiated in the last two years shows the commitment of the project partners as well as of the communities and regions to this concept. Even though funding rates are

([23]) Awareness of Hydrogen Technologies - Survey Report (europa.eu), 2023

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generally low, the participants are either heavily investing themselves or making the effort to secure additional (public) funding, which is usually reported to be one of the key challenges.

The large-scale valleys will have high impact due to their visibility and will contribute towards reaching the EU and SRIA goals. There is an increased focus on end-use, which is a positive step forward. For the small-scale Valleys, there is instead a good deal of variety in terms of the end-use applications, helping to further develop Valley archetypes which can then be replicated.

Infrastructure is being created for hydrogen delivery and storage, which will benefit other hydrogen initiatives in the region. Several projects have strong links to other initiatives, and in some cases are utilising infrastructure developed by other projects.

Also, digital tools are being developed to increase synergy and optimise performances between different steps of the value chain: specifically renewable energy production, hydrogen production and storage, and end use. At least five projects are developing digital tools to support replicability.

Pillar 7 - Hydrogen Supply Chains: European companies and research organisations are leaders in many segments along the hydrogen supply chain, which gives Europe competitive advantage with other key players such as Japan, South Korea, USA and more recently China. However, this leadership should be preserved by constant effort to keep up with R&I actions able to fill existing gaps and mitigate vulnerabilities and remain competitive at a global level.

An updated study of sustainable supply chain and industrialisation of hydrogen technologies has been recently finalised by the JU, identifying the weaknesses and strengths for different 14 hydrogen technologies, and proposing appropriate solutions. A summary report is available on the JU website ([24]). Additional information on suppliers of hydrogen-based systems and components, as well as service providers is also to be found in the European Hydrogen Observatory ([25]).

Pillar 8 – Strategic Research Challenges: Three projects ([26]) focus on the three research areas specified for this pillar in the Strategic Research and Innovation Agenda (SRIA). While similar research issues have been addressed in other pillars, these projects are unique due to their lower Technology Readiness Level (TRL) and long-duration nature, aimed at resolving research challenges rather than developing and demonstrating concrete prototypes or systems. This makes these projects more transversal, covering multiple technologies instead of just one. Additionally, Pillar 8 projects address multiple aspects, and this multi-faceted approach distinguishes them from other pillars' projects. Given

([24]) Study on sustainable supply chain and industrialisation of hydrogen technologies

([25]) https://observatory.clean-hydrogen.europa.eu/directory

([26]) The three projects on this pillar are the following ones:
SUSTAINCEL: https://sustaincell.eu/ , ECOHYDRO: https://ecohydro-project.eu/ and ELECTROLIFE: https://electrolife-project.eu/. The three research areas for this pillar are the following ones:

- low-PGM or PGM-free catalysts (including bio-inspired catalysts), reducing the use of critical (raw) materials in electrolysers and FCs, and ensuring the safe and sustainable use of all materials, including the development of PFAS-free ionomers and membranes;
- advanced materials and processes for hydrogen storage, such as carbon fibres, H2 carriers and additive manufacturing;
- enhanced understanding of the performance and durability mechanisms of electrolysers and FCs.

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their transversal and multi-technology focus, the lessons learned from these Pillar 8 projects can be applied and shared across different pillars.

1.2.4 Information on quantitative and qualitative leverage effects

A key objective and measure of the public-private partnership impact lies in the capacity to leverage funding from sources other than the EU.

The Horizon 2020 and the Horizon Europe Regulations define the contribution of the Members of the Clean Hydrogen JU (EU, Industry Grouping, Research Grouping) to the funding of the partnership in several ways:

- The contribution of the Union consists of a financial contribution (FC) to administrative expenditure and operational expenditure,
- The contribution of Members other than the Union (Industry Grouping and Research Grouping), consists of financial contribution to administrative expenditure and in in-kind contribution (IKC), the latter being composed of in-kind contribution to operational activities (IKOP) and in-kind contribution to additional activities (IKAA).

Tables 4 and 5 provide an overview of the status of the various types of contributions to the funding of the partnership from the Members other than the Union under the two programmes H2020 and Horizon Europe, depending on the status of contributions. In these tables, the target (minimum) value is set in the Regulation, the 'committed' value represents the value of in-kind contribution pending certification, and the 'validated / certified' value represents the value of contribution validated (for FC) or fully certified (for IKC).

TABLE 3. CONTRIBUTIONS FROM MEMBERS OTHER THAN THE EU UNDER H2020 (SITUATION AS OF 31 DECEMBER 2024) (MILLION EUR)

Nature		Target	Situation as of 31 December 2024	
			Committed	Validated / Certified
Financial contributions (FC) to administrative expenditure	Industry Grouping	16.34		16.34
	Research Grouping	2.66		2.66
Total FC from Members other than the EU		**19.00**		**19.00**
In-Kind contributions to Operational Activities (IKOP)	Industry Grouping	76.00	115.07 ([27])	76.06 ([28])

([27]) Cumulated IKOP foreseen for open H2020 projects at 31.12.2024 based on budget and membership at 31.12.2024

([28]) Cumulated IKOP validated (certified) for H2020 projects up to 31.12.2024, as it appears in our 2024 accounts

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	Research Grouping		0.14	3.65
In-Kind contributions to Additional Activities (IKAA)	Industry Grouping	285.00		1,039.05
	Research Grouping			
Total in-kind contributions from Members other than the EU		**361.00**	**115.21**	**1,118.76**
Total contributions from Members other than the EU		***380.00***	***115.21***	***1,137.76***

In 2024, the JU has received the final financial contributions to its administrative expenditure from all members, both EU and other than the EU, under H2020.

The Council Regulation establishing the FCH 2 JU set the minimum target leverage effect over the whole 2014–2020 period as 0.57 (EUR 380 million compared with the EU contribution of EUR 665 million). In practice, industry and research, members' overall contributions have already reached a much higher level (EUR 1.1 billion) than the minimum targets set forth in the legal basis (EUR 380 million) or the EU contribution to the H2020 programme (EUR 665 million). This represents an actual leverage effect of 1.70 (EUR 1 126 million compared to the EU contribution of EUR 665 million), far exceeding the initial target of 0.57.

Due to high amount of certified IKAA, the IKAA planning and certification exercise was discontinued in 2021 for H2020, shifting focus to the Horizon Europe programme, its strategic policy objectives and its quantitative targets. Moreover, for simplification under H2020, certification of IKOP is only due after the end of the project; therefore, the certified value of IKOP will not be available before the end of the projects. The amount of IKOP to be certified in the upcoming years is estimated at an additional EUR 159 million.

This demonstrates the success of the H2020 programme in the sector and a continuous willingness to invest and grow.

The Council Regulation establishing the Clean Hydrogen JU sets more ambitious targets for the contributions from Members other than the EU (Table 4).

TABLE 4. CONTRIBUTIONS FROM MEMBERS OTHER THAN THE EU UNDER HORIZON EUROPE (SITUATION AS OF 31 DECEMBER 2024) (MILLION EUR)

Nature		Target	Situation as of 31 December 2024	
			Committed	Validated / Certified
Financial contributions (FC) to administrative expenditure	Industry Grouping	25.97([29])		2.48

([29]) Rounded figures coming from the breakdown, 25.97 and 4.23. Original figures are 25 965 980 + 4 227 020 = 30 193 000. Total contribution from members: 30 193 000.

	Research Grouping	4.23([30])		0.40
Total FC from Members other than the EU		**30.19**		**2.89**
In-Kind contributions to Operational Activities (IKOP)	Industry Grouping		100.86([31])	0
	Research Grouping		0.47	0
In-Kind contributions to Additional Activities (IKAA)	Industry Grouping		2,419.34	1,437.97
	Research Grouping			
Total in-kind contributions from Members other than the EU		**969.81**	**2,520.67**	**1.437.97**
Total contributions from Members other than the EU		***1,000.00***	***2,520.67***	***1,440.86***

In 2024, complementing the financial contribution to administrative expenditure received under H2020, the JU started to collect financial contributions from all its members under Horizon Europe. This contribution will be collected until 2031. Like under H2020, every year, EU financial contribution is mirrored by the equivalent amount from members other than the Union.

The Horizon Europe Regulation does not establish leverage effect targets but requires that the financial and in-kind contributions from Members other than the Union equal at least 50 % and may reach up to 75 % of the aggregated JU budgetary commitments. Expressed in terms of leverage, this means an overall objective of at least 1:1 matching between the contribution of the Union and of Members other than the Union (i.e. a leverage effect of at least 1).

As in H2020, the committed IKOP will only be certified towards the end of the programme, using certificates that are due with the last reporting period of the projects. In 2024, through the signature of 29 new grant agreements from the 2023 Horizon Europe Call, private members committed around EUR 101 million in IKOP. Furthermore, each year, the Governing Board of the Clean Hydrogen JU approves the annual IKAA plans related to Horizon Europe as part of the Annual Work Programme. For the years from 2022 to 2024, the plans total more than EUR 2,419 million estimates. The IKAA is certified on an annual basis, so by the end of 2024 the final certified IKAA for the years 2022-2023 amounted to EUR 739,897,239.59; at the time of drafting this Annual Activity Report, the IKAA certification exercise for the year 2024 is still ongoing until end of December 2025, with EUR 698,069,787.03 certified as of 31 May 2025 as per the regulatory deadline of 31 May 2025.

([30]) Rounded figures coming from the breakdown: 25.97 and 4.23. Original figures are 25 965 980 + 4 227 020 = 30 193 000.

([31]) Cumulated IKOP foreseen for open HE projects at 31.12.2023 based on budget and membership at 31.12.2023

1.3 Calls for proposals, grant information and other funded actions

1.3.1 Information on Call for proposals 2024

As part of AWP 2024, the 2024 Call for proposals (HORIZON-JTI-CLEANH2-2024) was published on 17 January 2024, with an indicative budget of EUR 113.5 million. The deadline for the submission of proposals was 17/04/2024. The Call included 20 topics, distributed among the areas of activity of the Clean Hydrogen JU and its SRIA as follows:

- Renewable Hydrogen Production: 5 Topics
- Hydrogen Storage and Distribution: 5 Topics
- End-Uses Transport: 4 Topics
- End-Uses Heat and Power: 2 Topics
- Cross-cutting: 2 Topics
- Hydrogen Valleys: 2 Topics

On 26 January 2024, a public European Info Day took place on-site in Brussels. Upon invitation by the local hydrogen stakeholders, several National Info Days dedicated to the call for proposals 2024, took place either physically or remotely in some EU27 Member States and associated countries to Horizon Europe, namely: in Poland on 29th January, in Turkey on 30th January, in France on 31st January, in the UK on 1st February, in Italy on 8th February, in Spain on 14th February.

At the deadline, the 2024 Call for proposals received 132 proposals, with 122 proposals satisfying the eligibility and admissibility criteria. The distribution of the 122 proposals, according to areas and call topic, is provided in Table 5.

TABLE 5. PROPOSAL STATISTICS: ELIGIBILITY AND ADMISSIBILITY OF PROPOSALS RECEIVED IN THE 2024 CALL FOR PROPOSALS

Area	Topic	Submitted	Inadmissible	Ineligible	Eligible
Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2024-01-01	9	0	0	9
Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2024-01-02	12	0	0	12
Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2024-01-03	23	1	0	22
Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2024-01-04	10	0	1	9
Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2024-01-05	3	0	0	3
Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2024-02-01	2	0	0	2
Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2024-02-02	6	0	0	6
Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2024-02-03	2	0	0	2
Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2024-02-04	1	1	0	0
Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2024-02-05	2	0	0	2
Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2024-03-01	3	0	0	3
Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2024-03-02	3	0	0	3
Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2024-03-03	10	0	1	9
Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2024-03-04	2	0	0	2

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Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2024-04-01	10	0	3	7
Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2024-04-02	8	0	0	8
Cross-cutting	HORIZON-JTI-CLEANH2-2024-05-01	6	0	3	3
Cross-cutting	HORIZON-JTI-CLEANH2-2024-05-02	10	0	0	10
Hydrogen Valleys	HORIZON-JTI-CLEANH2-2024-06-01	13	0	0	13
Hydrogen Valleys	HORIZON-JTI-CLEANH2-2024-06-02	16	0	1	15
	Grand Total	***151***	***2***	***9***	***140***

Therefore, 19 out of the 20 topics have received eligible and admissible proposals.

The 140 eligible and admissible proposals submitted gathered 1 774 participations from legal entities established in 53 different countries. A breakdown by country where the legal entity is established, is provided in Table 6.

TABLE 6. DISTRIBUTION OF PARTICIPATION AND REQUESTED EU CONTRIBUTION BY COUNTRY

Country	Number of participants	Requested EU contribution
AL	2	118,625.00
AT	67	32,387,352.94
AU	1	40,000.00
BE	53	35,001,279.12
BG	8	1,890,915.63
BM	1	0.00
BR	1	0.00
CA	6	2,639,844.69
CH	50	1,000,000.00
CY	27	9,167,555.13
CZ	8	2,515,174.62
DE	217	117,254,051.00
DK	45	28,776,486.35
DZ	1	297,125.00
EE	12	7,256,318.75
EG	1	183,125.00
EL	66	26,656,011.73
ES	189	83,913,184.81
FI	74	28,815,577.30
FR	140	69,969,152.05
GE	2	510,375.00
HR	2	451,978.75
HU	4	473,398.25
IE	16	5,474,447.05
IL	20	10,160,949.08
IN	1	40,000.00
IS	14	8,420,955.00

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IT	194	96,514,764.62
JP	1	0.00
KR	3	0.00
LB	1	189,375.00
LT	1	168,083.13
LU	2	605,850.09
LV	4	453,437.50
MA	3	175,000.00
MK	3	240,000.00
MT	1	0.00
NL	104	46,432,942.38
NO	82	55,347,474.28
NZ	1	350,001.54
PL	45	16,749,287.79
PT	27	10,260,419.34
RO	6	822,625.00
RS	**1**	0.00
SA	1	0.00
SE	68	45,899,136.08
SI	34	15,203,344.16
SK	15	7,308,090.98
TR	38	23,426,369.91
UA	6	1,200,696.75
UK	102	49,052,565.66
US	1	0.00
ZA	2	300,000.00
TOTAL	***1774***	***844,113,346.46***

The distribution of the 1 774 legal entity participations is broken-down by entity in Table 7.

TABLE 7. DISTRIBUTION OF PARTICIPATION AND REQUESTED EU CONTRIBUTION BY TYPE OF ENTITY

Entity type	**Number of participants by entity type**	**Requested EU contribution**
Higher or Secondary Education	309	126,686,063.90
Other	104	37,719,885.68
Private for Profit	927	484,353,024.30
Public Body	105	32,214,191.03
Research Organisation	329	163,140,181.55
Grand Total	**1,774**	**844,113,346.46**

Out of the 1,774 participations of legal entities, 383 are SME (21.6%) accounting for 22.9% of the total requested EU contribution (EUR 193 694 228.21).

Moreover, out of the 1,265 unique legal entities, 884 of these participations correspond to "newcomers" (66.9%), entities that are not listed as a beneficiary of a grant awarded by an individual joint undertaking or its preceding initiative.

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After the evaluations, out of the 140 eligible and admissible proposals, 88 proposals (62.8 %) passed all the call's evaluations thresholds and were placed in either the main lists or reserve lists. This represents an improvement of the quality of the submitted proposals, because in the call 2023, 59.8 % of the proposals passed all evaluations thresholds. The exact distribution of the retained proposals and the budget per topic is provided in the Table 8.

TABLE 8. RETAINED PROPOSALS AND REQUESTED EU CONTRIBUTION PER TOPIC FOR THE 2024 CALL FOR PROPOSALS

Topic	Eligible proposals	Main list	Reserve list	Cumulative Requested EU Contribution (main list)	Available Budget in topic*
HORIZON-JTI-CLEANH2-2024-01-01	9	1	6	2,999,764.87	3,000,000.00
HORIZON-JTI-CLEANH2-2024-01-02	12	2	6	7,976,059.11*	4,000,000.00
HORIZON-JTI-CLEANH2-2024-01-03	22	4	10	15,994,929.00*	4,000,000.00
HORIZON-JTI-CLEANH2-2024-01-04	9	1	7	3,995,403.18	4,000,000.00
HORIZON-JTI-CLEANH2-2024-01-05	3	1	1	9,999,165.49	10,000,000.00
HORIZON-JTI-CLEANH2-2024-02-01	2	1	1	3,016,110.22	3,000,000.00
HORIZON-JTI-CLEANH2-2024-02-02	6	1	1	3,996,168.95	4,000,000.00
HORIZON-JTI-CLEANH2-2024-02-03	2	1	0	5,949,423.08	6,000,000.00
HORIZON-JTI-CLEANH2-2024-02-04	0	0	0	0.00	6,000,000.00
HORIZON-JTI-CLEANH2-2024-02-05	2	1	0	7,999,909.68	8,000,000.00
HORIZON-JTI-CLEANH2-2024-03-01	3	1	2	3,983,049.07	4,000,000.00
HORIZON-JTI-CLEANH2-2024-03-02	3	1	2	3,998,498.78	4,000,000.00
HORIZON-JTI-CLEANH2-2024-03-03	9	1	4	4,999,049.00	5,000,000.00
HORIZON-JTI-CLEANH2-2024-03-04	2	1	1	5,954,137.50	6,000,000.00
HORIZON-JTI-CLEANH2-2024-04-01	7	1	3	4,983,490.08	5,000,000.00
HORIZON-JTI-CLEANH2-2024-04-02	8	2	6	8,054,930.35*	4,000,000.00
HORIZON-JTI-CLEANH2-2024-05-01	3	1	1	1,499,976.56	1,500,000.00
HORIZON-JTI-CLEANH2-2024-05-02	10	3	5	8,993,200.82*	3,000,000.00
HORIZON-JTI-CLEANH2-2024-06-01	13	2	2	39,548,167.45**	20,000,000.00
HORIZON-JTI-CLEANH2-2024-06-02	15	3	1	26,996,574.61**	9,000,000.00
Grand Total	**140**	**29**	**59**	**170,938,007.80**	**113,500,000.00**

* In these topics, the remaining operational budget of EUR 25,968,893.21, originating from third countries and UK contributions, and call leftovers, was used to promote proposals from the reserve to the main lists in September and December 2024.

** in these topics, the 2024 RePowerEU budget of EUR 37,548,806.23, was used to promote proposals from the reserve list to the main list.

It is important to note that, as all the actions of the Clean Hydrogen JU contribute to the Horizon 2020 and Horizon Europe objectives to address climate action, the total of the cumulative requested EU contribution mentioned above (EUR 171 million) should be considered to be contributing to the HE (and H2020) objective to contribute at least 35% of expenditure to climate objectives ([32]).

([32]) In order to support EU's commitment to make it the world's first climate-neutral continent by 2050, Horizon Europe will direct a minimum of 35% of the funding available to climate objectives.

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1.3.2 Information on Grant Agreement Preparation (GAP)

In 2024, the Clean Hydrogen JU invited also 2 proposals from the reserve list of call HORIZON-JTI-CLEANH2-2023-1 to the grant agreement preparation stage, following additional decisions for the optimal implementation of the budget and related leftovers.

TABLE 9. INFORMATION ON GRANT AGREEMENT PREPARATION OF CALLS HORIZON-JTI-CLEANH2-2023-1 (RESERVE LISTS)

Call	Proposal number	Acronym	Ranking status	TTI	TTS	TTG
HORIZON-JTI-CLEANH2-2023-1	101137756	CARMA-H2	RESERVE	104	95	199
HORIZON-JTI-CLEANH2-2023-1	101137940	MANTHOVA	RESERVE	104	N/A	N/A

NB: TTS, time to sign.

One GA was signed in 2024 in 199 days, well within the 245 days of the time to grant (TTG) target fixed in the General Annexes to the Horizon Europe - Work Programme 2023-2024. The remaining grant agreement for MANTHOVA was terminated as the consortium's was not able to comply the original terms of their proposal.

In August 2024, the Clean Hydrogen JU informed the applicants of the outcome of the evaluations of the call HORIZON-JTI-CLEANH2-2024 (deadline at 17/04/2024). All consortia were informed of the evaluation results at the same time, 113 days after the closure of the call, well in advance of the TTI target fixed in the General Annexes to the Horizon Europe - Work Programme 2023-2024 (153 days).

Six proposals made requests for review (redress) under this call, none of which led to re-evaluation or change in the ranked lists established in the evaluation process.

In August 2024, immediately after the information letters were sent, the Clean Hydrogen JU invited 19 proposals from the main lists to grant agreement (GAs) preparation, in September 2024 another 5 proposals and in December 2024 another 5 proposals from the reserve lists were invited, following decisions on the optimal budget implementation including leftovers, and UK appropriations.

In total, 16 out of 29 GAs were signed in 2024, after an average 241 days - that is within the 245 days of time to grant (TTG) target fixed in the General Annexes to the Horizon Europe - Work Programme 2023-2024. Out of the remaining 13 GAs, 9 were signed in January-April 2025, six of them after the TTG of 245 days, after approval of the requests by the consortium to extend the GA preparation. These GAs refer to complex actions and/or consortium that required more time for grant preparation, such as those from the flagship and hydrogen valley topics (Table 10).

TABLE 10. INFORMATION ON GRANT AGREEMENT PREPARATION OF CALL HORIZON-JTI-CLEANH2-2024

Call	Proposal number	Acronym	Ranking status	TTI	TTS	TTG
HORIZON-JTI-CLEANH2-2024	101192454	ASTERISK	MAIN	113	122	235
HORIZON-JTI-CLEANH2-2024	101192365	BeBoP	MAIN	113	131	244
HORIZON-JTI-CLEANH2-2024	101192306	CleanH2Shipping	MAIN	113	225	338*
HORIZON-JTI-CLEANH2-2024	101192075	DELYCIOUS	MAIN	113	130	243
HORIZON-JTI-CLEANH2-2024	101192392	GUESS-WHy	MAIN	113	131	244
HORIZON-JTI-CLEANH2-2024	101192481	H2UpScale	MAIN	113	122	235
HORIZON-JTI-CLEANH2-2024	101192352	Hermes	MAIN	113	132	245
HORIZON-JTI-CLEANH2-2024	101192356	HI2 Valley	MAIN	113	132	245
HORIZON-JTI-CLEANH2-2024	101192337	HyDRA	MAIN	113	130	243

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HORIZON-JTI-CLEANH2-2024	101192442	HyPrAEM	MAIN	113	130	243
HORIZON-JTI-CLEANH2-2024	101192536	HySPARK	MAIN	113	130	243
HORIZON-JTI-CLEANH2-2024	101192349	InsigH2T	MAIN	113	122	235
HORIZON-JTI-CLEANH2-2024	101192425	NAVHYS	MAIN	113	193	306*
HORIZON-JTI-CLEANH2-2024	101192341	PEPPER	MAIN	113	131	244
HORIZON-JTI-CLEANH2-2024	101192151	PROMISERS	MAIN	113	117	230
HORIZON-JTI-CLEANH2-2024	101192503	REMEDHYS	MAIN	113	130	243
HORIZON-JTI-CLEANH2-2024	101192169	RESCUE	MAIN	113	130	243
HORIZON-JTI-CLEANH2-2024	101192534	SYRIUS	MAIN	113	126	239
HORIZON-JTI-CLEANH2-2024	101192497	VHyTTA	MAIN	113	N/A	N/A
HORIZON-JTI-CLEANH2-2024	101192495	CyLH2Valley	RESERVE	113	182	295*
HORIZON-JTI-CLEANH2-2024	101192335	EASTGATEH2V	RESERVE	113	182	295*
HORIZON-JTI-CLEANH2-2024	101192325	FASTCH2ANGE	RESERVE	113	172	285*
HORIZON-JTI-CLEANH2-2024	101192359	HYCELAND	RESERVE	113	N/A	N/A
HORIZON-JTI-CLEANH2-2024	101192342	SWEETHY	RESERVE	113	140	253*
HORIZON-JTI-CLEANH2-2024	101192557	ACCEPT	RESERVE	113	N/A	N/A
HORIZON-JTI-CLEANH2-2024	101192366	ECOPEM	RESERVE	113	120	233
HORIZON-JTI-CLEANH2-2024	101192485	ENDURION	RESERVE	113	116	229
HORIZON-JTI-CLEANH2-2024	101192418	HySEas	RESERVE	113	116	229
HORIZON-JTI-CLEANH2-2024	101192235	Sea4Volt	RESERVE	113	N/A	N/A

NB: TTS, time to sign.

The 29 projects listed above include 390 participations from 327 entities for a total Clean Hydrogen JU requested contribution of EUR 170,938,007.80. This amount was distributed by participant category shown in Table 11.

TABLE 11. BREAKDOWN OF PARTICIPATION AND CONTRIBUTION BY PARTICIPANT CATEGORY (IN EUR)

Entity type	Number of participations	Requested EU Contribution
Higher or Secondary Education	65	23,222,034.12
Other	20	7,542,555.93
Private for Profit	209	98,016,076.62
Public Body	12	3,381,617.75
Research Organisation	84	38,775,723.38
Grand Total	**390**	**170,938,007.80**

The 29 projects include 73 SME participations (18.7%) and amount to EUR 33,390,840.95 of funding. 188 of the 390 participations correspond to “newcomers” (48.2%), i.e. entities that are for the first-time beneficiaries of a grant awarded by an individual joint undertaking or its preceding initiatives.

In terms of country participations, participants from 29 EU Member States or Associated Countries are participating in the 29 projects and have received funding. In addition, entities from 4 third countries are participating. Table 12 indicates the distribution of the participants and the Clean Hydrogen JU contribution by country.

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TABLE 12. NUMBER OF ENTITIES PARTICIPATING AND CLEAN HYDROGEN JU CONTRIBUTION BY COUNTRY

Country	Number of entities participating	Requested EU Contribution (EUR)
AT	39	18.673.907,04
BE	6	1.481.468,00
BG	1	378.375,00
CH	14	0,00
CY	1	211.125,00
CZ	2	203.487,50
DE	52	25.255.110,63
DK	5	3.977.578,39
EE	5	2.413.378,50
EL	11	4.742.921,88
ES	45	24.902.736,97
FI	4	1.910.587,02
FR	38	13.824.821,71
HU	1	50.625,00
IE	5	2.260.775,28
IL	2	755.075,70
IS	14	8.420.955,00
IT	44	22.381.410,05
JP	1	0,00
LV	1	68.562,50
MA	2	175.000,00
NL	18	5.687.654,45
NO	12	6.187.551,29
NZ	1	350.001,54
PL	13	5.112.137,27
PT	2	715.000,00
RO	2	355.000,00
SE	4	1.524.451,69
SI	5	1.508.937,25
SK	15	7.308.090,98
TR	3	1.214.312,50
UA	2	927.334,25
UK	20	7.959.635,41
Grand Total	**390**	**170.938.007,80**

1.3.3 Other funded actions: calls for tenders

Operational calls for tenders in 2024

In accordance with its AWP for the year 2024, the Clean Hydrogen JU launched operational procurement procedures via open calls for tenders on the following topics:

- **Sustainable paths for the use and management of water in the hydrogen value chain**

The call for tenders was foreseen in AWP 2024.

The scope of the call for tenders is to assess the techno-economic, environmental and social sustainability of water use in green hydrogen value chain. The study should also analyse the resilience of water availability with respect to the concurrent demand from different sectors and in the proximity to upcoming large hydrogen production capacities in Europe and neighbouring countries at regional levels and across the seasonal changes. Proposed recommendations to develop a circular approach to reduce and manage water consumption in a sustainable way is also part of the study.

The call for tenders was launched in 2024, with evaluations on-going at the end of the year 2024. The contract is expected to be signed during the year 2025.

- **Potential of natural/geologic hydrogen in Europe**

The call for tenders was foreseen in AWP 2024.

The initial scope of the call was to address the lack of understanding and assess the potential for geologic hydrogen in Europe. The exact scope of the study was to be further elaborated while preparing the tender specifications to avoid duplication with on-going and planned activities in this area. Further to the preliminary market analysis in preparation of the procurement procedure with a view to gain prior knowledge and understanding of the market, as well as on the state-of-play, the JU has decided not to pursue this study as the publications and information on the market did not support its relevance.

- **Techno-economic-environmental analysis on the use of hydrogen in a RES-dominated European power generation sector.**

The call for tenders was foreseen in AWP 2024.

The scope of the tender was to perform a techno-economic-environmental analysis on the role of hydrogen in Europe's power generation sector.

Further to the preliminary market analysis in preparation of the procurement procedure with a view to gain prior knowledge and understanding of the market, as well as on the state-of-play, the JU has decided not to pursue this study as the publications and information on the market did not support its relevance.

- **Hydrogen Valleys Facility**

The call for tenders was foreseen in AWP 2024.

The tender's objective is to set-up and run a 'Hydrogen Valley Facility' aiming at accelerating the number of hydrogen valleys in Europe. The facility is to include project development assistance to support Hydrogen Valleys at different level of maturity. Whilst the focus will be on European countries, such project development assistance may be extended to third countries, in line with the Commission policy priorities. The Facility is to be used to also maintain and update the Mission Innovation Hydrogen Valley Platform.

The call for tenders was launched in 2024, with evaluations on-going at the end of the year 2024. The contract is expected to be signed during the year 2025.

- **European Hydrogen Sustainability and Circularity Panel (EHS&CP)**

A call for tenders was planned in Amendment No. 2 to the AWP 2024.

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The objective of this call is the extension of the European Hydrogen Sustainability and Circularity Panel activities, establishing a multidisciplinary pool of experts to support the integration of sustainability and circularity aspects into hydrogen projects.

Following the adoption of the Amendment to the AWP on 18/11/2024, the remaining time in 2024 was dedicated to preliminary market research and the preparation of technical specifications.

The tender process, including evaluation and contract signing, will take place in 2025.

- **European Hydrogen Safety Panel (EHSP)**

The procurement activities were carried out in 2024, and evaluation was concluded in 2024.

The ensuing framework contract was signed by both parties on 18/12/2024.

1.4 Evaluation procedures and outcomes

In March-April 2024, a pool of 184 experts was built. The selection prioritizes expertise, absence of conflict of interest, and availability over geography and gender, and demonstrates efforts to improve diversity through inclusion of associated countries, rotation, and outreach campaigns.

The evaluation of proposals of the call HORIZON-JTI-CLEANH2-2024 was carried out between May and June 2024. The proposals were evaluated by a total of 58 external experts taken from the pool of 184 experts. In addition, four Vice-Chairs (Quality Controllers) were appointed to assist with the management of the entire evaluation process, including the quality control task. The evaluation procedure had one observer (i.e. independent external expert to advise on the conduct and fairness of the evaluation sessions, the application of the evaluation criteria and ways to improve the processes). Of the 58 individual external experts, 15 were female (25.9%). Regarding the nationality of experts, 23 nationalities were represented as shown in Table 13.

TABLE 13. EXTERNAL EXPERTS BY GENDER AND COUNTRY OF NATIONALITY

Country group	Country	Number of female experts	%	Number of male experts	%	Total
Associated Countries	Morocco	0	0.00 %	1	100.00 %	1
Associated Countries	Türkiye	1	50.00 %	1	50.00 %	2
Associated Countries	Ukraine	0	0.00 %	1	100.00 %	1
Associated Countries	United Kingdom	0	0.00 %	2	100.00 %	2
Associated Countries		**1**	**16.67 %**	**5**	**83.33 %**	**6**
EU Member States	Belgium	0	0.00 %	1	100.00 %	1
EU Member States	Croatia	2	100.00 %	0	0.00 %	2

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EU Member States	Cyprus	0	0.00 %	1	100.00 %	1
EU Member States	Denmark	0	0.00 %	1	100.00 %	1
EU Member States	Finland	1	100.00 %	0	0.00 %	1
EU Member States	France	1	12.50 %	7	87.50 %	8
EU Member States	Germany	1	20.00 %	4	80.00 %	5
EU Member States	Greece	2	25.00 %	6	75.00 %	8
EU Member States	Hungary	1	100.00 %	0	0.00 %	1
EU Member States	Ireland	1	50.00 %	1	50.00 %	2
EU Member States	Italy	0	0.00 %	4	100.00 %	4
EU Member States	Netherlands	0	0.00 %	1	100.00 %	1
EU Member States	Poland	2	66.67 %	1	33.33 %	3
EU Member States	Portugal	0	0.00 %	5	100.00 %	5
EU Member States	Romania	1	100.00 %	0	0.00 %	1
EU Member States	Spain	1	20.00 %	4	80.00 %	5
EU Member States		**13**	**26.53 %**	**36**	**73.47 %**	**49**
Third countries	Cote d'Ivoire	0	0.00 %	1	100.00 %	1
Third countries	India	0	0.00 %	1	100.00 %	1
Third countries	Switzerland	1	100.00 %	0	0.00 %	1
Third countries		**1**	**33.33 %**	**2**	**66.67 %**	**3**
GRAND TOTAL		**15**	**25.86 %**	**43**	**74.14 %**	**58**

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1.5 Follow-up activities linked to past calls

1.5.1 Knowledge Management

1.5.1.1 Annual Programme Review

The annual Programme Review Exercise is one of the main knowledge management activities of the Clean Hydrogen JU. Its purpose is to monitor the implementation of the Clean Hydrogen JU Programme to ensure that it is aligned with the strategy and objectives set out in its founding regulation, as further elaborated in its SRIA for 2021-2027.

The Annual Programme Review can be separated into four main activities: (i) The annual data collection exercise, (ii) the JRC Annual Programme Technical Assessment (and Report), (iii) the Programme Review Report and (iv) the Innovation Forum incl Programme Review Day(s).

The annual data collection exercise ([33]) from projects was continued to be performed via the internally developed data collection platform TRUST (Technology Reporting Using Structured Templates) and the Project Fiche, which replaced the previous survey used to collect additional qualitative information.

Projects were invited to provide their data in February-March 2024 concerning results and achievements generated in 2023. The data collected allow for the benchmarking of the technology progress reported by the projects against the SoA and the Clean Hydrogen JU targets, as defined in the SRIA. Moreover, the annual iterations of the data collection exercise provide the necessary input for the development of a database of project results over time (and trends in technology development).

The Clean Hydrogen JU continuously aims to meet the objectives outlined in the SRIA by engaging as many stakeholders in the hydrogen technology sector as possible. Actions taken by the JU reflect the views of its public and private members, as well as recommendations from the JRC (who supports independently the annual review), as summarized in its annual assessments, and the broader scientific community.

To gather feedback on SRIA topics and implementation, the JU conducted surveys in 2023 and 2024, targeting the wider scientific community. The 2024 survey, launched on the EUSurvey platform on April 11, was initially set to close on May 9 but was extended twice, concluding on May 19.

Building on lessons from the previous 2023 survey, efforts were made to improve the questionnaire’s content, target the right audience through social media and emails, and extend the survey's timeline. Despite these efforts, participation remained low, with only 13 responses, which are not statistically significant. As a result, the JU decided to archive the survey and not to conduct a new one in 2025. Alternative consultation methods will be explored to align with Article 82(d) of the SBA such as the feedback received during the Innovation Forum and related Programme Review Days.

In terms of the novelty for 2023, the Project Fiche was introduced as a means to centralise all information for each project across all IT platforms, while also containing historical information for each project and making it possible to follow changes over time. The overall objective of the new Project Fiche was to integrate all important project related information and data available in the different IT platforms and tools and the stand-alone information coming from the projects or internal resources and staff.

([33]) https://www.clean-hydrogen.europa.eu/knowledge-management/annual-data-collection_en#data-collection-methodology

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The Project Fiches originally prepared in Excel format for the scope of the Data Collection, were further developed internally into an open-source SuiteCRM platform, ensuring a more streamlined and contemporary approach.

After the annual data collection exercise in Feb-March 2024, the JRC performed its detailed assessment and produced a report, the Annual Programme Technical Assessment, with observations on the major accomplishments of the projects, the difficulties encountered and an evaluation of the performance of the Programme against the KPIs (summary provided also above under the programme achievements).

Consequently, the Clean Hydrogen JU prepared its Programme Review Report ([34]) for 2024 (based on achievements and data from projects in 2023), based on the findings of the JRC report, complemented by an analysis of its funded activities and the views of the wider scientific community. It also included a section on relevant studies commissioned by the Clean Hydrogen JU and major reports of international bodies and one on the observed technological, economic and societal barriers to market entry ([35]). The contents of the Programme Review Report, allow it to go beyond the simple monitoring of the Programme, also becoming an important input (or feedback-loop) for the next Annual Work Programmes and the identification of research areas and topics for the forthcoming Calls.

Finally, the Annual Programme Review closes with the Innovation Forum (and related Programme Review Days), integrated into the Hydrogen Week (for more information, see Section 2.1). The event took place fully physically on 19-21 November 2024 and was attended by a large audience, mostly coming from the research and private community active in the hydrogen sector. During its sessions, there were panels and presentations assessing the progress and achievements in the various pillars of the Clean Hydrogen programme including presentations of successful projects results and discussing ways forward and key issues concerning research and innovation in the clean hydrogen field.

1.5.1.2 European Hydrogen Observatory (EHO)

The JU contributes also to the monitoring of the deployment of hydrogen technologies, to the adoption of related policies and to academic activities and research results through the European Hydrogen Observatory (FCHO) ([36]). EHO is an open platform providing data and up to date information about the entire hydrogen sector, aiming to address the lack of data publicly available at EU and national level concerning the uptake of fuel cell and hydrogen technologies on the EU market and the absence of a coordinated methodology on how to monitor their market evolution.

The Observatory was created for the use of policy makers, industry stakeholders and the general public equally, and is the main public portal for European hydrogen data. Initiated under FCH 2 JU, as the Fuel Cells and Hydrogen Observatory, EHO continues its activity as of November 2021 and for 4 more years under the support of the Clean Hydrogen Partnership.

EHO focuses on technology and market statistics, socio-economic indicators, policies and regulations, and financial support. It has been seeing a steadily increasing number of visitors since then, with the largest share of them in recent months entering via direct entry to the website, indicating its acknowledgement as an important source of information for hydrogen.

([34]) https://op.europa.eu/en/publication-detail/-/publication/00f833fa-7ec4-11ee-99ba-01aa75ed71a1/language-en/format-PDF/source-296436320

([35]) As requested by SBA Article 74 (a)

([36]) https://observatory.clean-hydrogen.europa.eu/

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The Observatory website is being continuously developed and expanded with additional data sets and key information for the hydrogen sector's stakeholders. Moreover, increasing emphasis is placed on the improved visualisations and tools that it can offer.

1.5.1.3 Knowledge Management Tools and Clean Hydrogen Knowledge Hub

The Programme Office of the Clean Hydrogen JU continued to use and further develop the tools used to collect and monitor information, most notably the data collection platform TRUST and the TIM tool developed by JRC. These were complemented by the tools provided by DG RTD (CORDA, COMPASS, CORTEX, etc) and the databases and tools developed internally to better manage information for supporting the operations of the Clean Hydrogen JU.

As all the above-mentioned tools and platforms are independent and accessed separately, in 2023 the Programme Office published a Call for Tenders ([37]) for a new unique digital platform, the Clean Hydrogen Knowledge Hub, which will gather, encompass and analyse information and data coming from the Clean Hydrogen JU projects and the available internal tools/platforms of the Clean Hydrogen JU. The Clean Hydrogen Knowledge Hub contract was consequently signed and started in 2024, and is expected to provide the necessary tools and capabilities to better collect and manage knowledge, and to facilitate access to nonconfidential information to its members and the wider public.

It will be a single platform that will not only address many of the aspects regarding the access to and handling of data, but also bring together information and data from the available tools/platforms into a new integrated system. The Clean Hydrogen JU aspires for this platform to have access and be linked to the different data sources, and will be able to manipulate, analyse and visualise the information and data in order to allow Hub users to navigate through them based on their access rights. Apart from the Clean Hydrogen JU staff, other Hub users are expected to be policy makers (including the European Commission and national and regional authorities), decision makers, international organisations, academics, members of industry and the general public, all with different roles and access levels. As of 2025, the Hub is expected to be already used for the annual data collection.

1.5.2 Feedback to Policy

The Clean Hydrogen JU is contributing to the activities of several services in the European Commission and therefore to the continuous update and development of different policies in line with its objectives (e.g. R&I, energy, transport, climate and industrial policies). Contributions vary in content and format, but the common goal is to provide fact-based information on the state-of-the-art of fuel cells and hydrogen technologies and their contribution to the EU initiatives and policies especially in the energy, transport and industry sectors and competitiveness and growth.

In practical terms, this means taking part in several technical groups organised by the EC (e.g. the Horizon Feedback to Policy Group ([38])) and other international bodies, active participating in meetings, providing written technical input and ensuring that fuel cells and hydrogen technologies are properly represented. It also involves providing feedback from projects and studies to the EC in contribution to relevant energy, transport, industrial, R&I and clean air policy files.

In 2024, the Clean Hydrogen JU Programme Office continued to reinforce the collaboration with policy makers in the European Commission by providing input in response to ad-hoc requests or in a more structured manner.

([37]) https://etendering.ted.europa.eu/cft/cft-document.html?docId=154165

([38]) The Horizon Feedback to Policy Group is one of the pillars of the governance structure to coordinate implementation, according to the D&E Strategy for the post-H2020 period and the Horizon Europe.

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The European Hydrogen Observatory (EHO) maintained by the Clean Hydrogen JU is also an important resource in the context of the feedback to policy, as it contains useful information on hydrogen technologies, deployment, policies and funding and research-related information (publications, patents and trainings). This will be enhanced by the planned work on the Clean Hydrogen Knowledge Hub (see Section 1.5.1 for more information).

In addition, the outcomes of the study on the 'sustainable supply chain and industrialisation of hydrogen technologies' delivered and published in 2024 are important to policy makers (e.g. DG GROW and the Clean Hydrogen Alliance) for monitoring the progress on the competitiveness of clean energy technologies. The results of this study were provided and contributed to the Draghi report on the future of European competitiveness([39]), while the database of EU entities involved in the hydrogen supply chain is to be integrated into the European Hydrogen Observatory.

In addition, the JU has supported Clean Hydrogen H2 Alliance (managed by DG GROW) with further development of IPCEIsrelated website, as part of the Clean Hydrogen Observatory activities. Similarly and in support to Mission Innovation (DG RTD), the JU is continuously developing the H2 Valleys Platform. Finally, it also supports the Ports Initiative of the Clean Energy Ministerial (DG ENER) with fact-based studies.

1.6 Openness, cooperation, synergies and cross-cutting themes and activities

1.6.1 Support to EU Policies

SET Plan

In 2024 the Clean Hydrogen JU has continued to follow the work of 2 SET plan Temporary Working Groups, namely the group on Renewable Fuels and Bioenergy and the group on Hydrogen. The Hydrogen group was quite active in 2024 aiming to finalise the implementation plan to establish itself as the Implementation group (this is expected from all the temporary groups in 2025) and by establishing four working groups along the entire value chain with consideration of cross-cutting issues, namely: System integration, Production, Infrastructure and Application. The JU has provided input in terms of the current developments and achievements of our projects, as well as information about our updated SRIA and corresponding KPIs. The JU plans to continue following both groups in 2025 and explore better alignment with Member States related plans

Support to Transport Policies

The Clean Hydrogen JU also supports the e-HRS availability system (E-HRS-AS), which establishes and validates hydrogen availability signal at 135 HRS in Europe, out of the 195 HRS with public access in December 2024. This action is supporting the roll-out of the AFIR, which plans the deployment of 1tH2/d HRS every 200 km on the TEN-T core network and one HRS in every urban node by the end of 2030. The E-HRS-AS will be revamped in 2025 to cope with the AFIR roll-out and focus on heavy duty transport. Moreover, the E-HRS-AS is the data provider for DG MOVE's EAFO and TENtec platforms. EAFO is the European Commission's key reference portal for alternative fuels, infrastructure and vehicles in Europe, and supporting the European Commission in the monitoring of the implementation of AFIR. TENtec provides a comprehensive overview on the European Commission's work in relation

([39]) https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en

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to the Trans-European Transport Network (TEN-T) and aims to raise citizens' awareness of the benefits of the TEN-T policy development.

Concerning the maritime sector, the project e-SHyPS aims to define new guidelines for the effective introduction of hydrogen in the maritime passenger transport sector. Engaged in the development of a regulatory framework, and through its standardization plan and adoption roadmap, e-SHyPS stands at the forefront of the development of hydrogen-based alternative fuels for waterborne transport. The project organised a policy workshop "Hydrogen as Maritime Fuel: Defining New Guidelines for a Sustainable Future", in May 2024 at CEN/CENELEC, and gathering DG MOVE, DG RTD, DG MOVE, International Maritime Organisation and stakeholders from maritime and hydrogen sectors. -

Looking at railways research, the project FCH2rail has pursued an extensive gap analysis within the current regulatory framework, initially from a theoretical point of view and then from a prototype testing point of view, following train testing in public and private railroad. The results are public and they have been divided by field of application (train, refuelling station, pantograph, infrastructure). The project produced 3 deliverables on this matter, including a strategy to disseminate the results to interested stakeholders, normative bodies, working groups and platform where regulatory bodies and institutions are present.

Support to Industrial Policy

During 2024, the Clean Hydrogen JU continued taking part as an observer of the Steering Committee of the European Clean Hydrogen Alliance.

In March 2023, the European Commission released the "EU Net-Zero Industry Act" (NZIA) proposal([40]) as a means to execute the Commission's "Green Deal Industrial Plan for the Net Zero Age"([41]) , released in February 2023. The NZIA aims to ensure the deployment and competitiveness of technologies associated with decarbonisation by strengthening Europe's net-zero technology products manufacturing ecosystem, and the proposed regulation sets out a variety of actions and instruments to strengthen the competitiveness of Europe's net-zero technology manufacturing ecosystem. One of the regulations is focused on enhancing skills, and the Act will ensure the availability of a skilled workforce for the clean energy transition by supporting the set-up of specialised European Academies on strategic net-zero technologies, among which hydrogen technologies are included.

Following up on the discussions started in 2023, in 2024 the Clean Hydrogen JU has worked in close contact in view of aligning the activities of the Clean Hydrogen JU to maximise the JU's contribution to the NZIA goals. Discussions are ongoing to potentially expand the H2 Academy activities in 2026.

Furthermore, the findings of the Clean Hydrogen JU contracted study and concluded in 2024 on the sustainable supply chain and industrialization of hydrogen technologies[42] are highly relevant to policymakers, including DG GROW and the Clean Hydrogen Alliance. These insights support the continuous monitoring and assessment of the competitiveness of hydrogen technologies and the strategic decision-making at both national and European levels. Notably, the study's results contributed to the Draghi Report on the future of European competitiveness, reinforcing the role of hydrogen in the EU's industrial and economic strategy. Additionally, the comprehensive database of EU entities engaged in the hydrogen supply chain is set to be integrated into the European Hydrogen

([40]) 2023/0081 (COD)

([41]) COM(2023) 62 final

([42]) Summary report available here

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Observatory, enhancing transparency, facilitating stakeholder collaboration, and supporting data-driven policy initiatives.

Work with and inputs provided to other DGs of the European Commission are included in the section 1.6.3 on synergies.

1.6.2 Collaboration with JRC – Rolling Plan 2024

The Commission's Joint Research Centre (JRC) undertakes high quality research in the field of fuel cells and hydrogen that is of considerable relevance to the implementation of the Clean Hydrogen JU activities. During the Horizon 2020 period, a Framework Contract between the FCH 2 JU and JRC was approved by the Governing Board on 23/12/2015 and signed by both parties on 18/02/2016. Under Horizon Europe, a new Framework Agreement between Clean Hydrogen JU was signed in the spirit and as continuous of the previous Framework Contract on 29/11/2022.

The scope of the new Framework Agreement covers the activities that JRC provides to the Clean Hydrogen JU, against payment from the Clean Hydrogen JU operational budget. In line with the JRC mission, these support activities will primarily support the formulation and implementation of the Clean Hydrogen JU strategy and activities in the areas of standardisation, technology monitoring and assessment and sustainability. In addition, Clean Hydrogen JU may call upon JRC to perform specific actions for individual projects, by which the JRC provides added value to programme objectives. These activities are discussed and agreed on an annual basis between the JRC and the Programme Office of the Clean Hydrogen JU, with involvement of representatives of Hydrogen Europe and Hydrogen Europe Research. As in previous years, the annual activities expected for 2024, were set out in a Rolling Plan, which was published as part of the Annual Work Plan 2024 of the Clean Hydrogen JU. For the annual rolling plan of year 2024, an indicative budget of 969K from the Clean Hydrogen JU operational budget was foreseen. The annual Rolling Plan 2024 describes the annual activities and their related deliverables provided by JRC to Clean Hydrogen JU against payment. In line with the JRC's mission, these support activities contribute to the formulation and implementation of the JU strategy and activities in the areas of RCS, safety, harmonisation of testing protocols, and technology monitoring and assessment.

Support to formulation and implementation of RCS strategy

JRC supports the industry led Regulations, Codes and Standards Strategy Coordination (RCS SC) Task Force. In general, RCS activities should consist of identifying and prioritising RCS needs of strategic importance for the EU. In addition, the necessary PNR activities to support the RCS priorities should be identified.

JRC direct contribution to implementing RCS strategy (Harmonisation)

<u>Electrolysis harmonisation</u>

The electrolysis harmonisation activities were continued, with JRC following the progress with international standardisation for fuel cells and electrolysers. A draft report entitled " EU harmonised testing procedure: polarisation curve measurement of high-temperature fuel cell and electrolyser was produced and circulated for public stakeholder consultation.

<u>Survey among stakeholders on their use of AST protocols</u>

JRC also prepared a note on the survey results, which was finalised in December 2024 upon collecting and analysing all 64 responses to the developed online questionnaire. Overall, harmonisation efforts are regarded as useful to the research community in academia and industry. Certain documents may

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still require enhancements to provide clearer guidance, particularly for those conducting experiments. Among other things, it was suggested to develop AST based for other applications (HDV, maritime, stationary, etc.) and to do further work for electrolysis harmonisation activities.

JRC ZERO∇CELL test hardware

In 2024, no ad-hoc requests were received for providing support regarding the design and manufacture guidance of the JRC ZERO∇CELL test hardware (DOI: 10.17632/c7bffdv7yb.1). This link had 908 views and 296 downloads (accessed: 28 February 2025). By the end of 2022 these two figures were 617 and 168.

JRC contribution to programme monitoring and assessment

Maintenance, operation and extension of FCH Technology Innovation Monitoring System for the Clean Hydrogen JU

In collaboration with the Knowledge Management team, JRC has maintained, operated and extended the Tools for Innovation (TIM) system with customized FCH Technology fields.

Historical analysis report on electrolysers

The JRC has performed an update of the historical analysis report on electrolysers. The action was undertaken in a data-driven approach with an emphasis on quantifying and increasing the quality and consistency of TRUST data reported by projects from 2016 to 2023. The JRC provided the confidential and anonymised plots showing the progress made by 44 projects spanning over all 4 electrolysis technologies on 7 key parameters indicators. To support the development of the new Knowledge Hub, the JRC also provided the harmonised datasets, the parameter mapping, the actionable Python scripts as well as a methodological note detailing the approach taken for this deliverable. A presentation was given in September 2024 to share the outcomes of this analysis.

The JRC has conducted a comprehensive literature review to assess the current State-of-the-Art of direct seawater electrolysis (DSE) technology. The review aimed to identify the latest advancements, challenges, and opportunities in this field, with a focus on technology, including its efficiency, scalability, and potential applications, as well as a comparison with the indirect seawater electrolysis (ISE) technology. The review also investigated economic and environmental aspects of the two technologies. The assessment was based on a thorough analysis of existing academic and industry publications, as well as relevant research projects and initiatives. A detailed report summarizing the findings of the literature review was delivered, and highlighted the key challenges, limitations and recommendations associated with DSE.

The scope of research on DSE proved to be more extensive than initially anticipated, encompassing a wide range of technologies at various stages of development, many of which are at low Technology Readiness Levels (TRL). Due to the lack of a universally accepted classification system, JRC invested significant effort in categorising the diverse technological solutions presented in the literature. Additionally, the novel nature of this field necessitated multiple rounds of reviews to gather insights and feedback from a diverse array of experts, which further contributed to the increased time demands for this project.

2024 Annual Programme Technical Assessment

The JRC has performed the 2024 Annual Programme Technical Assessment (APTA) - see also Knowledge Management chapter. The purpose of the APTA is to ensure that the Clean Hydrogen JU

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Programme is aligned with the strategy and objectives set out in its Council Regulation and the Strategic Research and Innovation Agenda (SRIA). The 2024 Annual Programme Technical Assessment has included all projects up to and including 2020 Calls for Proposals that were ongoing in the period January 2023-March 2024. The current Programme Assessment therefore covers 150 projects in total, of which 67 projects began under H2020 and 83 projects under Horizon Europe. The JRC's 2024 APTA Report summarises the findings from the assessment of the projects in 8 Pillars and 31 research areas, aligned with the SRIA structure. The report has similar structure as the 2023 APTAR report and contained additional data and information from the historical analysis JRC conducted, part of the Technology progress and state of the art chapter.

The progress reported by the projects towards achieving the MAWP 2020 state of the art (SoA) targets for the Key Performance Indicators (KPIs) is assessed, in addition to the SRIA 2024 targets. Recommendations specific to each Pillar and/or research area are provided, as well as general and cross-cutting recommendations in the final chapter of APTAR.

JRC Contribution to assessment of sustainability of hydrogen and fuel cells

In 2024, JRC continued to support the Clean Hydrogen JU by offering ongoing advice and delivering reports aimed at assisting the JU and its funded projects in evaluating, reporting, and mitigating the environmental impact of hydrogen technologies. In particular:

- report with the outcomes of the regular review and assessment of the life cycle based deliverables of all ongoing JU projects
- summary of the assessments performed between 2018 and 2023 of the LCA deliverables produced by JU projects to support the work of the European Hydrogen Sustainability and Circularity Panel
- summary of JRC supporting activities to the SH2E, eGHOST, and HyPEF projects
- progress on the activities performed with regards to the life cycle inventory (LCI) data collection process and on the development and use of a "Hydrogen node" in the Life Cycle Data Network infrastructure

JRC Contribution to safety, and safety awareness

JRC has continued to work in 2024 on maintaining, updating and upgrading the public European Hydrogen incidents and Accidents Database HIAD. This annual work consists of two parallel work streams targeting two objectives: (i) to guarantee continuity of business (continuous quality improvement, events collection, input and validation, engagement with the users, assessment and dissemination activities), and (ii) to prepare the uptake of ownership of the databases by the JU. A report describing the achievements of these two work streams in 2024 was produced.

1.6.3 Synergies

1.6.3.1 Synergies at the programming level

This section explains how the synergies at the programming level, including activities to prepare new initiatives or calls for proposals were implemented during 2024.

Synergies implemented under Calls for Proposals

The projects supported by the JU under the Call for Proposals 2024 which started in 2024, have included specific activities in their Description of Actions, aiming to materialise the synergies identified

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un the Annual Work Programme 2024([43]). In particular, for the Hydrogen Valleys topics, the call for proposals 2024 included a provision for the awarding of Seals of Excellence to applications exceeding the evaluation thresholds set out in this work programme but that could not be funded due to a lack of budget available to the call. In this regard, the Call 2024 resulted in Hydrogen Valleys proposals evaluated above the threshold, but for which the JU could not grant funding due to lack of budget. These proposals will be awarded Seals of Excellence once all grants under the Call 2024 are signed (and this is not yet the case).

Since the early stages of the preparation of the topics included in the call for proposals 2025([44]), the Clean Hydrogen JU has interacted with the members of its Stakeholder Group and with a number of European partnerships and other entities responsible for different EU programmes. Given that only a limited number of European partnerships are represented under the Stakeholders Group – an advisory body to the Governing Board of the Clean Hydrogen JU – this cooperation took on different formats but managed to take all of their views into account, to the maximum possible extent, in the design of the call for proposals. All these allowed to identify synergies (including with other European and even national programmes)([45]) although on an ad-hoc basis and to avoid potential overlaps during the drafting process of the Call. As a result, a number of the projects supported under the Call 2025 have included specific activities aiming to materialise these synergies ([46]).

For Hydrogen valleys, applicants were encouraged to consider additional synergies with other Programmes (e.g. European Structural and Investment Funds, Recovery and Resilience Facility, Just Transition Fund, Connecting Europe Facility, Innovation Fund, Modernisation Fund, LIFE, etc.) and/or to cluster with other projects within Horizon Europe or funded under other EU, national or regional programmes, or projects with loans through the EIB or other promotional or commercial banks. As a result, the proposals received under the Hydrogen valleys topics provided early funding and financing strategies including public funding, private organisations own funds and bank loans.

In addition, for all Innovation Action topics in the Call 2025, including Hydrogen Valleys, instead of Seal of Excellence the STEP Seal ([47])(so called "Sovereignty Seal" under the STEP Regulation ([48])) will be awarded to proposals exceeding all of the evaluation thresholds set out in this Annual Work Programme. The STEP Seal is a label, which aims to increase the visibility of quality projects available for funding and help attract alternative and cumulative funding, and simultaneously to provide a potential project pipeline for regional and national programmes. The STEP Seal is focused on projects contributing to the development or manufacturing of critical technologies throughout the Union or

([43]) https://www.clean-hydrogen.europa.eu/system/files/2024-01/Clean%20Hydrogen%20JU%20AWP%202024%20-%20all%20chapters_Final_For_Publication.pdf

([44]) The preparation and drafting of the Clean Hydrogen JU Call for Proposals 2025, took place during 2024

([45]) Including EURAMET, Zero Emission Waterborne Transport partnership, Processes4Planet partnership, Materials for EU Partnership, Circular Bio-based Europe Joint Undertaking, Zero-Defect Manufacturing Platform, Interregional Innovation Investments instrument, Innovation Fund, other parts of Horizon Europe Work Programmes, French Agency for Ecological Transition, etc.

([46]) For more information on the synergies identified in the topics included in the Clean Hydrogen JU Call for Proposals 2025, see the Clean Hydrogen Partnership Annual Work Programme 2025

([47]) https://strategic-technologies.europa.eu/about_en#paragraph_207

([48]) https://strategic-technologies.europa.eu/about_en#paragraph_207

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safeguarding and strengthening the respective value chains in clean and resource efficient technologies, including net-zero technologies.

Other synergies at programming level

Outside the Call for Proposals, the Clean Hydrogen JU have exchange with other Commission services and partnerships, to better plan joint activities and identify opportunities for synergies. This included regular exchanges between the Clean Hydrogen JU and the Clean Aviation JU for the coordination of the activities that both JUs are implementing. Cooperation with EU rail has also continued in 2024 with ad-hoc exchanges on progress of FCH2RAIL project and H2 needs and issues if the rail sector. Furthermore, the JU exchanged with the Clean Energy Transition Partnership to identify areas of collaboration.

In addition, the Clean Hydrogen JU has continued supporting Commission services as necessary. This includes internal feedback provided to DG CLIMA during the preparation of the second auction of the Hydrogen Bank; in particular on sharing approaches to secure the contribution to European competitiveness of EU funded programmes, as already experienced by the JU. In 2024, the Clean Hydrogen JU also participated in the discussions of the Hydrogen technical group of the SET-Plan (see above under Policy). Regarding skills, the Clean Hydrogen JU has had regular exchanges with colleagues in DG GROW responsible for the skills part of the Net-Zero Industry act. This is of relevance in the context of the activities the Clean Hydrogen JU is supporting on education and training and in particular in the context of the Hydrogen Academy project supported by the Clean Hydrogen JU. In addition, during 2024, the Clean Hydrogen JU continued taking part as an observer of the Steering Committee of the European Clean Hydrogen Energy Alliance.

Of particular significance were the exchanges between the JU and DG BUDG regarding the Strategic Technologies for Europe Platform (STEP), which led to the adoption of the STEP Seal as part of the Clean Hydrogen Partnership Annual Work Programme.

At the Member States level, the Clean Hydrogen JU has continued exchange with national representatives (e.g. German NOW) on key strategic areas such as Hydrogen Valleys, and also with representatives of other Member States, either via the Clean Hydrogen JU States Representative Group (SRG) e.g. feedback provided during the process of drafting the 2025 Clean Hydrogen JU AWP/Call or through bilateral exchanges.

1.6.3.2 Collaborations with other programmes, agencies and partnerships to deliver synergies (at implementation level)

In 2024, the JU has continued cooperation with CINEA on synergies between CEF Transport calls and projects. The JU has supported the 1st cut-off date evaluation of AFIF in fall 2024, which has resulted in a several projects selected with H2 components (2 airports in FR, HRS in FR (1), DE (2) and ES (26) and 1 ES port (bunkering for methanol + ammonia, part of the Andalusian Green Hydrogen Valley). The JU will continue with the exchanges on the project results in 2025, the same as with ongoing JU H2-ACCELERATE-TRUCKS project (150 trucks) and five CEF-T grants (supporting HRS network).

In addition, in 2024 the exchange on project results continued between H2020/HE projects on hydrogen releases (JU project NHyRA & CINEA project HYDRA) and liquid hydrogen carriers for ships (JU project LH2CRAFT & CINEA projects NH3CRAFT and SAFECRAF) at project officer level. Exchange with HADEA on Cluster 4 ‘Process4 Planet Partnerships’ has also continued in 2024 at project officer level (e.g. attendance to KoMs, exchange of information on similar projects).

Cooperation with EIC, based on the Memorandum of Cooperation, was primarily focused on exploring of ways for EIC hydrogen projects to participate in the JU’s annual data collection exercise (GH2 project

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participated in the JUs annual data collection exercise 2024). In addition, several projects funded by other Horizon Europe calls (for example Cluster 5), showed also interest to report in the JUs annual data exercise. Cooperation with the European networks of Horizon Europe National Contact Points Greenet and NCP_WIDERA.NET. - low performing Member States (MS) and Associated Countries (AC) - continued in 2024, especially with the pitching session co-organized during the H2 week 2024.

1.6.3.3 Supporting regions and Member States

Cooperation with the Member States has continued in 2024 with exchanges in the JUs States Representative Group. In addition, the JU has continued with other types of consultation, such as on the informal opinion on the Call 2025 topics in May 2024 and opinion on the annual work programme 2025 in November 2025 (comments on topics, clarifications on the budget and additional support to hydrogen valleys and alignment with national strategies/support schemes).

Working with regions continued in 2024 with Memoranda of Cooperation (MoC) signed with 9 Managing Authorities, 3 during the first edition of the Hydrogen Valley Days in June 2024 (Croatia, Bulgaria and Friuli-Venezia Giulia Region of Italy) and 6 during the Hydrogen Week in November 2024 (Médio Tejo Region (Portugal), Castilla y Léon (Spain), Wielkopolska Region (Poland), Košice Self-governing Region (Slovakia), Noord-Holland (The Netherlands) and Slovenia). The remaining MoC with Turkey was signed in early 2025.

The Clean Hydrogen JU has also presented its activities to the Research and Innovation network of Managing Authorities ([49]) coordinated by the European Commission. Furthermore, the JU has provided regular updates of its activities to the European Commission Hydrogen Energy Network (bringing together representatives from the energy ministries in EU countries).

In 2024, the Project Development Assistance for Regions II ([50]) (PDA II) initiative was successfully concluded, marking the completion of an important phase in supporting hydrogen project development across Cohesion Countries, Outermost Regions, and Islands. A total of 14 projects across 9 European countries received expert guidance aimed at maturing hydrogen initiatives to a stage where they could begin implementation. These projects primarily focused on the transport sector, particularly on hydrogen-powered buses, and involved the development of new electrolysis-based hydrogen production facilities connected to renewable energy sources such as solar PV and wind turbines. The initiative played a critical role in enabling these regions—many of which had limited prior hydrogen deployment—to explore and establish viable hydrogen ecosystems.

Building on the activities mentioned above, the Clean Hydrogen JU also launched a Call for Tender in 2024 to set up and operate a 'Hydrogen Valleys Facility' aimed at accelerating the development of hydrogen valleys across Europe. The Facility will provide project development assistance—including to regions—to support hydrogen valleys at various levels of maturity.

1.6.4 Regulations, Codes and Standards Strategy Coordination (RCS SC)

The implementation of suitable and hydrogen-specific regulatory and enabling frameworks is crucial for the EU-wide deployment of hydrogen, fuel cells and hydrogen-based technologies to meet the goals set out in the EU Hydrogen Strategy.

([49]) https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/rima-new-network-brings-together-key-ri-and-cohesion-policy-actors-2023-06-13_en

([50]) https://www.clean-hydrogen.europa.eu/media/publications/final-report-project-development-assistance-regions-ii-cohesion-countries-outermost-regions-and_en

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Whilst most of the Pre-Normative Research (PNR) activities in the JU Programme will be implemented as part of the activities within Horizontal Activity 1 (see Pillar 5): Cross-cutting Issues (JU SRIA, Section 3.6), a strategic and coordinated approach is needed at the Programme level. To this end, the Clean Hydrogen JU set up in 2022 a Regulations, Codes and Standards Strategy Coordination (RSC SC) Task Force, composed of representatives of the European Commission, Hydrogen Europe and Hydrogen Europe Research secretariats, and the JU Programme Office.

The main goal of the RCS SC Task Force is the definition, coordination and monitoring of the strategy related to RCS within the Programme with the ultimate goal of increasing the EU impact in RCS development in Europe and beyond, with the focus but not limited to Standards.

In 2024 the RCS SC Task Force held regular meetings in view of reaching a common agreement on the practical work of the Task Force bearing in mind its role, priorities, and tasks entrusted to the Task Force (JU SRIA, Section 4.3). As a result, there is a common understanding that the focus of RCS Task Force activities is twofold:

(i) Coordination for the identification of PNR needs of strategic importance in Europe that can be addressed as topics in the subsequent JU calls for proposals

(ii) Design and deploy a batch of measures to increase the impact of the RCS/ PNR-related activities at the programme and the project level in standardisation.

Concerning the identification of PNR needs, in 2024, Task Force members concluded the review of relevant reports where different organisations flagged the gap/need for PNR activities relevant to hydrogen and fuel cell technologies in the EU aiming at identifying out of all the PNR needs, what priorities can be addressed within the JU Programme in the next years. These include the reports([51])([52]) published by the CEN-CENELEC Sector Fora on Energy Management Working Group on Hydrogen (SFEM WG H2)([53]), or the "Roadmap on Hydrogen Standardisation"([54]) published by the European Clean Hydrogen Alliance (ECH2A)([55]) to name but a few.

On the other hand, in 2024, the Task Force assessed a set of potential measures to increase the impact of the JU projects in the relevant RCS. As a result of this work, the Task Force endorsed a few measures that have been included in the AWP 2025. For example, projects performing PNR activities have an additional information obligation to report up to 4 years after the end of the project if the results of the project have effectively contributed to European or international standards, and projects resulting from Innovation Actions should consider a public report with both the Legal and Administrative Processes (LAP) and the Regulations, Codes, and Standards relevant to the technologies and/or applications at the project scope, and the barriers and/or gaps identified during the project implementation alongside any other relevant information to share the lessons learned and provide recommendations to support the update and/or development of suitable and enabling legal and

51 https://op.europa.eu/en/publication-detail/-/publication/99f62cea-a877-11e5-b528-01aa75ed71a1

52 https://publications.jrc.ec.europa.eu/repository/handle/JRC117765

53 https://www.cencenelec.eu/areas-of-work/cenelec-sectors/energy-and-utilities-cenelec/hydrogen/

54 https://ec.europa.eu/docsroom/documents/53721

55 https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en

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regulatory frameworks. Last. projects are also encouraged to involve the relevant standardization bodies, for example through liaison organisations ([56]).

In conclusion, the RCS SC Task Force activities in 2024 contributed to better steering and coordination of the RCS-related matters in the JU and increasing the impact of the JU Programme in this domain.

1.6.5 European Hydrogen Safety Panel (EHSP)

The European Hydrogen Safety Panel (EHSP) initiative ([57]) was launched by the JU in 2017. The mission of the EHSP is to assist the JU both at programme and at the project level in assuring that hydrogen safety is adequately managed, and to promote and disseminate hydrogen safety culture within and outside of the JU Programme.

The EHSP is composed of a multidisciplinary pool of experts grouped in ad-hoc working groups (task forces) according to the tasks to be performed and to expertise. Collectively, the members of the EHSP have the necessary scientific competencies and expertise covering the technical domain needed to make science-based recommendations to the Clean Hydrogen JU.

In 2024, the Clean Hydrogen JU concluded a service framework contract for the provision of support for coordinating and managing the EHSP, strengthening its coordination, activities, and impact. The framework contract CleanHydrogen/OP/Contract 353 entered into force on 18 December 2024, and the activities are expected to start at the beginning of 2025.

1.6.6 European Hydrogen Sustainability and Circularity Panel (EHS&CP)

The European Hydrogen Sustainability & Circularity Panel (EHS&CP) was established in February 2024 to enhance the integration of sustainability and circularity (S&C) principles into hydrogen technologies. The EHS&CP, composed of 15 independent experts, was managed on behalf of the Clean Hydrogen Partnership by few consulting partners led by Ecorys Europe together with TNO and Grant Thornton.

In 2024, the panel focused on assessing how well projects funded by the Clean Hydrogen Joint Undertaking (JU) incorporated environmental, economic, and social sustainability aspects. This work aimed to align hydrogen development with the EU's climate neutrality and circular economy goals.

One of the key activities of the panel was reviewing 356 Clean Hydrogen JU funded projects, covering hydrogen production, storage, distribution, and end-use applications. The review found that while economic factors, such as capital and operational costs, were widely considered, environmental and circularity indicators—such as recyclability, resource efficiency, and material criticality—were often overlooked. Social aspects, including labour conditions and public acceptance, were also largely absent from project assessments.

To address these gaps, the EHS&CP developed key sustainability indicators and proposed structured methodologies for evaluating projects. It recommended strengthening data collection, introducing standardised reporting templates, and ensuring that future funding calls include clear sustainability requirements. The panel also engaged with policymakers and stakeholders to improve policy alignment and encourage best practices in sustainability governance.

Collaboration with institutions like the Joint Research Centre (JRC) will be helping to further refine sustainability frameworks for hydrogen projects. The panel also emphasised the importance of stakeholder engagement through workshops and policy dialogues, advocating for better transparency

[56] https://www.cencenelec.eu/media/Guides/CEN-CLC/cenclcguide25.pdf

[57] https://www.clean-hydrogen.europa.eu/get-involved/european-hydrogen-safety-panel-0

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and industry participation in sustainability efforts.

Looking ahead, the EHS&CP aims to build on its initial findings by reinforcing sustainability reporting standards, expanding circular economy strategies, and ensuring social impact assessments are integrated into hydrogen projects. By strengthening these aspects, the panel seeks to position hydrogen as a key pillar in Europe's green transition while minimizing environmental impact and maximizing societal benefits.

A new tender process is expected to be put in place in 2025 for the extension of the panel activities, as the current tenure ended in February 2025.

1.6.7 International Cooperation

As the deployment of fuel cells and hydrogen technology is carried out globally and key stakeholders of the Clean Hydrogen JU are involved in these developments, the establishment of links with other major hydrogen related programmes globally and with international organisations monitoring the developments in the hydrogen sector is very important.

In 2024, the Clean Hydrogen JU, in agreement with the European Commission representatives continued to participate in the IEA Hydrogen Technology Collaboration Programme (TCP) Task 42 on Underground Hydrogen Storage , 'on Task 41 'Analysis and Modelling of Hydrogen Technologies' and in the definition of Tasks on 'Renewable Hydrogen' and 'Hydrogen Export value chains'.

In addition, in June 2024, on the occasion of the Japan-EU Hydrogen High-Level Business Forum, a cooperation agreement between the Clean Hydrogen Partnership and the New Energy and Industrial Technology Development Organization (NEDO) of Japan was signed ([58]). The agreement explores the possibility of synergies and promoting joint research and demonstration projects and is expected to promote the collaboration between research centres and industries in Europe and Japan. As a first follow-up, a first workshop was organized as a side event of the Hydrogen Week in November 2024, to discuss detailed ideas for possible collaborations in the field of electrolysis as a mutual area of interest.

Also in 2024, the JU exchanged with the hydrogen responsible at UNIDO and in particular in the area of skills. It is also worth to mention the exchanges the JU had with the Korean Institute of Civil Engineering and Building Technology (KICT), in response to the interest they showed on the European Clean Hydrogen Observatory being developed by the JU.

Furthermore, the innovation forum organised by the Clean Hydrogen Partnership as part of the 2024 edition of the Hydrogen Week, highlighted the international perspective, by partnering with IPHE ([59]), and Mission Innovation to discuss global research and innovation. In addition, a Memorandum of Understanding between the Clean Hydrogen Partnership and the Clean Hydrogen Mission of Mission Innovation([60]) was signed.

([58]) https://www.clean-hydrogen.europa.eu/media/news/clean-hydrogen-partnership-signs-cooperation-agreement-japans-nedo-2024-06-03_en

([59]) International Partnership for Hydrogen and Fuel Cells in the Economy

([60]) https://explore.mission-innovation.net/mission/clean-hydrogen/

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1.6.8 Openness

In addition to the cooperation and synergies mentioned in the above sections, specific activities were included to preserve the openness of the Clean Hydrogen JU activities in line with the SBA and the Clean Hydrogen JU SRIA.

More specifically, the Clean Hydrogen JU continued its usual practice of making no exception to the 'open calls' principle, and the call of 2024 followed this same approach.

As per the rules stated in the Horizon Europe Regulation ([61]), any legal entity, regardless of its place of establishment and including legal entities from non-associated third countries or international organisations, may participate in actions under the Programme, provided that the conditions laid down in the Horizon Europe Regulation have been met together with any conditions laid down in the work programme or call for proposals.

In particular, the call for proposals in the AWP 2024, including evaluation and award procedures, were managed according to, and the proposals complied with, the General Annexes to the Horizon Europe Work Programme 2023-2024 that applied mutatis mutandis to the call covered in the AWP 2024 (with limited exceptions introduced in specific topic conditions as explained below).

In line with the SBA ([62]), one additional condition was included for some specific topics that at least one beneficiary in the consortium must be a member of one of the Clean Hydrogen JU private Members (i.e. Hydrogen Europe or Hydrogen Europe Research). This requirement concerned only those topics targeting activities where the industrial and research partners of the Clean Hydrogen JU were seen to apply a key role, such as large-scale demonstrations, ensuring a balance between commitment from partners and openness. This specific condition was applied to in accordance with the SRIA of the Clean Hydrogen JU, as described under its *Section 5.2. Conditions for participation and eligibility for funding*.

Note that none of these additional conditions changed the open nature of the call.

Furthermore, the JU continued to apply a number of measures to attract newcomers to the Clean Hydrogen JU activities, as follows:

- Concerning the call for proposals, in addition to the general Info Day organised in Brussels, that was widely advertised, easy to access and register, as well as the possibility to follow online or watch the recording afterwards, several dedicated (national) Info Days took place in different countries, including those with a history of limited participation in EU R&I programmes.
- With the objective of increasing participation in its activities, the JU collaborated actively with the European networks of Horizon Europe National Contact Points Greenet and NCP_WIDERA.NET ([63]). In particular, these networks featured a pitching session as part of the Hydrogen Week in the fall of 2024. This allowed the Clean Hydrogen Partnership to reach a wider range of stakeholders with a focus on widening countries.
- Furthermore, as mentioned above, in 2024 9 Memoranda of Cooperation (MoC) were signed with 9 Managing Authorities, 3 during the first edition of the Hydrogen Valley Days in June

([61]) Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013 (Text with EEA relevance). OJ L 170, 12.5.2021, p. 1–68

([62]) Recital 16 and Article 15(2)(a) of the SBA

([63]) https://www.ncpwideranet.eu/

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2024 (Croatia, Bulgaria and Friuli-Venezia Giulia Region of Italy) and 6 during the Hydrogen Week in November 2024 (Médio Tejo Region (Portugal), Castilla y Léon (Spain), Wielkopolska Region (Poland), Košice Self-governing Region (Slovakia), Noord-Holland (The Netherlands) and Slovenia). The remaining MoC with Turkey was signed in early 2025.
- In addition, the JU has regularly updated the Hydrogen Valleys S3 Partnership ([64]) on the funding opportunities in the JU Call for Proposal, with a view to expanding the European regions interested to benefit from the JU support for Hydrogen Valleys.

1.7 Progress against Key Impact Pathways and Ju's Key Performance Indicators

1.7.1 Progress against Horizon 2020 legacy Key Performance Indicators

The legal basis of Horizon 2020 specified a list of compulsory Key Performance Indicators to be taken into account in its evaluation and monitoring system. They were intended to provide a solid and coherent basis for the monitoring and evaluation system of Horizon 2020, coupled with the focus on measuring the results and impacts of the Programme. In addition, the legal basis indicated a list of 14 cross-cutting issues that serve to monitor basis Horizon 2020 programme implementation on an annual and which were reported in the Annual Horizon 2020 Monitoring Report.

In terms of the scoreboard of common KPIs (Annex 6), the indicators reflecting the impact and outcomes of the H2020 Programme have been steadily increasing. There were 65 more publications in peer-reviewed journals, and there were 6 more patents awarded while there are still 12 patent applications pending. New products, processes, methods and prototypes were reported, most notably an additional 130 prototypes on top of the 591 already reported. Even more impressively, a significant increase was observed in the turnover of SMEs and their number of employees, with these numbers increasing by fourfold times compared with those of 2023.

Not surprising for a research funding programme, these very positive results highlight that the real outcomes of the Programme can only be seen in the first few years after its ending.

In terms of the indicators for monitoring cross-cutting issues (Annex 5.5.2), these have more or less stabilised after the end of H2020, as they concern mostly the participants in Calls and the Clean Hydrogen JU beneficiaries for the H2020 projects.

1.7.2 Progress against General Horizon Europe Key Impact Pathways Indicators (KIPs)

Horizon Europe (HE) incorporates a novel approach to capturing and communicating impacts via the Key Impact Pathways (KIPs) ([65]). The objective of this approach is to enable policy makers and the wider public to gain regular insights into the effects and benefits of the Programme over time in relation to European science, economy and the wider society.

([64]) https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_hydrogen_valleys_en

([65]) The General HE KPIs are available here: Regulations establishing HE - Annex V (page 65) https://eur-lex.europa.eu/eli/reg/2021/695/oj

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The nine Key Impact Pathways ([66]) cover areas of scientific, societal and technological/economic impact. A full list of these KPIs can be found in the table of Section 6. The KIPs do not aim to represent the full set of pathways that can lead to impacts of the Framework Programme – which would, in most cases, be non-linear – but instead they reflect key dimensions on which information is collected over time to track and report progress. All of the KIPs focus on the impact of the Horizon Europe Programme as a whole.

The KIPs will be calculated and reported via the Horizon Europe Dashboard, based on the continuous reporting of the projects.

1.7.3 Progress against HE Common JUs Key Performance Indicators

Horizon Europe introduces common criteria for all Partnerships:

1. Directionality and Additionality;
2. International visibility and positioning;
3. Transparency and Openness;
4. Coherence and Synergies;
5. Flexibility of implementation.

An independent Commission Expert Group has developed a set of indicators to monitor progress towards the performance of European Partnerships, including the Clean Hydrogen JUs, in relation to these criteria. The common indicators are complementary to the KIPs and individual partnership KPIs.

In its first interim report ([67]), the Expert Group focused on developing a framework on reporting and monitoring the progress made by all forms of European partnerships – individually ('partnership-specific indicators') and as a whole ('common indicators'), while making sure it is aligned with the Horizon Europe monitoring system and its Key Impact Pathways.

In particular, the Expert Group has proposed a set of Horizon Europe Common JU KPIs, including recommendations to make them operational, such as methodologies and the identification of the data required to monitor these indicators. The aim of these indicators is to monitor quantitative and qualitative information and aspects, which should be able to capture the full value the partnerships, an aspect not well developed in the past. This framework should enable monitoring across the partnerships landscape and allow their evaluation as an integral component of Horizon Europe and put into perspective with other Horizon Europe modalities and instruments. This will allow to assess European Partnerships and their impact in their proper policy context.

On May 2022 the Commission released its Biennial Monitoring Report 2022 on Partnerships under Horizon Europe (BMR 2022)([68]). The report provides an overview of the new Partnership landscape

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([66]) For a more detailed description and methodology of the KIPs see: European Commission, Directorate-General for Research and Innovation, Nixon, J., Study to support the monitoring and evaluation of the framework programme for research and innovation along key impact pathways: indicator methodology and metadata handbook, Nixon, J. (editor), Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/44653

([67]) A robust and harmonised framework for reporting and monitoring European Partnerships in Horizon Europe, 2021, RTD, https://europa.eu/!b3TBfW

([68]) European Commission, Directorate-General for Research and Innovation, Performance of European Partnerships: Biennial Monitoring Report (BMR) 2022 on partnerships in Horizon Europe, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/144363

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under Horizon Europe and establishes the basis for assessing the partnerships' progress in future reports.

The reporting on the HE Common JU KPIs can found in the table of Annex 7. The methodology followed was based on the guidance of DG R&I in 2023, provided through a series of four meetings dedicated for this purpose. The subsequent sections provide additional qualitative information for the reported indicators, split by the criterion they address.

1.7.3.1 Additionality

The main added value of European Partnerships derives from the additional private and/or public R&I investments in EU priorities (additionality) that can be translated into a leverage effect resulting from the Union intervention. The alignment of these investments and contributions with common objectives (directionality) and the achievement of impacts that cannot be created by other Horizon Europe or national actions alone are a main justification for using a partnership approach.

There are two HE Common JU KPIs measuring the criterion of additionality, KPI-1 on the progress towards contributions from partners other than the Union and KPI-2 on additional investments triggered by the EU contribution, as presented in Annex 7.

For KPI-1 on Additionality, detailed information is provided in Section 1.2.4 'Information on quantitative and qualitative leverage effects.

In terms of KPI-2, the Clean Hydrogen JU supports three activities that aim to deliver additional investments:

1. Technical Assistance Study ([69]);
2. Project Development Assistance Study ([70]);
3. Provision of Seals of Excellence to successful Hydrogen Valley projects that could not be funded by the Clean Hydrogen JU.

These actions are described in more detail in Sections 1.6.3.1 and 1.6.3.3.

Directionality

Directionality addresses the focus of EU funding through the partnerships, but also the level of partnership alignment with the EU policies and priority areas and how the partnership contributes towards them.

There is one HE Common JU KPI measuring the criterion of directionality, KPI-3 on overall investments mobilised towards EU priorities, as presented in Annex 7. This indicator shows that 100% of the overall investment is mobilised towards the Green Deal and Europe's 2030 climate ambition.

1.7.3.2 International visibility and positioning

The partnerships act as global ambassadors for the European R&I system. They establish global relevance and achieve scientific and technological reputation in the international context and serve as hubs for international cooperation, where appropriate. To this end, it is expected that there should be a minimum level of international cooperation at partnership and project level, resulting in visibility for the European Partnership. The activities of the Clean Hydrogen JU in relation to international cooperation are presented in detail in Section 7.

([69]) https://etendering.ted.europa.eu/cft/cft-display.html?cftId=11585

([70]) https://etendering.ted.europa.eu/cft/cft-display.html?cftId=9759

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There are two HE Common JU KPIs measuring the criterion of international visibility and positioning, KPI-4 on international actors involved and KPI-11 on the visibility of the partnership in national, European and international policy/industry cycles, as presented in Annex 7.

In terms of KPI-4, a very large number of actors were involved in the activities of the Clean Hydrogen JU, be it participation in proposal submissions, following events and workshops organised by the Clean Hydrogen JU or reading its publications. As this is a newly introduced KPI, the Clean Hydrogen JU can only report (like last year) only on the available data of total number of international applicants to the Clean Hydrogen JU Calls, which as can be seen in Annex 7, just for Calls 2022, 2023 and 2024, this has already exceeded the total number of international applicants over all FCH 2 JU Calls.

In terms of KPI-11, the Clean Hydrogen JU has organised or participated in a number of international and national events. It also produced and published different publications and supported hydrogen related web platforms to promote its work, increase its visibility and strengthen the public awareness of hydrogen technologies, obtaining a synergic effect. It has also obtained visibility through the media opportunities throughout various countries and increased social media efforts across different channels. The activities are summarized in Table 47 of Annex 5.7 and described in more detail in Section 2.1.

1.7.3.3 Transparency and openness

A European Partnership should aspire to be open and serve the interests of all relevant stakeholders. Consequently, the implementation of the partnership should include regular activities that allow new players to enter, participate in and benefit from its activities.

There are three HE Common JU KPIs measuring the criterion of transparency and openness, KPI-5 on the share and type of stakeholders and countries engaged, KPI-6 on the number and types of newcomer members in the partnership and KPI-7 on the number and types of newcomer beneficiaries, as presented in Annex 7.

As regards KPI-5, a large number of stakeholders from different countries and of different types were invited to and engaged in activities of the Clean Hydrogen JU, be it through participation in proposal submissions and projects, being members of the governance structure of the Clean Hydrogen JU or participating in the panels and groups supported by the Clean Hydrogen JU. In terms of reporting, the Clean Hydrogen JU reports (similar to last year) only on the total beneficiaries to the Clean Hydrogen JU Calls so far (i.e. Call 2022, Call 2023 and Call 2024), including the type and country of origin of the beneficiaries. As can be seen in the tables in Annex**Error! Reference source not found.** the Clean Hydrogen JU already has 2536 beneficiaries from 69 countries, compared to the 1506 FCH 2 JU beneficiaries from 50 countries. The fact that in just its first 2 years the Clean Hydrogen JU has almost the same amount of beneficiaries as the whole FCH 2 JU Programme and with the participation of 19 more countries, confirms the high interest in the Clean Hydrogen JU Programme. In terms of the types of beneficiaries, there has been a change in participation since 2022, which can be attributed to the Hydrogen Valley topics that were included in Call 2022-2, Call 2023 and Call 2024. For these topics, there were high levels of interest from public organisations and other organisation types (apart from private companies, research centres and higher education schools), which lead to a higher number of participants than the whole FCH 2 JU Programme. This increased participation came with the loss of the participation of research centres and higher education schools.

In terms of KPI-7, in the past FCH 2 JU exhibited a very high number of new beneficiaries in funded projects, something expected considering the emerging hydrogen sector. More than 70% of the total beneficiaries of FCH 2 JU were new beneficiaries. Nevertheless, it is interesting to see that the Clean

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Hydrogen JU continues to attract new beneficiaries: more than one third of its beneficiaries in Call 2023 and Call 2024 were new, with two thirds of them being new private for-profit companies.

KPI-6 ‘Transparency and openness’ is not applicable to the Clean Hydrogen JU in its current definition as the Clean Hydrogen JU’s membership is defined and fixed Article 75 of SBA. The actions of the Clean Hydrogen JU, especially the calls for proposals, are fully open.

1.7.3.4 Coherence and synergies

Partnerships do not act in isolation but in the broader landscape of R&I and sectoral policies. In order to improve their additionality and directionality, European Partnerships should seek and exploit synergies with related Horizon Europe and other Union initiatives as well as national/sectorial initiatives.

The activities of the Clean Hydrogen JU in relation to coherence and synergies are presented in detail in Section 1.6.3.

There are three HE Common JU KPIs measuring the criterion of coherence and strategies, on the number and type of coordinated and joint activities with other European Partnerships (KPI-8) and with other R&I initiatives (KPI-9), as well as KPI-10 on the complementary funding from other Union funds, as presented in Annex 7. Moreover, KPI-2 described under additionality also contributes to the measuring of this criterion.

KPI-8 reports on the number and type of coordinated and joint activities with other Partnerships. The Clean Hydrogen JU has been collaborating with all relevant Partnerships on ah-hoc basis, starting with the identification of possible synergies already in its SRIA. Moreover, it has been participating with other Partnerships in the inter-partnership assembly and working together with the other JUs in the implementation of the back-office arrangements, while a number of Partnerships are participating in its Stakeholder Group.

The Clean Hydrogen JU has also collaborated with three other Partnerships—Clean Aviation, Zero Emission Waterborne Transport, and KDT—to prepare calls for proposals whose results could be taken up at a later stage by other Partnerships. In April 2023 a joint workshop on hydrogen-powered aviation was organised by the Clean Hydrogen JU and the Clean Aviation JU. As a result of the workshop, a set of key recommendations was made to address potential gaps and barriers in the hydrogen-powered aviation roadmap. The Clean Hydrogen JU has also continued participation in activities concerning hydrogen projects supported under the Process4Planet Partnership (P4P) managed by HADEA.

KPI-9 reports on the same topic, but for other R&I initiatives at EU, national, regional and sectorial levels. In terms of funding, as the first grants were signed only in December 2022, there haven’t been any confirmed synergies in funding for any projects so far, although a number of Hydrogen Valleys projects have been signed (which by definition require synergies with other sources of funding).

In terms of formal collaboration and as part of its JU’s PDA project, 15 regions have received support to develop detailed hydrogen project plans. Following the Call for a Call for Expression of Interest launched in 2023, 10 regional or national managing authorities were selected to foster a structured cooperation and implementation of synergies on research and innovation activities between the Clean Hydrogen JU and managing authorities of Member States and Regions. After the selection process, 9 Memoranda of Cooperation were signed in two ceremonies: in June, during the Hydrogen Valleys Days (3), and in November, during the H2 Week (6). The final MoC was signed early in 2025.

A number of joint activities, in the form of ad-hoc collaboration, were performed with CINEA. A joint event was organised to formalise the collaboration between the Clean Hydrogen JU H2-ACCELERATE-TRUCKS project (deployment of 150 trucks) and several HRS projects supported by CEF-T, to formalise

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the collaboration among these projects. Also with CINEA, there was coordination during the grant agreement preparation of two related and interlinked projects looking at hydrogen releases in the atmosphere. The Clean Hydrogen JU continued its collaboration with EIC on activities looking at the production of hydrogen using renewable energy sources, including the co-organisation of a June 2023 workshop on the use of seawater for renewable hydrogen production. In relation to the Innovation Fund, the Clean Hydrogen JU and its projects participated in workshops on "hydrogen knowledge sharing", creating synergies between these projects and the Innovation Fund.

In terms of other coordinated and joint activities, in addition to the ones reported in AAR 2023, there were joint activities with the Marie Skłodowska-Curie actions (MSCA) Staff Exchanges programme. In addition, the Clean Hydrogen JU has fulfilled ad-hoc requests for participation, including participation in events organised by ERA-LEARN and provided regular updates for the Energy and Managing Authorities Network of the European Commission and for the Hydrogen Valleys S3 Partnership. Finally, in collaboration with Mission Innovation 2.0, the Clean Hydrogen JU has continued to support the activities of the Hydrogen Valley platform. It currently features 90 hydrogen valleys worldwide, of which 60 are in Europe. In 2024, also collaborated with the European networks of Horizon Europe National Contact Points Greenet and NCP_WIDERA.NET, who co-organized a pitching session focused on Hydrogen Valleys during the Hydrogen Week.

In terms of international cooperation, the Clean Hydrogen Partnership signed in June 2024, on the occasion of the Japan-EU Hydrogen High-Level Business Forum, a cooperation agreement with the New Energy and Industrial Technology Development Organization (NEDO) of Japan. A first workshop was organized as a side event of the Hydrogen Week, to discuss detailed ideas for possible collaborations in the field of electrolysis as a mutual area of interest. During the Hydrogen Week, the JU partnered up with IPHE, NEDO and Mission Innovation to discussion global challenges on research and innovation. During that session, a Memorandum of Understanding between the Clean Hydrogen Partnership and the Clean Hydrogen Mission of Mission Innovation was signed.

In terms of KPI-10, there are no validated qualitative data to report yet, as the first grants from Call 2022 were only signed in December 2022, although – as mentioned above - significant complementary funding is expected, at least for the Hydrogen Valleys funded by the Clean Hydrogen JU.

1.7.4 Progress against JU-specific Key Performance Indicators

1.7.4.1 Resources (input), processes and activities

In its first few years of activity the Clean Hydrogen JU took a number of actions and performed a number of activities, in line with its operational objectives and additional tasks described in the SBA, in order to put in place the building blocks for the specific and general objectives of the Clean Hydrogen JU. Three broad areas of activities are identified in the SRIA and the Clean Hydrogen JU's Strategy Map:

- Supporting climate neutral and sustainable solutions

The Clean Hydrogen JU has aligned its work with its new objectives by using the majority of its Horizon Europe Calls for Proposals budget to support sustainable solutions. Already the budget of the projects supported by the Clean Hydrogen JU that have research objectives related to either end-use solutions in hard to abate sectors or on circular and sustainable solutions has reached 28% and 12% respectively of the total JU budget (including REPowerEU, so of the EUR 1.2 billion), surpassing the related targets for 2023.

- Research and Innovation for hydrogen technologies

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Half (63 of 102) of the projects of the Clean Hydrogen JU are low TRL projects (TRL 2 or 3) and have already reached 16% of the total JU budget. It is worth mentioning that this is already 30% higher than the 10% minimum budget allocation set out in the SRIA, and thus this target is expected to be significantly surpassed.

At the same time, another 5 grants were signed with demonstration or flagship projects (TRL 7 or 8), corresponding to 21% of the total Clean Hydrogen JU budget. This shows that the Clean Hydrogen JU focuses on both sides of the TRL scale, the early research side having plentiful low TRL projects and the demonstration side using a significant part of the budget.

- Supporting market uptake of clean hydrogen applications

The Clean Hydrogen JU performed a number of activities related to the monitoring of technology progress and economic and societal barriers to market entry, as part of its knowledge management activities. These are described in Section 1.5.1.

Moreover, it contributed to the development of regulations and standards, under the Commission's policy guidance and supervision, and supported the Commission, including through technical expertise, in its international initiatives on the hydrogen strategy. These are described in Sections **Error! Reference source not found.** and **Error! Reference source not found.**.

Moreover, there are already three projects related to education and training, most notably the HyAcedamey.EU from Call 2023, surpassing the target of two projects by 2023.

1.7.4.2 Outcomes

The activities planned and implemented through the Programme aim to achieve the two sets of specific objectives, as defined in the SBA. They both focus on the acceleration of the transition towards the goals set by the Green Deal, the enhancement of the research and innovation ecosystem, including SMEs and involving stakeholders in all MS, as well as the delivery of innovative technology solutions and their uptake by the market, with a view to local, regional and Union-wide deployment. The specific level objectives of the Clean Hydrogen JU identify what should be the main direct outcomes and results from the activities of the Clean Hydrogen JU. These should be contributing to the general level impacts of the Clean Hydrogen JU.

The specific objectives of the Clean Hydrogen JU were translated into five specific-level outcomes in the Clean Hydrogen JU's Strategy Map. The first two are:

- Limiting environmental impacts
- Improving cost-effectiveness

These two outcomes are linked to the R&I results coming from the projects. As the first grants were only signed in December 2022, no results are available yet to show the progress towards these objectives.

- Synergies with other partnerships

The Horizon Europe Programme places a lot of emphasis on developing synergies between EU Partnerships & Programmes, but also with Regional and National Programmes. Clean Hydrogen JU has been very active in setting up such synergies and collaborating with various Programmes. The related actions are presented in detail in Section 1.6.3.

In terms of the specific KPI following the progress in this area, the first synergy - between the Clean Hydrogen JU and CEF - has been materialised, within the H2Accelerate TRUCKS project and CEF.

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Together with the 11 grants given to hydrogen valleys, the number of synergies has already reached 12 surpassing even the 2025 target.

- Increasing Public Awareness

Increasing public and private awareness, acceptance and uptake is a key objective of the Clean Hydrogen JU. A public opinion survey was conducted in 2022 to examine public awareness and perception of hydrogen. The section 2.1 contains all the relevant details.

Additionally, in 2023 the Clean Hydrogen JU signed a grant with project HYPOP ([71]), aiming to raise public awareness and trust towards hydrogen technologies and present their benefits.

- Reinforcing EU scientific and industrial ecosystem, including SMEs

The Clean Hydrogen aims to strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain, while supporting the uptake of industry-related skills.

The inherited JU projects ([72]) continue to show increased activity in terms of academic and research results. In 2024 there was an almost equal number of publications (167 in total) in peer-reviewed journals from the Clean Hydrogen JU projects, as well as six more patents were approved, bringing the total of patents approved to 23, while 12 more pending approval.

In terms of trainings, this outcome is again linked to the R&I results coming from the projects. As the first projects on education and training were only signed in 2023, no results are available yet to show the progress towards this objective.

In terms of the reinforcement of the industrial ecosystem and the specific KPI monitoring this, despite Call 2022-1 not including any projects promoting cross-sectoral solutions, Calls 2022-1, Call 2023 and Call 2024 led to 20 such grants being signed, 16 of them being hydrogen valleys. This way the target of 2025, of 15% of the total Clean Hydrogen JU budget being directed in such solutions, has almost already been met.

1.7.4.3 Impacts

The Clean Hydrogen JU is expected to contribute towards a number of EU policy objectives related to the clean energy transition and climate neutrality, most notably towards the Green Deal and the Hydrogen Strategy.

The set of KPIs under "impact" report the progress of the hydrogen sector at the EU level, to which the Clean Hydrogen JU is contributing. Targets for KPI-14 to KPI-17 are based on the related ambition set in the EU's Hydrogen Strategy. Targets for KPI-18a and KPI-18b are based on current trends and expectations for the sector, while KPI-18c reflects the 2025 target mentioned in the Joint Declaration signed between the European Commission and the European electrolysers manufacturers in May 2022. For this set of KPIs, the status refers to Europe as a whole and not on the individual actions of the Clean Hydrogen JU, helping to identify where more effort should also be placed by the Clean

([71]) https://www.clean-hydrogen.europa.eu/projects-repository/hypop_en

([72]) Due to the lag observed in producing publications and patents, the related indicator includes H2020 projects. In particular, for patents, due to the long time required for their approval, the reporting is cumulative over also the predecessor's lifetime; as observed in practice applications for patents are submitted towards the second half of a Programme. For the publications, they will be reported cumulatively as of 2022, with the initial publications stemming from H2020 projects.

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Hydrogen JU in the coming years. For all the KPIs, the source of the reported values is the European Hydrogen Observatory.

Considering these general objectives and placing them in the context of the macro level objectives of the Horizon Europe Programme related to major societal challenges, led to the following three major areas that the Clean Hydrogen JU should have an impact on, according to its Strategy Map:

- Action against climate change by drastically reducing greenhouse gas emissions

The development and scale-up of hydrogen technologies, replacing existing fossil use, will unquestionably have an impact on the reduction of greenhouse gas emissions. In order to assess the possible impact of supporting such activities, the Clean Hydrogen JU developed a complex methodology with the contractor of the European Hydrogen Observatory to calculate the expected avoided emissions. For the moment the indicator is off-track, are generally the deployment of hydrogen technologies in Europe is lagging behind to the ambitious EU targets.

- Transition to a clean energy system with renewable hydrogen as one of its main pillars

The EU's hydrogen strategy ([73]) has put forward a comprehensive framework to support the uptake of renewable and low-carbon hydrogen to help decarbonise the EU in a cost-effective way and reduce its dependence on imported fossil fuels. Among its major targets, it set as strategic objectives to install at least 6 GW of renewable hydrogen electrolysers in the EU and the production of up to 1 million tonnes of renewable hydrogen by 2024, and 40 GW and 10 million tonnes respectively by 2030.

The Clean Hydrogen JU’s activities will particularly contribute towards these two areas, considering the significant focus on both hydrogen production and hydrogen end-use (which is necessary to make the increase in the hydrogen production meaningful) and on the necessary distribution and storage of hydrogen.

The two indicators selected in the strategy map to best monitor the progress towards these goals are the deployment of electrolysers and the market uptake of clean hydrogen. The KPI values reported in Section 5 - and thus KPI 14 which is directly linked to them - are off track, as despite the ambitiousness of the Hydrogen Strategy, hydrogen technologies require more time and research to be ready for commercialisation and scaling up. Nevertheless, the significant funding planned from the European Hydrogen Bank and other European, regional and national instruments may be able to turn this around in the coming years. This can be further supported by the activities of the Clean Hydrogen JU. Although it may have a limited direct impact on these deployment figures due to its small budget and large ambition, the JU can play an important role in increasing the technology readiness of the hydrogen solutions, allowing their faster market uptake.

- Emergence of a competitive and innovative European hydrogen value chain.

The third area that the Clean Hydrogen JU actions should contribute to is the emergence of a competitive and innovative European hydrogen value chain. The total costs of hydrogen in end-uses should be significantly reduced to make hydrogen competitive as a fuel. This will be partly achieved by improving the performance of the hydrogen technologies, but also by scaling-up production and increasing the size of the sector across the value chain.

For this reason, two indicators in the strategy map will be used to monitor progress in this area, both developed in collaboration with the contractor of the European Hydrogen Observatory. The first

([73]) This was further enhanced by the REPowerEU Plan, which was adopted though after the SRIA of the Clean Hydrogen JU and the setting of its relative targets.

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indicator looks at the cost of producing renewable hydrogen, while the second looks at the developments in the sector in terms of the numbers of active companies and projects in the pipeline and electrolyser manufacturing capacity. Based on the latest statistics and trends / announcements, all indicators are either on track or expected to be on track in 2024.

1.7.5 Progress against other Programmes' implementation indicators [if applicable]

Not applicable

1.8 Dissemination and information about project results

Closely aligned with the knowledge management objectives, the monitoring of the dissemination and exploitation activities of Clean Hydrogen JU projects under the H2020 programme ([74]) continued during 2024, while implementation of the new Programme under Horizon Europe started with the first call. Following the best practices already inaugurated by its predecessors, the Clean Hydrogen JU continues to support efforts to increase the impact of the R&I activities though the dissemination and exploitation of project results.

Dissemination and Exploitation Internal Guide: The Clean Hydrogen JU strongly and actively supported the initiatives of the EC to reinforce the Dissemination and Exploitation (D&E) of the results of the projects. In 2021, the Programme Office endorsed an internal D&E Guide to support the project officers in their project monitoring activities and to enhance and customise the D&E monitoring good practices that are implemented by the projects before and after their conclusion. The guide maps the steps undertaken by the Clean Hydrogen JU to reinforce the monitoring of the D&E at the project level. It complements the list of consecutive steps with detailed guidelines on each step to be performed by the Project Officers, that extends from the Call for Proposals and the Model Grand Agreement ([75]) provisions to the period of up to 4 years after the end of the project. This project-level approach is being complemented by a thorough mapping of overarching activities that the Clean Hydrogen JU performs annually to support the D&E function at the programme level and increase the impact of the programme.

Finished projects – Continuation of D&E Activities: One of the main issues regarding the project implementation remains the continuation of the D&E activities of the project beneficiaries after the final reporting and the end of the funding period. According to Article 28.1 of the H2020 MGA and the Annex 5 of the Horizon Europe Lump Sum MGA, beneficiaries must take measures aiming to ensure the 'exploitation' of their results up to four years after the end of a project. However, it remains challenging for the Programme Office to follow up any D&E activities performed by the beneficiaries after the end of the project, although continuous reporting avenues on the Funding and Tenders platform remain accessible to the project for it to update information on D&E activities, including patents and scientific publications.

As also reflected in the internal D&E guide, the Programme Office reach out to the project coordinators of completed projects 18-24 months after the end of the project, to motivate the consortium to

([74]) The projects funded under H2020 programme have been progressed enough and are ready to disseminate and exploit their key results. Projects under Horizon Europe (Call 2022) are expected to start having substantial D&E activities in 2024.

([75]) https://ec.europa.eu/research/participants/data/ref/h2020/other/mga/jtis/h2020-mga-fch_en.pdf

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continue disseminating the results, to remind them about the existing EC tools and services (e.g. the Horizon Results Platform, the HR Booster etc) available to support them, and to encourage them to inform the Clean Hydrogen JU of any D&E activities performed and report them through continuous reporting.

Horizon Groups: Under the new Dissemination & Exploitation (D&E) Strategy ([76]) for Horizon Europe established in and implemented since 2021, the governance structure consists of the following coordination groups:

- The Horizon Dissemination & Exploitation Group (D&E Group), and
- The Horizon Feedback to Policy Group (F2P Group).

The 8th D&E group meeting took place in January 2024. The Clean Hydrogen JU is following the group closely and contributes to all the meetings.

1.5.2**Horizon Results Platform (HRP)** ([77])**:** The HRP is a platform launched by DG-RTD in 2019, aiming to assist projects in presenting their prominent exploitable results to targeted audiences (e.g. business partners, angel investors, venture capital, policy makers or business development assistance) and help the result owners to exploit the results accordingly. By the end of 2024, 11 Clean Hydrogen JU projects have uploaded **26** results in total in the platform (Table 14). All Clean Hydrogen JU projects are continuously encouraged to upload their exploitable results, thus increase visibility and chances to exploit them.

TABLE 14. CLEAN HYDROGEN PROJECT RESULTS IN THE HORIZON RESULTS PLATFORM

Programme	Project Acronym	Thematic Priority	Results Title	Result Type	Result id
FP7	ENE.FIELD	ENERGY	Energy system benefits of FC micro-CHP	Policy Related Result	14200
FP7	ENE.FIELD	ENERGY	Environmental benefits of Fuel Cell micro-CHP	Policy Related Result	14259
FP7	ENE.FIELD	ENERGY	Fuel Cell micro-CHP consumer benefits and end-users' satisfaction	Policy Related Result	14273
FP7	UNIFHY	ENERGY	120 hours of continuous pure hydrogen production (99.99% H2) from biomass	Scientific or Technological R&D Result including ICT Hardware	30277
H2020	HPEM2GAS	ENERGY	Scalable PEM electrolyser system	Scientific or Technological R&D Result including ICT Hardware	13890
H2020	HPEM2GAS	ENERGY	Project workshop	Other	13891
H2020	HPEM2GAS	ENERGY	products for electrochemical systems and development of components and MEAs	Scientific or Technological R&D Result including ICT Hardware	13892
H2020	HPEM2GAS	ENERGY	ionomer membranes for PEM water electrolysis application	Scientific or Technological R&D	13893

([76])https://webgate.ec.europa.eu/fpfis/wikis/pages/viewpage.action?pageId=738755339&preview=/738755339/741311561/Dissemination_and_exploitation_strategy_Horizon_Europe%20_%20Endorsed_Nov2020.pdf

([77]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform

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				Result including ICT Hardware	
H2020	HPEM2GAS	ENERGY	Renewable power sources with cost-competitive electrolysis plants	Scientific or Technological R&D Result including ICT Hardware	13894
H2020	BIG HIT	ENERGY	BIG HIT: Demonstration of the use of hydrogen and RES locally, in an integrated manner	Scientific or Technological R&D Result including ICT Hardware	14554
H2020	Cell3Ditor	ENERGY	Multi-material 3D printer for advanced ceramic materials	Scientific or Technological R&D Result including ICT Hardware	14317
H2020	Cell3Ditor	ENERGY	Nanoscale Dispersions of YSZ, NiO-YSZ and LSM	Other	14499
H2020	QualyGridS	ENERGY	Standardized Testing protocols for electrolysers performing grid service	Other	14462
H2020	MEMPHYS	ENERGY	Effective Poison Mitigation Strategies for Hydrogen pumps with a Reformate Feed or contaminated hydrogen	Scientific or Technological R&D Result including ICT Hardware	21331
H2020	MEMPHYS	ENERGY	New approaches for operation, control and condition monitoring of electrochemical systems	Scientific or Technological R&D Result including ICT Hardware	21501
H2020	MEMPHYS	ENERGY	Cost analysis for electrochemical hydrogen purification (EHP) system	Other	21525
H2020	MEMPHYS	ENERGY	Toolbox for the evaluation of stamped metallic bipolar plates	ICT Software Digital solution	21665
H2020	MEMPHYS	ENERGY	Computation fluid dynamics model for electrochemical hydrogen separation and compression	ICT Software Digital solution	21675
H2020	MEMPHYS	ENERGY	Forming of metal plates for compression and purification stacks.	Scientific or Technological R&D Result including ICT Hardware	21845
H2020	INLINE	TRANSPORT	Automated endoscopic burr detection in tank valves	Scientific or Technological R&D Result including ICT Hardware	14271
H2020	INLINE	TRANSPORT	Assisted assembly station	Scientific or Technological R&D Result including ICT Hardware	14348
H2020	INLINE	TRANSPORT	Smart camera sensor with adaptive light control for assisted assembly	Scientific or Technological R&D Result including ICT Hardware	14581
H2020	Fit-4-AMandA	TRANSPORT	Commissioning of the mass manufacturing machine for automatic fuel cell stack assembling	Scientific or Technological R&D Result including ICT Hardware	13858

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H2020	Fit-4-AMandA	TRANSPORT	BPP design for moulding verified	Scientific or Technological R&D Result including ICT Hardware	13859
H2020	TeacHy	ENERGY	MSc blended learning degree in Fuel Cell and Hydrogen Technologies	Services	29573
H2020	FCHgo	ENERGY	FCHgo educational toolkit for teaching hydrogen energy and fuel cell technology in schools	Other	19884

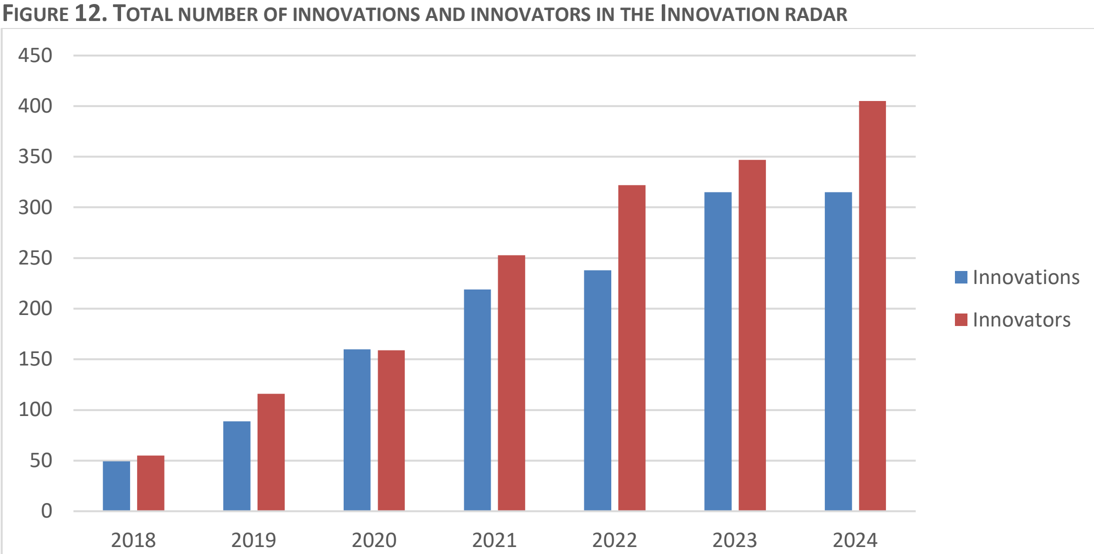
NB: ICT, information and communications technology; R & D, research and development.
Source: RTD.G.6

Innovation Radar (IR): The Innovation Radar is a European Commission initiative aiming to identify and increase the visibility of high potential innovations and innovators in EU-funded research and innovation projects. Via the IR platform, innovations and innovators become accessible by the right audiences, encouraging the development of a dynamic ecosystem of incubators, entrepreneurs, funding agencies and investors that can help get EU-funded innovations moving to 'make it happen' faster and more efficiently.

In the project mid-term review, an external expert analyses potential innovations related to the project objectives through a questionnaire incorporated into the workflow of Project Monitoring. The Innovation Radar expert provides concrete recommendations on the innovation aspects of the project and for individual innovator organisations within the consortium. These recommendations are also integrated into the formal review report.

The Clean Hydrogen JU projects have been participating in the IR initiative since its pilot in 2018. So far, innovations of 125 JU projects have been analysed: a total of 385 innovations (more than half of which are considered “very innovative” or “obviously innovative and [having] easily appreciated advantages to customer”), coming from 249 innovators, have been analysed and uploaded to the platform (Figures 12 and 13).

FIGURE 12. TOTAL NUMBER OF INNOVATIONS AND INNOVATORS IN THE INNOVATION RADAR



Source: IR Dashboard V2

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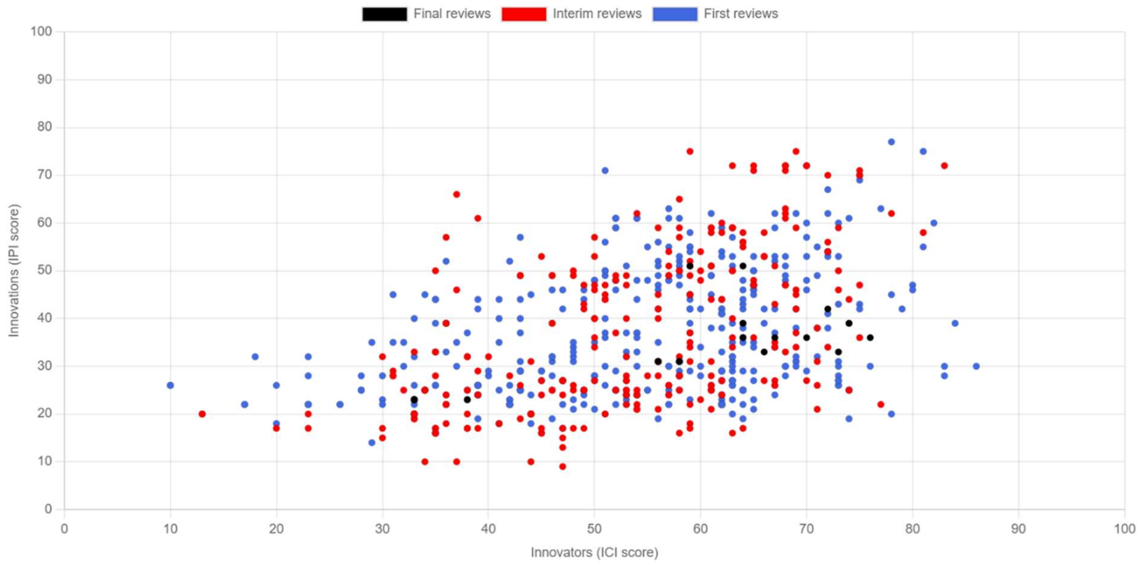
FIGURE 13. CLASSIFICATION OF CLEAN HYDROGEN PROJECTS INNOVATIONS BASED ON THEIR INNOVATOR CAPACITY SCORE AND THE INNOVATION POTENTIAL INDEX



Source: IR Dashboard V2

Based on the Innovation Radar methodology, innovations are classified between 'exploring', 'business ready', 'market ready' and 'tech ready' (Figure 13). This classification is meant to span the path between the most basic TRLs of 'exploration' to the most advanced and closest to the market, further research or standardization activities. A very positive result has also been the identification of at least 84 innovations that scored 50 points and above in the innovation potential indicator (IPI), making them ideal first candidates for follow-up actions for exploitation proposals. As the projects have not been finished, the number of final reviews, represented by the black dots, is fewer than the other reviews.

FIGURE 14. CLUSTERING OF INNOVATIONS BASED ON THE MATURITY LEVEL

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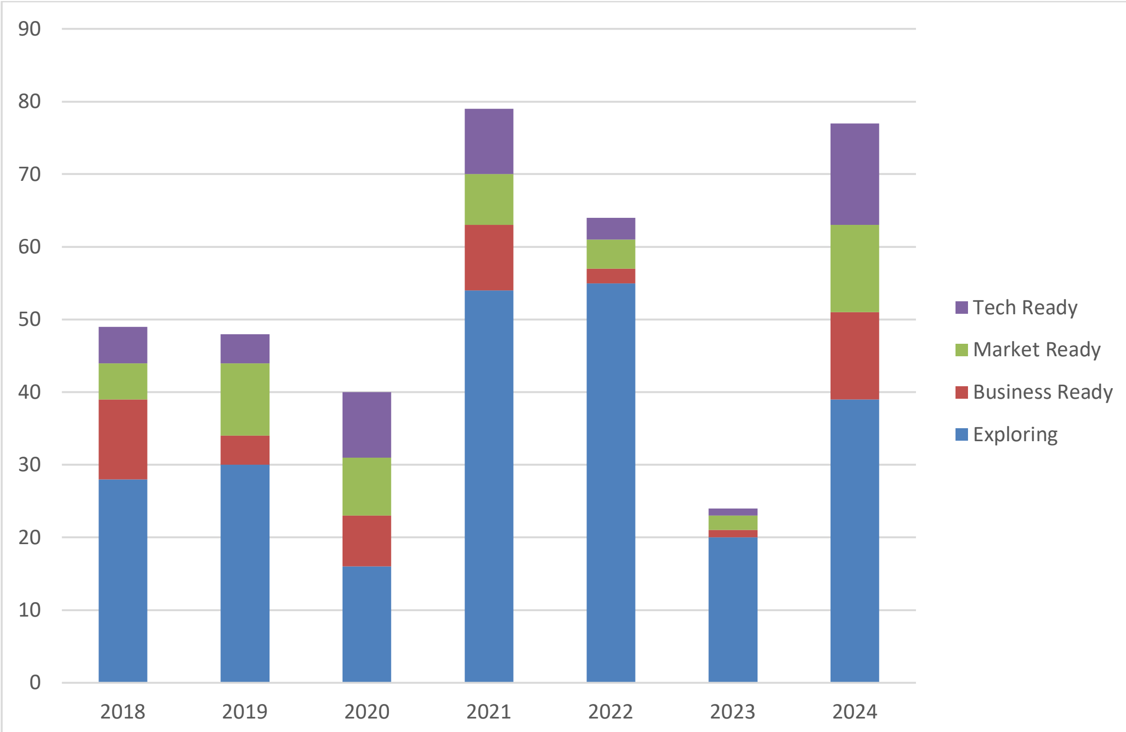

Source: IR Dashboard V2

Since the pilot launch of the IR, the Clean Hydrogen JU has collected valuable feedback to communicate with EC (e.g. DG R&I, DG CONNECT etc) and has participated in the Innovation Radar R&I family meetings to support further improvement of Innovation Radar and explore how the information collected can be further utilised by other EC services that support further exploitation of research results (e.g. Horizon Results Booster, Horizon Results Platform etc.) ([78]).

D&E Activities of the on-going Projects: The data collection exercise is a key component of the Programme Review and plays a vital role in the Clean Hydrogen JU's ability to meet its increased monitoring and reporting obligations under the Horizon Europe Programme. The tools used to conduct this data collection include:

- the TRUST platform, used to collect descriptive and operational technological data related to the activities of the projects, including D&E activities for the first time after the replacement of the EU Survey questionnaire,
- the Project Fiche, introduced as an information repository file in a spreadsheet to integrate all important project-related information and data available across the different platforms and tools and stand-alone information coming from the projects or the project officers following them.

([78]) Furthermore, a service offered to the innovations analysed by the IR, the Dealflow.eu, is available to support the innovations/innovators in further exploiting their results, especially in commercializing their innovations ("go-to-Market"), by facilitating access to clients and investors and providing high-end coaching services (e.g. venture-building, preparation for fundraising, networking, pitching to possible investors, etc).

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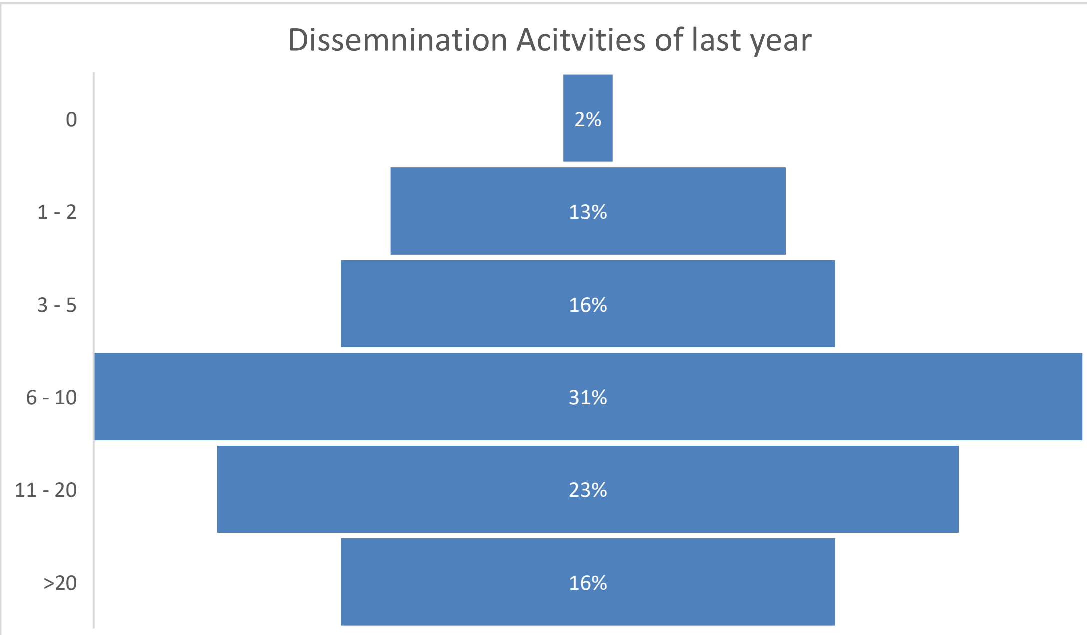
Based on data provided by 64 out of 67 active projects in 2023 on their D&E activities and key exploitable results (KERs):

- **20 projects** reported conducting **6 - 10 dissemination activities** in the last year (see figure 15).
- **24 projects** reported engaging in **55 exploitation activities** over the past year.

FIGURE 15. DISSEMNINATION ACITVITIES OF LAST YEAR



In total the projects reported 391 scientific publications and 11 new patent applications (see Annexes 5.3 and 5.4 respectively).

Dissemination Activities Performed by Projects

The types of dissemination activities reported fall into four main categories:

- **36% of projects** reported having **3-5 presentations** of results at conferences, events, and workshops (see Figure 16).
- The remaining dissemination activities were divided as follows:
  - **53%** were related to meetings with stakeholders.
  - **22%** involved education and training.
  - **25%** focused on scientific publications (see Figure 17).

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FIGURE 16. PRESENTATION OF RESULTS IN CONFERENCES, EVENTS AND WORKSHOPS

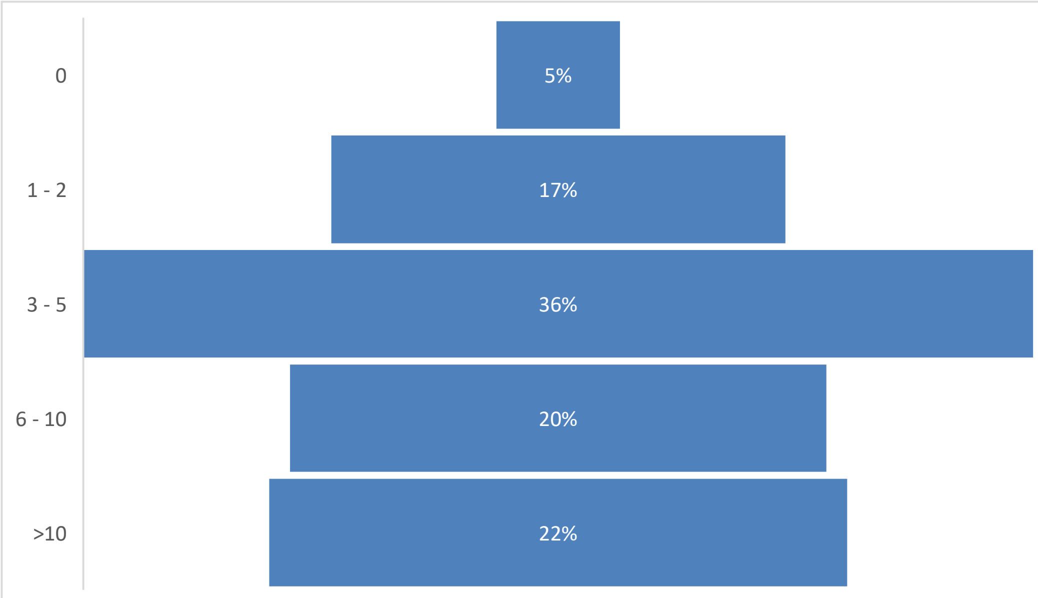
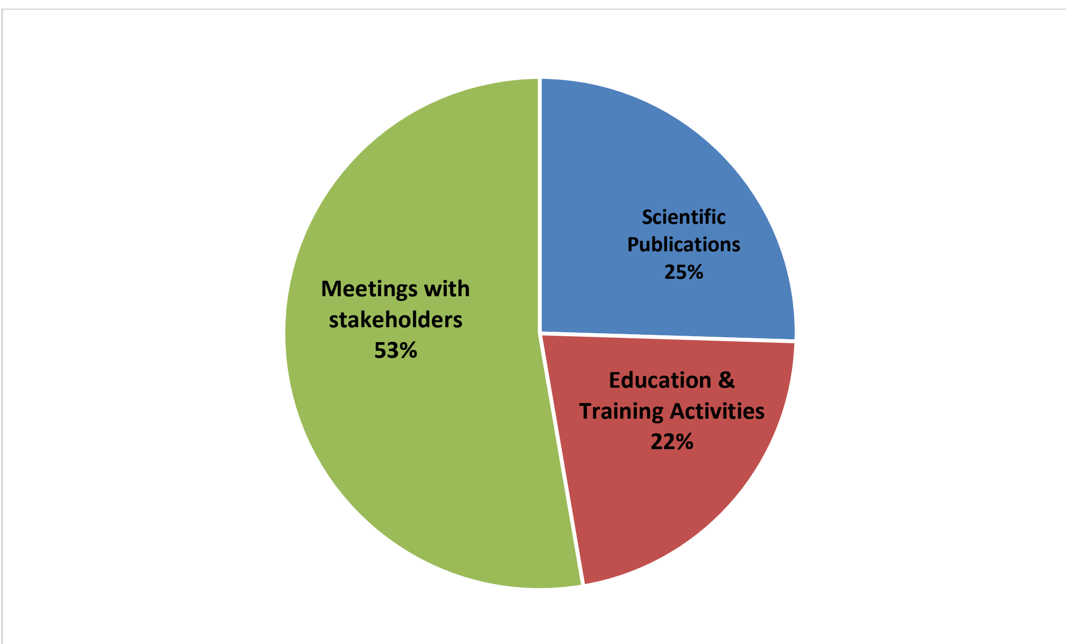


FIGURE 17. REMAINING TYPES OF DISSEMINATION ACTIVITIES CONDUCTED BY CLEAN HYDROGEN JU PROJECTS



The dissemination activities of the projects targeted five key audiences. The analysis of the reported data highlights significant variations across these groups (Figure 18).

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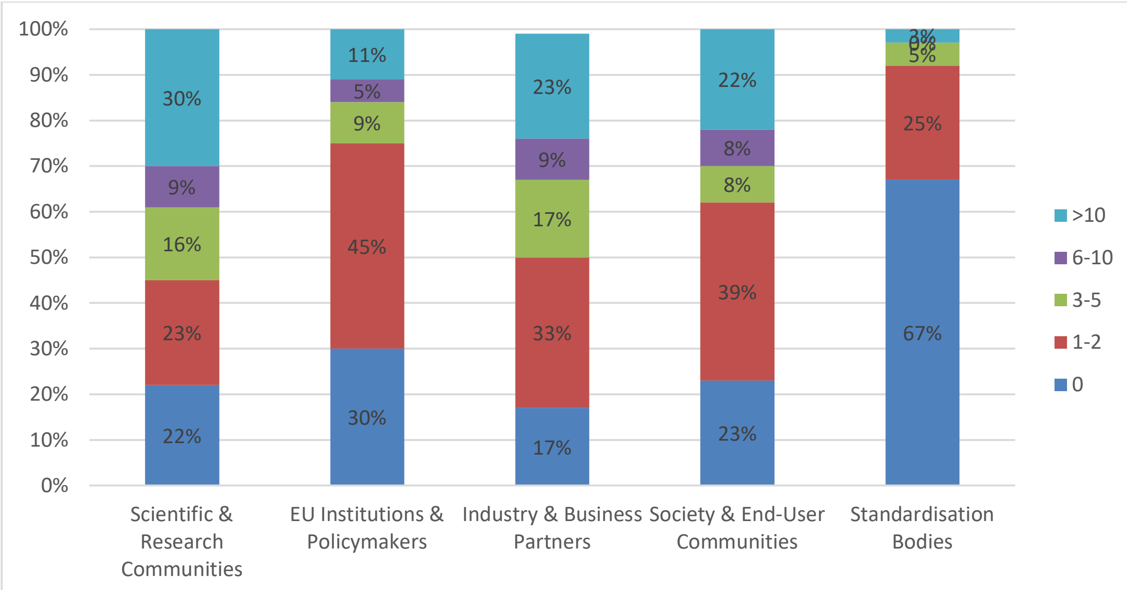
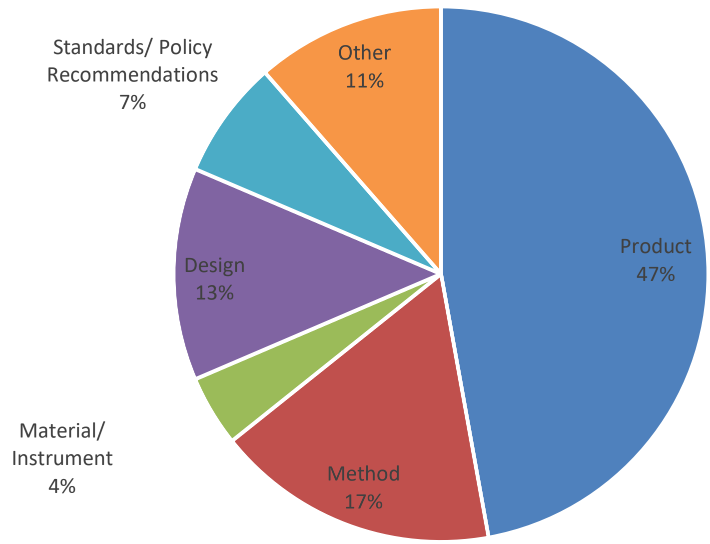
FIGURE 18. DISSEMINATION ACTIVITIES BY TARGET AUDIENCE



1. **Scientific and Research Communities:** A majority of projects (69%) reported disseminating activities to the scientific and research communities, with 30% indicating more than 10 activities. This suggests a strong focus on this audience, reflecting the importance of knowledge sharing within the research community.
2. **EU Institutions and Policymakers:** Dissemination efforts towards EU institutions and policymakers were less frequent, with 30% of projects reporting no activities. However, 45% of projects indicated 1-2 activities, and 11% reported more than 10, showing a targeted effort toward influencing policy.
3. **Industry and Business Partners:** Industry and business partners received a moderate level of dissemination. While 17% of projects reported no dissemination, a combined 59% reported between 1 and 10 activities, with 23% reporting more than 10 activities, suggesting a growing engagement with this audience.
4. **Society and End-User Communities:** Dissemination to society and specific end-user communities was more evenly spread. A notable 39% of projects reported 1-2 activities, with 22% reporting more than 10 activities, indicating significant outreach efforts to wider societal groups.
5. **Standardisation Bodies:** Standardisation bodies were the least targeted, with 67% of projects reporting no dissemination activities to this audience. However, 25% of projects did report 1-2 activities, indicating some engagement but suggesting room for greater involvement in this area.

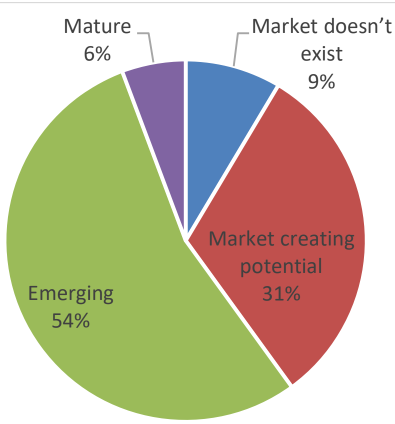
FIGURE 19. RESULT TYPE OF THE OUTCOMES AND PROJECTS RESULTS REPORTED BY THE PROJECTS



Achievements and results in the reference period are identified as products in 47% of the cases, whereas methods account for 17%, design 13%, standards and policy recommendations 7% and material/instruments for 4% (Figure 19).

The market maturity analysis of the results and outcomes shows that almost half of them (54%) are considered to be pointing to emerging markets, which is expected in terms of maturity of hydrogen technologies in general. Another 31% are flagged as having potential to create a market, while for 9% of them a market currently doesn't exist and only 6% of them are mature enough to be introduced into the market (Figure 20).

FIGURE 20. MARKET MATURITY LINKED TO THE RESULTS



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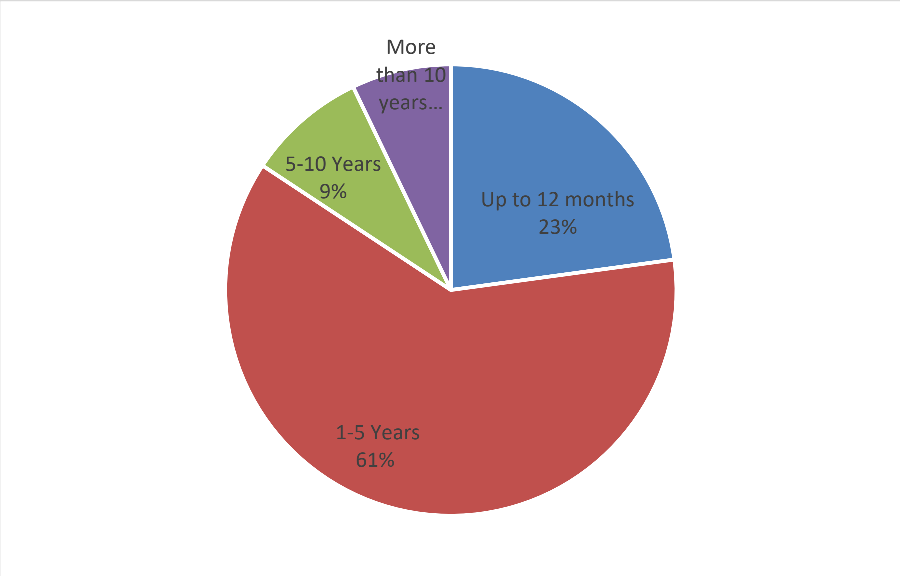
In terms of the expected impact the vast majority, almost 6 out of 10 (61%) of the results, are expected to have an impact in the next 1 to 5 years, while 23% are expected to have an impact within 12 months. The rest are more long-term: 9% are expected to have an impact in the next 5 to 10 years and 7% in more than 10 years (Figure 21).

FIGURE 21. EXPECTED TIME TO IMPACT OF THE RESULTS REPORTED



Exploitation Activities Performed by Projects

The exploitation activities carried out by the projects to support the uptake of their results were as follows:

- **33% of projects** reported engagement in activities related to **business models/plans** (Yes), while the remaining **67%** did not participate in such activities (No).
- **31% of projects** focused on **reaching out to potential investors and users** (Yes), while **69%** did not pursue this type of activity (No).
- **25% of projects** took steps towards **standardisation** (Yes), while **75%** did not engage in such activities (No).
- **6% of projects** focused on **patent applications** (Yes), while a significant **94%** did not engage in patent-related activities (No) (Figure 22).

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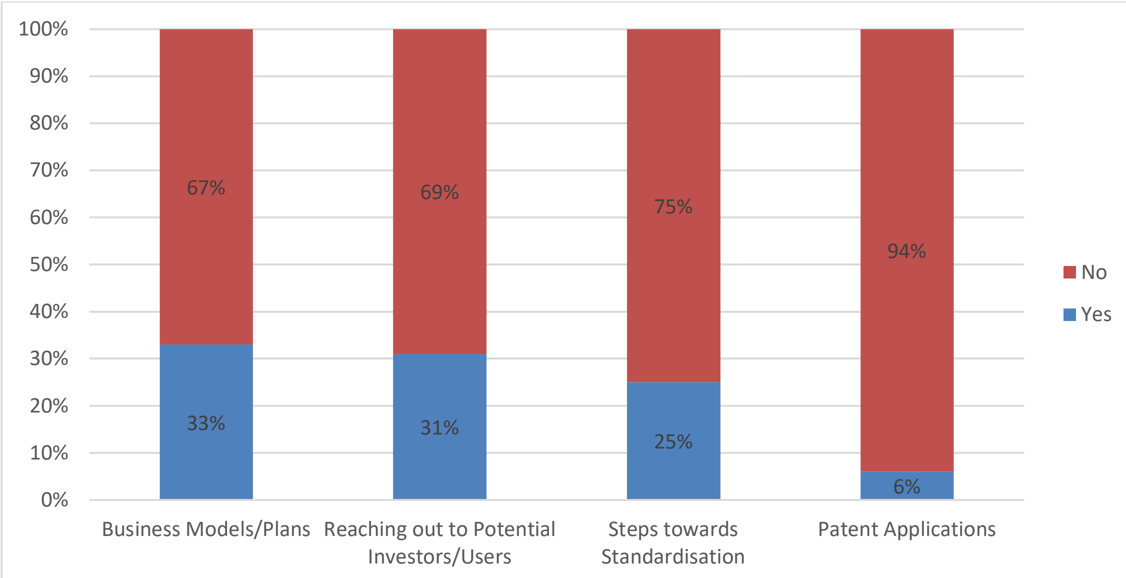
FIGURE 22. TYPES OF EXPLOITATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS

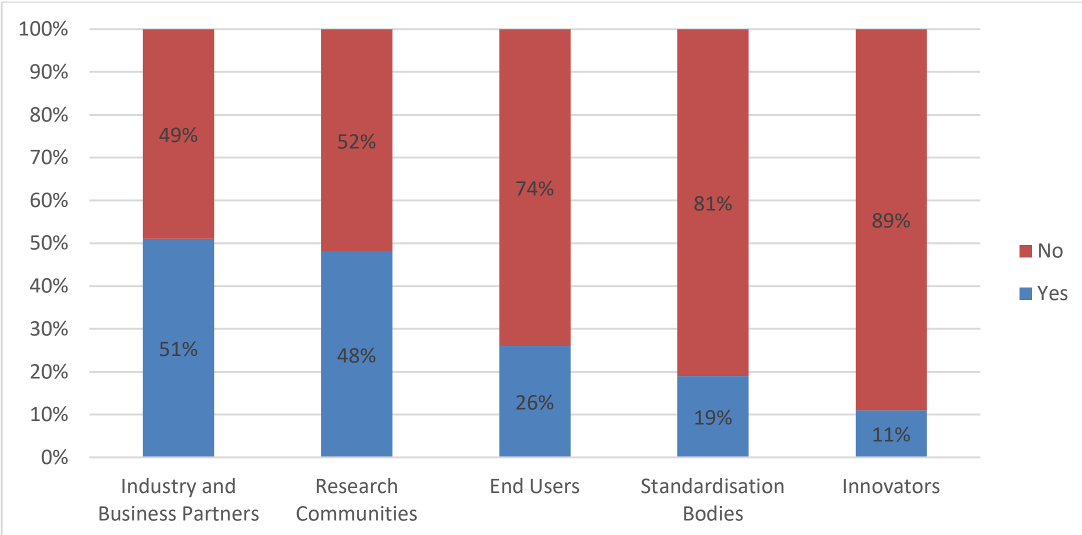


Finally, the target audiences for the exploitation activities were distributed as follows:

- **Industry and Business Partners**: 51% of projects reported targeting this audience (Yes), while 49% did not (No).
- **Research Communities**: 48% of projects reported targeting research communities (Yes), while 52% did not (No).
- **End Users**: 26% of projects targeted end users (Yes), while 74% did not (No).
- **Standardisation Bodies**: 19% of projects reported targeting standardisation bodies (Yes), while 81% did not (No).
- **Innovators**: Only 11% of projects reported targeting innovators (Yes), while 89% did not (No).

The data shows that the majority of projects are focusing on industry and business partners (51%) and research communities (48%), reflecting an emphasis on practical applications and academic dissemination. However, fewer projects are targeting end users (26%), standardisation bodies (19%), and innovators (11%), which may suggest that many projects are still in early stages or prioritizing business and academic sectors (Figure 23).

FIGURE 23. TARGET AUDIENCES OF THE EXPLOITATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS



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2 SUPPORT TO OPERATIONS

2.1 Communication activities

Throughout 2024, communication activities included the organisation of and participation in several events, the development of the programme's online tools and content on both the website and social media channels, and outreach campaigns and activities via traditional and online media.

2.1.1 Events

26 January 2024: Info day for Call 2024, Brussels

The Info Day – Call for Proposals 2024 took place on 26 January in Brussels as a hybrid event, attracting over 900 registered participants, with more than 700 joining online and over 200 attending on-site at the Clean Hydrogen Partnership's premises in Brussels. The event provided key insights into the 2024 Call for Proposals, offering stakeholders an opportunity to ask questions, and get insights into the call specs. The event included a presentation of the H2 valleys activities, including call related topics, and a brokerage session for 25 projects and companies could make their pitches.

30 January-1 February 2024: Hyvolution , Paris

At Hyvolution 2024, one of the leading European hydrogen exhibitions, the Clean Hydrogen Partnership was present with an exhibition stand and participated in the summit programme. The team was able to establish valuable contacts within the hydrogen sector and presented the opportunities provided by the Clean Hydrogen Partnership through its call for proposals. Additionally, Mirela Atanasiu, Executive Director ad interim, moderated a session at Hyvolution Forum 1 on "Sustainable Water Management in the Hydrogen Value Chain," highlighting the importance of integrated and cross-disciplinary solutions in advancing hydrogen technologies. The partnership also held an info day for potential French participants in the call.

15-18 April 2024 Transport Research Arena (TRA), Dublin

The Clean Hydrogen Partnership actively participated in the Transport Research Arena 2024, which brought together over 4,000 attendees. The Clean Hydrogen Partnership was present with a joint booth in the Exhibitor Area, alongside other transport-focused JUs and the European Commission and led a special session on "Hydrogen for Heavy Duty Transportation: Working in Synergy with the Partnerships" on 18 April. Engaging discussions took place on this occasion with members and partners of the four Joint Undertakings—Clean Hydrogen, Europe's Rail, Clean Aviation, and SESAR 3—on the latest transport research advancements. Additionally, the team welcomed students from the Schools Outreach Programme, providing insights into hydrogen transport projects and their impact on EU citizens.

Hydrogen Valley Days , 17 - 18 June 2024, Brussels

The first edition of this flagship event, co-organised by the Clean Hydrogen Partnership and the European Commission - DG Research and Innovation, took place in Brussels on 17-18 June 2024, at the Hotel.

More than 200 people met on-site during the two days event and used the various sessions to discuss and shape the future of the European hydrogen valleys. About 50 experts contributed in 7 sessions with their knowledge and expertise.

Hydrogen Valley Days also marked a new milestone in efforts to further develop Europe's green hydrogen regions, with the signing of the first memoranda of co-operation with national and regional authorities such as Ministry of Innovation and Growth of the Republic of Bulgaria, Croatian Hydrocarbon Agency and ESF+ Managing Authority and ERDF Managing Authority of Friuli Venezia Giulia Region.

18 November: Workshop Electrolysis R&I: 1st Information Exchange

In the broader frame of the Clean Hydrogen Partnership and the New Energy and Industrial Technology Development Organization (NEDO) cooperation, representatives of the two organisations met on the sidelines of the European Hydrogen Week, for a workshop to discuss detailed ideas for possible collaborations in the field of electrolysis.

The exchange centred on Research & Innovation in Electrolysis and served as the first working meeting since the cooperation agreement was signed in June 2024 in Tokyo during the Japan-EU Hydrogen High-Level Business Forum. The agenda focused on four discussion themes such as sustainability activities, safety-related framework, performance of electrolysers and R&I programs on electrolysis.

European Hydrogen Week, 18-22 November 2024 , Brussels

The European Hydrogen Week was held in Brussels on 18-22 November 2024 at the Brussels Expo. The event provided policymakers and industry with a forum to discuss the state of the hydrogen economy and for the Clean Hydrogen Partnership to present the innovative results of its various funded projects. Stakeholders from up and down the hydrogen value chain came together for multiple days of exhibitions, lively panel debates, and excellent networking opportunities.

The European Hydrogen Week was jointly organised under the umbrella of Hydrogen Europe, the Clean Hydrogen Partnership and the European Commission bringing together a comprehensive programme, including an exhibition, a policy conference, an innovation forum, an EU projects pavilion and the B2B forum. More than 200 speakers discussed, debated, and devised solutions to the sector's greatest challenges across 25 panel sessions at the High-Level Policy Conference, the B2B Forum and the Innovation Forum over the four days.

The Innovation Forum (20 – 21 November 2024) complemented the High-Level Policy Conference with sessions on Research and Innovation covering the whole value chain, focusing on EU competitiveness, skills and H2 Valleys. It has also featured a pitching session co-organised by the European networks of Horizon Europe National Contact Points Greenet and NCP_WIDERA.NET. More than **1333 visitors attended the sessions during the 2 days.**

An EU projects pavilion and its technical forum completed the programme, with several of the Clean Hydrogen Partnership projects participating and presenting, among them: BalticSeaH2, H2Haul, SherLOHCk, Jive or HyPop.

Lastly, six memoranda were signed at this year's forum by the Clean Hydrogen Partnership with the regions of Castilla y León (Spain), North-Holland (The Netherlands), Košice Region (Slovakia) and Wielkopolska (Poland), as well as with the Médio Tejo Intermunicipal Community (Portugal) and the National Managing Authority from Slovenia. The aim of these agreements, tailored to the needs of each member, is to create a more robust and mutually beneficial partnership framework, including through knowledge transfer and capacity building. Further the Clean Hydrogen Partnership signed a Memorandum of cooperation with the Clean Hydrogen Mission -Mission Innovation, committing to continue advancing clean hydrogen technologies through key initiatives such as creating an enabling environment through global events, expanding Hydrogen Valleys with strategic tools or enhancing

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knowledge management with shared platforms.

The presence of a **joint booth** between four parties (European Commission, Hydrogen Europe, Hydrogen Europe Research and Clean Hydrogen Partnership) sent a strong message of unity and collective ambition. It served as a central hub for networking, collaboration, and knowledge exchange, reinforcing the commitment of the partnership to drive innovation and progress in the sector. The joint booth not only showcased the combined strengths but also highlighted the shared dedication to achieving common goals, making a lasting impression on attendees and stakeholders alike.With over 9200 participants and 231 exhibitors, the expo brought together organisations across the whole hydrogen value chain.

2.1.2 Clean Hydrogen Partnership - 20 November 2024

The 7th edition of the Clean Hydrogen Partnership Awards, presented in Brussels on 20 November 2024, during the Hydrogen Week, celebrated the latest advances in European clean hydrogen technologies.

The awards recognized achievements in five categories: Best Success Story, Best Innovation, Best Outreach and European Hydrogen Valleys. The Women in Hydrogen Innovation Award was introduced this year, to encourage the participation of more women engineers and scientists in the development of clean hydrogen technologies.

The Clean Hydrogen Partnership selected the finalists for the best innovation, based on the data of the European Commission's EU Innovation Radar Platform, and for the best success story, based on the running projects' reported results and achievements. The public then voted for the winners, on the dedicated event website. The Clean Hydrogen Partnership selected the winning outreach and hydrogen valley projects, the latter with the help of the contractor running the Mission Innovation H2 Valleys platform, and winner of the Women in Hydrogen Innovation Award.

Best Innovation Award: on track for success

This year's winner, FCH2RAIL, advanced clean rail transport by developing a testing system for retrofitting diesel trains to run on hydrogen without using a real train. The project created a fuel cell hybrid power system for various rail applications, which can be retrofitted in existing electric and diesel trains. Six projects were nominated for the award, which was presented by Joanna Drake, Deputy Head of the European Commission's Directorate-General for Research and Innovation.

Best Success Story: Portable Power

The winner, EVERYWH2ERE, was selected by public vote, out of six nominees. The project designed and built an easy-to-install, transportable generator that can supply temporary power in places such as construction sites, cultural events, and ports. Combining fuel cell stacks with hydrogen technology eliminates the need for noisy and polluting diesel generators.

Best Outreach: setting sail for clean waterborne transport

The Best Outreach award highlights the importance of effective outreach and communication in promoting hydrogen technologies. The winner, FLAGSHIPS, retrofitted the H2 Barge 2 with hydrogen fuel cells, launching it on 8 February 2024 to transport containers on the Rhine. The project will also demonstrate the Zulu 6, a new hydrogen-powered cargo barge, on the Seine in Paris, making it the first of its kind on a French waterway. Both vessels will continue normal commercial operations after the 18-month demonstration period.

European Hydrogen Valleys: adding value across multiple sectors

Now in its third year, this award goes to regional projects that are leaders in integrated hydrogen production, supply, storage and use across multiple sectors. Both large and small-scale European valleys are eligible for the prize. Projects are scored using six criteria: value chain coverage, hydrogen production volume, variety of end uses, project finalisation, diversity of stakeholders and innovation. The award was presented by Joanna Drake from the Directorate-General for Research and Innovation. The two winning European hydrogen valleys are Triērēs Valley in Greece and Hydrogen Valley Emsland in Germany. They were selected out of 73 listed on the Mission Innovation Hydrogen Valley Platform.

Women in Hydrogen Innovation: recognizing talent

Clean Hydrogen JU initiated this award in 2024 to encourage women's participation in clean hydrogen technologies. The first winner is Deborah Jones, Research Director at CNRS and head of the laboratory for aggregates, interfaces and materials for energy at Montpellier University, France. Her work focuses on materials used in hydrogen technologies, particularly in proton and anion exchange membrane fuel cells and electrolysers. She has authored over 250 publications and holds several patents related to these materials. Her leadership roles include associate director of the 'Key Challenge' on clean hydrogen, which unites academic research laboratories in the Occitania region of France. The Hydrogen Europe Research Awards, celebrating best young scientists and researchers took place as well on the same occasion.

2.1.3 Website and Social Media activities

2024 Highlights – Web Analytics

In 2024, the website attracted a total of 113,334 visitors, representing a 1.72% increase compared to 2023. Visitors engaged in 177,532 sessions, marking a 2.29% decrease from the previous year. Despite the slight reduction in sessions, user interaction notably intensified, with events per session rising by 73.32% to reach an average of 4.53 events per session. Total pageviews significantly increased by 29.02%, reaching 492,550. Additionally, users spent an average of 2 minutes and 23 seconds per session, a 1.88% increase from 2023. However, the proportion of returning visitors decreased by 9.63%, accounting for 20.16% of total visitors.

The Clean Hydrogen Partnership newsletters reached nearly 15,000 subscribers in 2024. Throughout the year, two comprehensive newsletters and 14 news updates were distributed. The complete newsletter archive is accessible at: https://www.clean-hydrogen.europa.eu/media/newsletter-archive_en.

2024 Highlights – Social Media

Social media platforms, including LinkedIn, X, and YouTube, complemented the website and newsletters as key communication channels for disseminating information regarding Clean Hydrogen Partnership events, funding opportunities, and reports.

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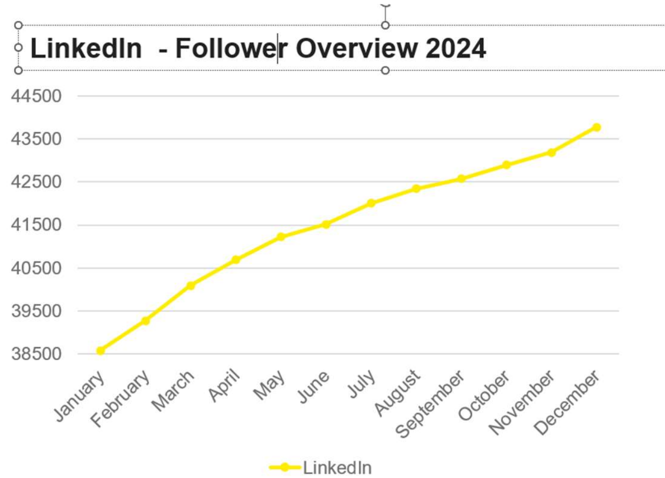

LinkedIn

In 2024, our LinkedIn platform has demonstrated consistent and encouraging growth. Throughout the year, we have published 305 posts, which have collectively received 14,198 reactions, indicating a strong and sustained level of audience engagement.

The accompanying graph illustrates the progression of our follower count over the course of the year, highlighting the increased visibility of our LinkedIn presence. We have reached a total of 42,888 followers, representing a net increase of 5,532 followers since the beginning of the year, an increase of 14.81%

YouTube

In 2024, the Clean Hydrogen Partnership YouTube channel published three new videos:

Recording of the Clean Hydrogen Info Day – Call 2024

Highlights from Hydrogen Valley Days 2024

Season's Greetings from the Clean Hydrogen Partnership

These videos collectively achieved 4,551 views and 37,728 impressions. Additionally, the YouTube channel gained 74 new subscribers, reaching a total of 652 subscribers.

2.1.4 Media outreach

Following the d**esign of a strategic communications calendar**, a media relations campaign has been developed in 2024 alongside the flagship events delivered by the Clean Hydrogen Partnership. It comprised sustained efforts to engage with the media both organically and through advertisements, to increase visibility of the Clean Hydrogen Partnership and build strong relationships with journalists from across various types of media and countries.

Media presence as a result of the campaign included the following:

A series of organic interviews around the launch of the 2024 call for proposals, targeting media in Central, Eastern and Southern European Countries, including top radio stations, media agencies and online media with significant audience in the respective countries.

TABLE 15. INTERVIEWS AROUND LAUNCH OF THE 2024 CALL FOR PROPOSALS ON CENTRAL, EASTERN AND SOUTHERN EUROPEAN MEDIA

Radio Romania Actualitati	https://www.romania-actualitati.ro/stiri/in-lume/nu-m-ar-surprinde-ca-europa-sa- piarda-batalia-pentru-hidrogen-mirela-athanasiu-parteneriatul-pentru-hidrogen- curat-id191438.html
BTA (Bulgarian News Agency)	https://www.bta.bg/bg/news/economy/643237-balgariya-e-mnogo-aktivna-v- oblastta-na-chistiya-vodorod
Greenfo	https://greenfo.hu/hir/tiszta-hidrogennel-a-holnapert/
Capital Radio	https://www.capitalradio.es/audio/2024041111-04-2024_ELPROGRAMADELAENERGIA/125393537
El Español-Invertia	La UE cerrará en días una convocatoria de 113,5 millones para innovación en hidrógeno: España, entre las favoritas: https://www.elespanol.com/invertia/empresas/energia/20240409/ue-cerrara-dias-convocatoria-millones-innovacion-hidrogeno-espana-favoritas/846165771_0.html

A press event around the first edition of the Hydrogen Valleys Days, with the participation of journalists from Italy (Aska News), Hungary (Greenfo.hu), Spain (El Independiente) and Belgium. The press point was attended by the following speakers:

Rosalinde van der Vlies, Clean Planet Director, DG RTD, European Commission

Valerie Bouillon-Delporte, Clean Hydrogen Partnership, Executive Director

Mirela Atanasiu, Head of Unit of Operations and Communication

Attendee correspondents actively engaged with the speakers and asked questions during the press point. Journalists were particularly interested in how hydrogen energy could be used for public transport and the focus of research fundings. Following the press point, one piece was published by the Hungarian journalist Eva Molnar: Fókuszban a hidrogéngazdaság - Greenfo

Organic and paid media opportunities around the European Hydrogen Week 2024. This included selecting appropriate media channels and targeting audiences based on demographics, interests, behaviours, and geographic location.

The **media buying campaign** focused on Tier-1 EU-Bubble outlets. Three Tier-1 outlets were selected for the campaign: The Parliament, Science|Business, and Euractiv, based on the impact-to-budget ratio, as well as the relevance of their audiences.

An Op-Ed by Valerie Bouillon-Delporte, Executive Director Partnership, was published in the Energy & Environment section of The Parliament on December 2nd. Available here. The article was also promoted on the social media channels: two posts on X, launched on December 3rd. Available here and and a LinkedIn post, available here.

An article was published on December 5th in Science and Business, available here.The article was also promoted on the Science|Business newsletter on December 5th, available here and on social media channels: LinkedIn post, available here; Facebook post launched on December 5th, here.

An Op-Ed by Mirela Atanasiu,Head of Unit of Operations and Communication, was published by

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Euractiv under the Energy, Environment & Transport section, on December 9th. Available [,](,) with subsequent social media posts launched on December 10th on X here and Facebook here.

Among these, the Parliament achieved the highest visibility, generating an impressive 1.4 million impressions and leading in direct article clicks with 863, accompanied by strong engagement metrics such as 152 likes and 27 reposts. While its social media impact was more limited, the outlet's prominence within the EU-Bubble audience made it a vital platform for spreading key messages. In comparison, Science|Business excelled in multi-channel distribution, featuring the article prominently on its website, newsletters, and social media. Despite its modest 556 website views, it secured 299 clicks and performed particularly well on LinkedIn, where it achieved a 2.9% click-through rate and a 5.81% engagement rate. However, its overall reach was lower than the other platforms.

Euractiv emerged as a strong contender in balancing visibility and engagement. Its article generated 133,340 impressions and 1,436 page views on its website, supported by exceptional social media performance with 127,833 impressions and 610 engagements. Notably, the 18 direct logo clicks on its platform highlighted its value in enhancing the Clean Hydrogen Partnership's branding. While its total impressions were lower than The Parliament, Euractiv outperformed Science|Business in both visibility and engagement metrics. Together, the three outlets complemented each other by combining high reach, multi-channel targeting, and robust engagement, delivering a comprehensive media impact that effectively positioned the Clean Hydrogen Partnership as a leading force in Europe's clean hydrogen transition.

On the other hand, an **earned media strategy** was also employed, involving a broader media outreach to secure interviews with key spokespeople from the Clean Hydrogen Partnership. This approach resulted in the following successful interviews and distribution of a press release amongst media contacts in the key countries identified.

- Interview with Nick Edstrom, Managing Editor Hydrogen for S&P Global Commodity Insights. (not published)
- Interview with Stefano Porciello for MLex. (not published)
- Interview with Martin Greenacre for Science|Business, published on December 17th. Available here.
- Interview with Alice Hancock for Financial Times. Scheduled for 2025.
- Coverage of the awards by El Economista, published on November 28th. Available here.

The campaign successfully secured earned media coverage, enhancing the overall reach and credibility of the Clean Hydrogen Partnership's messaging. Key interviews were featured in prominent outlets such as Science|Business and the Financial Times. These interviews provided an authoritative platform to discuss the Clean Hydrogen Partnership's role in advancing hydrogen innovation, as well as underscoring the institution's ability to attract high-value media attention, positioning the Partnership as a central voice in Europe's clean energy transition. This earned media effort effectively complemented the paid media strategy, reinforcing the campaign's objectives through trusted, policy-driven narratives.

2.2 Legal and financial framework

With regard to protection of personal data, the Clean Hydrogen JU, as an EU body applying Regulation (EU) 2018/1725, continued its data protection activities in 2024. The legal framework was updated

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with the entry into force of the AI Data Act (Regulation 2024/1689) which gave the European Data Protection Supervisor (EDPS) new powers in terms of supervision in the use of Artificial Intelligence by EU Institutions.

In addition, 2024 marked the 20th anniversary of the establishment of the EDPS, which fostered different activities aimed at gathering information on the approach to compliance across all EU institutions. In this context, the Clean Hydrogen JU replied to in depth surveys on the performance of Data Protection Impact Assessments and data breaches.

In addition, the Clean Hydrogen JU, along with other JUs that share a common IT infrastructure, have coordinated to update their collective DPIA on the use of Microsoft services, in light of the results of the EDPS' investigation on the Commission's use of Microsoft products. Consultancy services and the updated security assessments will be performed through a specific contract under a framework contract lead by SESAR 3 JU to secure availability of data protection and cyber security consultancy services.

No new decision regarding the legal and financial framework have been adopted in 2024.

2.3 Budgetary and financial management

2.3.1 Budget

The JU budget comprises revenue and expenditure.

On the expenditure side, the budget is divided in three titles:

• **Title 1** covers staff expenditure, such as salaries, allowances and benefits, contributions, and taxes. In addition, it includes expenses for training, missions and medical services as well as the costs associated with the recruitment procedure and representation costs;

• **Title 2** covers the costs associated with the functioning of the Programme Office, such as renting premises, IT needs, expenses related to communications, other service contracts and various office supplies;

• **Title 3** covers expenditure related to the operational activities under the H2020 and Horizon Europe programmes. Compared with 2023, the 2024 appropriations related to Titles 1 and 2 increased by 13% in terms of commitments and by 21% in terms of payments. Appropriations related to Title 3 included commitment and payment appropriations for the fourth call for proposals under Horizon Europe and other operational expenditure such as procurement activities, JRC collaboration and experts' fees.

There were two budget amendments and two budget transfers in 2024. The first amendment introduced the reactivation of commitment appropriations to cover additional operational activities related to the Programme Horizon Europe; the second budget amendment reactivated commitment appropriations for operational activities, introduced additional commitment appropriations due to UK contributions, and reactivated payment appropriations related to the JU's refurbishment project. An overview of the initial budget and amendments is presented in Table 18.

TABLE 16. BUDGET FOR YEAR 2024 – STATEMENT OF REVENUE WITH INITIAL VOTED BUDGET AND BUDGET AMENDMENTS.

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Statement of revenue	Voted budget		Amended budget 1		Amended budget 2	
	2024		2024		2024	
Heading	**Commitment appropriations (in EUR)**	**Payment appropriations (in EUR)**	**Commitment appropriations (in EUR)**	**Payment appropriations (in EUR)**	**Commitment appropriations (in EUR)**	**Payment appropriations (in EUR)**
EU contribution (excl. EFTA and third country contributions)	**117,777,031**	**103,875,655**	**117,777,031**	**103,875,655**	**117,777,031**	**103,875,655**
of which Administrative	3,577,400	3,554,247	3,577,400	3,554,247	3,577,400	3,554,247
of which Operational	114,199,631	100,321,408	114,199,631	100,321,408	114,199,631	100,321,408
EFTA and third countries contribution	**64,141,317**	**39,572,478**	**64,141,317**	**39,572,478**	**83,141,317**	**39,572,478**
of which Administrative	98,650	121,676	98,650	121,676	98,650	121,676
of which Operational	4,042,667	3,450,802	4,042,667	3,450,802	4,042,667	3,450,802
of which Operational third countries excluding EFTA	60,000,000	36,000,000	60,000,000	36,000,000	79,000,000	36,000,000
Financial Members other than the Union contribution	**3,676,050**	**3,675,923**	**3,676,050**	**3,675,923**	**3,676,050**	**3,675,923**
of which Administrative	3,676,050	3,675,923	3,676,050	3,675,923	3,676,050	3,675,923
Unused appropriations of previous years	**404,216**	**513,304**	**7,441,165**	**513,304**	**7,969,743**	**1,108,161**
Reactivation of unused appropriations from administrative expenditure	404,216	513,304	404,216	513,304	404,216	1,108,161
Of which from 2020						
Of which from 2021						594,857

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Of which from 2022	404,216	513,304	404,216	513,304	404,216	513,304
Of which from 2023						
Reactivation of unused appropriations from operational expenditure			7,036,949		7,565,527	
Of which from 2020						
Of which from 2021						
Of which from 2022					528,578	
Of which from 2023			7,036,949		7,036,949	
TOTAL	**185,998,614**	**147,637,360**	**193,035,563**	**147,637,360**	**212,564,141**	**148,232,217**

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2.3.2 Budget execution

2.3.2.1 *Administrative expenditure*

The JU's administrative budget execution increased to 85% (compared to 80% in 2023) in terms of commitment appropriations.

In terms of payments appropriations, the execution rate decreased to 66% (from 75% in 2023).

More specifically, Title 1 commitment and payment rates decreased compared to 2023 (commitment rates: 83% in 2024 and 87% in 2023, payment rates: 73% in 2024 and 86% in 2023). Staff in active employment comprises 51% of total administrative budget. This decrease was primarily due to delays in filling at least seven positions, including the Executive Director, Synergies Officer, Internal Control Manager, Financial Officer, Knowledge Management Officer, Management Assistant, and an SNE. These recruitment delays accounted for 52 months of vacant positions, equivalent to 4 Full-Time Equivalents (FTEs) and 12% of the Staff Establishment Plan (SEP).

Mission budget execution increased to 79% in 2024 (from 77% in 2023) mostly due to the arrival of the JU's Executive Director since June 2024.

Title 2, on the other hand, improved in commitment rates compared to 2023 (committed: 87% in 2024 and 71% in 2023), but slightly decreased in terms of payments (paid: 58% in 2024 and 61% in 2023). All budget lines show an execution rate below 90%, but mainly three are the budget lines responsible for the overall low execution in 2024 (see above):

- Rental and office equipment expenses, associated with the delayed refurbishment plan;
- Service contracts, due to the significantly lower value of the final payment for the 1st Project Technical Assistance contract, as the contract did not cover the entire previous year, resulting in fewer deliverables than initially anticipated.

2.3.2.2 *Operational expenditure*

The budget execution reached 99% of commitment appropriations in 2024, mostly due to the global commitment related to the 4th call for proposals under Horizon Europe which launched in January 2024. Payment implementation for Horizon 2020 reached 72%, an improvement compared to 69% in 2023. Toward the end of the year, delays in two high-value payments were reported, primarily due to on-going amendments that postponed these payments from 2024 to 2025. For Horizon Europe, the budget execution increased to 100% in commitments (from 97% in 2023), reflecting excellent planning. For payments, the execution reached 88% in 2024 (89% in 2023), with the remaining amounts to be disbursed in 2025, following the signature of grant agreements by the February 2025 deadline. The overall execution in payments reached 85%, maintaining the same level as in 2023.

TABLE 17. BUDGET 2024 – STATEMENT OF EXPENDITURE

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Statement of expenditure	COMMITMENTS				PAYMENTS			
Heading	Voted budget 2024 (AWP)	Amended budget 2024 after transfers	Executed Budget 2024	%	Voted budget 2024 (AWP)	Amended budget 2024 after transfers	Executed Budget 2024	%
Title 1 - Staff expenditure	**5,168,000**	**4,814,500**	**3,992,867**	**82.93%**	**5,168,000**	**5,164,500**	**3,758,472**	**72.78%**
Salaries & allowances	4,716,000	4,320,500	3,638,159	84.21%	4,716,000	4,670,500	3,485,346	74.62%
Expenditure relating to Staff recruitment	5,000	5,000	1,500	30.00%	5,000	5,000	84	1.68%
Mission expenses	68,000	83,000	83,000	100.00%	68,000	83,000	65,859	79.35%
Socio-medical infrastructure (incl. training)	45,000	72,000	68,365	94.95%	45,000	72,000	54,935	76.30%
External services	330,000	330,000	198,843	60.26%	330,000	330,000	150,397	45.57%
Receptions, events and representation	4,000	4,000	3,000	75.00%	4,000	4,000	1,851	46.27%
Title 2 - Infrastructure and operating expenditure	**3,330,615**	**3,687,115**	**3,194,985**	**86.65%**	**3,332,615**	**3,931,972**	**2,287,747**	**58.18%**
Rental of buildings and associated costs	480,000	830,000	404,645	48.75%	480,000	830,000	392,117	47.24%
Information, communication technology and data processing	449,847	450,847	437,118	96.95%	449,847	450,847	348,172	77.23%

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Movable property and associated costs	5,000	5,000	0	0.00%	5,000	249,857	0	0.00%
Current administrative expenditure	9,270	12,770	12,770	100.00%	9,270	12,770	10,330	80.89%
Postage / Telecommunications	8,998	8,998	8,998	100.00%	8,998	8,998	7,321	81.37%
Expenditure on formal meetings	52,000	52,000	36,416	70.03%	52,000	52,000	34,749	66.82%
External communication information and publishing	786,500	786,500	756,323	96.16%	786,500	786,500	624,443	79.40%
Service contracts	1,539,000	1,541,000	1,538,714	99.85%	1,539,000	1,541,000	870,614	56.50%
Title 3 - Operational expenditure	**177,500,000**	**206,571,622**	**203,746,023**	**98.63%**	**139,138,746**	**141,644,841**	**120,948,018**	**85.39%**
Previous years' Calls/other funded actions		10,071,622	7,554,344	75.01%		2,506,094	17,395	0.69%
Current year's Calls/other funded actions	177,500,000	196,500,000	196,191,679	99.84%	139,138,746	139,138,746	120,930,623	86.91%
TOTAL	**185,998,615**	**215,073,237**	**210,933,875**	**98.08%**	**147,637,361**	**150,741,313**	**126,994,237**	**84.25%**

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2.4 *Financial and in-kind contributions from Members other than the Union*

This section builds on and provides more details to overall summary provided in the Section 1.2.4 'Information on quantitative and qualitative leverage effects'. JU Members other than the EU contribute to the JU in the following ways:

- Financial contributions of the Members to the running costs of the Clean Hydrogen JU;
- co-financing required to carry out R&I actions supported by the Clean Hydrogen JU (i.e. in-kind contributions in operational activities (IKOP) through co-funding Clean Hydrogen JU projects);
- contributions towards additional activities (IKAA) by members other than the EU or their constituent or affiliated entities, as specified in an additional activities plan, which should represent contributions to the broader FCH Joint Technology Initiative and the sector as a whole.

In 2024, contributions from JU Members other than the Union are presented in Table 18.

TABLE 18. CONTRIBUTIONS FROM MEMBERS OTHER THAN THE EU IN 2024 (EUR)

Contributions from JU Members other than the Union in 2024	
Nature	**Amount (in €)**
Financial contributions (FC) reported	3,675,922.00
In-Kind to Operational Activities (IKOP) reported	2,649,252.31
In-Kind to Additional Activities (IKAA) reported and certified in 2024	698,069,787.03
TOTAL all contributions reported, including certified IKAA	**704,394,961.34**

The certification of In-Kind Contributions to operational activities (IKOP) is still ongoing. Cumulated in kind contributions to operational activities up to 2024 is presented in Table 19.

TABLE 19. EVOLUTION OF CUMULATED IKOP UP TO 2024 (EUR)

Values of IKOP - Evolution (in EUR) (or graph-Optional)				
Reference of the Project-Call	**Total amount of IKOP planned for the project**	**Amount of IKOP reported before 2024**	**Amount of IKOP reported in 2024**	**Total Amount of IKOP certified until 2024**
Call 2014	33,080,357.24	33,080,357.24	-	33,080,357.24
Call 2015	52,665,736.43	22,751,752.95	168,367.97	15,282,416.39
Call 2016	8,414,605.24	7,631,592.64	-11,260.45	7,620,332.19
Call 2017	21,076,639.25	23,926,345.29	1,050,642.30	14,351,195.22

Call 2018	25,054,222.77	11,576,863.50	393,858.28	6,525,881.76
Call 2019	26,461,250.63	10,386,650.46	- 230,725.75	1,276,940.47
Call 2020	17,893,544.78	14,801,079.89	244,010.38	1,567,433.49
Call 2022	81,836,640.37	2,028,909.07	365,806.46	-
Call 2023	19,025,312.05		668,553.12	-
Call 2024				
TOTAL	**285,508,308.76**	**126,183,551.04**	**2,649,252.31**	**79,704,556.76**

Similarly, certification of In-Kind Contributions to additional activities (IKAA) for 2024 is still ongoing until end of December 2025; provisional certified 2024 IKAA figures as of 31 May 2025 as per the SBA regulatory reporting deadline are presented in Table 20, together with the cumulative updated IKAA figures from previous years.

TABLE 20. EVOLUTION OF CERTIFIED IKAA IN 2023 AND 2024, AND TOTAL SINCE 2021 (MILLION EUR)

Values of certified IKAA – Evolution (in million EUR)	
Year	**Amount of certified IKAA**
2022 closed at year-end 2024	**256.94**
2023 closed at year-end 2024	**482.96**
2024 provisional as of 31 May 2025	**698.07**
TOTAL since 2022 (No IKAA reporting in 2021)	**1,437.97**

2.5 Administrative Procurement and contracts

In 2024, the tendering and contract management strategy has weighed on interinstitutional procurement procedures launched by the European Commission or other EU bodies in order to use the resulting multiannual framework contracts.

In addition, the Clean Hydrogen JU also cooperates with other Joint Undertakings on tendering needs in order to minimise the administrative effort in the context of the Back Office Arrangements (BOA – see also in Section 2.7.2 on efficiency gains and synergies) the establishment of which was formalized in 2023 through a Service Level Agreement, signed between the Clean Aviation JU and seven other Joint Undertakings.

Most of the Clean Hydrogen JU's administrative contracting was carried out through existing multiannual framework contracts under the lead of the European Commission, with the remaining part being covered through the Clean Hydrogen JU's own contracts, namely a framework contract for operational support of communication activities (booth services) and the contract for the organization of the Clean Hydrogen JU's yearly forum and event, the Hydrogen Week.

Table 21 provides an overview of the contracts awarded in 2024, including the procedure used in each case and the name(s) of the contractor(s); only those contracts with a value exceeding EUR 15 000 are listed.

In cases of specific contracts implementing a framework contract, the information is aggregated for each contractor under the same framework contract.

TABLE 21. CONTRACTS AWARDED IN 2024

Subject of the contract	*Type of Contract*[79]	*Contractor*	*Tender Procedure [if applicable]*	*Start date*	*Amount in EUR*
Success Stories 2024 - Specific contract under FWC COMM-2019-OP-0029-Lot2	Specific contract	Consortium E2COMMs formed by: EUROPEAN SERVICE NETWORK (leader) and ECORYS EUROPE	N/A	26/03/2024	28 480.11
INTERIM POSITION - PERIOD 08/01/2024 - 05/07/2024 – Specific contract implementing Framework contract HR/R1/PR/2019/023	Specific contract	Randstad Belgium NV	N/A	08/01/2024	31 541.18
INTERIM POSITION - PERIOD 18/03-13/09/2024 - Specific contract implementing Framework contract HR/R1/PR/2019/023	Specific contract	Randstad Belgium NV	N/A	18/03/2024	34 738.08
Specific contract No. 8 implementing Framework Contract CleanHydrogen/OP/ Contract 282 – OPERATION AND MAINTENANCE OF THE EUROPEAN HRS AVAILABILIY SYSTEM	Specific contract	Spilett New technologies GmbH	N/A	08/03/2024	22 230
Specific contract No. 9 - implementing Framework Contract CleanHydrogen/OP/ Contract 282 - 282 –	Specific contract	Spilett New technologies GmbH	N/A	31/07/2024	68 008

[79] Framework Contract, SLA, others

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OPERATION AND MAINTENNACE OF THE EUROPEAN HRS AVAILABILIY SYSTEM					
EU Hydrogen Valleys Days – Specific contract implementing Framework Contract COMM-2020-OP-0030	Specific contract	ICF NEXT S.A.	N/A	14/05/2024	101 462.74
Info Day Call 2025 – Specific contract implementing Framework Contract COMM-2020-OP-0030	Specific contract	ICF NEXT S.A.	N/A	18/12/2024	56 074.79
Specific Contract No 1 implementing Framework contract EEA/COM/21/004 - Development of a video for the Clean Hydrogen JU	Specific contract	MARCO DE COMUNICACION SL	N/A	19/07/2024	15 850
Provision Of Data And Services In Support of The European Hydrogen Observatory and Monitoring of the Hydrogen Sector - Specific contract No 4 / implementing Framework contract CleanHydrogen /OP/Contract 332	Specific contract	Hydrogen Europe AISBL	N/A	13/12/2024	123 062.5
Booth Transport, setup and dismantle for Hyvolution event in Paris 2024 – Specific contract Implementing Framework contract CleanHydrogen/Contract 356 - Lot 1	Specific contract	CREASET SA	N/A	26/01/2024	17 586.64
Booth Transport, setup and dismantle - Hyvolution Paris 2025 - Specific contract Implementing Framework contract CleanHydrogen/Contract 356 -Lot 1	Specific contract	CREASET SA	N/A	27/01/2025	22 351.64

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Managed IT Services Package 2024 - Specific Contract for the period 01/01/2024-31/12/2024, implementing Framework contract CAJU.2022.OP.02	Specific contract	RealDolmen	N/A	01/01/2024	65 824.64
Clean Hydrogen hosting services for the drupal platforms FCHO / H2V / TRUST / CRM Specific contract number 8 implementing Framework Contract number CAJU.2022.OP.02	Specific contract	RealDolmen	N/A	01/01/2024	27 869.28
Rental of space for a joint booth for all JUs at Transport Research Arena 2024	Direct contract	Conference Partners International Ltd.		14/04/2024	38 850
Investment Pitching Session 2024	Direct contract	Tech Tour Europe S.A.	Low value procedure	13/08/2024	15 000
Organisation of Hydrogen Week 2024	Direct contract	Hydrogen Europe AISBL	Direct contract with Member	14/11/2024	368 091.4
Interim contract for period 5/08/2024 – 31/01/2025 – Implementing Framework contract HR/2024/OP/0095	Specific contract	Randstad Belgium NV	N/A	12/08/2024	35 755.72
Interim contract for period 14/10/2024-11/04/2025 – Implementing Framework contract HR/2024/OP/0095	Specific contract	Randstad Belgium NV	N/A	14/10/2024	37 130.94
Specific Contract No 1 Implementing Framework Contract number EU-Rail.OP.02.22 - Audit of accounts 2024 and 2025	Specific contract	Baker Tilly Bedrijfsrevisoren	N/A	29/10/2024	34 938

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2.6 *IT and logistics*

Information and communications technology (ICT) provides the ICT infrastructure, tools and services that enable staff members to work and teams to collaborate. Since its creation, the JU has been one of the most active promoters of a single approach for all the JUs to the ICT environment, reducing costs, outsourcing, and increasing performance

The year 2024 was marked by specific actions fulfilled in the following mentioned distinct areas: ICT governance, Information and document management, digital transformation, cybersecurity and logistics and facility management.

2.6.1 ICT Governance

The Joint Undertakings took all opportunities to build synergies on areas of joint interest and maintain the strong partnership with other entities such as DIGIT or other partnerships to harmonise processes and good practice. This has particularly materialized in 2024 by the adoption of the service level agreement for the back-office arrangement on ICT and the governance lead by Clean Hydrogen.

To further develop the ICT services, the JU joined each interinstitutional framework contracts or inter-agency joint procurement of added-value, and adopted the new delivery model of DIGIT composed of Dynamic Purchasing Systems (DPS). DPS TELCO was used to upgrade our classical telephony system and integrate this in our Microsoft solution for IT Services.

2.6.2 Digital infrastructure

Regarding the digital infrastructure, the JU continue to rely on the secure pan-European networks for the Commission, executive agencies and other European institutions. The new TESTA line design shared with more agencies operated under the new DIGIT broker model is shared with the IT community and more agencies are using this innovative solution.

The common conference centre of the White Atrium building is being gradually upscaled with the necessary audio-visual functions to hold hybrid meetings. Design and level of equipment has been agreed with the management of the 8 Joint Undertakings using this facility in the White Atrium building. To this effect a convention has been signed between the Joint Undertakings and SCIC for the installation and support of AV equipment for meeting spaces. The installation will take place during 2025.

2.6.3 Digital transformation

In the area of digital transformation, the main objective is to build a performing digital infrastructure and a fit-for-purpose Digital Workplace. Each staff member is receiving modern IT equipment, but also encouraged to develop the digital skills, mobile hardware and software solutions, and collaboration with the cloud approach and keeping cybersecurity mindsets anytime.

2.6.3.1 Information management

2.6.3.1.1 EC Solutions

The JU has implemented ICT tools designed and made available by the EC for the financial and call management. These tools are updated and maintained on regular basis by the Commission services; they require continuous input from the side of the JU, on the one hand, to correct the multiple and repetitive mistakes and, on the other hand, in terms of future developments to meet the expectations of the partnership. The roles of the Single Point of Contact for COMPASS or the IT accounting system ((Accrual Based Accounting, (ABAC)) were again useful to ensure the successful implementation of the call 2024 but also the transition period of the Executive Director mandate. To ensure the correct usage

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and implementation of these applications, the JU also makes use of the training services offered by the EC on these applications (see section 2.7 Human resources).

For the execution of the calls for proposals, the EC IT systems were used throughout the entire process: from the publication of the call, the submission and evaluation of the proposals as well as for grant preparation. The EC IT systems "e-submission/e-tendering" is supporting the operational tender procedures. The Clean Hydrogen JU is also using (or adopting when possible) flagship digital solutions developed by the European Commission, such as SysPer and Systal for HR services, ARES for document management and the Next-EUROPA platform as web communication platform.

- The additional module MIPS for Mission Processing System has been tested extensively for a deployment in January 2025 and further harmonize the processes, workflows and procedures for Human Resources administration.
- The JU's web presence is supported by a website compliant with the Europa Web Publishing Platform (EWPP) hosted under the Next-EUROPE platform. This ensured stability and continuity of this essential tool for the external communication and visibility of the Clean Hydrogen JU programme.

2.6.3.1.2 Other Agencies/JUs' framework contracts

The Clean Hydrogen JU initiated in 2010 with the first Joint Undertakings the joint strategic ICT plan for the JUs located in the White Atrium building. Since then the JU shares its virtual IT infrastructure that is hosted by a private cloud computing provider and also shares the ICT managed services performed by a private company, in synergy with the other JUs. In 2024, the connectivity to the EC tools has also been migrated to this private cloud, which provides a full mobility and independence from the original premise in Brussels, which proved to be very efficient during the Covid-19 pandemic and will greatly support the business continuity plan.

The hosting of the different knowledge platforms delivered to the JUs, such as TRUST, Observatory, Hydrogen Valley, the new CRM suite and the recent Knowledge Hub is ensured by our IT managed services provider. This provides the technical support of the various applications but also developments by third parties contracted aside. The public access to those communication tools is also supported by the necessary maintenance and support contracts. The EU Login services provided by Commission has been used for the Knowledge Hub to reinforce audit trail and data protection of our key asset.

Along with the progressive implementation of the mitigating measures from the Data Protection Impact Assessment (DPIA) and security risk assessment performed on the Microsoft Office 365 public cloud environment, as required by the adopted EU regulation on the protection of personal data by EU institutions and bodies (Regulation (EU) 2018/1725), the deployment of such software-as-a-service solutions started in 2022 for Clean Hydrogen. First with Teams for meetings, then SharePoint and OneDrive. Finally Exchange online as well as the document libraries in SharePoint, and Teams groups.

2.6.3.2 Document Management

Since December 2023, the IT Officer has taken over the role of Document Management Officer (DMO) after completing the mandatory training. This ensures the continuation of the correct implementation and monitoring of the European Commission electronic archiving and document management (e-Domec) policy within the entire JU.

The main activities in 2024 on document management can be summarised as follows:

"Job users" were created and interfaced the Knowledge hub tool developed by Clean Hydrogen so that the exploitation of registered filled documents is facilitated for data mining and data collection.

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The JU exploited further the potential of the data, information, knowledge and content management of Teams/SharePoint by developing for the benefit of all the Joint Undertakings in a common tenant a dedicated collaboration platform using Microsoft Teams channels and SharePoint libraries. This is reinforcing the synergies and interaction of the newly created back offices arrangements (ICT, Accounting, Procurement) but also internal and external actors organized in dedicated working groups.

The JU also foresees the implementation of AresBridge integrated in Microsoft 365 SaaS information system to complement the IT tool Hermes-ARES-NomCom already adopted as document (record) management system provided by DIGIT.

2.6.3.3 Cybersecurity

Regarding the JU's resilience to ever-evolving digital security threats, the Cybersecurity was reinforced by focusing on the business continuity operations:

- a close follow-up of the infrastructure-as-a-service solution and managed IT service contracts available to the Clean Hydrogen JU;
- efficient remote support provided by the IT officer and the service desk;
- making sure that JU is not affected by security incidents arising from external cyberattacks.

The developments of the new information security (Infosec) regulation and the dedicated role of Cyber Security Officer were followed closely in each dedicated meeting and group. The implementation of those recommendations for improvement are facilitated by the preparation of the cybersecurity service group under the ICT back-office arrangement (BOA) lead by IHI JU.

Awareness-raising activities are held regularly for the benefit of the JU's staff to draw their attention to the importance of protection of assets and information, especially towards phishing campaigns for the staff members and redteaming exercises performed on an annual basis with the support of European Union Agency for Cybersecurity (ENISA) and CERT-EU for the IT experts.

Security recommendations and assessments for Microsoft 365 were performed by CERT-EU and Microsoft. Suggested improvements were immediately taken on board and implemented with the help of the ICT managed services provider to the extent possible.

The JU Local Information Security Officer (LISO) continued participating in the dedicated DIGIT Interinstitutional Committee for Digital Transformation (ICDT) CyberSecurity sub-group and the CERT-EU stakeholders forum. The new roles of LCO has been taken by the IT Officer.

2.6.3.4 Logistics and facility management

In addition, logistical support continued to be provided in the context of general administration. This encompasses the management of the supply and maintenance of equipment, namely stationery, goods and services for administration, and includes the monitoring of services provided in particular through the Office for Infrastructure (Brussels), the Translation Centre and the Publications Office of the European Union.

In consideration of the end date of the current usufruct contract (31.12.2024), the Clean Hydrogen JU launched an exceptional negotiated procedure end of 2023, and the new contract will be signed in the course of 2025. This procedure is part of the back-office arrangements for procurement matters common to the JUs in application of Article 13 of the basic act establishing the JUs (127). The new contract will enter into effect on 01 January 2025.

Logistical management and facility management were adapted to the new ways of working, in line with the Commission decision on new ways of working and hybrid working.

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The Clean Hydrogen JU continued to use remote working capabilities as an integrated way of working; dynamic approaches to the use of office space and use of modern and wireless technologies as a valid sustainable alternative which represents a significant benefit in terms of environmental footprint, efficiency, and work-life balance. The failover solution for damaged or missing device was also kept, giving the possibility to work with a virtual desktop solution on a private device. This was extensively used by the extra-muros work without any additional investment.

The JU challenged also in 2024 the office design and space allocation for staff members when working in White Atrium. This project will materialize in 2025 but as preliminary steps, a big clean-up exercise of the paper archives was done and in-depth inventory check followed by some disposals of obsolete pieces of equipment.

2.7 Human Resources

2.7.1 HR Management

Staff selection and recruitment

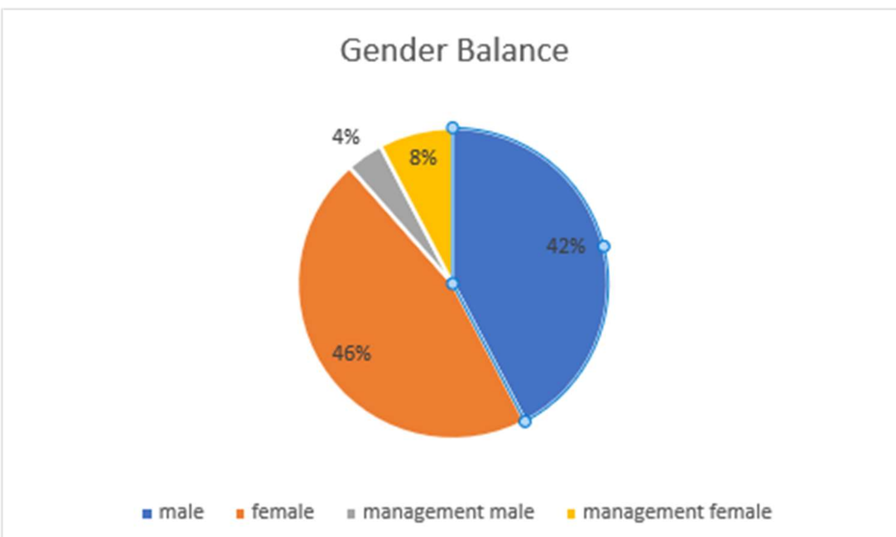
The staff establishment plan (SEP) allows for 27 Temporary agents, 2 contract agents and 3 SNEs.

On 31/12/2024, there were 25 positions occupied for Temporary Agents, 1 for Contract Agents and 2 SNEs.

In 2024, the new Executive Director, the Synergies Officer and Audit and Internal Control Manager joined the Clean Hydrogen JU. During 2024, the following selection procedures were completed: Financial Officer, Assistant to the Executive Director while the selections of a SNE and the Knowledge Management Officer were ongoing.

FIGURE 24. STAFF STATISTICS: (A) GENDER BALANCE AND (B) NATIONALITIES

Gender Balance



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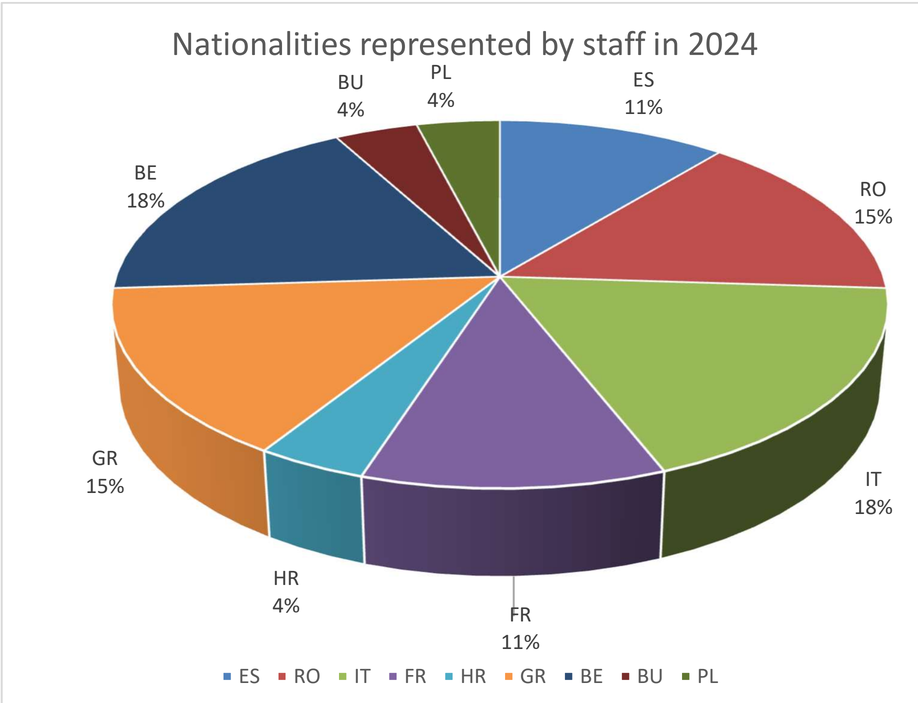
Geographical Balance



Learning and professional development

Most trainings followed by Clean Hydrogen JU staff members in 2024, were on Lump sum, SUMMA and the new Experts Management tool (eExperts).

In order to create more synergies between the JUs especially in the HR area, several trainings have been organized by one JU and were available to staff of all the JUs as mentioned in the Table 24.

TABLE 22. TRAINING OVERVIEW

Name of training	Organized by	Given by
Anti-fraud awareness session	SESAR JU	SESAR JU
Cyber security awareness training	IHI	European Commission
Prevention of Harassment for JU managers	IHI	External trainer
Respect and dignity at the workplace (for managers)	IHI	E&Y

TABLE 23. STAFF IMPLEMENTING RULES (SIR) ADOPTED IN 2024

SIR implemented in 2024	
Title of the SIR	**Reference and date of the GB decision (if relevant)**
IR on the prevention of and fight against psychological and sexual harassment	N/A: adopted by analogy

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2.7.2 Efficiency gains and synergies

In 2024, under the BOA HR, the Joint Undertakings have continuously maximised their synergies and have implemented several actions in three HR main areas: selection and recruitment, HR legal framework and HR digitisation. In particular, by holding bi-monthly meetings the JUs have continued to promote best practices, ensure consistent HR support services, and achieve efficiencies and economies of scale.

In line with the HR BOA action plan 2024, the JUs have:

- implemented a common online assessment solution for remote proctoring services to support the running of written tests as part of selection procedures. To this end, a SLA among JUs was signed in September 2024 to proceed with the purchase of the above-mentioned services;
- launched a series of workshops to align and harmonise the selection recruitment procedures practices among JUs;
- strengthened their cooperation by:
- organising an HR Officers Away Day to share best practise and shape collaboration;
- sharing reserve lists to shorten time to recruit;
- providing expertise and resources allowing staff members to be panel members in several selection procedures at other JUs;
- supporting new joint undertakings during their on-boarding/start-up phase, providing guidance, advice and templates
- centralising the organisation of training courses of general interest for all JUs (e.g., ethics and integrity, antifraud, respect and dignity at the workplace for JU staff members, cybersecurity training courses for JU staff);
- contributing to developing a common JU HR legal framework by sharing ED and GB decisions on diverse HR regulatory topics;
- launching a new call for interests for the JUs confidential counsellors, and supporting the communication campaign on the role of confidential counsellors in the JUs;

BOA Accounting

The JUs took over the Accounting services that until 30 November 2022 were provided by DG BUDG and succeeded in implementing the BOA for Accounting Services in 2022, and immediately for the accounting closure 2022.

EU-Rail is the lead JU of this BOA and concluded the SLA with the other JUs on 16 December 2022. Accounting services will be provided by 3 Accounting Officers coming from the following JUs: CA JU, SESAR JU and EU-Rail JU.

Organisation:

The Executive Director of the Lead JU is responsible for the organization, oversight and coordination of the accounting services to the other JUs on the basis of an annexe of the BOA SLA.

The Head of Corporate Services or another officer with the necessary grade, skills and competencies of the Lead JU shall act as Accounting Coordinator of the BOA Accounting Officers.

The Accounting Officer(s) of the JU Accounting Providers delivers the service to one or more JU Accounting Beneficiary and is responsible for the accounts she/he signs off, while counting on the support and coordination with the lead JU.

In order to ensure the provision of these services, it was agreed between the EC and the JUs to make use of the support of 3 additional Contractual Agents and of an external Accounting Services provider.

The BOA for Accounting services are fully operational and are delivering the intended services, including the preparation of the Annual Accounts for 10 Joint Undertakings. As of January 2024, the BOA team is composed of 3 Accounting Officers supported by 3 Accounting Assistants.

BOA HR

BOA Procurement

Although the primary objective of the BOA Procurement concept was to centralise administrative procurement capability to enhance the synergies among the JUs and to increase their operational efficiency, a closer cooperation across 2023 and 2024 proved that despite limited resources the JUs managed to establish in a very short period an effective mechanism of a joint services' model.

The BOA Procurement concept was presented recently during the NAPO 2024 annual conference which is hosting Head of Procurement units and sectors working in different EU Bodies, Regulatory and Executive Agencies. The feedback received from the audience was very positive, full of appreciation and interests. This just confirms the scale of the achievement reached by the JUs and reinsures the coordinator that the investment in the form of time and engagement dedicated to the BOA Procurement is worth it and that the collaboration in the area of public procurement and contract management should continue.

Through joint initiatives in the area of public procurement and contract management for subjects of common interest and use, the JUs complement each other and work in synergy towards an economically efficient way of use of its available a resources and establishment of a higher negotiation power.

Sharing knowledge and best practices as well as providing legal/procurement support by the entities possessing specific expertise and practical experience in management of call for tenders leads to time and costs savings among participating JUs. At the same time an interchangeable system among the members of the BOA Procurement performing role of a LCA allows to optimise the use of resources.

Integration and balancing of individual efforts provide a smooth and harmonious teamwork and makes possible to achieve greater result. By publication of inter-institutional calls for tenders, the JUs increase the purchasing power which affects the response of the market.

The higher volume of the services to be purchased, the greater the interest of large economic operators. The increase of a volume of services also minimalizes the risk of cancelation of procedures, since the contracting authority draws the attention of companies more familiar with EU Institutions procurement process and procedures.

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Finally, inter-institutional calls for tenders help to eliminate the saucissonnage effect by replacing the number of individual low value contracts with a more solid 4 years' instrument of a framework contract and thus contributing to the compliance with the applicable procurement and financial rules.

Among challenges and areas for a further process improvement the BOA Procurement Coordinator has identified the following items:

- A need for more strategic public procurement planning targeting long term perspective and taking into consideration the European Commission's resources offered to the JUs aiming to innovate the organisation of work of the JUs by different tools to be developed like, for example, AI (artificial intelligence);
- A need for more efficient synchronisation of individual procurement needs with the BOA Procurement bi-annual planning;
- A need to reduce a red-tape and an unnecessary administrative burden linked to the signature of a memorandum of understanding every time a new joint procurement procedure or a new joint specific contract is going to be award and signed by a leading JU on behalf of participating JUs;
- A higher workload for the JUs providing services under the BOA Procurement (coordination & implementation of inter-JUs procurement procedures) impacting their business operations in other areas requiring legal expertise and a legal officer's involvement (e.g. calls for proposals, grants management, litigation, recoveries, audits preparation and implementation, access to documents requests, data protection, partnership management, governance advice, etc.).

The BOA Procurement addressing common administrative needs of the JUs has proved to be successful. Despite limitations in resources, the JUs managed to establish an effective mechanism of joint services model recognised by other EU institutions, Agencies and Bodies.

BOA ICT

The Clean Hydrogen JU and the IHI JU co-lead the BOA ICT, which continues the common approach to ICT services before 2024, referred to as a "pre-BOA" for ICT.

In 2024, in continuation of the practice over the previous years, the JUs held 4 ICT coordination meetings (called "IT gov meetings"), during which:

- The implementation of the common ICT annual work plan and budget for 2024 (AWP2024) was monitored.
- The common ICT annual work plan and budget for 2025 (AWP2025) was defined, with an adoption during the meeting of November 2024.

The AWP2024 contains the following 7 actions and related budget:

- Action 1. Back-office IT (BOA) implementation
- Action 2. Common infrastructure migrations
- Action 3. Upgrade of AV Equipment in Common Meeting Rooms
- Action 4 Cybersecurity – data protection – Infosec regulation

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- Action 5. EULogin integration with M365 ?
- Action 6. SaaS O365 assets
- Action 7. reconversion White Atrium building

The actions of the AWP 2024 were implemented in accordance with the plan.

The AWP2025 includes the following actions:

- Action 1. BOA ICT implementation on Governance and Management of shared infrastructure (see below)
- Action 2. Next FWC for ICT Managed services
- Action 3. Upgrade Common Meeting rooms
- Action 4. Internet line provider
- Action 5. Security regulation(s) related to Service #5 - Security and compliance management on CERT-EU Services, Infosec regulation, Business Continuity Plan and Disaster Recovery Plan, and Cybersecurity Regulation
- Action 6. SaaS O365
- Action 7. Windows 11 migration
- Action 8. reconversion of White Atrium building

In parallel, the JUs drafted the Service Level Agreement and Description of Services, describing the services to be provided under the BOA ICT in accordance with the priorities set forth in the BOA ICT concept note adopted by the Governing Boards in early 2024, namely:

- Service area #1 Inter-JU IT Governance,
- Service area #2 Management of shared ICT infrastructure and Service area #4 Workplace services provision,
- Service area #5 Security and compliance management;

The SLA and Descriptions of Services were signed by the EDs of 10 Joint Undertakings until the end of 2024, paving the way for BOA ICT implementation, fully in accordance with Article 13 of the SBA and continuing the shared practices of the past 14 years as from 1st January 2025.

The JUs, as interinstitutional partners, have also attended meetings held by the European Commission on the HR transformation programme that intends to set up a new IT platform to replace SYSPER.

The JUs will further strengthen this collaboration in 2025.

3 GOVERNANCE

3.1 Major developments

In 2024, a new Executive Director was appointed (see the following section for related and subsequent activities). In addition, a new Chair of the Governing Board was elected.

3.2 Phasing-out plan monitoring

In December 2023, in accordance with the provisions of Article 17(2)(a1) of the SBA and Article 10(2)(c) of the Horizon Europe Regulation, the Clean Hydrogen JU adopted a phasing-out plan focused on the administrative and operational adaptations needed for a 'winding-up procedure'.

It is expected that an updated version of the Plan will be prepared and adopted in Q1 of 2025.

During the year 2024, no specific activity regarding the monitoring of the winding up procedure was needed, in view of the recent adoption of the plan and the start of the JU activities.

The previous sections of this document do however report on the achievements in reaching towards JU objectives and overall policy objectives.

3.3 Governing Board

The Governing Board of the JU comprises three representatives from the European Commission representing the EU, six from Hydrogen Europe and one from Hydrogen Europe Research.

The GB chair was Ms Melissa Verykios, until 22 October 2024, when she was replaced by Ms Danica Maljković, representative of the Industry Grouping (Hydrogen Europe). The Vice-Chair was Ms Rosalinde van der Vlies, Director of Clean Planet at DG Research and Innovation and representative of the Commission.

During the year, the Governing Board held three meetings, on 27 February, 26 June and 22 October.

All the meetings focused on strategic issues and discussions on the progress of the programme and included updates from the members on policy developments and Horizon Europe.

The first meeting, in February, was mainly dedicated to discussions regarding the SRIA amendment, the AWP 2025 strategic priorities, the Stakeholders Group composition, an update on synergies and the Report on national and regional policies on Hydrogen (2023).

In June, the main topics included discussion on SRIA amendment, on the AWP 2025 status (including topics/budget), the contribution to the administrative costs of the JU, an update on the Hydrogen Week, an update on synergies, a presentation on the Report on national and regional policies on Hydrogen (2023), the status of JU current multi-annual budget for the period 2021-2031, an update on mid-term evaluation and on guidance for the phasing-out plan, a presentation on next multiannual financial framework (MFF) and perspective for a new partnership/JU.

The third meeting, in October, tackled the introduction of new GB members, including the election of the new Chair (Ms Danica Maljković), an update on the status of the SRIA amendments, the presentation on Use of 2024 additional budget and RePowerEU 2025, an update on AWP 2025

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(including budget), and update on Hydrogen Week including budget, an update on phasing-out plan, a presentation on the findings of the IAS audit on operational synergies, an update on synergies.

The GB also adopted major decisions by written procedure, which are:

- CleanHydrogen-GB-2023-22 - Approval of 5 April 2024 of the meeting minutes of 26.10.2023
- CleanHydrogen-GB-2024-02 - Approval of 11 April 2024 of the Back-Office Arrangements for procurement, information and communication technologies, and human resources
- CleanHydrogen-GB-2024-03 - Approval of 12 April 2024 of adopting the first amendment to the Clean Hydrogen JU 2024 Annual Work Programme and approving additional lists of actions selected for funding under the Clean Hydrogen Joint Undertaking call for proposals with reference HORIZON-JTI-CLEANH2-2023-1
- CleanHydrogen-GB-2024-04 - Approval of part 2 of the minutes of the meeting of the GB of 27 February 2024 – item 12 'Selection of Executive Director – interviews with candidates and decision'
- CleanHydrogen-GB-2024-05 - Approval of 2 May 2024 part 1 of the minutes of the meeting of the GB of 27 February 2024 – items from 1 to 11
- CleanHydrogen-GB-2024-06 - Adoption of 7 May 2024 of the selection of the new Members of the Stakeholders Group of the Clean Hydrogen JU
- CleanHydrogen-GB-2024-07 - Approval of the 26 June 2024 of the Consolidated Annual Activity Report for 2023 including the corresponding expenditure and its assessment
- CleanHydrogen-GB-2024-08 - Adoption of the first amendment of the SRIA of 28 June 2024
- CleanHydrogen-GB-2024-09 - Adoption of the 26 June 2024 of the GB's opinion on the 2023 Annual Accounts of the Clean Hydrogen JU
- CleanHydrogen-GB-2024-10 - Adoption of 8 November 2024 of the minutes of the GB meeting of the 26 June 2024
- CleanHydrogen-GB-2024-11 - Adoption of 5 August 2024 of the list for funding resulting from the evaluation of the call for proposals HORIZON-JTI-CLEANH2-2024-1
- CleanHydrogen-GB-2024-12 - Adoption of 27 September 2024 of the additional list for funding resulting from the evaluation of the call for proposals HORIZON-JTI-CLEANH2-2024-1
- CleanHydrogen-GB-2024-13 - Adoption of 18 November 2024 of the second amendment to the Clean Hydrogen JU 2024 Annual Work Programme and Budget
- CleanHydrogen-GB-2024-14 - Adoption of 3 December 2024 of the second additional list for funding resulting from the evaluation of the call for proposals HORIZON-JTI-CLEANH2-2024-1
- CleanHydrogen-GB-2024-15 - Adoption of 17 December 2024 of the Clean Hydrogen JU's annual work programme and budget for 2025

More information on the role and composition of the Clean Hydrogen JU Governing Board is available on the JU's website (https://www.clean-hydrogen.europa.eu/about-us/organisation/governing-board_en).

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3.4 Executive Director

The Executive Director, Ms. Valérie Bouillon-Delporte, started her mandate on 1st June 2024.

3.5 States Representatives Group

Established in 2022, the States Representatives Group (SRG) has 75 members, of which 64 representatives (main and alternate) are from the 27 Member States and 11 representatives are from 5 Associated Countries (4 Associated Countries have not nominated a representative).

In 2024, the SRG met on 29 May and 3 October. Its activities focused on following up the JU's work and results and advising the Governing Board accordingly, including the following:

- During the June meeting, the SRG members were updated on the European Commission initiatives on Hydrogen, on the status of the call for proposals in 2024 and on the progress of the discussion on topics of the call for proposals in 2025. The Chair presented the opinions on the AAR 2023 and discussions were held on the process and expected content of the Report on national and regional policies related to Hydrogen due by the end of 2024;
- At the October meeting, the Programme Office presented the status of the call for proposals in 2024, sharing the call results, and updated the SRG members on the AWP for 2025, on the Hydrogen Week and on the Cooperation with Member States. The Chair presented the template and process of the "Report describing the national or regional policies and identifying specific ways of cooperation" (SBA Article 20(9) and (10)).

The formal consultation of the SRG took place in April 2024 regarding the Annual Activity Report for 2023 and in November regarding the Annual Work Programme for 2025. Both consultations concluded with positive opinions provided to the Governing Board, with some comments taken into account by the Programme Office.

The report on national and regional policies on Hydrogen (2024 version) was under construction development and consolidation at the end of 2024, prior to its submission to the Governing Board in the beginning of 2025. It includes the contributions of 19 countries and covers, for each country, the following content:

1) Policy initiatives and programmes on Hydrogen;

2) Hydrogen research and innovation update;

3) Demonstrations, deployment and uptake;

4) Dissemination events, dedicated technical workshops and communication activities;

5) National or regional policies and initiatives for complementarity with SRIA and AWP;

6) Government and collaborative Hydrogen funding;

7) Specific ways of cooperation of MS and Countries with the actions funded by the Clean Hydrogen JU.

3.6 Scientific Committee

N/A

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3.7 Stakeholders Group

The Stakeholders Group is an official advisory body, to be consulted on various horizontal issues or specific questions in areas relevant to the work of the Clean Hydrogen JU.

On 2 February 2022, following a Call for Expression of Interest, the members of the Stakeholders Group were appointed for a four-year term. However, considering the need to ensure full sector coverage, as well as geographical and gender balance, the Governing Board decided that the composition of the Stakeholders Group would be reassessed in 2023 for the remainder of the four-year period.

Thus, the Clean Hydrogen JU launched a new Call for Expression of Interest for new Members open to all candidate groups or sector representatives. The Call closed on 15 February 2024 with 17 new expressions of interest.

On 7 May 2024, the new five members of the Stakeholders Group, Europe's Rail Joint Undertaking, European Committee of the Regions, EIT Urban Mobility, European Association of Automative Suppliers and WIVA P&G, were appointed by the Governing Board and participated to their first meeting on May 30th 2024. A second meeting took place on October 2nd 2024.

On these meetings, the members were informed of the progress of activities of the JU, particularly those concerning synergies, but also presented their activities in relation to hydrogen. The members were asked to comment on the priorities and topics for the 2025 Annual Work Plan, particularly identifying potential for synergies, on two moments: May/June and October/November. The replies were analysed and taken into account accordingly. The activities of the SET-Plan concerning hydrogen were also presented on both meetings by the chair, Nils Røkke.

Bilateral meetings with members of the SG also took place, particularly EU-RAIL, EIT Urban Mobility, S3P Hydrogen Valleys and Waterborne Technology Platform.

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4 FINANCIAL MANAGEMENT AND INTERNAL CONTROL

4.1 Control results

This section focuses on the results generated by the whole internal control system and presents other related information that supports management assurance of the achievement of the financial management and internal control objectives.

The Governing Board adopted the revised internal control framework on 16 August 2018. The Clean Hydrogen JU applies mutatis mutandis the components, principles and characteristics laid down in the internationally acknowledged Committee of Sponsoring Organizations of the Treadway Commission model of internal control, in line with the European Commission's internal control framework. Internal control systems and procedures are applicable at all levels of management and are designed to provide reasonable assurance of achieving the following objectives:

- effectiveness, efficiency and economy of operations;
- reliability of reporting;
- safeguarding of assets and information;
- prevention, detection, correction and follow-up of fraud and irregularities.

4.1.1 Effectiveness of controls (ex-ante and ex-post controls)

Control results regarding the legality and regularity of operations, fraud prevention and other control objectives - in particular the safeguarding of assets - are detailed in the subsequent sections.

4.1.2 Legality and regularity of the financial transactions

The control objective is to ensure that the Clean Hydrogen JU has reasonable assurance that the **total amount of any financial operation** authorised during the reporting year, which would **not** be **in conformity** with the applicable contractual or regulatory provisions, **does not exceed 2 % of the authorised payments** or revenue concerned. To reach this conclusion, the Clean Hydrogen JU reviewed the results of the key controls in place. For each item, materiality is assessed in accordance with Annex 14.

Despite the large number and magnitude of transactions, the Clean Hydrogen JU's residual error rate has not only stayed below the target threshold of 2% but has decreased from 0.59% in 2023 to 0.51% in 2024. This is the first time, the Clean Hydrogen JU has obtained such a low error rate, which was detected by *ex post* audits covering operational expenditure (grants) and showed the effectiveness and efficiency of the Clean Hydrogen JU's *ex ante* controls at the programme level.

In order to get a low error rate, the JU must achieve the main objective of *ex ante* controls: to ascertain that the principles of sound financial management have been applied.

Table 24 outlines and compares the main principles of *ex ante* and *ex post* controls.

TABLE 24. *EX ANTE* AND *EX POST* CONTROLS

	EX ANTE CONTROLS	EX POST CONTROLS
When?	**Before** the transaction is authorised	**After** the transaction is authorised
Frequency?	Mandatory on **all** transactions	Made on a **sample** basis

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How?	Mainly **desk review** of supporting documents, requests for clarification (e.g. beneficiaries' proposals and reports) and available results of controls already carried out relating to the operational and financial aspects of the operation.	Mainly **on-the-spot** checks at the beneficiary's premises
Impact?	Errors detected should be corrected **before** the transaction is approved	Errors detected (e.g. ineligible expenditure) should be corrected through **recovery orders** or offsetting with future payments
Level of assurance?	**Primary** means of ensuring sound financial management and legality and regularity of transactions, but based on desk review of available evidence.	**Secondary** means of ensuring sound financial management and legality and regularity of transactions, but more robust as normally carried out 'on the spot'

The Clean Hydrogen JU has developed and continues to apply procedures defining the controls to be performed by project and finance officers for every financial claim, invoice, commitment, payment and recovery order, taking into account risk-based and cost-effectiveness considerations.

For operational expenditure, the processing and recording of transactions in ABAC are performed using the corporate IT tools (System for Grant Management (SyGMa) and COMPASS) for H2020 and Horizon Europe grants and experts, which ensures a high degree of automation, and the controls are embedded in each workflow.

4.1.2.1 Ex-ante control activities in 2024

The implementation of ex-ante controls appropriate to the characteristics of each transaction remains the **primary means** of ensuring sound financial management and legality and regularity of transactions. Ex-ante control is obligatory on all transactions, and errors detected during such controls should be corrected before the transactions are approved. When well-constructed and supervised, ex-ante checks can identify and prevent irregularities, allowing for immediate correction and avoiding time-consuming recovery action. Analysing the results of ex-ante controls can identify systemic errors which need to be addressed through revisions to the internal control system or other action (such as information or training for staff).

The Ex ante control activities in 2024 included:

- assessment, request for clarifications and signature of the 6 GAPs of the call 2023 using actual costs and 16 GAPs of the call 2024 using the lump sum scheme;
- large number of targeted financial webinars focused on the specificities of each project using actual costs within 6 months after the GAP signature;
- assessment, request for clarifications and payment of 41 periodic reports of the H2020 programme and 25 periodic reports of the Horizon Europe programme based on the "*Guidance H2020 ex-ante controls on interim & final payments*" and "Guidance on Horizon Europe - ex-ante controls" issued by the Commission;

- reinforced monitoring and targeted checks during *ex ante* controls for interim and final payments, in accordance with the H2020 and HE *ex ante* control strategy;
- interactions and clarifications between coordinators/beneficiaries and Project Officers and Financial Officers;
- reinforced internal review through internal meetings between Project and Financial Officers;
- double funding and plagiarism checks.

TABLE 25. GUIDANCE AND MANUALS USED TO ASSESS THE GAPS AND PAYMENTS

Manuals		
	GAPs	**Interim and final payments**
H2020 programme (2014-2020)	Finished programme, no more GAPs to be signed	Guidance on H2020 ex-ante controls on interim & final payments
Horizon Europe programme (2021–2027)	• Internal guidance • Guidance: Horizon Europe - ex-ante controls	Guidance on Horizon Europe - ex-ante controls

Regarding the GAPs, the internal guidance for grant agreement preparation has been updated based on the Horizon Europe rules, allowing the first grants signed under Horizon Europe to be compliant with these new rules.

Regarding the interim and final payments, a key element of the ex-ante controls applicable to the H2020 and Horizon Europe grants of the JU is the two related guidances issued by the European Commission to streamline and standardise ex-ante control procedures throughout the Research 'family'.

The Horizon Europe *ex ante* controls guidance (version 01 September 2023) is the first guidance published for the Horizon Europe programme, helps staff with ex ante control checks. It describes the common ex-ante control procedures to be implemented for Horizon Europe (HE) grants (at the grant agreement preparation (GAP), amendments (AMD) and payments (REPA) stages) and provides guidance on streamlining and standardising practices throughout Horizon Europe implementing services.

The Clean Hydrogen JU published the call for proposals 2024 using only lump sum grants. Beneficiaries to lump sum grants do not have to report actual costs and there are no financial declarations to be made nor reviewed. Lump sums remove the obligation of financial reporting, checks, reviews or audits related to actual costs and resources used. By doing so, it will reduce the financial error rate.

As there won't be any financial audits and no JU's representative error rate on the Horizon Europe grants using lump sum (e.g. call 2024), the Horizon Europe Control Strategy for the Research family is characterised by a risk-based approach and details how the HE control system will maintain a balance between economy, effectiveness and efficiency in the achievement of the HE programme goals. In that respect, the error rate from the *ex post* audits of HE projects will be a single aggregated risk-based error rate based on all JUs' error rates and not an error rate at each JU level. The first HE projects signed in early 2023 with a 12-month reporting period were selected for audits in 2025 as part of this new risk-based audit strategy. In addition, a risk-based *ex ante* control methodology will be applied in all grant

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management cycles in order to prevent the error from (re-)appearing. The more significant the risk (detected), the higher the intensity of risk-based *ex ante* controls.

4.1.2.2 Value and share of the operational transactions

The overview of the administrative and operational expenditures in terms of amounts and percentage provides an idea of the size of the transactions. Table 26 provides the total payment execution.

TABLE 26. TOTAL PAYMENT EXECUTION IN 2024

Total payments execution in 2024		
Operational budget	195 payments	120 948 018
Administrative expenditure	458 payments	6 046 219
Total	653 payments	126 994 237

Table 27 and Figure 25 present the amounts and shares of operational and administrative expenditure.

TABLE 27. AMOUNTS AND SHARES OF OPERATIONAL AND ADMINISTRATIVE EXPENDITURE

Payments made	Amounts (EUR)	%
Operational expenditure		
H2020 - grants	14,715,600.56	11.59%
H2020 - studies	850,966.19	0.67%
Horizon Europe – grants	98,891,625.70	77.87%
HE – studies	1,573,139.68	1.24%
HE – JRC	716,923.33	0.56%
HE – Experts	599,763.17	0.47%
RePowerEU	3,599,999.40	2.83%
Administrative expenditure	6,046,219.20	4.76%
Total	**126,994,237.23**	**100%**

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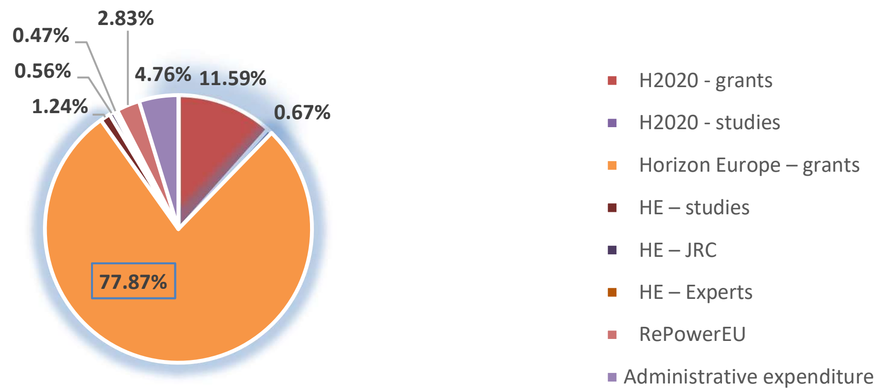
FIGURE 25. SHARES OF OPERATIONAL AND ADMINISTRATIVE EXPENDITURES



As for the share of expenditures, **grant management** represents more than **90 %** of the total 'payments made' while procurement accounts for 1.24% and expenditure payments for 4.76%.

Since a large part of the budget is implemented via H2020 and Horizon Europe grants with actual costs, the main control activities focused on *ex ante* and *ex post* controls in this area.

4.1.2.3 Ex post control of operational expenditure and error rates identified

Ex-post controls are defined as the controls executed to verify the financial and operational aspects of finalised budgetary transactions in accordance with Article 23 of the JU Financial Rules ([80]). Ex post controls are the final stage of the Clean Hydrogen JU's control strategy in the project lifecycle.

Ex-post audits have three main objectives:

- to assess the legality and regularity of expenditure on a multi-annual basis;
- to provide an indication of the effectiveness of the ex-ante controls;
- to provide the basis for corrective and recovery mechanisms.

The ex-post audit activities for EU Framework Programmes for R&I grants are fully centralised in the Common Audit Service (CAS) of the Directorate-General Research and Innovation (DG R&I). This contributes to a consistent harmonised audit approach and aims at reducing the audit burden for beneficiaries, who participate in projects with several granting authorities of the R&I family. The implementation of the audit results remains under the responsibility of the individual granting authorities.

Clean Hydrogen JU uses two types of audits to arrive at a substantial representative coverage across beneficiaries as well as to identify and correct irregularities by providing coverage of certain participants' risk profiles:

- **Representative audits** contribute to an error rate representative of the whole JU population. This kind of audit is conducted based on representative samples in accordance with the sampling methodology identified in the ex-post audit strategy. Each sample includes a combination of the largest cost claims by beneficiaries and randomly selected entities.

(80) GB DECISION FCH-GB-2019 (18.12.2019) , Article 23

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- **Corrective audits** aim to identify and correct irregularities and allow the coverage of certain risk profiles through risk-based audits. This kind of audit provides with flexibility, ensuring risks are adequately addressed.

The main indicators on legality and regularity for the programme delegated to Clean Hydrogen JU are:

- **The cumulative representative error rate (RepER)** based on errors detected by ex post audits. It provides a reasonable estimate of the level of error in the population relating to the accepted Clean Hydrogen JU contributions on completion of the audits but does not take into account the corrections and follow-up undertaken.
- **The cumulative residual error rate (ResER)** is the level of error remaining in the population after deducting corrections and recoveries made by Clean Hydrogen JU. It includes the extension of audit results to non-audited financial statements of the audited beneficiaries to correct systemic errors.

The formulas for the calculation of the cumulative representative error rate and residual error rate are presented in Annex 12 – Materiality Criteria.

The targets set for the control system are, respectively:

- For H2020, to ensure that the cumulative residual error rate remains within a range of 2-5%, aiming to be close as possible to 2%.
- For Horizon Europe, (actual costs) to ensure that the cumulative detected and residual error ates do not exceed 2%.

Progress against these targets is assessed annually based on the results of the implementation of the ex-post audit strategy and taking into account the frequency and importance of the detected errors along with the cost-benefit considerations regarding the effort and resources needed to detect and correct the errors.

It should be noted, however, that due to its multi-annual nature, the effectiveness of the ex-post control strategies of the R&I Family can only be measured and assessed fully in the final stages of the EU Framework Programme, once the ex-post audit strategies have been fully implemented and errors, included those of systemic nature, have been detected and corrected.

Horizon 2020 (H2020) Programme

H2020 Audit objective

For the Clean Hydrogen JU, an initial target of 295 participations [(81)] was defined. Thanks to positive audit results (residual error rate of -0.51% as of 31 December 2024) and to the significant ex post audit coverage achieved, the initial target was reduced to 250 participations. in 2022.

By 31 December 2024, 201 participations were selected to be audited. The Table 28 gives an overview

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[81] Participation is defined as a combination of a beneficiary and a grant. For example, audits are launched at the beneficiary level and can include up to three different grants. For the achievement of the CAS targets, an audit with one grant agreement is counted as one participation, whereas an audit with three grant agreements is counted as three participations. For the initial Clean Hydrogen JU targets, an average of two participations was envisaged to be included in each ex post audit (based on the FP7 statistics).

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of the status of the individual audit assignments as of 31 December 2024.

TABLE 28. NUMBER OF H2020 PARTICIPATIONS AUDITED - STATE OF PLAY UP TO 31 DECEMBRE 2024

Audits	NUMBER OF PARTICIPATIONS					
	Initial target	Revised target	Selected for audits	% (selected /revised target)	Audited (audited closed)	Being audited (audit on-going)
Corrective audits (including CRaS & Top-up)			**74**		**67**	**7**
Representative audits			**127**		**112**	**15**
Total up to 31 December 2024	295	250	201	80%	179	22

H2020 Audit coverage (cumulative)

The Clean Hydrogen JU selected corrective and representative audits to reach the 25% audit coverage of H2020 expenditure (to be reached by the end of the framework programme) and support the annual declaration of assurance.

By 31 December 2024, the overall audit target had been exceeded and provide sufficient and timely basis for assurance of achievement. The table below shows the coverage in completed audits (representative and risk based) compared to the accepted Clean Hydrogen contribution per year.

TABLE 29. EX POST AUDITS, DIRECT AUDIT COVERAGE UP TO 31 DECEMBER 2024 (H2020 EC CONTRIBUTION)

YEAR	EC CONTRIBUTION IN MIL. EUR				
	Accepted	Selected for audits	Cumulative coverage	Audits closed	Cumulative coverage
2017	37.09	8.14	21.95%	1.47	3.96%
2018	58.65	10.8	19.78%	4.71	6.45%
2019	98.53	27.27	23.79%	11.39	9.04%
2020	70.03	48.48	35.83%	23.84	15.67%
2021	88.62	17.38	31.76%	13.89	15.67%
2022	59.12	15.69	31.01%	26.02	19.74%
2023	93.07	19.87	29.23%	44.22	26.86%
2024	44.13	26.89	31.77%	12.64	25.16%
Total up to 31 December 2024	**549.24**	**174.52**	**31.77%**	**138.18**	**25.16%**

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The Table 30 shows the distribution of the two main audit streams.

TABLE 30. CLASSIFICATION OF PARTICIPATIONS SELECTED FOR EX-POST AUDITS AS OF 31 DECEMBER 2024

YEAR	Clean Hydrogen JU contribution in mil. EUR		
	Corrective	Representative	Total
2017	4.98	3.16	8.14
2018	2.59	8.22	10.80
2019	14.66	12.61	27.27
2020	19.86	28.62	48.48
2021	10.29	7.10	17.39
2022	5.42	10.27	15.69
2023	11.74	8.13	19.87
2024	11.03	15.85	26.88
Total up to 31 December 2024	**80.57**	**93.96**	**174.52**

Representative and residual error rate

The results of the ex post controls were measured to give reasonable assurance on the legality and regularity of the financial transaction in the reporting year. The review of ex post audit results showed that on 31 Decembre 2024:

The Clean Hydrogen representative (detected) error rate is –2.81%
The Clean Hydrogen residual error rate is –0.51%

The Table 31 provides the evolution of the residual error rate.

TABLE 31. EVOLUTION OF THE H2020 JE CUMULATIVE RESIDUAL ERROR RATE ON EC CONTRIBUTION

YEAR	JU cumulative residual error rate
2018	**-0.46%**
2019	**-0.70%**
2020	**-1.34%**
2021	**-1.73%**
2022	**-0.88%**
2023	**-0.59%**
2024	**-0.51%**

The results of the performed controls shows that Clean Hydrogen JU error rates remain below the materiality threshold of 2 % of the total expense recognised until the end of the programme.

A reservation on the financial transaction for the reporting year is therefore not necessary.

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European Court of Auditors H2020 audits

Since 2020, the European Court of Auditors (ECA) has been performing additional testing within each JU. This additional testing, based on a monetary unit sample of transactions, should provide the additional assurance required to assess the implementation of ongoing projects, and ensure the quality of the audit opinion, in line with auditing standards.

In respect of the individual discharge for each of the Clean Hydrogen JUs, the ECA will continue to provide each JU with a separate audit opinion. The opinion on the legality and regularity of underlying transactions will be assessed separately considering the following elements:

- the Clean Hydrogen JU's individual error rate from the ex post audits;
- the common error rate based on the results of the ECA's substantive testing;
- the error rate related to the transactions of a specific JU within the ECA's substantive testing;
- the correctness of the calculation of the residual error rate reported by the Clean Hydrogen JUs, based on the ex post audit results for their grant payments.

For 2024, the ECA selected and reviewed three transactions from JU participations validated in 2024.

H2020 programme – Implementation of audit results

The Clean Hydrogen JU has implemented the necessary controls and monitoring mechanisms to ensure that all errors detected in favour of the Clean Hydrogen JU are corrected in due course (either through a recovery order or by offsetting a future payment). Extension of audit findings Extension of the audit findings (formerly known as extrapolation) is the process whereby systematic errors detected in audited cost claims are extrapolated to all other non-audited JU claims from the same audited beneficiary. This means that systematic errors identified in individual cost claims of H2020 projects will be corrected in all projects of the beneficiaries concerned, including those funded by other granting authorities. For efficiency reasons, the minimum threshold for the audit extension is an average systematic error of 2% identified in the individual audits. All audit adjustments (positive, nil or negative), including extensions, are implemented via H2020 corporate tools in Sygma/Compass via an AURI (130) workflow.

The Table 32 summarises the status of the implementation of audit results for the finalised audits on a cumulative basis, as of the reporting cut-off reporting date of 31 December 2024.

TABLE 32. H2020: IMPLEMENTATION OF AUDIT RESULTS -CUMULATIVE FROM THE START OF THE MFF- STATUS UP TO 31 DECEMBER 2024

	Audit Results Processed	% Audit results processed	Audit Results Pending	% Audit results pending	TOTAL
Audit	185	95.36%	9	4.64%	194
Extensions	67	100.00%	0	0.00%	67

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TOTAL	252	96.55%	9	3.45%	261

The Table 33 summarises the time taken to implement closed audit results in the 2024 financial year for closed and ongoing projects.

TABLE 33. H2020: TIME TO IMPLEMENT CLOSED AURI IN FINANCIAL YEAR 2024

	0-6 months	% 0-6 months	above 6 months	% above six months	TOTAL
Closed projects: Negative adjustments with recovery	0	0.00%	1	100.00%	1
Closed projects: Positive or zero adjustment	8	88.89%	1	11.11%	9
On-going projects: Negative adjustments	6	100.00%	0	0.00%	6
On-going projects: Positive or zero adjustment	7	100.00%	0	0.00%	7
TOTAL	21	91.30%	2	8.70%	23

Horizon Europe

2024, was the fourth year of implementation of the Horizon Europe Framework Programme by Clean Hydrogen, and by end of 2024.

No Horizon Europe representative error rate is available in 2024 as the Clean Hydrogen JU's ex post audit campaign for the Horizon Europe Programme was launch in mid-2024, with audits to be performed in 2025.

4.1.3 Fraud prevention, detection, and correction

The Clean Hydrogen JU implements the common research anti-fraud strategy. In March 2019, the CIC adopted the revised strategy and the associated action plan. The implementation of the action plan is monitored through regular meetings of the Fraud and Irregularity Committee, in which the Clean Hydrogen JU participates.

Furthermore, for areas of expenditure other than grants, the Clean Hydrogen JU applies mutatis mutandis, by analogy, the anti-fraud strategy of DG Research and Innovation.

For Horizon Europe, the new" Guidance – Horizon Europe – Ex-ante Checks to Detect Potential Fraud (version 07/22)" helps alert staff members about additional checks. This is relevant in particular to expert management, procurement and internal fraud. The risk analysis leads to the conclusion that the residual risks (after mitigating actions) are low.

Awareness raising remains the main preventive measure. In addition to the OLAF anti-fraud training courses that took place in 2023 for the whole JU staff, Sesar JU organised three identical training sessions on the 8th, the 14th, the 19th of November 2024 (for the whole JU staff).

In the reporting year, no fraud cases involving the JU were identified, and no OLAF investigations were reported to the JU management.

Based on the above-mentioned information, the JU has reasonable assurance that the anti-fraud measures and controls in place are effective and efficient.

4.1.4 Assets and information, reliability of reporting

The safeguarding of assets provides reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of the company's assets that could have a material effect on the financial statements.

In that respect and to protect EU public funds from potential irregular or illegal application, Clean Hydrogen thoroughly applies within the grant and procurement management all the requirements regarding controls and checks following from the applicable legal framework as well as from the common methodological guidance provided by the Commission.

In addition to the safeguards aimed at financial aspects, Clean Hydrogen pays attention also to non-financial elements of its assets and information. Due care is taken with regard to personal data protection (see Section 2.2). For example, a comprehensive Data Protection Impact Assessment was carried out in connection with the Microsoft Office Online services implementation, results of which were properly documented. Measures are applied for the deployed IT tools and IT infrastructure so that information processed electronically is adequately protected from theft or loss.

Similarly, measures for physical protection of assets, documents and data contained therein are in place at the Clean Hydrogen premises. This has been ensured since 2011 by following the inventory procedure, which covers not only assets over EUR 420 but also any items below this level kept in the inventory. We keep the control effective by using our own inventory tags and perform annual physical inventory counts in relation to the assets report, which is provided to the accountant for the preparation of the annual accounts. Phaseout and impairment are also kept in a timely way in the database to support the disposal exercises performed on an ad hoc basis.

In the event of a disaster, the JU ensures the complete restoration of the system. In the common IT Security procedure for the JUs, we use cloud storage for the information management system, the JU is relying on the security measures and backup provided by the Microsoft 365 solution. Nevertheless, a cloud backup solution has been deployed as a safeguard of the retention policy of documents, together with antivirus software, firewalls and change management processes ensured by our ICT managed service providers.

Regarding cybersecurity vigilance, we use the active solution of Microsoft Defender to safeguard our storage and communication, together with the passive support and monitoring of CERT-EU for intrusion detection and weaknesses.

A comprehensive Document Management Policy is applied at the JU which is formalised by means of the respective ED Decision. Attention is paid to maintaining audit trail, mostly by means of registering files in Ares, either automatically using the Commission IT tools and systems or manually.

As for reliability of reporting, Clean Hydrogen continuously uses precise and up-to-date information for reporting purposes, most notably for the production of its consolidated annual activity reports. In this respect, especially in the field of EC grant management deployed by Clean Hydrogen (Compass, SyGMa, Corda), used as the primary source for collecting various sets of data but not only. These are further complemented by internal tools, databases and repositories such as the Observatory, TRUST platform and Knowledge hub (see section 1.5.1.1).

4.1.5 Efficiency of controls ("Time to")

TIME-TO-PAY ([82])

Operational payments

H2020

In 2024, 41 (21 interim and 20 final) H2020 reports were assessed (53 in 2023). The overall time to pay (TTP) remained stable and in line with that of prior years (73 days in 2024 compared with 65 in 2023).

The gross TTP (including any suspensions due to requests for clarifications and amendments) reached 110 days (113 in 2023).

Horizon Europe

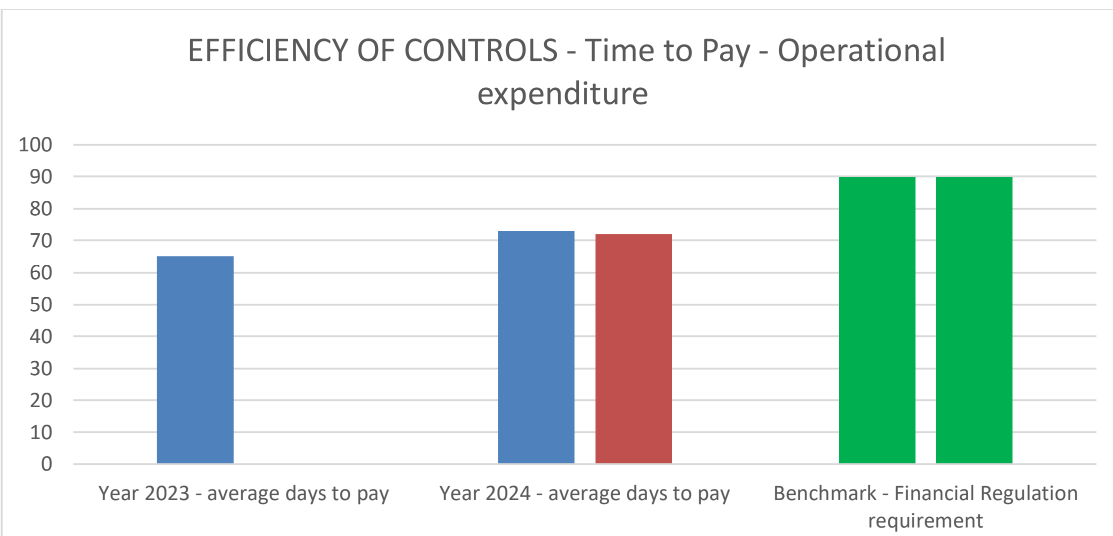
In total, 22 **prefinancing payments** were processed by 31 December 2024. The number of first HE **interim payments** amounts to 25 by 31 December 2024.

Time-To-Pay: Overall efficiency

TABLE 34. EFFICIENCY OF CONTROLS – TTP: OPERATIONAL EXPENDITURE

Framework programme - interim and final payments	Year 2023 - average days to pay	Year 2024 - average days to pay	Benchmark - Financial Regulation requirement
H2020	65	**73**	90
Horizon Europe	N/A	**72**	90

FIGURE 26. EFFICIENCY OF CONTROLS – TTP: OPERATIONAL EXPENDITURE



([82]) Art 116.1 FR: 90 calendar days for contribution agreements, contracts and grant agreements involving technical services or actions which are particularly complex to evaluate and for which payment depends on the approval of a report or a certificate.

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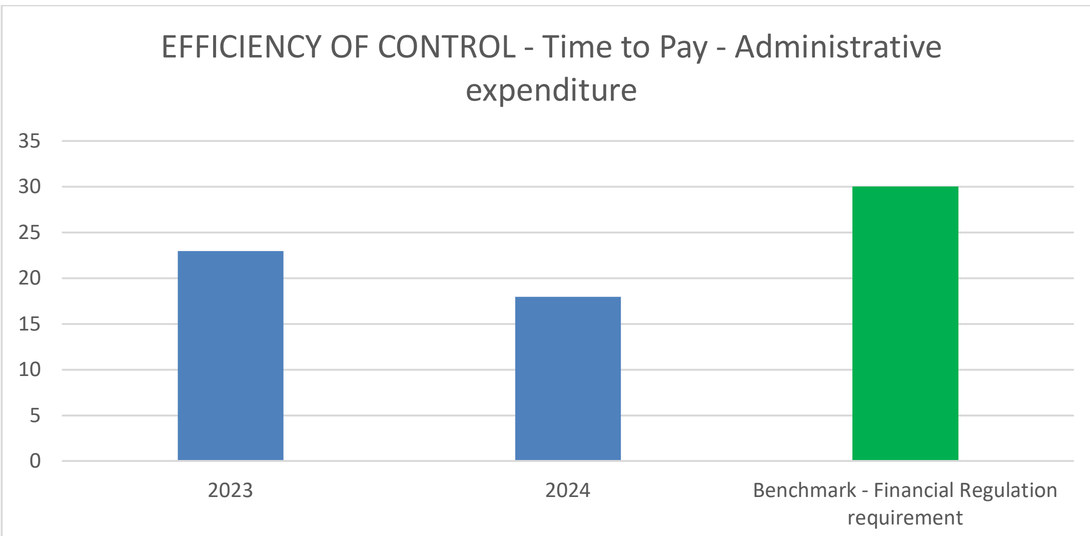
TABLE 35. EFFICIENCY OF CONTROLS – TTP: ADMINISTRATIVE EXPENDITURE

Administrative payments	2023	2024	Benchmark - Financial Regulation requirement
Average number of days	23	**18**	30

The number of days to assess and pay the administrative expenditure decreased from 23 days in 2023 to 18 days in 2024 (Table 35 and Figure 27).

FIGURE 27. EFFICIENCY OF CONTROLS – TTP: administrative EXPENDITURE



As shown by comparative analysis of an average TTP indicator over the past 2 years against required benchmarks, the Clean Hydrogen JU performed well below the limits of each of the required indicators.

This was achieved through effective monitoring and prioritising system that assesses various aspects, such as the timeliness of responses, priorities and the complexity of transactions. For complex transactions, such as final payments (based on a risk assessment), the Clean Hydrogen JU put preventive measures in place to anticipate and address any potential delays (e.g. missing certificates on financial statements)

Thanks to all these preventive and monitoring measures, the average TTP for both operational and administrative expenditure in 2023 and 2024 demonstrated high levels of efficiency.

4.1.6 Economy of controls

The **principle of economy** "requires that the resources used by the institution in the pursuit of its activities are made available in due time, in appropriate quantity and quality and at the best price."

The analysis of the economy of controls can be estimated based on their costs. Therefore, we have reported on the cost of the controls put in place in the Clean Hydrogen JU. Based on the calculation and assessment of the amount and percentage of the budget managed, we have assessed the economy

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aspect of our controls (Table 36).

TABLE 36. COST OF CONTROLS UP TO 31 DECEMBER 2024

Efficiency and effectiveness of controls until 31 December 2024	Operational expenditure/ running grants (H2020 & Horizon Europe) and newly signed grants (Horizon Europe)	Resources used on ex ante and ex post controls – estimated	Average proportion
Operational expenditure for 2024	722,253,479.63	1,558,800.00	0.22%
Number of running grants	122.00	9.00	13.56

As regards grant management, the Clean Hydrogen JU's total cost of controls, measured by the ratio of costs/to payments, is 0.22% (0.29% in 2023). This means **that the cost of controls represented 0.22% of the Clean Hydrogen JU's operational expenditure** in 2024 and can be quantified as **EUR 12,777.05** per running grant agreement.

As an additional measure of effectiveness, we consider that the residual error rate shows a stable trend over the years, well below 2 %. In 2024, in particular, we demonstrated a significant reduction in the error rate, mainly thanks to targeted risk-based *ex ante* webinars, first introduced in 2020.

Table 36 demonstrates the measurable benefits of the efficient and effective use of resources in the Clean Hydrogen JU to reduce error rates and ensure that principles of sound financial management are well understood and followed by the Clean Hydrogen JU beneficiaries throughout the lifetime of the projects, as well as the monitoring of their scientific progress. From a long-term perspective, we believe that other benefits of a preventive nature that are not directly measurable will be materialised in the future.

4.1.7 Conclusion on the cost-effectiveness of controls

Based on the most relevant key indicators and control results, the Clean Hydrogen JU has assessed the effectiveness, efficiency and economy of its control system and reached a positive conclusion on the cost-effectiveness of the controls for which it is responsible.

Nevertheless, with the introduction of the new Horizon Europe programme, accompanied by significant increases in the budget and the number of grants to be assessed, the pressure on the JU team has increased dramatically compared with 2022 and is expected to increase further in the upcoming years.

In order to ensure an adequate level of *ex ante* controls, especially for interim and final payments, the staffing issue shall also be addressed adequately ([83]).

4.2 Audit observations and recommendations

This section sets out the observations, opinion and conclusions reported by the auditors and summaries the management measures taken in response to the audit recommendations.

([83]) We refer to the top staff issue risk identified in the Risk Assessment, Section 1 of the AAR

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4.2.1 Audits of the Internal Audit Service (IAS)

Internal audits are carried out by the Internal Audit Service (IAS) of the European Commission according to Art. 28 of the financial rules.

In 2022, the IAS performed an in-depth Risk Assessment of the entire business processes of the JU and established the Strategic Internal Audit Plan (SIAP) for the years 2023 to 2025 with two audits to be carried out during that period.

End of 2024, the IAS completed the first audit on *"operational synergies"*. No critical recommendation was raised. The "very important" recommendation mentioned that the Clean Hydrogen JU should, under the guidance of its Governing Board (GB) and with input from the JU's advisory bodies, develop an overall synergies strategy and systemic approach covering the three levels of synergy listed in the Single Basic Act (SBA). The JU should also establish operational arrangements to clarify the specific roles and responsibilities of all the JU's bodies in the identification of the opportunities for synergies and establish internal processes and guidance to formalise and optimise its synergies-related practices. The recommendation was issued at the end of 2024, so it remained open at the time when the limited conclusion was issued.

In parallel, the IAS launched the second audit on *"back-office arrangements"*, with the objective to complete the audit by end of 2025.

4.2.2 Audit of the European Court of Auditors

Audit on annual accounts for the financial year 2023

In 2024, the Clean Hydrogen JU was audited on its annual accounts 2023 by the European Court of Auditors. In November 2024, the ECA published its 'Annual report on the EU Joint Undertakings for the financial year 2023.

As in previous years, the ECA issued a "clean opinion" regarding the reliability of the JU's annual accounts and on the legality and regularity of the underlying transactions.

Without calling into question its opinion, ECA raised the below observation:

The implementation rate for the Horizon 2020 operational payment appropriations further decreased from 81% to 69 %, mainly caused by external factors beyond the JU's control. And the implementation rates for the 2023 infrastructure expenditure budget remained low at 71 % of commitment appropriations and 61 % of payment appropriations.
The common JU business continuity plan (BCP) and related disaster recovery plan (DRP) did not reflect the significant changes to the JUs' operating environment that has occurred since 2020. To mitigate the related operational risks, such as incomplete or delayed recovery of operational data in case of a disaster, ECA recommended to update and the BCP and DRP should be updated and their effectiveness tested. Following the ECA's recommendation, the Clean Hydrogen JU (in collaboration with other JU's) started updating the BCP and DRP and scheduled the testing for 2025-2026.
The JU did not yet have a policy on the management of sensitive functions in place to enable the JU to identify sensitive functions, keep them up to date, define appropriate control measures to prevent or mitigate risks of inappropriate or fraudulent actions, such as fraudulent reporting, loss of assets,

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disclosure of sensitive information, and corruption. The Clean Hydrogen JU took note of the observation and immediately drafted the guidelines on sensitive function.

Audit on the annual accounts for financial year 2024

In accordance with Art. 54 of the JU financial rules, the 2024 annual accounts are audited by an independent external auditor. A two-year renewable contract was signed in 2024 with Baker Tilly Belgium to perform this activity.

The ECA will draw the final audit opinion on the 2024 accounts, revenue and transactions based on the work by independent external auditors as well as the substantial audit work performed by the ECA's dedicated team.

The final report is due by November 2025.

4.2.3 Overall Conclusions

Internal and external audit work significantly contributes to Clean Hydrogen's continuous improvements. In 2024, the Clean Hydrogen JU received positive feedback from both the Internal Audit Service (IAS) of the European Commission and the European Court of Auditors (ECA) on its performance and the legality and regularity of the operations.

These results, jointly with the other key performance indicators, confirmed the continuous improvement and maturity of the internal control environment and the efficiency and effectiveness of the processes and controls put in place by the JU.

The current residual risk from the audit recommendations that remain open do not impair the declaration of assurance.

4.3 Assessment of the effectiveness of internal control (IC) systems

4.3.1 Continuous monitoring

In line with the Commission's internal control framework and in line with the objectives and priorities described in the 2024 AWP, the Clean Hydrogen JU assesses annually all internal control components and 17 related principles to ensure that all internal control principles are present and functioning.

In order to conduct the assessment, internal control strengths and deficiencies are identified by using all available information sources such as self-assessment, weaknesses spontaneously reported by staff, exceptions and non-compliance events, ongoing monitoring of the implementation of control and anti-fraud strategies and audit conclusions, findings and recommendations.

The assessment results are evaluated and any potential weaknesses are addressed in the form of actions for improvement, communicated and corrected in a timely manner, with any serious matters reported as appropriate.

4.3.2 Risk assessment and management

On 16 August 2018, the Governing Board adopted a new internal control framework (ICF) stemming from the most up-to-date internationally acknowledged Committee of Sponsoring Organizations of the

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Treadway Commission model of internal control, in line with the European Commission's ICF. Risk assessment is one of the five key ICF components and consists of four principles:

ICF components and principles – risk assessment

Principle 6. The organisation specifies objectives with sufficient clarity to enable the identification and assessment of risks relating to objectives.
Principle 7. The organisation identifies risks to the achievement of objectives across the entity and analyses the risks as a basis for determining how the risks should be managed.
Principle 8. The organisation considers the potential for fraud in assessing risks to the achievement of objectives.
Principle 9. The organisation identifies and assesses changes that could significantly impact the system of internal control.

For the risk assessment and its conclusions, we refer to Section 1 of the AAR.

4.3.3 Prevention of Conflict of Interest

On 16 August 2018, the Governing Board adopted a new internal control framework (ICF) stemming from the most up-to-date internationally acknowledged Committee of Sponsoring Organizations of the Treadway Commission model of internal control, in line with the European Commission's ICF. Risk assessment is one of the five key ICF components and consists of four principles:

ICF components and principles – risk assessment

Principle 6. The organisation specifies objectives with sufficient clarity to enable the identification and assessment of risks relating to objectives.

Principle 7. The organisation identifies risks to the achievement of objectives across the entity and analyses the risks as a basis for determining how the risks should be managed.

Principle 8. The organisation considers the potential for fraud in assessing risks to the achievement of objectives.

Principle 9. The organisation identifies and assesses changes that could significantly impact the system of internal control.

For the risk assessment and its conclusions, we refer to Section 1 of the AAR.

4.4 Conclusion on the assurance

This section provides an overall conclusion on the declaration of assurance. It is important to note that only material weaknesses/ risks lead to any reservation concerning the assurances. The concept of materiality provides the Executive Director with the basis for assessing the importance of the weaknesses/risks identified. Deciding whether something is material involves making a judgement in both qualitative and quantitative terms (see details of the materiality criteria in Annex 11).

Based on the information provided in the previous sections, the following conclusions can be drawn:

• Concerning the Clean Hydrogen JU's policy activities, no qualification needs to be made. Likewise, there is no reservation in the procedures relating to the selection of contractors and beneficiaries for JU grant agreements and their underlying financial operations (legal and financial commitments). This

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is also the case for the JU's payments relating to administrative expenditure and procurement and for pre-financing payments in the case of grants.

• The amounts with a greater risk of being affected by errors are the expenditures incurred against cost statements. Based on the analysis of error rates and the effectiveness of the preventive, detective and corrective actions presented in Section 4.1., no reservation is necessary in this area either.

• At the time of developing the annual activity report, the certification process for the IKAA 2024 was still ongoing. The value of the certified IKAA 2023 stands at EUR 483 million (out of EUR 520.77 million in the IKAA Plan) and provisional IKAA 2024 of 698 million as of 4 June 2025 (out of EUR 995 million planned), will be updated with 2024 final data to be available end of December 2025, further and will be reported to the Clean Hydrogen JU Governing Board later in the years 2025 and beyond. Therefore, no reservation in this area is necessary either.

In conclusion, the Clean Hydrogen JU's management has reasonable assurance that, overall, suitable controls are in place and are working as intended, risks are being properly monitored and mitigated, and necessary improvements noted by the auditors (i.e. the IAS and the ECA) are being implemented.

Therefore, the Executive Director, in her capacity as authorising officer, has signed the declaration of assurance presented in the following section.

4.5 Statement of Assurance

4.5.1 Assessment of the Annual Activity Report by the Governing Board

The declaration of the Executive Director and the Clean Hydrogen JU's AAR for 2024 give a fair assessment of the operational and financial management needed for achieving the objectives.

Based on the information provided, the Clean Hydrogen JU key objectives set up for 2024 were all achieved in compliance with the principles of legality and regularity of operations.

The Governing Board notes that the management of the Clean Hydrogen JU has reasonable assurance that, overall, suitable controls are in place and working as intended and that risks are being properly monitored and mitigated.

Therefore, the Executive Director, in her capacity as Authorising Officer, has signed the Declaration of assurance without any reservation.

The Governing Board thanks Ms Valérie Bouillon-Delporte, Executive Director since 1st June 2024, and Ms Mirela Atanasiu, Executive Director ad interim of the Clean Hydrogen JU until May 2024, for their continuous effort to deliver the Clean Hydrogen JU's work programme in 2024.

4.5.2 Declaration of assurance

I, the undersigned,

Executive Director of the Clean Hydrogen JU

In my capacity as authorising officer by delegation

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Declare that the information contained in this report gives a true and fair view.

State that I have reasonable assurance that the resources assigned to the activities described in this report have been used for their intended purpose and in accordance with the principles of sound financial management, and that the control procedures put in place give the necessary guarantees concerning the legality and regularity of the underlying transactions.

This reasonable assurance is based on my own judgement and on the information at my disposal, such as the results of the self-assessment, ex-post controls, the work of the internal audit capability, the observations of the Internal Audit Service and the lessons learnt from the reports of the Court of Auditors for years prior to the year of this declaration.

Confirm that I am not aware of anything not reported here which could harm the interests of the Joint Undertaking.

Brussels, date 30 June 2025

Valérie Bouillon-Delporte

Executive Director

Digitally signed by:
VALÉRIE MARTHE MICHÈLE
DELPORTE-GUINTRAND
Date: 2025-06-30 09:14:09
UTC

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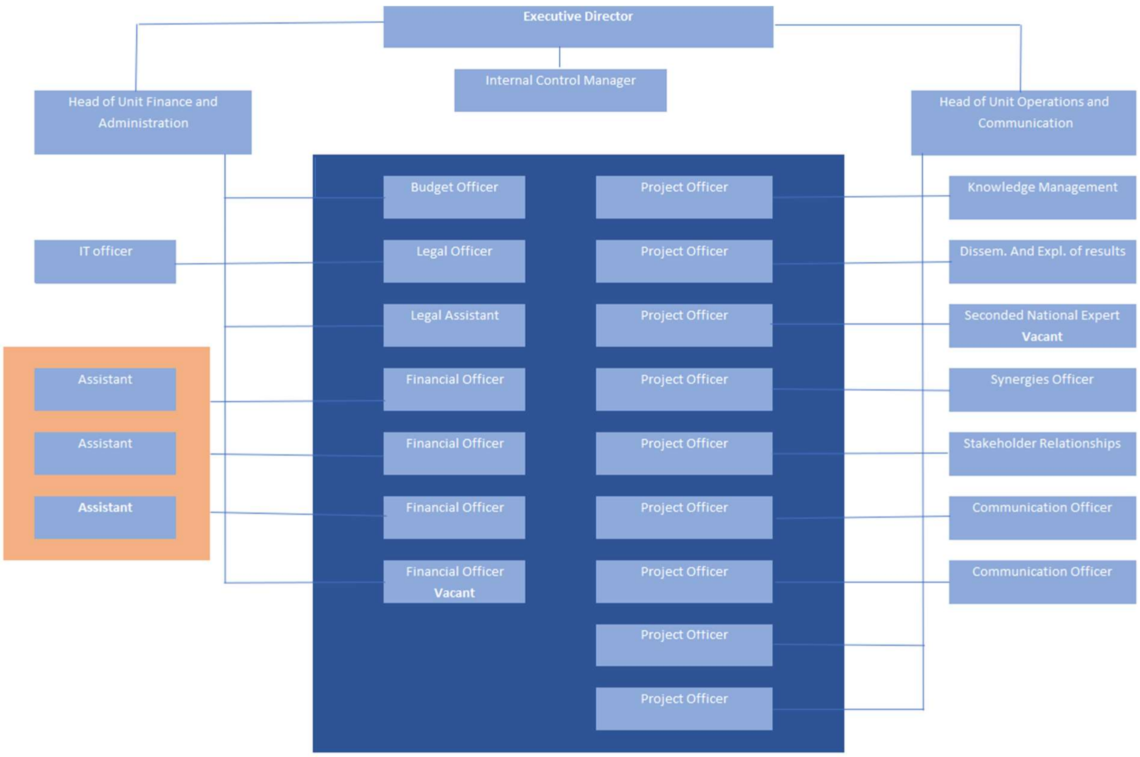
5 ANNEXES

5.1 *Organisational chart*

FIGURE 28. ORGANISATIONAL CHART



5.2 *Establishment plan and additional information on HR management*

The JU team of statutory staff consists of 29 positions (27 TA and 2 CA).

In addition, staff resources include 2 Seconded National Experts (SNE).

The 2024 Staff Establishment Plan is shown below.

TABLE 37. HUMAN RESOURCES BY FUNCTION GROUP/GRADE AND TYPE OF POST, 2023 AND 2024

Grade	2023 authorized	2023 filled as of 31/12	2024 authorized	2024 filled as of 31/12
AD 16				
AD 15				
AD 14	1		1	1
AD 13				
AD 12	2	2	2	2
AD 11				
AD 10	2	2	2	2

AD 9	3	3	3	3
AD 8	2	2	2	1
AD 7	5	4	5	5
AD 6	2	2	2	2
AD 5				
Total AD	**17**	**15**	**17**	**16**
AST 11				
AST 10			1	1
AST 9	2	2	1	1
AST 8	1	1	1	1
AST 7	1	1	1	1
AST 6			1	1
AST 5	5	4	4	3
AST 4				
AST 3	1	1	1	1
AST 2				
AST 1				
Total *AST*	**10**	**9**	**10**	**9**

NB: AD, administrator; AST, assistant; SC, secretary.

TABLE 38. CONTRACT STAFF BY FUNCTION GROUP

Contract Agents	Authorized	Actually filled as of 31/12/2024
Function Group IV	1	1
Function Group III	1	0
Function Group III		
Function Group I		
TOTAL	**2**	**1**

TABLE 39. SNEs

Seconded National Experts	Authorized	Actually filled as of 31/12/2024
SNE	3	2

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TOTAL	3	2

5.3 *Publications from projects*

Publications in 2024 related to H2020 and Horizon Europe projects, based on the information extracted from multiple sources:

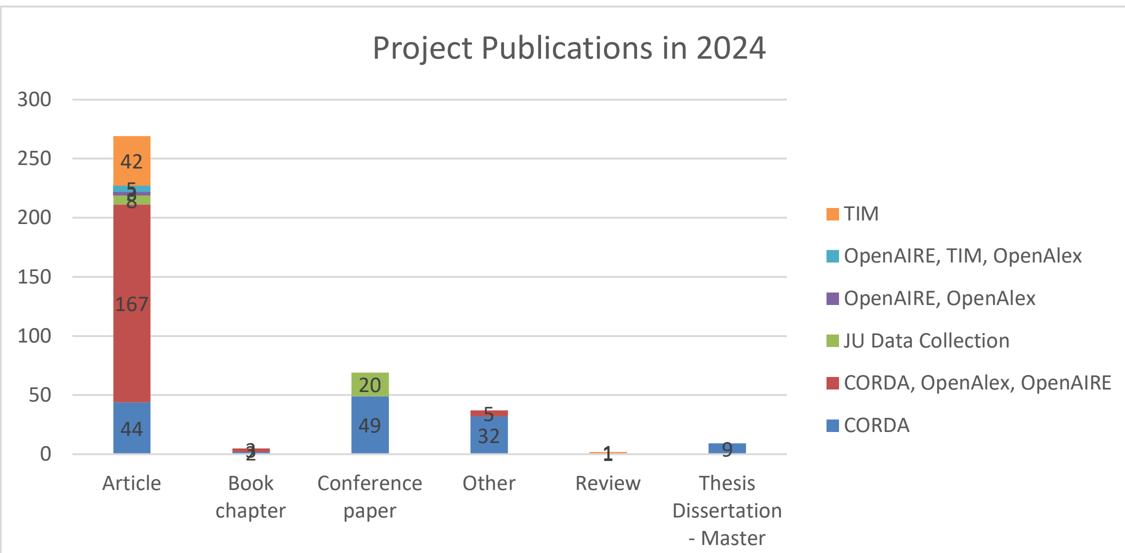
- CORDA
- JRC's TIM tool
- Clean Hydrogen JU Data Collection 2024
- OpenAIRE
- OpenAlex

The list also includes publications from 2022 that were not reported in due time by the projects for the Annual Activity Report of 2023. As regards publications of (H2020) projects of previous years, please refer to our past Annual Activity Report publications.

In total we identified 391 publications, 182 in 2022, 132 in 2023 and 77 in 2024. About one third of them was extracted from CORDA (137 in total), 28 additional ones came from the Clean Hydrogen JU Data Collection and 226 more were identified using CORDA, TIM, OpenAIRE and OpenAlex.

Focusing in 2024 publications, in the figure below you can find their split per type and source collected:

FIGURE 29. PROJECT PUBLICATIONS BY TYPE AND SOURCE IN 2024



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5.3.1 Additional Publications of 2022 (complementing AAR 2022)

TABLE 40. ADDITIONAL PUBLICATIONS OF 2022

Source	Project Acronym	Publication Type	Title	Authors	Publication Title	Year
CORDA	GAMER	Article	Thermo-fluid dynamics modelling of steam electrolysis in fully-assembled tubular high-temperature proton-conducting cells	['Michael Budd', 'José M. Serra', 'P. Veenstra', 'Einar Vøllestad', 'David Catalán-Martínez', 'Mateusz Tarach', 'Joaquín Santos', 'Laura Navarrete', 'Truls Norby']	International journal of hydrogen energy	2022
CORDA	Haeolus	Conference paper	Green Hydrogen from Intermittent Renewables	['Zenith, Federico']		2022
CORDA	Haeolus	Conference paper	Producing and Exporting Hydrogen from Stranded Resources	['Zenith, Federico']		2022
CORDA	WASTE2WATTS	Book chapter	Biogas from animal manure in Switzerland : Energy potential, technology development and resource mobilization	['Vanessa Burg, Gillianne Bowman, OliverThees, Urs Baier, Serge Biollaz, Theodoros Damartzis, Jean-Louis Hersener, Jeremy Luterbacher, Hossein Madi, Francois Marechal, Emanuele Moioli, Florian Rusch, Michael Studer, Jan Van herle, Frederic Vogel, Oliver Krocher']	White Paper	2022
CORDA	HyCARE	Article	An effective activation method for industrially produced TiFeMn powder for hydrogen storage	David Michael Dreistadt, Thi-Thu Le, Giovanni Capurso, José M. Bellosta von Colbe, Archa Santhosh, Claudio Pistidda,	Journal of Alloys and Compounds	2022

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				Nico Scharnagl, Henry Ovri, Chiara Milanese, Paul Jerabek, Thomas Klassen, Julian Jepsen		
CORDA	HyCARE	Article	In-situ neutron diffraction during reversible deuterium loading in Ti-rich and Mn-substituted Ti(Fe,Mn)0.90 alloys	Erika Michela Dematteis, Jussara Barale, Giovanni Capurso, Stefano Deledda, Magnus H. Sørby, Fermin Cuevas, Michel Latroche, Marcello Baricco	Journal of Alloys and Compounds	2022
CORDA	HyCARE	Article	TiFe0.85Mn0.05 alloy produced at industrial level for a hydrogen storage plant	Jussara Barale, Erika M. Dematteis, Giovanni Capurso, Bettina Neuman, Stefano Deledda, Paola Rizzi, Fermin Cuevas, Marcello Baricco	International Journal of Hydrogen Energy	2022
CORDA	HyUsPRe	Thesis Dissertation - Master	Analyzing the transition of electricity generation in the European electricity system until 2030	C.M. Perez Villanueva		2022
CORDA	e-SHyIPS	Conference paper	Feasibility analysis of an innovative naval on-board power-train system with hydrogen- based PEMFC technology	Simona Di Micco, Mariagiovanna Minutillo, Antonio Forcina, Viviana Cigolotti, Alessandra Perna	E3S Web of Conferences	2022
CORDA	e-SHyIPS	Conference paper	Development of a Learning Ecosystem for Effective Learning in Socio-Technical Complex Systems	M. Callupe, M. Rossi, B.P. Sullivan, S. Terzi	Proceedings of IFIP 2022 - "19th International Conference on Product Lifecycle Management"	2022

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CORDA	FCH2RAIL	OTHER	FCH2RAIL deliverable D5.1 - Implementation and Integration in Demonstrator Train	Fabien Bouyssou		2022
CORDA	FCH2RAIL	Conference paper	Hydrogen On-Board Storage Options for Rail Vehicles	Bhm, Mathias	European Hydrogen Energy Conference 2022	2022
CORDA	FCH2RAIL	Conference paper	Using Absorption Refrigerator and Metal Hydrides in Hydrogen Fuel Cell Trains: Draft Design Process and Feasibility	Markus Kordel, Florian Heckert, Kevin Knetsch, Lutz Boeck	European Hydrogen Energy Conference 2022 Proceeding Book	2022
CORDA	FCH2RAIL	Conference paper	FCH2RAIL: Demonstration of the Fuel Cell Hybrid PowerPack	Dittus, Holger		2022
CORDA	FCH2RAIL	OTHER	FCH2RAIL deliverable D7.1Gaps in regulatory framework prior to the demonstrator train test	Esteban Rodriguez Muoz Beatriz Nieto Caldern		2022
CORDA	FCH2RAIL	OTHER	FCH2RAIL insights: Demonstration of the Fuel Cell Hybrid PowerPack	Dittus, Holger; Terron, Eva; Olavarrieta, Jose Maria; Bouyssou, Fabien	Innotrans 2022 - Speakers Corner FCH2RAIL	2022
CORDA	FCH2RAIL	Conference paper	The EU Project FCH2RAIL - Fuel Cell Hybrid PowerPack for Rail Applications	Holger Dittus, Eva Terron, Thomas Landtmeters, Abraham Fernandez del Rey, Antonio Martin-Carillo, Carlos De la Cruz, Francisco Ganhao, Susanna Kck	Proceedings of the World Congress on Railway Research 2022	2022

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CORDA	FCH2RAIL	OTHER	FCH2RAIL deliverable D1.1 - Report concerning line and use case based requirements	Sebastian Herwartz Florian Khlkamp		2022
CORDA	FCH2RAIL	Conference paper	Bi-Mode Hydrogen Train Requirements Using Geospatial Line Assessment	Sebastian Herwartz, Florian Khlkamp, Johannes Pagenkopf, Abraham Fernandez del Rey, Maider Valera, Antonio Martin-Carillo, Francisco Ganhao	Proceedings of the World Congress on Railway Research 2022	2022
CORDA	FLHYSAFE	Article	Design and Demonstration of a 540 V/28 V SiC-Based Resonant DCDC Converter for Auxiliary Power Supply in More Electric Aircraft	Bhattacharya, S.; Willich, C.; Kallo, J.	Electronics	2022
CORDA	FURTHER-FC	Article	In die Tiefen der Brennstoffzelle	Tobias Morawietz, Jan-Frederik Heger, K. Andreas Friedrich, Hanno Kaess	GIT Labor-Fachzeitschrift	2022
CORDA	FURTHER-FC	Article	Benchmarking proton exchange membrane fuel cell cathode catalyst at high current density: A comparison between the rotating disk electrode, the gas diffusion electrode and differential cell	Raphal Riasse, Clmence Lafforgue, Florent Vandenberghe, Fabrice Micoud, Arnaud Morin, Matthias Arenz, Julien Durst, Marian Chatenet	Journal of Power Sources	2022
CORDA	FURTHER-FC	Article	Into the depths of hydrogen fuel cells	Tobias Morawietz, Jan-Frederik Heger, K. Andreas Friedrich, Hanno Kaess	Imaging & Microscopy	2022
CORDA	GRASSHOPPER	Conference paper	Grasshopper: A Modular and Flexible Hydrogen PEM Power	M. Tejada, G. Nieto and B. Sarmiento	European Hydrogen Energy Conference	2022

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			Plant for Grid Balancing Services			
CORDA	GrInHy2.0	Conference paper	Experimental Report on Galvanostatic Operation of Electrolyte-Supported Stacks for High Temperature Electrolysis	J. Aicart, L. Tallobre, A. Surrey, D. Reynaud, and J. Mougin	15th European SOFC & SOE Forum	2022
CORDA	H2Future	Article	Decarbonization of the steel industry. A techno-economic analysis	Amaia Sasiain Conde1*, Katharina Rechberger1, Andreas Spanlang1, Hermann Wolfmeir2 and Christopher Harris	Matériaux & Techniques	2022
CORDA	Haeolus	Conference paper	Optimal Tracking of Grid Operated Load Demand with Hydrogen based Storage System Using Model Based Predictive Control	Muhammad Bakr Abdelghany, Muhammad Shehzad, Valerio Mariani, Luigi Glielmo	World Hydrogen Energy Conference	2022
CORDA	HYPSTER	Conference paper	Creep tests on salt samples performed at very small stresses	Armines / Polytechnique, Brouard Consulting		2022
CORDA	HYPSTER	Conference paper	Calibration of rock salt thermal and mechanical parameters based on available field data	Armines / Polytechnique & Brouard Consulting		2022
CORDA	HyStorIES	Conference paper	Enabling Large-Scale Hydrogen Storage in Salt Caverns: Recent Developments.	Rveillre, A. , Fournier, C., Karimi-Jafari, M., Courault, C.		2022

CORDA	HyStorIES	Article	Modeling hydrogen rock brine interactions for the Jurassic reservoir and cap rocks from Polish Lowlands	Krzysztof Labus a, Radosaw Tarkowski b	International Journal of Hydrogen Energy	2022
CORDA	HyTunnel-CS	Conference paper	Water Mist Characteristics for Explosion Mitigation	Lundberg, J., Sikka, R., Vaagsaether, K. Bjerketvedt, D.	10th Int. Seminar on Fire and Explosion Hazards	2022
CORDA	HyTunnel-CS	Article	The pressure peaking phenomenon for ignited under-expanded hydrogen jets in the storage enclosure: experiments and simulations for release rates of up to 11.5 g/s	Cirrone, D., Makarov, D., Lach, A.W., Gaathaug, A.V., Molkov, V.	Energies	2022
CORDA	HyTunnel-CS	Conference paper	Thermal effects from downwards hydrogen impinging jet flame experimental results from high-pressure releases in a carpark	Lach, A.W., Gaathaug, A.V. and Vaagsaether, K.	10th Int. Seminar on Fire and Explosion Hazards	2022
CORDA	HyTunnel-CS	Conference paper	QRA methodology of hydrogen tank rupture in a fire in a tunnel	Kashkarov, S., Sivaraman, S., Molkov, V.	10th Int. Seminar on Fire and Explosion Hazards, Oslo, Norway	2022

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CORDA	HyTunnel-CS	Conference paper	Risk associated to H2 vehicles in tunnels and other confined spaces	Russo, P., Cortellini, M.C., Markert, F.	Nordic Fire and Safety Days 2022 – Book of Abstracts	2022
CORDA	MORELife	Conference paper	Unified model of hydrogen peroxide production and transport in LT-fuel cell membrane-electrode assembly	Ambro Kregar, Andra Kravos, Toma Katranik		2022
CORDA	MultHyFuel	Conference paper	Ignition likelihood of a sudden hydrogen release in the Proceedings of the Tenth International Seminar on Fire and Explosion Hazards, 22-27 May 2022, Oslo, Norway	Proust, Christophe. Edited by Vgsther, Knut; Lach, Agnieszka; Bradley, Derek; Lundberg, Joachim		2022
CORDA	PRHYDE	Conference paper	MODELING FOR THE DEVELOPMENT OF HEAVY-DUTY REFUELING PROTOCOLS	Arnaud Charolais, Fouad Ammouri, Elena Vyazmina, Alexander Grab, Antonio Ruiz, Alexander Kvasnicka, Christian Spitta, Rony Tawk, Quentin Nouvelot, Nicola Benvenuti, Thomas Guewouo	BOOK OF ABSTRACTS of World Hydrogen Energy Conference (WHEC) 2022	2022
CORDA	PRHYDE	Conference paper	Influence of the Turbulence Model in the CFD Simulation of Hydrogen Tank Filling by an Impinging Oblique Jet	Julien Martin, Quentin Nouvelot, Vincent Ren, Guillaume Lodier, Pierre Carrere, Arnaud Charolais, Fouad Ammouri, Elena Vyazmina, Alexander Grab, Antonio Ruiz	BOOK OF ABSTRACTS of World Hydrogen Energy Conference (WHEC) 2022	2022

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CORDA	REFLEX	Conference paper	SOC development at Elcogen	Matti Noponen, Hanna Gran-Fabritius, Sergii Pylypko, Enn unpuu	15th European SOFC & SOE Forum, 5-8 July 2022	2022
CORDA	REFLEX	Conference paper	Solid Oxide Electrolysis stack developement and upscaling	Stphane Di Iorio, Thibault Monnet, Graldine Palcoux, Livia Ceruti, Julie Mougin	15th European SOFC & SOE Forum, 5-8 July 2022	2022
CORDA	RUBY	Conference paper	Utilisation dEcho State Networks multi-rservoirs bidirectionnels appliqus au pronostic dune PEMFC-BT	D. Chanal, N. Y. Steiner, D. Chamagne and M. -C. Pera	JCGE 2022	2022
CORDA	SH2APED	Conference paper	Hydrogen refuelling station model for fuelling protocol	Hazhir Ebne-Abbasi	H2FCSUPERGEN conference	2022
CORDA	SO-FREE	Article	Progress of SOC Development at Elcogen	Matti Noponen, Pauli Torri, Jukka Gs, Jouni Puranen, Timo Lehtinen, Sergii Pylypko, Enn Ounpuu	ECS Meeting Abstracts	2022
CORDA	StasHH	Conference paper	Developing high power fuel cell systems for automotive applications	Greg Harris	Proceedings of the International Hydrogen Energy Exhibition and Forum	2022
CORDA	TeacHy	Conference paper	TEACHY - A FLAGSHIP PROJECT FOR TEACHING FUEL CELL AND HYDROGEN TECHNOLOGY	Ioan Iordache, Virgil Dumbrava , Robert Steinberger-Wilckens, Naser Al-Mufachi, Aravind Purushothaman Vellayani, Massimo Santarelli, Yegor Brodnikovskyi, Lars N. Cleeman, Karel Bouzek, Jan Van Herle, Jean-Luc Delplancke, Florence Druart, Vladimir Molkov, Olaf Jedicke	Proceedings WHEC 2022, Istanbul, June 2022	2022

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CORDA	TeacHy	Conference paper	Training Staff in Fuel Cell and Hydrogen Technologies Continuous Professional Development and Blended Learning	Robert Steinberger-Wilckens, Naser Al-Mufachi, Ahmad El-kharouf, Yousif Al-Sagheer, Kun Zhang, Artur Majewski, John Hooper	Proceedings of the EFCF-2022 - SOFC-SOE Forum, Lucerne July 2022	2022
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Stability of methane reforming catalysts towards dimethyl sulfide	Yosua Hanria	Master thesis	2022
CORDA	WASTE2WATTS	Conference paper	Techno-economic evaluation of biogas-fed SOFC power system integrated with CCS and CCU	Hangyu Yu, Ligang Wang, Jan Van herle	European Fuel Cell Forum	2022
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Solid Oxide Fuel Cells: performance analysis for integrated cogeneration with bio-syngas	Giacomo Tamburrano	Master thesis ENEA	2022
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Experimental analysis about the performances of commercial materials for biogas purification	Luca Giacalone	Master thesis	2022
CORDA	WASTE2WATTS	Article	Reversible solid-oxide cell stack based power-to-x-to-power systems: Comparison of thermodynamic performance	Ligang Wang, Yumeng Zhang, Mar Prez-Fortes, Philippe Aubin, Tzu-En Lin, Yongping Yang, Franois Marchal, Jan Van herle	Applied Energy	2022

CORDA	WASTE2WATTS	Conference paper	Operating SOFC on reformed biogas with sulfide poisoning	Cdric Frantz, Lucas Schucan, Jan Van herle	European Fuel Cell Forum	2022
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Purification of biogas from sulphur compounds: experimental investigation and techno-economic assessment	Francesca Cappai	Master thesis	2022
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Adsorptive removal of dimethyl sulfide from biogas for solid oxide fuel cell applications	Adelaide S. Calbry-Muzyka, Hossein Madi, Chirayu Thakur, David Rast, Julian Indlekofer, Tanja Wieseler, Serge M.A. Biollaz, Tilman J. Schildhauer		2022
CORDA	WASTE2WATTS	OTHER	Performance Losses of Anode-supported SOFC Exposed to Sulphide Contaminants	Lucas Schucan	Semester project report	2022
CORDA	WINNER	Article	Redox-stable composite electrodes for CH4 conversion reactors based on proton ceramic electrochemical cells	L. Almar, N. Baus, M. Fabuel, S. Escolstico, J. M. Serra	Journal of Power Sources	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Redox Cycling for SOFC Accelerated Degradation	['Asrar Sheikh', 'Blagoy Burdin', 'Dario Montinaro', 'Paolo Piccardo', 'Daria Vladikova', 'Milena Krapchanska']	E3S web of conferences	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Degradation of Ni-YSZ and Ni-GDC fuel cells after 1000 h operation: Analysis of different overpotential contributions according to	['Anke Hagen', 'Aiswarya Krishnakumar Padinjarethil', 'Fiammetta Rita Bianchi', 'Bárbara Bosio']	E3S web of conferences	2022

			electrochemical and microstructural characterization			
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Test and Modelling of Solid Oxide Fuel Cell Durability: A Focus on Interconnect Role on Global Degradation	['Paolo Piccardo', 'Roberto Spotorno', 'Fiammetta Rita Bianchi', 'Daniele Paravidino', 'Bárbara Bosio']	Energies	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Prediction of crack nucleation and propagation in porous ceramics using the phase-field approach	['Johan Debayle', 'Arata Nakajo', 'Dominique Leguillon', 'Sylvain Meille', 'Amira Abaza', 'Jérôme Laurencin']	Theoretical and applied fracture mechanics	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Investigation of a Metallic Interconnect Extracted from an SOFC Stack after 40,000 h of Operation	['Paolo Piccardo', 'Roberto Spotorno', 'Christian Geipel']	Energies	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Fracture properties of porous yttria-stabilized zirconia under micro-compression testing	['Thomas David', 'Arata Nakajo', 'Federico Monaco', 'Christian Lenser', 'Sylvain Meille', 'Amira Abaza', 'Maxime Hubert', 'Jérôme Laurencin']	Journal of the European Ceramic Society	2022
CORDA, OpenAlex, OpenAIRE	AD ASTRA	Article	Accelerated Stress Tests for Solid Oxide Cells via Artificial Aging of the Fuel Electrode	['Asrar Sheikh', 'Blagoy Burdin', 'Dario Montinaro', 'Paolo Piccardo', 'Roberto Spotorno', 'Daria Vladikova', 'Milena Krapchanska']	Energies	2022
CORDA, OpenAlex, OpenAIRE	ANIONE	Article	Performance and stability of a critical raw materials-free	['Sabrina Campagna Zignani', 'Massimiliano Lo Faro', 'Stefano Trocino', 'Alessandra	Electrochimica acta	2022

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			anion exchange membrane electrolysis cell	Carbone', 'Cristina Italiano', 'A.S. Aricò', 'Giuseppe Monforte']		
CORDA, OpenAlex, OpenAIRE	BEST4Hy	Article	Hydrothermally-assisted recovery of Yttria- stabilized zirconia (YSZ) from end-of-life solid oxide cells	['Massimo Santarelli', 'Federico Smeacetto', 'Sonia Fiorilli', 'Sabina Fiorot', 'Silvia Fiore', 'Sofia Saffirio', 'Domenico Ferrero', 'Ilaria Schiavi', 'Sergii Pylypko']	Sustainable materials and technologies	2022
CORDA, OpenAlex, OpenAIRE	BEST4Hy	Article	Analysis of Lanthanum and Cobalt Leaching Aimed at Effective Recycling Strategies of Solid Oxide Cells	['Massimo Santarelli', 'Federico Smeacetto', 'Sonia Fiorilli', 'Silvia Fiore', 'Ilaria Schiavi', 'Alice Benedetto Mas']	Sustainability	2022
CORDA, OpenAlex, OpenAIRE	CHANNEL	Article	Ternary NiCoFe nanosheets for oxygen evolution in anion exchange membrane water electrolysis	['Frode Seland', 'Alaa Y. Faid', 'Alejandro Oyarce Barnett', 'Svein Sunde']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	CHANNEL	Article	Composition-Dependent Morphology, Structure, and Catalytical Performance of Nickel–Iron Layered Double Hydroxide as Highly-Efficient and Stable Anode Catalyst in Anion Exchange Membrane Water Electrolysis	['Astrid Besmehn', 'Morgane Desmau', 'Meital Shviro', 'Alaa Y. Faid', 'Wulyu Jiang', 'Carlos Manuel Silva Lobo', 'Bruna Ferreira Gomes', 'Werner Lehnert', 'Patrick Borowski', 'Heinrich Hartmann', 'Svein Sunde', 'И. В. Галкина', 'Artjom Maljusch', 'Lu Xia', 'Christina Roth']	Advanced functional materials	2022
CORDA, OpenAlex, OpenAIRE	CHANNEL	Article	Unveiling hydrogen evolution dependence on KOH concentration for polycrystalline and	['Bruno G. Pollet', 'Alaa Y. Faid', 'Faranak Foroughi', 'Svein Sunde']	Journal of applied electrochemistry	2022

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			nanostructured nickel-based catalysts			
CORDA, OpenAlex, OpenAIRE	ComSos	Article	When SOFC-based cogeneration systems become convenient? A cost-optimal analysis	['Massimo Santarelli', 'Paolo Marocco', 'Marta Gandiglio']	Energy reports	2022
CORDA, OpenAlex, OpenAIRE	Demo4Grid	Article	Hydrogen in Grid Balancing: The European Market Potential for Pressurized Alkaline Electrolyzers	['Ewald Perwög', 'Marcos Millán', 'Emmanuel Zoulias', 'Emmanuel Stamatakis', 'Ermis Garyfallos', 'Nikolaos Chalkiadakis']	Energies	2022
CORDA, OpenAlex, OpenAIRE	eGHOST	Article	Social Life Cycle Assessment of a Proton Exchange Membrane Fuel Cell stack	['Javier Dufour', 'Felipe Campos-Carriedo', 'Eleonora Bargiacchi', 'Diego Iribarren']	E3S web of conferences	2022
CORDA, OpenAlex, OpenAIRE	e-SHyIPS	Article	A life cycle perspective to sustainable hydrogen powered maritime systems – functional and technical requirements	['Giuditta Margherita Maria Ansaloni', 'Mónica Rossi', 'Arianna Bionda', 'Brendan P. Sullivan']	International journal of product lifecycle management	2022
CORDA, OpenAlex, OpenAIRE	e-SHyIPS	Article	Hydrogen-based technologies in maritime sector: technical analysis and prospective	['Giovanni Di Ilio', 'Viviana Cigolotti', 'Thomas Wannemacher', 'E.J. Boonen', 'Arianna Bionda', 'Mariagiovanna Minutillo']	E3S web of conferences	2022
CORDA, OpenAlex, OpenAIRE	e-SHyIPS	Article	EcoDesign strategies for zero-emission hydrogen fuel vessels scenarios	['Giuditta Margherita Maria Ansaloni', 'Mónica Rossi', 'Arianna Bionda']	2022 7th International Conference on Smart and Sustainable	2022

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					Technologies (SpliTech)	
CORDA, OpenAlex, OpenAIRE	FCH2RAIL	Article	Review and comparison of worldwide hydrogen activities in the rail sector with special focus on on-board storage and refueling technologies	['Pagenkopf, Johannes', 'Abraham Fernández Del Rey', 'Beatriz Nieto Calderón', 'M. Varela', 'Sebastian Herwartz-Polster', 'Mathias Böhm']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	FLAGSHIPS	Article	Electric Power Integration Schemes of the Hybrid Fuel Cells and Batteries-Fed Marine Vessels—An Overview	['Ahmed Abdelhakim', 'Sami Kanerva', 'Arber Haxhiu', 'Jostein Bogen']	IEEE transactions on transportation electrification	2022
CORDA, OpenAlex, OpenAIRE	FLHYSAFE	Article	Design and Demonstration of a 540 V/28 V SiC-Based Resonant DC–DC Converter for Auxiliary Power Supply in More Electric Aircraft	['Sumantra Bhattacharya', 'Caroline Willich', 'Josef Kallo']	Electronics	2022
CORDA, OpenAlex, OpenAIRE	FLHYSAFE	Article	Comparing Distributed and Integrated Hazard Analysis Environments	['Viola Voth', 'Axel Berres', 'Michael Schäfer', 'Sascha M. Lübbe']	Proceedings of the 32nd European Safety and Reliability Conference (ESREL 2022)	2022
CORDA, OpenAlex, OpenAIRE	FURTHER-FC	Article	The challenges in reliable determination of degradation rates and lifetime in polymer electrolyte membrane fuel cells	['Qian Zhang', 'Pawel Gazdzicki', 'Kaspar Andreas Friedrich', 'Corinna Harms', 'Jens Mitzel']	Current opinion in electrochemistry	2022

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CORDA, OpenAlex, OpenAIRE	FURTHER-FC	Article	Exploring critical parameters of electrode fabrication in polymer electrolyte membrane fuel cells	['Patrick Sarkezi-Selsky', 'Krishan Talukdar', 'Tobias Morawietz', 'Pawel Gazdzicki', 'Kaspar Andreas Friedrich', 'Jan-Frederik Heger', 'В. П. Сереев', 'Khrystyna Yezerska', 'Thomas Jahnke']	Journal of power sources	2022
CORDA, OpenAlex, OpenAIRE	GAIA	Article	Enhancing the activity and stability of carbon-supported platinum–gadolinium nanoalloys towards the oxygen reduction reaction	['Jacques Rozière', 'Carlos A. Campos-Roldán', 'Deborah J. Jones', 'Pierre-Yves Blanchard', 'F. Pailloux', 'Sara Cavalière']	Nanoscale advances	2022
CORDA, OpenAlex, OpenAIRE	GAIA	Article	Influence of the Carbon Support on the Properties of Platinum–Yttrium Nanoalloys for the Oxygen Reduction Reaction	['Alice Parnière', 'Jacqués Rozière', 'Carlos A. Campos-Roldán', 'Deborah J. Jones', 'Pierre-Yves Blanchard', 'Nicolas Donzel', 'F. Pailloux', 'Sara Cavalière']	ACS applied energy materials	2022
CORDA, OpenAlex, OpenAIRE	GRASSHOPPER	Article	Dynamic Modeling of a PEM Fuel Cell Power Plant for Flexibility Optimization and Grid Support	['Giulio Guandalini', 'Stefano Campanari', 'German Nieto Cantero', 'Elena Crespi']	Energies	2022
CORDA, OpenAlex, OpenAIRE	H2Future	Article	Country-specific cost projections for renewable hydrogen production through off-grid electricity systems	['Remko J. Detz', 'Jacob L.L.C.C. Janssen', 'Bob van der Zwaan', 'M. Weeda']	Applied energy	2022
CORDA, OpenAlex, OpenAIRE	Haeolus	Article	The Haeolus project in Berlevåg	['Zenith, Federico']	Hydrogen Production in the Arctic seminar	2022

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CORDA, OpenAlex, OpenAIRE	Haeolus	Article	Degradation identification and prognostics of proton exchange membrane fuel cell under dynamic load	['Robin Roche', 'Zhongliang Li', 'Samir Jemeï', 'Noureddine Zerhouni', 'Meiling Yue']	Control engineering practice	2022
CORDA, OpenAlex, OpenAIRE	Haeolus	Article	Two-stage model predictive control for a hydrogen-based storage system paired to a wind farm towards green hydrogen production for fuel cell electric vehicles	['Valerio Mariani', 'Muhammad Faisal Shehzad', 'Davide Liuzza', 'Muhammad Bakr Abdelghany', 'Luigi Glielmo']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	Haeolus	Book chapter	Electrolysers towards EU MAWP 2023 targets and beyond	['Yash Dharmendra Raka', 'Sara Andrenacci', 'Yejung Choi', 'Belma Talic', 'Luis C. Colmenares']	Zenodo (CERN European Organization for Nuclear Research)	2022
CORDA, OpenAlex, OpenAIRE	Haeolus	Article	Value of green hydrogen when curtailed to provide grid balancing services	['Maider Santos-Mugica', 'Valerio Mariani', 'Corey Duncan', 'Zenith, Federico', 'Martin Nord Flote', 'Claudio Marcantonini']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	Haeolus	Article	Operating Hydrogen-Based Energy Storage Systems in Wind Farms for Smooth Power Injection: A Penalty Fees Aware Model Predictive Control	['Valerio Mariani', 'Zenith, Federico', 'Luigi Glielmo']	Energies	2022
CORDA, OpenAlex, OpenAIRE	HYDROSOL-beyond	Article	Conceptual design of an innovative gas–gas ceramic compact heat exchanger	['Alberto Ortona', 'Maurizio Barbato', 'Edoardo Arrivabeni', 'Luca Cornolti', 'Simone A. Zavattoni', 'R. Puragliesi']	Heat and mass transfer	2022

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			suitable for high temperature applications			
CORDA, OpenAlex, OpenAIRE	HyStorIES	Article	Assessment of the potential for underground hydrogen storage in salt domes	['Leszek Lankof', 'Kazimierz Urbańczyk', 'Radosław Tarkowski']	Renewable & sustainable energy reviews	2022
CORDA, OpenAlex, OpenAIRE	HyStorIES	Article	Modeling hydrogen – rock – brine interactions for the Jurassic reservoir and cap rocks from Polish Lowlands	['Krzysztof Labus', 'Radosław Tarkowski']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	HyTunnel-CS & SH2APED	Article	Quantitative Risk Assessment Methodology for Hydrogen Tank Rupture in a Tunnel Fire	['Srinivas Sivaraman', 'Mohammad Dadashzadeh', 'Sergii Kashkarov', 'Vladimir Molkov']	Hydrogen	2022
CORDA, OpenAlex, OpenAIRE	HyTunnel-CS	Article	Blast Wave Generated by Delayed Ignition of Under-Expanded Hydrogen Free Jet at Ambient and Cryogenic Temperatures	['Keiji Takeno', 'Joachim Grüne', 'Kaspar Andreas Friedrich', 'Dmitriy Makarov', 'Vladimir Molkov', 'Donatella Cirrone']	Hydrogen	2022
CORDA, OpenAlex, OpenAIRE	HyTunnel-CS	Article	Full-scale tunnel experiments: Blast wave and fireball evolution following hydrogen tank rupture	['Sergey Kudriakov', 'Gilles Bernard-Michel', 'Constantin Ledier', 'H. Gueguen', 'D. Bouix', 'M. Martin', 'Léo Domergue', 'P. Manicardi', 'D. Forero', 'F. Sauzedde', 'Etienne Studer']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	HyUsPRe	Article	Cushion Gas in Hydrogen Storage—A Costly CAPEX or a Valuable Resource for Energy Crises?	['Mark Wilkinson', 'Robert Haszeldine', 'Kate Adie', 'Niklas Heinemann', 'Eike Marie Thaysen', 'Katriona Edlmann', 'Aliakbar Hassanpouryouzband']	Hydrogen	2022

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CORDA, OpenAlex, OpenAIRE	HyUsPRe	Article	Geological Hydrogen Storage: Geochemical Reactivity of Hydrogen with Sandstone Reservoirs	['Mark Wilkinson', 'Ian B. Butler', 'Kate Adie', 'Niklas Heinemann', 'Trystan Cowen', 'Eike Marie Thaysen', 'Katriona Edlmann', 'Aliakbar Hassanpouryouzband']	ACS energy letters	2022
CORDA, OpenAlex, OpenAIRE	HyUsPRe	Article	Relative Permeability of Hydrogen and Aqueous Brines in Sandstones and Carbonates at Reservoir Conditions	['Zeinab Derikvand', 'R. Stuart Haszeldine', 'Katriona Edlmann', 'Amin Rezaei', 'Aliakbar Hassanpouryouzband', 'Ian L. Molnar']	Geophysical research letters	2022
CORDA, OpenAlex, OpenAIRE	HyUsPRe	Article	Mapping hydrogen storage capacities of UK offshore hydrocarbon fields and exploring potential synergies with offshore wind	['Martinez-Felipe, Alfonso', 'Mouli-Castillo, Julien', 'Russell McKenna', 'Peecock, Anna', 'Katriona Edlmann']	Special publication - Geological Society of London/Geological Society, London, special publications	2022
CORDA, OpenAlex, OpenAIRE	IMMORTAL	Article	Platinum-Rare Earth Alloy Electrocatalysts for the Oxygen Reduction Reaction: A Brief Overview	['Jacques Rozière', 'Carlos A. Campos-Roldán', 'Deborah J. Jones', 'Sara Cavalière']	ChemCatChem	2022
CORDA, OpenAlex, OpenAIRE	IMMORTAL	Article	Nitrogen Plasma Modified Carbons for PEMFC with Increased Interaction with Catalyst and Ionomer	['Alice Parnière', 'Jacqués Rozière', 'Deborah J. Jones', 'Pierre-Yves Blanchard', 'Nicolas Donzel', 'Bénédicte Prelot', 'Sara Cavalière']	Journal of the Electrochemical Society	2022
CORDA, OpenAlex, OpenAIRE	LOWCOST-IC	Article	Fracture toughness of reactive bonded Co–Mn and Cu–Mn contact layers after long-term aging	['Henrik Lund Frandsen', 'Ragnar Kiebach', 'Ilaria Ritucci', 'Belma Talic', 'Yousef Alizad Farzin']	Ceramics international	2022

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CORDA, OpenAlex, OpenAIRE	MAMA-MEA	Article	Multilayer additive manufacturing of catalyst-coated membranes for polymer electrolyte membrane fuel cells by inkjet printing	['Marcello Romagnoli', 'Farzin Z. Tabary', 'T. A. Зубкова', 'Paolo E. Santangelo', 'Reinhard R. Baumann', 'Andreas Willert']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	MORELife	Article	Mathematical Model of Hydrogen Peroxide Production in Anode, Cathode, and Membrane of LT-PEMFC	['Tomaž Katrašnik', 'Ambrož Kregar', 'Andraž Kravos']	Meeting abstracts/Meeting abstracts (Electrochemical Society. CD-ROM)	2022
CORDA, OpenAlex, OpenAIRE	NEPTUNE	Article	Reinforced short-side-chain Aquivion® membrane for proton exchange membrane water electrolysis	['Stefano Tonella', 'Claudio Oldani', 'S. Siracusano', 'A.S. Aricò', 'Fabiola Pantò']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	NEWELY	Article	Optimization of the membrane electrode assembly for an alkaline water electrolyser based on the catalyst-coated membrane	['Lukáš Pavlovec', 'Miroslav Otmar', 'Karel Bouzek', 'Jaromír Hnát', 'Michaela Plevová', 'Zitka']	Journal of power sources	2022
CORDA, OpenAlex, OpenAIRE	NEWELY	Article	Properties of Anion Exchange Membranes with a Focus on Water Electrolysis	['Hamza Khalid', 'Dirk Henkensmeier', 'Hyun Park', 'Chulsung Bae', 'Malikah Najibah']	Membranes	2022
CORDA, OpenAlex, OpenAIRE	NewSOC	Article	Torsional behaviour of glass-joined, laser-processed Crofer 22 APU interconnect: Unravelling the effect of	['Davide Janner', 'Federico Smeacetto', 'Monica Ferraris', 'Hassan Javed', 'Milena Salvo', 'Elisa Zanchi', 'Devanarayanan Meena	Ceramics international	2022

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			surface roughness on the shear strength	Narayana Menon', 'Soukaina Lamnini', 'Stefano De La Pierre']		
CORDA, OpenAlex, OpenAIRE	NewSOC	Article	Printability of carboxymethyl cellulose/glass-containing inks for robocasting deposition in reversible solid oxide cell applications	['Francesco Baino', 'Federico Smeacetto', 'Hassan Javed', 'Giorgia Montalbano', 'Soukaina Lamnini']	Materials letters	2022
CORDA, OpenAlex, OpenAIRE	NewSOC	Article	Novel SrO-Containing Glass-Ceramic Sealants for Solid Oxide Electrolysis Cells (SOEC): Their Design and Characterization under Relevant Conditions	['Massimo Santarelli', 'Federico Smeacetto', 'Hassan Javed', 'Domenico Ferrero', 'Elisa Zanchi', 'Chiara Bert', 'Fabiana D'Isanto']	Materials	2022
CORDA, OpenAlex, OpenAIRE	REMOTE	Article	The role of hydrogen in the optimal design of off-grid hybrid renewable energy systems	['Massimo Santarelli', 'Paolo Marocco', 'Andrea Lanzini', 'Domenico Ferrero']	Journal of energy storage	2022
CORDA, OpenAlex, OpenAIRE	REMOTE	Article	Life cycle assessment of a renewable energy system with hydrogen-battery storage for a remote off-grid community	['Massimo Santarelli', 'Paolo Marocco', 'D. Lovera', 'Marta Gandiglio', 'Giovanni Andrea Blengini', 'Isabella Bianco']	International journal of hydrogen energy	2022
CORDA, OpenAlex, OpenAIRE	REMOTE	Article	Life cycle environmental analysis of a hydrogen-based energy storage system for remote applications	['Massimo Santarelli', 'Paolo Marocco', 'Kyrre Sundseth', 'David Bionaz', 'Domenico Ferrero']	Energy reports	2022

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CORDA, OpenAlex, OpenAIRE	RUBY	Article	Online Diagnosis of PEM Fuel Cell by Fuzzy C-Means Clustering	['Nadia Yousfi Steiner', 'Didier Chamagne', 'Marie-Cécile Pera', 'Raffaele Petrone', 'Damien Chanal']	Elsevier eBooks	2022
CORDA, OpenAlex, OpenAIRE	RUBY	Article	Voltage prognosis of PEMFC estimated using Multi-Reservoir Bidirectional Echo State Network	['Nadia Yousfi Steiner', 'Didier Chamagne', 'Marie-Cécile Pera', 'Damien Chanal']	2022 10th International Conference on Systems and Control (ICSC)	2022
CORDA, OpenAlex, OpenAIRE	SH2E	Article	Assessing the prospective environmental performance of hydrogen from high-temperature electrolysis coupled with concentrated solar power	['Javier Dufour', 'Eleonora Bargiacchi', 'Diego Iribarren', 'Gonzalo Puig-Samper']	Renewable energy	2022
CORDA, OpenAlex, OpenAIRE	SHERLOHCK	Article	Low-Pt-Based Sn Alloy for the Dehydrogenation of Methylcyclohexane to Toluene: A Density Functional Theory Study	['Kingsley Onyebuchi Obodo', 'Dmitri Bessarabov', 'Cecil Naphtaly Moro Ouma']	Catalysts	2022
CORDA, OpenAlex, OpenAIRE	SHERLOHCK	Article	Modified Pt (2 1 1) and (3 1 1) surfaces towards the dehydrogenation of methylcyclohexane to toluene: A density functional theory study	['Kingsley Onyebuchi Obodo', 'Dmitri Bessarabov', 'Cecil Naphtaly Moro Ouma']	Applied surface science	2022

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CORDA, OpenAlex, OpenAIRE	StaSHH	Article	The StasHH Fuel-Cell Module Standard	['Zenith, Federico']	Vehicle Power and Propulsion Conference	2022
CORDA, OpenAlex, OpenAIRE	SWITCH	Article	Operation Analysis of a Flexible Solid Oxide Cell Module for Power to Hydrogen and Polygeneration	['Marc P. Heddrich', 'S. A. Ansar', 'Marius Tomberg', 'Dirk Ullmer', 'Matthias Metten', 'Santiago Salas Ventura']	Chemie-Ingenieur-Technik/Chemieingenieurtechnik	2022
CORDA, OpenAlex, OpenAIRE	SWITCH	Article	Experimental validation of a dynamic modelling of a Reversible Solid Oxide Cells (rSOCs)	['Michele Bolognese', 'Lorenzo De Bortoli', 'Luigi Crema', 'Testi Matteo', 'Ruben Bartali']	E3S web of conferences	2022
CORDA, OpenAlex, OpenAIRE	THOR	Article	Classification of compromised DOFS data with LSTM neural networks	['K. Lasn', 'V. Usenco']	8th European Congress on Computational Methods in Applied Sciences and Engineering	2022
CORDA, OpenAlex, OpenAIRE	THOR	Article	Integration of optical fibre sensors by material extrusion 3-D printing – The effect of bottom interlayer thickness	['Shaoquan Wang', 'Kaspar Lasn']	Materials & design	2022
CORDA, OpenAlex, OpenAIRE	THyGA	Article	The Impact of Hydrogen Admixture into Natural Gas on Residential and Commercial Gas Appliances	['Johannes Schaffert', 'Jörg Leicher', 'Patrick Milin', 'Stéphane Carpentier', 'Eren Tali', 'Hristina Cigarida', 'Frank Burmeister', 'Rolf Albus', 'A. Giese', 'Jean Schweitzer', 'Klaus Görner']	Energies	2022

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CORDA, OpenAlex, OpenAIRE	WASTE2WATTS	Article	Biogas composition from agricultural sources and organic fraction of municipal solid waste	['Serge M.A. Biollaz', 'Florian Rüsch-Pfund', 'Hossein Madi', 'Adelaide Calbry-Muzyka', 'Marta Gandiglio']	Renewable energy	2022
CORDA, OpenAlex, OpenAIRE	WASTE2WATTS	Article	Comparison and optimization of different fuel processing options for biogas-fed solid-oxide fuel cell plants	['Ligang Wang', 'Changqing Dong', 'François Maréchal', 'Shuai Ma', 'Gabriele Loreti', 'Jan Van herle']	International journal of hydrogen energy	2022
JU Data Collection	eGHOST	Conference paper	Sustainability assessment of a proton-exchange membrane fuel cell stack as a basis for the development of eco-design guidelines	Mitja Mori, Diego Iribarren, Julie Cren, Elise Monnier, Rok Stropnik, Andrej Lotri?, Mihael Sekav?nik, Darío Cortés, Lara Giménez, Laurent Rey, Gonzalo Puig-Samper, Felipe Campos-Carriedo, Eleonora Bargiacchi, Javier Dufour, Emmanuelle Cor	23rd World Hydrogen Energy Conference	2022
JU Data Collection	eGHOST	Conference paper	The role of circularity and criticality indicators in the eco-design of fuel cells and hydrogen technologies	E. Bargiacchi, F. Campos-Carriedo, G. Puig-Samper, D. Iribarren, L. Rey, E. Cor, J. Dufour	European Hydrogen Energy Conference 2022	2022
JU Data Collection	HYPSTER	Conference paper	Characteristic features of salt cavern behavior	Armines/Polytechniques	SaltechMech Conference Utrech	2022
JU Data Collection	HYPSTER	Article	Computational Fluid Dynamics applied to Hydrogen Safety?	INERIS	Journal Energies	2022
JU Data Collection	HYPSTER	Conference paper	Haze, Rain and Inversion Temperature in Gas Storage Salt Caverns?	Armines, Polytechniques	Arma 2022, Santa Fe, New Mexico	2022

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JU Data Collection	HYPSTER	Conference paper	Modélisation de léruption dune cavité saline de stockage souterrain dhydrogène?	Armines, Polytechniques, Brouard consulting, Ineris, Storengy	11ème journée JNGG, Lyon	2022
JU Data Collection	HYPSTER	Conference paper	Risk identification for a hydrogen storage in salt cavern?	Ineris	Submitted for Gas Tech Conference 2022	2022
JU Data Collection	NEWELY	Conference paper	High-performance alkaline water electrolysis using anion-exchange membrane-electrode assembly with catalyst coated membrane and platinum free catalysts.	Naah, M., Tsoy, E., Khalid, H., Chen, Y., Li, Q., Bae, C., ... & Henjibkensmeier, D.	ECS Meeting Abstracts	2022
JU Data Collection	SH2E	Conference paper	Prospective life cycle assessment of hydrogen production in a solid oxide electrolyser integrated into a parabolic trough concentrated solar power plant	G. Puig-Samper, E. Bargiacchi, D. Iribarren, J. Dufour	Proceedings of HYPOTHESIS XVI	2022
JU Data Collection	ShipFC	Conference paper	Comparison of Decarbonisation Solutions for Shipping: Hydrogen, Ammonia and Batteries	Haibin Wang, Nikoletta Trivyza, Evangelos Boulougouris, Foivos Mylonopoulos	SNAME 14th International Marine Design Conference	2022
JU Data Collection	ShipFC	Conference paper	Fuel cell, ammonia powered container ship: A case study	Panagiotis Louvros, Nikoletta L. Trivyza, Alexandros Komianos, Evangelos Boulougouris	Transport Research Arena (TRA) Conference 2022	2022

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JU Data Collection	SO-FREE	Conference paper	Solid Oxide Fuel Cell Systems for decentralized, hydrogen-based power generation	Raphael Neubauer Bernd Reiter Martin Hauth		2022
JU Data Collection	WASTE2WATTS	Article	Deep analysis of biogas composition from agricultural sources and organic fraction of municipal solid waste	Adelaide Calbry-Muzyka, Hossein Madi, Florian Rüsch-Pfund, Marta Gandiglio, Serge Biollaz	Renewable Energy journal	2022
JU Data Collection	AD ASTRA	Article	A Physically-based Modelling to Predict the Cyclic Voltammetry Response of LSCF-type Electrodes: Impact of the Ohmic Losses and Microstructure	E. Effori, J. Laurencin, V. Tezyk, C. Montella, L. Dessemond, E. Siebert	Solid State Ionics	2022
JU Data Collection	HYPSTER	Conference paper	Blowout from a hydrogen storage cavern?	Armines/Polytechniques, Brouard Consulting, Ineris, Storengy	SMRI Spring Meeting, Rapid City, South Dakota.	2022
JU Data Collection	RUBY	Article	A dynamic multi-scale model for solid oxide cells validated on local current measurements: impact of global cell operation on the electrodes reaction mechanisms	E. Da Rosa Silva, M. Hubert, B. Morel, H. Moussaoui, J. Debayle and J. Laurencin	ECS Transactions	2022
OpenAIRE, TIM, OpenAlex	HyTunnel-CS	Article	Effect of heat transfer through the release pipe on simulations of cryogenic	['Kaspar Andreas Friedrich', 'М. Кузнецов', 'Dmitriy Makarov', 'Vladimir Molkov', 'Donatella Cirrone']	International journal of hydrogen energy	2022

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			hydrogen jet fires and hazard distances			
OpenAIRE, TIM, OpenAlex		Article	Chemical Treatment of Sn-Containing Transparent Conducting Oxides for the Enhanced Adhesion and Thermal Stability of Electroplated Metals	['Ibbi Y. Ahmet', 'Fatwa F. Abdi', 'Roel van de Krol']	Advanced materials interfaces	2022
OpenAIRE, TIM, OpenAlex		Article	Scalable Photovoltaic-Electrochemical Cells for Hydrogen Production from Water - Recent Advances	['Minoh Lee', 'Stefan Haas', 'Uwe Rau', 'Tsvetelina Merdzhanova', 'Vladimir Smirnov']	ChemElectroChem	2022
OpenAIRE, TIM, OpenAlex	ShipFC	Article	Intercomparison between LH2, LNG and pressurized NH3 dispersion using an adiabatic mixing approach	['A.G. Venetsanos', 'Georgios C. Boulougouris', 'S. Andronopoulos', 'Th. Krassa', 'S.G. Giannissi', 'J.G. Bartzis']	International journal of hydrogen energy	2022
TIM		Article	Volatilization of chromium from AISI 441 stainless steel: Time and temperature dependence	['S. Delsante', 'Paolo Piccardo', 'Roberto Spotorno', 'Daniele Paravidino']	Surface & coatings technology/Surface and coatings technology	2022
TIM		Article	Characterization of a metallic interconnect operated in stack during 40,000 hours in SOFC mode	['Francesca Valente', 'Greta Patrone', 'Paolo Piccardo', 'Roberto Spotorno', 'Daniele Paravidino', 'Valeria Bongiorno', 'Christian Geipel']	E3S web of conferences	2022

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TIM		Article	Kinetic Diagnostics and Synthetic Design of Platinum Group Metal-Free Electrocatalysts for the Oxygen Reduction Reaction Using Reactivity Maps and Site Utilization Descriptors	['Shuang Li', 'Huan Wang', 'Mathias Primbs', 'Fang Luo', 'Wen Ju', 'Ulrike I. Kramm', 'Peter Strasser', 'Stephan Wagner']	Journal of the American Chemical Society	2022
TIM	Demo4Grid ?	Article	Optimal dispatch model for PV-electrolysis plants in self-consumption regime to produce green hydrogen: A Spanish case study	['Cláudio Monteiro', 'Jesus Beyza', 'José M. Yusta', 'G. Matute']	International journal of hydrogen energy	2022
TIM		Article	Understanding the Effects of Ultrasound (408 kHz) on the Hydrogen Evolution Reaction (HER) and the Oxygen Evolution Reaction (OER) on Raney-Ni in Alkaline Media	['Bruno G. Pollet', 'Faranak Foroughi', 'Christian Immanuel Bernäcker', 'Lars Röntzsch']	Ultrasonics sonochemistry	2022
TIM		Article	FPGA-based Real-Time Simulation for LLC Resonant Converter Prototyping	['Mayank Garg', 'Marija Stevic', 'Sumantra Bhattacharya', 'Caroline Willich', 'Josef Kallo', 'Luc-André Grégoire']	2022 IEEE 13th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)	2022

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TIM	Article	A Green Hydrogen Energy System: Optimal control strategies for integrated hydrogen storage and power generation with wind energy	['Michiel A.J. uit het Broek', 'Arjen A.T. Veenstra', 'Albert H. Schrotenboer', 'Evrim Ursavas']	Renewable & sustainable energy reviews	2022
TIM	Article	A Novel Emergency Gas-to-Power System Based on an Efficient and Long-Lasting Solid-State Hydride Storage System: Modeling and Experimental Validation	['David Michael Dreistadt', 'Thi Thu Le', 'Stefanie Meilinger', 'Julián Puszkiel', 'José M. Bellosta von Colbe', 'Myriam Covarrubias Guarneros', 'Gerd Steinebach', 'Thomas Klassen', 'Julian Jepsen', 'Giovanni Capurso']	Energies	2022
TIM	Article	Measuring Total Sulphur Amount Fraction at picomol/mol in Hydrogen Fuel: New Results from cryo-GC-SCD Analytical Method	['Ole S. Kjos', 'Abigail Morris', 'Thomas Bacquart', 'Sam Bartlett', 'Arul Murugan', 'Ward Storms']	Processes	2022
TIM	Article	Impact of Hydrogen Liquefaction on Hydrogen Fuel Quality for Transport Applications (ISO-14687:2019)	['Niamh Moore', 'Martine Carré', 'Abigail Morris', 'Cyril Coulpier', 'Erwann Le Gendre', 'Thomas Bacquart', 'Mathew Hookham', 'Yoana Hristova']	Processes	2022
TIM	Article	Experimental investigation of the applicability of a 250 kW ceria receiver/reactor for solar thermochemical hydrogen generation	['Alon Lidor', 'Jan-Peter Säck', 'G. Piesche', 'Henrik von Storch', 'Th. Fend', 'Maria Syrigou', 'Th. Denk', 'A. Gonzales-Pardo', 'Jörg Lampe', 'Steffen Menz', 'Alfonso Vidal', 'J. Hertel', 'Martin Roeb', 'Vamshi Krishna Thanda', 'Souzana Lorentzou', 'Christian Sattler', 'S. Berger', 'D. Laaber']	Renewable energy	2022

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TIM	Article	Revealing the Nature of Active Sites on Pt–Gd and Pt–Pr Alloys during the Oxygen Reduction Reaction	['Eleftherios Psaltis', 'Shujin Hou', 'Federico Calle-Vallejo', 'Richard W. Haid', 'Thorsten O. Schmidt', 'Regina M. Kluge', 'Oliver Schneider', 'Aliaksandr S. Bandarenka', 'Batyr Garlyyev']	ACS applied materials & interfaces	2022
TIM	Article	Preliminary risk assessment of hydrogen refuelling stations in a multifuel context	['Ju-Lynne Saw', 'Elena Vyazmina', 'Sylvaine Pique', 'B. Weinberger', 'Sebastien Quesnel', 'Quentin Nouvelot', 'Déborah Houssin', 'David Torrado']	DOAJ (DOAJ: Directory of Open Access Journals)	2022
TIM	Article	Scalable and thermally-integrated solar water-splitting modules using Ag-doped Cu(In,Ga)Se2 and NiFe layered double hydroxide nanocatalysts	['İlknur Bayrak Pehlivan', 'Minoh Lee', 'Stefan Haas', 'Nicole A. Saguì', 'Lars Stolt', 'Zhen Qiu', 'Martin Mueller', 'Tomas Edvinsson', 'Johan Oscarsson', 'Walter Zwaygardt', 'Marika Edoff']	Journal of materials chemistry. A	2022
TIM	Article	Nickel Site Modification by High-Valence Doping: Effect of Tantalum Impurities on the Alkaline Water Electro-Oxidation by NiO Probed by Operando Raman Spectroscopy	['İlknur Bayrak Pehlivan', 'Nicole A. Saguì', 'Tomas Edvinsson', 'Petter Ström']	ACS catalysis	2022
TIM	Article	The evolution and structure of ignited high-pressure cryogenic hydrogen jets	['Jennifer X. Wen', 'A.G. Venetsanos', 'Kaspar Andreas Friedrich', 'T. Jordan', 'M. Кузнецов', 'Zhaoxin Ren', 'S.G. Giannissi']	International journal of hydrogen energy	2022

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TIM	Article	A CFD analysis of liquefied gas vessel explosions	['A.G. Venetsanos', 'Nicola Paltrinieri', 'I.C. Tolias', 'Federico Ustolin', 'S.G. Giannissi']	Process safety and environmental protection/Transactions of the Institution of Chemical Engineers. Part B, Process safety and environmental protection/Chemical engineering research and design/Chemical engineering research & design	2022
TIM	Article	Towards Replacing Titanium with Copper in the Bipolar Plates for Proton Exchange Membrane Water Electrolysis	['Ulrich Rost', 'Delia Andrada Duca', 'Tobias Morawietz', 'Aldo S. Gago', 'Jeffrey Roth', 'Indro Biswas', 'Pawel Gazdzicki', 'Syed Asif Ansar', 'Kaspar Andreas Friedrich', 'Narcis Duțeanu', 'Andrea Kellenberger', 'Florian J. Wirkert', 'Mircea Laurențiu Dan', 'Nicolae Vaszilcsin', 'Svenja Stiber', 'Michael Brodmann']	Materials	2022
TIM	Article	Developing an Automated Tool for Quantitative Analysis of the Deconvoluted Electrochemical Impedance Response of a Solid Oxide Fuel Cell	['Massimiliano Della Pietra', 'Domenico Borello', 'Davide Pumiglia', 'Sergii Pylypko', 'Stephen J. McPhail', 'Mohammad Alboghobeish', 'Andrea Monforti Ferrario']	Energies	2022

TIM	Article	Evaluation of inkjet-printed spinel coatings on standard and surface nitrided ferritic stainless steels for interconnect application in solid oxide fuel cell devices	['Rumen I. Tomov', 'Robert Steinberger-Wilckens', 'Manuel Bianco', 'Ahmad El-Kharouf', 'Sathish Pandiyan']	Ceramics international	2022
TIM	Article	Performance and Degradation of Electrolyte-Supported Single Cell Composed of Mo-Au-Ni/GDC Fuel Electrode and LSCF Oxygen Electrode during High Temperature Steam Electrolysis	['Dimitrios K. Niakolas', 'L.G.J. de Haart', 'Izaak C. Vinke', 'Rüdiger-A. Eichel', 'Fotios Zaravelis', 'Stylianos G. Neophytides', 'Vaibhav Vibhu']	Energies	2022
TIM	Article	Fuel Cell prognosis using particle filter: application to the automotive sector	['Daniel Hissel', 'Yousfi Steiner Nadia', 'Noureddine Zerhouni', 'Aubry Julie', 'Simon Morando', 'Van der Linden Fabian']	2022 IEEE 31st International Symposium on Industrial Electronics (ISIE)	2022
TIM	Article	A high-performance, durable and low-cost proton exchange membrane electrolyser with stainless steel components	['N. Sata', 'Tobias Morawietz', 'Aldo Gago', 'Aimy Bazylak', 'A. Fallisch', 'Kaspar Andreas Friedrich', 'Kaspar Andreas Friedrich', 'Jason Lee', 'Thomas Jahnke', 'Svenja Stiber', 'Syed Asif Ansar']	Energy & Environmental Science	2022
TIM	Article	Addressing planar solid oxide cell degradation mechanisms: A critical review of selected components	Stephen J. McPhail, Stefano Frangini, Jérôme Laurencin, Elisa Effori, Amira Abaza, Aiswarya Krishnakumar Padinjarethil, Anke Hagen, Aline Léon, Annabelle Brisse, Daria	Journal Electrochemical Science Advances	2022

				Vladikova, Blagoy Burdin, Fiammetta Rita Bianchi, Barbara Bosio, Paolo Piccardo, Roberto Spotorno, Hiroyuki Uchida, Pierpaolo Polverino, Ennio Andrea Adinolfi, Fabio Postiglione, Jong-Ho LeeHamza Moussaoui, Jan Van herle		
TIM		Article	Ag–SiO2 - An optimized braze for robust joining of commercial coated stainless steel to ceramic solid oxide cells	['Zhiquan Wang', 'Peyman Khajavi', 'Chun Li', 'Ragnar Kiebach', 'Ilaria Ritucci', 'Jian Cao']	Ceramics international	2022
TIM		Article	Chemical Treatment of Sn-Containing Transparent Conducting Oxides for the Enhanced Adhesion and Thermal Stability of Electroplated Metals	Ibbi Y. Ahmet, Fatwa F. Abdi, Roel van de Krol	Advanced materials interfaces	2022
TIM	PECSYS	Article	Development of Various Photovoltaic-Driven Water Electrolysis Technologies for Green Solar Hydrogen Generation	Sonya Calnan, Rory Bagacki, Fuxi Bao, Iris Dorbandt, Erno Kemppainen, Christian Schary, Rutger Schlatmann, Marco Leonardi, Salvatore A. Lombardo, R. Gabriella Milazzo, Stefania M. S. Privitera, Fabrizio Bizzarri, Carmelo Connelli, Daniele Consoli, Cosimo Gerardi, Pierenrico Zani, Marcelo Carmo, Stefan Haas, Minoh Lee, Martin Mueller, Walter Zwaygardt, Johan Oscarsson, Lars Stolt,	Solar RRL	2022

			Marika Edoff, Tomas Edvinsson, and Ilknur Bayrak Pehlivan		
TIM	Article	Lattice Boltzmann simulation of liquid water transport in gas diffusion layers of proton exchange membrane fuel cells: Parametric studies on capillary hysteresis	['Kube, Alexander', 'Sarkezi-Selsky, Patrick', 'Schmies, Henrike', 'Latz, Arnulf', 'Thomas Jahnke']	Journal of Power Sources	2022
TIM	Article	Parametrization, Simulation and Energy Management Evaluation of a Fuel Cell Hybrid Electric Bus	['Petr Hajduk', 'Joel Anttila', 'Josu Olmos', 'Rafael Åman', 'Andoni Saez-de-Ibarra', 'Valtteri Pulkkinen']	2022 IEEE Vehicle Power and Propulsion Conference (VPPC)	2022
TIM	Article	Revealing the Nature of Active Sites on Pt-Gd and Pt-Pr Alloys during the Oxygen Reduction Reaction	Regina M Kluge, Eleftherios Psaltis, Richard W Haid , Shujin Hou, Thorsten O Schmidt, Oliver Schneider, Batyr Garlyyev, Federico Calle-Vallejo, Aliaksandr S Bandarenka	ACS Appl Mater Interfaces	2022
TIM	Review	Scalable Photovoltaic-Electrochemical Cells for Hydrogen Production from Water - Recent Advances	Minoh Lee, Stefan Haas, Vladimir Smirnov, Tsvetelina Merdzhanova & Uwe Rau	European Chemical Societies	2022
TIM	Article	Spatially Resolved Electrochemical Impedance Spectroscopy of Automotive PEM Fuel Cells	['Jarek P. Sabawa', 'Tuan Dao', 'Felix Haimerl', 'Aliaksandr S. Bandarenka']	ChemElectroChem	2022

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5.3.2 Additional Publications of 2023 (complementing AAR 2023)

TABLE 41. ADDITIONAL PUBLICATIONS OF 2023

Source	Project Acronym	Publication Type	Title	Authors	Publication Title	Year
CORDA	ELVHYS	Article	Modelling of Fireballs Generated after the Catastrophic Rupture of Hydrogen Tanks	Giannini L., Tincani G., Collina G., Salzano E., Cozzani V., Ustolin F.	Chemical Engineering Transactions	2023
CORDA	ELVHYS	Article	Safety of liquid and cryo-compressed hydrogen: overview of physical and CFD models developed at Ulster University	Cirrone D., Makarov D., Molkov V.	Chemical Engineering Transactions	2023
CORDA	ELVHYS	Article	Fragments Generated during Liquid Hydrogen Tank Explosions	Collina, G., Ustolin, F., Tincani, G., Giannini, L., Salzano, E., Cozzani, V.	Chemical Engineering Transactions	2023
CORDA	Haeolus	Conference paper	Grid Balancing with Electrolysers and Wind Power	['Federico Zenith; Martin Nord Flote; Maider Santos-Mugica; Corey Scott Duncan; Valerio Mariani; Claudio Marcantonini']		2023
CORDA	HIGGS	Other	HIGGS_D7.6 Final summary of communication, awareness and dissemination actions	['Tobias Weide, Hans Rasmusson,Javier Snchez, Vanesa Gil']	Deliverable D7.6	2023
CORDA	HIGGS	Other	HIGGS_D4.2 Report on results of the validation	['Virginia Madina, Jorge Aragn,Ekain Fernanndez, Vanesa Gil, Javier Snchez, Alberto Cerezo']	Deliverable D4.2	2023

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CORDA	HIGGS	Other	HIGGS_D6.2_Report on main interoperability and cross border issues	['Stefan Gehrmann, Michael Walter, Hiltrud Schlken, Javier Snchez,VanesaGil,Alberto Cerezo Alarcn, Cristina Rodrguez Vilario']	Deliverable D6.2	2023
CORDA	HIGGS	Other	D4.3 Update on test results	['Madina, Virginia; Aragn, Jorge; Fernandez, Dr. Ekain; Gil, Vanesa; Sanchez-Lainez; Javier Cerezo, Alberto']	Deliverable 4.3	2023
CORDA	HIGGS	Other	HIGGS_D6.3_ Pathway and proposals summary to enable wider injection of H2 in EU gas networks	['Stefan Gehrmann, Michael Walter, Hiltrud Schlken, AlbertoCe-rezo Alarcn, Cristina Rodrguez Vilario, Lola Storch de Gracia, Javier Snchez Lanez, Vanesa Gil, Virginia Madina Arrese, Sal-vatore Oricchio']	Deliverable D6.3	2023
CORDA	TeacHy	Conference paper	Hydrogen readiness of European education systems? A gap analysis	R. Steinberger-Wilckens	Proceedings of the Czech Hydrogen Days 2023	2023
CORDA	e-SHyIPS	Article	Challenges for zero-emission yacht design	G.M.M. Ansaloni, A. Bionda, M. Rossi	MD Journal	2023

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CORDA	FCH2RAIL	Conference paper	Waste Energy AC Technologies in H2-Multiple Units	Kordel, Markus Heeland, Matthew Maikel Knetsch, Kevin	Proceedings of the 4th International Railway Symposium Aachen 2023	2023
CORDA	FLEX4H2	Other	Turning to sequential combustion technology to push hydrogen fuel content to the extreme	Ansaldo Energia	Gas Turbine World	2023
CORDA	FLHYSAFE	Article	Immersed and Integrated Converter (30 kW) for Fuel Cell System in Aircraft Application	Sylvain Mercier, Bruno Beranger, Jacques Ecrabey and Frdric Gaillard	Bodo's Power Systems	2023
CORDA	FURTHER-FC	Article	Nanostructured Catalyst Layer Allowing Production of Ultralow Loading Electrodes for Polymer Electrolyte Membrane Fuel Cells with Superior Performance	Colleen Jackson, Michalis Metaxas, Jack Dawson, Anthony R. Kucernak	ACS Applied Energy Materials	2023
CORDA	HIGGS	OTHER	HIGGS_D2.2_Assessment document of RCS barriers and enablers at EU level	Armin Bollien; Frank Dietzsch; Javier Snchez Lanez; Hiltrud Schlken	Deliverable 2.2	2023
CORDA	HIGGS	OTHER	Presentation of HIGGS results at Hydrogen Dialogue 2023 conference	Felix Knkel	Hydrogen Dialogue 2023	2023
CORDA	HIGGS	Conference paper	Investigation of the impact of hydrogen blends on materials and equipment of high-pressure natural gas grids - Presentation in conference	Vanesa Gil, Javier Snchez-Lanez, Alberto Cerezo, Maria Dolores Storch de Gracia,Ekain Fernndez, Virginia Madina	World Congress of Chemical Engineering - WCCE	2023
CORDA	HIGHLAND ER & IMMORTAL	Article	Stabilization of Carbon-Supported PlatinumRare Earth Nanoalloys during Electrochemical Activation	C. A. Campos-Roldn, J.-S. Filhol, H. Guesmi, M. Bigot, R. Chattot, A.	ACS Catalysis	2023

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				Zitolo, P.-Y. Blanchard, J. Rozire, D. J. Jones, S. Cavalier		
CORDA	HyLICAL & SH2APED	OTHER	Explosion mitigation techniques in tunnels and their applicability to scenarios of hydrogen tank rupture in a fire	V. Shentsov, L. Giuliani, W. Liu and F. Markert		2023
CORDA	HySelect	Other	Allothermally heated reactors for solar-powered implementation of sulphur-based thermochemical cycles	Vamshi Krishna Thanda, Dennis Thomey, Michael Wullenkord, Kai-Peter Eer, Christos Agrafiotis, Dimitrios Dimitrakis, Martin Roeb, Christian Sattler	29th SolarPACES Conference 2023	2023
CORDA	HySelect	Other	Construction and Optimization of SO2 Depolarized Electrolyser	Pragya Narayana Prasad	Aalto University	2023
CORDA	HySelect	Other	Enhanced system design to reduce the SO2 crossover to the cathode in SO2 Depolarized Electrolyser (SDE)	Pragya Narayana Prasad, Neha Garg, Annukka Santasalo-Aarnio	International Conference on Electrolysis	2023
CORDA	HySelect	Other	Sulphur dioxide Depolarized Electrolysis for Hydrogen production: Approaches and applications	Larissa Queda, Dimitrios Dimitrakis, Vamshi Krishna Thanda, Dennis Thomey, Christian Sattler	Helmholtz Energy Conference 2023	2023
CORDA	HyUsPRe	Book chapter	Natural hydrogen seeps as analogues to inform monitoring of engineered hydrogen storage	Christopher J. McMahon, Jennifer J. Roberts, Gareth	Geological Society Special Publications	2023

				Johnson, Katriona Edlmann, Stephanie Flude and Zoe K. Shipton		
CORDA	MultiPLHY	Article	Development of a Versatile and Reversible Multi-Stack Solid Oxide Cell System Towards Operation Strategies Optimization	Geraud Cubizolles, Simon Alamome, Flix Bosio, Brigitte Gonzalez, Christian Tantolin, Lucas Champelovier, Sebastien Fantin, Jerome Aicart	ECS Transactions	2023
CORDA	MultiPLHY	Article	Benchmark Study of Performances and Durability between Different Stack Technologies for High Temperature Electrolysis	Jerome Aicart, Alexander Surrey, Lucas Champelovier, Kilian Henault, Chistian Geipel, Oliver Posdziech, Julie Mougin	Fuel Cells	2023
CORDA	REFLEX	Conference paper	Recent Highlights on Solid Oxide Cells, Stacks and Modules Developments at CEA	Julie Mougin, Jrme Laurencin, Julien Vulliet, Marie Petitjean, Elisa Grindler, Stphane Di Iorio, Karine Couturier, Theo Dejob, Brigitte Gonzalez, Geraud Cubizolles	ECS Transactions	2023

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CORDA	RH2IWER	Other	Hydrogen fuel cells for decarbonizing inland waterway shipping	M Rivarolo, GN Montagna, T Lamberti, S Barberis	Proceedings OF THE 10TH EUROPEAN FUEL CELL PIERO LUNGHI CONFERENCE	2023
CORDA	SO-FREE	Conference paper	Compositional analysis of SOFC short stacks operating under different feedstocks: experimental analysis and model-based interpretation.	Francesca Santoni,, Gabriele Loreti, Andrea Monforti Ferrario, Francesco Marino, Viviana Cigolotti	European Fuel Cells and Hydrogen, book of proceeding	2023
CORDA	SO-FREE	Conference paper	Designing for flexible use of hydrogen and natural gas: the SO-FREE project	Stephen McPhail, Viviana Cigolotti, Mathias Innerkofler, Matti Noponen, Stefan Megel, Carlo Tregambe, Michal Wierzbicki, Lukasz Bubniak, Luca Del Zotto	European Fuel Cells and Hydrogen 2023, Book of proceeding	2023
CORDA	SO-FREE	Conference paper	Validation of Solid Oxide Fuel Cell short Stack test bench in SO-FREE Project	Francesco Marinoa, Lorenzo Arcidiaconoa, Francesca Santonia, Andrea Monforti Ferrarioa, Luca Simonettia, Antonio Scotinia, Arda Hatunoglu	European Fuel Cells and Hydrogen 2023, Book of proceeding	2023

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CORDA	TeacHy	Conference paper	Hydrogen readiness of European education systems A gap analysis	Robert Steinberger-Wilckens	Proceedings of the Czech Hydrogen Days 2023	2023
CORDA	TeacHy	Conference paper	Training, re- and up-skilling for the hydrogen economy	Robert Steinberger-Wilckens	Proceedings of theconference 'Hydrogen and Fuel Cells -Fuelling the future now'	2023
CORDA	WASTE2WATTS	Conference paper	Techno-Economic Feasibility of Biogas-Fed SOFC Power System Integrated with Biogas Cleaning Unit and Carbon Capture Technologies	H. Yu, L. Wang, J. Van herle, E. A. Pina	Electrochemical Society Series ECS	2023
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Techno-economic assessment of different biogas purification and carbon capture technologies for multi-scale biogas-fed SOFC system	Gianluca Monticone	Master Thesis	2023
CORDA	WASTE2WATTS	Thesis Dissertation - Master	Carbon Neutrality in Switzerland: Exploring the Role of Waste Water Treatment Plants in Carbon Capture, Storage, and Utilization	Lon Stcker	Master thesis	2023
CORDA	WASTE2WATTS	OTHER	Performance Losses of electrolyte-supported SOFC Exposed to Sulphide Contaminants	Louis Savioz	Semester project Report	2023
CORDA	WASTE2WATTS	OTHER	Strategy for improved recovery of an anode-supported SOFC exposed to sulfide contaminants	Tatsuma Yamauchi	Semester project Report	2023
CORDA	WASTE2WATTS	Conference paper	Testing of solid oxide fuel cells fed with dry and steam reformed biogas with hydrogen sulfide and dimethyl sulfide contaminants	C. Frantz, L. Shucan, L. Savioz, S. Diethelm, P. Aubin, D. Montinaro,	European Biomass Conference	2023

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				F. Mittmann, and J. Van herle		
CORDA	WASTE2WATTS	Conference paper	Deactivation mechanisms of Ni-Fe and Ru-exsolution reforming catalysts during prolonged exposure to H2S and DMS contaminants	C. Frantz, Y. Hanria, L. Rumpf, M. Mensi, M. Jank, C.R. Mller, J. Van herle	European Biomass Conference	2023
CORDA	WASTE2WATTS	Conference paper	Techno-economic evaluation of biogas-fed SOFC power system integrated with biogas cleaning unit	Hangyu Yu, Ligang Wang, Jan Van herle	European Biomass Conference & Exhibition	2023
CORDA, OpenAlex, OpenAIRE	24_7 ZEN	Article	Thickness effect of thin-film barrier layers for enhanced long-term operation of solid oxide fuel cells	['Àlex Morata', 'Marc Torrell', 'Dario Montinaro', 'Jaime Dolado', 'Jaime Segura-Ruiz', 'Albert Tarancón', 'Federico Baiutti', 'Fjorelo Buzi', 'Lucile Bernadet']	APL energy	2023
CORDA, OpenAlex, OpenAIRE	24_7 ZEN	Article	Ternary Fe- or Mo-Au-Ni/GDC as Candidate Fuel Electrodes for the Internal Dry Reforming of CH4: Physicochemical and Kinetic Investigation	['Dimitrios K. Niakolas', 'Evangelia Ioannidou', 'Stylianos G. Neophytides']	Energies	2023
CORDA, OpenAlex, OpenAIRE	24_7 ZEN & NewSOC	Article	Enhancement of the intrinsic Ni/GDC activity under rSOC operation by means of Fe–Au doping: An electro-kinetic study	['Dimitrios K. Niakolas', 'Fotios Zaravelis']	International journal of hydrogen energy	2023
CORDA, OpenAlex, OpenAIRE	ADVANCEPEM	Article	Ce-radical Scavenger-Based Perfluorosulfonic Acid Aquivion® Membrane for Pressurised PEM Electrolysers	['Stefano Tonella', 'Claudio Oldani', 'S. Siracusano', 'A.S.	Polymers	2023

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				Aricò', 'Fausta Giacobello']		
CORDA, OpenAlex , OpenAIRE	ANIONE	Article	Aquivion-based anion exchange membranes: Synthesis optimization via dispersant agents and reaction time	['Sabrina Campagna Zignani', 'Irene Gatto', 'Claudio Oldani', 'Rolando Pedicini', 'Alessandra Carbone', 'Alice Cattaneo', 'A.S. Aricò']	Chemical engineering journal	2023
CORDA, OpenAlex , OpenAIRE	BRAVA & HIGHLANDER	Article	A Comparative Study on the Activity and Stability of Iridium-Based Co-Catalysts for Cell Reversal Tolerant PEMFC Anodes	['F. Eweiner', 'Robert Marić', 'Peter Strasser', 'Christian Gebauer']	Journal of the Electrochemical Society	2023
CORDA, OpenAlex , OpenAIRE	CHANNEL	Article	The Influence of Loadings and Substrates on the Performance of Nickel-Based Catalysts for the Oxygen Evolution Reaction	['Meital Shviro', 'Wulyu Jiang', 'Werner Lehnert']	ChemElectroChem	2023
CORDA, OpenAlex , OpenAIRE	ComSos	Article	Evaluation of the environmental sustainability of SOFC-based cogeneration systems in commercial buildings	['Massimo Santarelli', 'Paolo Marocco', 'Marta Gandiglio']	Energy reports	2023
CORDA, OpenAlex , OpenAIRE	DOLPHIN	Article	Proton transport through nanoscale corrugations in two-dimensional crystals	['Alex W. Colburn', 'Enrico Daviddi', 'Patrick R. Unwin', 'D. Barry', 'E. Griffin', 'B. Xin', 'M. Yagmurcukardes', 'F. M. Peeters', 'M. Lozada-Hidalgo', 'A. K.	Nature	2023

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				Geĭm', 'Pengzhan Sun', 'Oluwasegun J. Wahab']		
CORDA, OpenAlex , OpenAIRE	eGHOST	Article	How can the European Ecodesign Directive guide the deployment of hydrogen-related products for mobility?	['Javier Dufour', 'Felipe Campos-Carriedo', 'Eleonora Bargiacchi', 'Diego Iribarren']	Sustainable energy & fuels	2023
CORDA, OpenAlex , OpenAIRE	ELVHYS	Article	Physical model of non-adiabatic blowdown of cryo-compressed hydrogen storage tanks	['Kaspar Andreas Friedrich', 'Sergii Kashkarov', 'Dmitriy Makarov', 'Vladimir Molkov', 'Donatella Cirrone']	International journal of hydrogen energy	2023
CORDA, OpenAlex , OpenAIRE	ELVHYS	Article	Numerical Modelling of Liquid Hydrogen Tanks Performance During Fire Engulfment	['Giordano Emrys Scarponi', 'Valerio Cozzani', 'Alice Schiaroli', 'Federico Ustolin']	Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023) 3 – 8 September 2023, Southampton, UK	2023
CORDA, OpenAlex , OpenAIRE	e-SHyIPS	Article	H2-fueled passenger ship hazards: challenges in risk assessment for a front edge technology application	['Marta Tome Maintega', 'Brendan P. Sullivan', 'Oscar Noguero Torres', 'D. A. Sanchez⋆', 'Arianna Bionda']	AHFE international	2023

CORDA, OpenAlex , OpenAIRE	FCH2RAIL	Article	Comparison of simulative methods for dimensioning of fuel cell-battery hybrid powertrains in FCH2Rail and VirtualFCS	['Schindler, Christian', 'DVV Media Group GmbH', 'Nießen, Nils']	Proceedings of the 4th International Railway Symposium Aachen 2023	2023
CORDA, OpenAlex , OpenAIRE	FURTHER-FC	Article	Computation of oxygen diffusion properties of the gas diffusion medium -microporous layer assembly from the combination of X-ray microtomography and focused ion beam three dimensional digital images	['Thomas David', 'Laure Guétaz', 'Mohamed Ahmed-Maloum', 'Paul Duru', 'Michel Quintard', 'Joël Pauchet', 'Marc Prat']	Journal of power sources	2023
CORDA, OpenAlex , OpenAIRE	FURTHER-FC	Article	Detailed Catalyst Layer Structure of Proton Exchange Membrane Fuel Cells from Contrast Variation Small-Angle Neutron Scattering	['Gérard Gébel', 'Florent Vandenberghe', 'Sandrine Lyonnard', 'Jongmin Lee', 'Laure Guétaz', 'Sébastien Rosini', 'Arnaud Morin', 'Florian Chabot', 'Lionel Porcar']	ACS applied energy materials	2023
CORDA, OpenAlex , OpenAIRE	HIGGS	Other	HIGGS_D5.1_Report on baseline, assumptions and scope for techno-economic modelling	['Villuendas, Teresa', 'Alberto Cerezo', 'M. Dolores Storch de Gracia', 'Leonhard, Robin', 'Sanchez-Lainez, Javier', 'Steiner, Christoph']	Deliverable 5.1	2023
CORDA, OpenAlex	HIGGS	Article	D6.1 Considerations on H2 injection potential to reach EU decarbonisation goals	['Sanchez-Lainez, Javier']	Deliverable 6.1	2023

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CORDA, OpenAlex , OpenAIRE	HyLICAL	Article	Magnetocaloric materials for hydrogen liquefaction	['Jorge Revuelta-Losada', 'Carlos Romero-Mu ntilde iz', 'Jia Yan Law', 'Luis M. Moreno-Ram iacute rez', 'V. Franco']	˜The œInnovation materials	2023
CORDA, OpenAlex , OpenAIRE	HyLICAL	Article	Designing magnetocaloric materials for hydrogen liquefaction with light rare-earth Laves phases	['Oliver Gutfleisch', 'Nuno M. Fortunato', 'Alex Aubert', 'Tino Gottschall', 'Franziska Scheibel', 'Konstantin Skokov', 'Wei Liu', 'Hongbin Zhang', 'Eduard Bykov']	arXiv (Cornell University)	2023
CORDA, OpenAlex , OpenAIRE	HyLICAL	Article	On the high-field characterization of magnetocaloric materials using pulsed magnetic fields	['J. Wosnitza', 'M. Straßheim', 'T. Niehoff', 'Y. Skourski', 'C. Salazar Mejía', 'Tino Gottschall', 'Eduard Bykov']	JPhys energy	2023
CORDA, OpenAlex , OpenAIRE	HyLICAL	Article	The role of Debye temperature in achieving large adiabatic temperature changes at cryogenic temperatures: a case study on Pr_2In	['Imants Dirba', 'Oliver Gutfleisch', 'Nuno M. Fortunato', 'Tino Gottschall', 'Franziska Scheibel', 'Konstantin Skokov', 'Wei Liu', 'Hongbin Zhang']	arXiv (Cornell University)	2023

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CORDA, OpenAlex , OpenAIRE	HyLICAL	Article	Tunable magnetocaloric effect towards cryogenic range by varying Mn:Ni ratio in all-d-metal Ni(Co)-Mn-Ti Heusler alloys	['Aun N. Khan', 'Álvaro Díaz-García', 'Jia Yan Law', 'Luis M. Moreno-Ramírez', 'V. Franco']	Journal of alloys and compounds	2023
CORDA, OpenAlex , OpenAIRE	HyP3D	Article	3D printed electrolyte-supported solid oxide cells based on Ytterbium-doped scandia-stabilized zirconia	['Marc Torrell', 'Antonio Maria Asensio', 'Marc Núñez', 'Albert Tarancón', 'Simone Anelli', 'Santiago Márquez', 'Maritta Lira']	JPhys energy	2023
CORDA, OpenAlex , OpenAIRE	HyStorIES	Article	An Insight into Underground Hydrogen Storage in Italy	['Y. Le Gallo', 'Erika Barison', 'Federica Donda', 'Barbara Merson', 'Arnaud Réveillère']	Sustainability	2023
CORDA, OpenAlex , OpenAIRE	HyStorIES	Article	Assessing and modeling hydrogen reactivity in underground hydrogen storage: A review and models simulating the Lobodice town gas storage	['Y. Le Gallo', 'Joachim Trémosa', 'Rasmus Jakobsen']	Frontiers in energy research	2023
CORDA, OpenAlex , OpenAIRE	HyStorIES	Article	First assessment of an area potentially suitable for underground hydrogen storage in Italy	['S. Mattera', 'Y. Le Gallo', 'Erika Barison', 'Federica Donda', 'Umberta Tinivella', 'C. Vincent']	International journal of hydrogen energy	2023
CORDA, OpenAlex , OpenAIRE	HyUsPRe	Article	Geochemical Integrity of Wellbore Cements during Geological Hydrogen Storage	['Adnan Aftab', 'R. Stuart Haszeldine', 'Abby Martin', 'Jackie E. Kendrick', 'Niklas	Environmental science & technology letters	2023

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CORDA, OpenAlex , OpenAIRE	HyUsPRe	Article	Empirical and Numerical Modelling of Gas–Gas Diffusion for Binary Hydrogen–Methane Systems at Underground Gas Storage Conditions	['Julia Michelsen', 'Sebastian Hogeweg', 'Leonhard Ganzer', 'Birger Hagemann']	Transport in porous media	2023
CORDA, OpenAlex , OpenAIRE	HyUsPRe	Article	Microbial risk assessment for underground hydrogen storage in porous rocks	['Timothy Armitage', 'Lubica Slabon', 'Eike Marie Thaysen', 'Katriona Edlmann', 'Aliakbar Hassanpouryouzband']	Fuel	2023
CORDA, OpenAlex , OpenAIRE	IMMORTAL	Article	Stabilization of Carbon-Supported Platinum–Rare Earth Nanoalloys during Electrochemical Activation	['Jacques Rozière', 'Hazar Guesmi', 'Raphaël Chattot', 'Jean-Sébastien Filhol', 'Carlos A. Campos-Roldán', 'Deborah J. Jones', 'Pierre-Yves Blanchard', 'Mickaël Bigot', 'Andrea Zitolo', 'Sara Cavalière']	ACS catalysis	2023
CORDA, OpenAlex	IMMORTAL	Article	Structure Dynamics of Carbon-Supported Platinum-Neodymium Nanoalloys during the Oxygen Reduction Reaction	['Hazar Guesmi', 'Raphaël Chattot', 'Jean-Sébastien Filhol',	ACS catalysis	2023

, OpenAIRE				'Carlos A. Campos-Roldán', 'Deborah J. Jones', 'Jakub Drnec', 'Pierre-Yves Blanchard', 'Rémi Bacabe', 'F. Pailloux', 'Andrea Zitolo', 'Sara Cavalière']		
CORDA, OpenAlex , OpenAIRE	MORELife	Article	Elucidating mechanistic background of the origin and rates of peroxide formation in low temperature proton exchange fuel cells	['Tomaž Katrašnik', 'Ambrož Kregar']	Journal of electrochemical science and engineering	2023
CORDA, OpenAlex , OpenAIRE	MORELife	Article	Degradation of Pt-Based Cathode Catalysts Upon Voltage Cycling in Single-Cell PEM Fuel Cells Under Air or N2 at Different Relative Humidities	['Leonardo Isaias Astudillo', 'Hubert A. Gasteiger']	Journal of the Electrochemical Society	2023
CORDA, OpenAlex , OpenAIRE	MORELife	Article	Educational Scale-Bridging Approach towards Modelling of Electric Potential, Electrochemical Reactions, and Species Transport in PEM Fuel Cell	['Tomaž Katrašnik', 'Ambrož Kregar', 'Andraž Kravos', 'Klemen Zelič']	Catalysts	2023
CORDA, OpenAlex , OpenAIRE	MORELife & RealHyFC	Article	Hybrid Methodology for Parametrisation of Proton Exchange Membrane Fuel Cell Model for Diagnostics and Control Applications	['Tomaž Katrašnik', 'Tit Voglar', 'Ambrož Kregar', 'Andraž Kravos']	Journal of the Electrochemical Society	2023
CORDA, OpenAlex , OpenAIRE	MultiPLHY	Article	Recent Highlights on Solid Oxide Cells, Stacks and Modules Developments at CEA	['Géraud Cubizolles', 'Julie Mouginn', 'Brigitte Gonzalez', 'Elisa Lay-Grindler', 'Félix Bosio', 'Jérôme	ECS transactions	2023

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CORDA, OpenAlex , OpenAIRE	NEWELY	Other	Final report (D1.10)	['Miriam Goll', 'Aldo S. Gago', 'Dirk Henkensmeier', 'Reissner, Regine', 'Frédéric Fouda-Onana', 'Jelena Stojadinović', 'Francesca Ferrari Pellegrini', 'Jaromír Hnát', 'Fatemeh Sanaz Razmjooei', 'Zitka', 'Lukas Mues']	Zenodo (CERN European Organization for Nuclear Research)	2023
CORDA, OpenAlex , OpenAIRE	NEWELY	Article	Pre-swelling of FAA3 membranes with water-based ethylene glycol solution to minimize dimensional changes after assembly into a water electrolyser: Effect on properties and performance	['Hamza Khalid', 'Dirk Henkensmeier', 'Malikah Najibah', 'Karel Bouzek', 'Jaromír Hnát', 'Jimin Kong', 'Hyun S. Park']	Journal of membrane science	2023
CORDA, OpenAlex , OpenAIRE	NEWELY	Other	MPL coating procedure	['Aldo S. Gago', 'Syed Asif Ansar', 'Reissner, Regine', 'Fatemeh Sanaz Razmjooei']	Zenodo (CERN European Organization for Nuclear Research)	2023

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CORDA, OpenAlex , OpenAIRE	NEWELY	Other	MEA production	['Miriam Goll', 'Reissner, Regine', 'Frédéric Fouda-Onana', 'Fatemeh Razmjooei', 'Lukas Mues']	Zenodo (CERN European Organization for Nuclear Research)	2023
CORDA, OpenAlex , OpenAIRE	NEWELY	Other	TEA and LCA of the new AEMWE Technology (D6.3)	['Ankit Patel', 'Roberta Olindo']	Zenodo (CERN European Organization for Nuclear Research)	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Hole polarons in LaFeO3 and La1−xSrxFeO3−δ</...	['Grégory Geneste', 'Cintia Hartmann', 'Jérôme Laurencin']	Physical review. B./Physical review. B	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Large area solid oxide fuel cells with room temperature sputtered barrier layers: Role of the layer thickness and uniformity in the enhancement of the electrochemical performances and durability	['G. Carapella', 'Cesare Pianese', 'Dario Montinaro', 'Francesca Martinelli', 'Alice Galdi', 'Pierpaolo Polverino', 'Nunzia Coppola', 'L. Maritato', 'V. Granata', 'Hafiz Sami Ur Rehman']	International journal of hydrogen energy	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Effect of Steam to Carbon Dioxide Ratio on the Performance of a Solid Oxide Cell for H2O/CO2 Co-Electrolysis	['Stella Balomenou', 'D. Tsiplakides', 'Argyro Konstantinidou', 'Kalliopi-Maria Papazisi', 'Naouma Bimpiri']	Nanomaterials	2023

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CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Understanding the Ni Migration in Solid Oxide Cell: A Coupled Experimental and Modeling Approach	['Ming Chen', 'Lijun Zhang', 'Maxime Hubert', 'Jérôme Laurencin', 'Yijing Shang', 'Shenglan Yang', 'Karine Couturier', 'Julien Vulliet', 'Léa Rorato']	Journal of the Electrochemical Society	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Low Temperature Performance and Durability of Solid Oxide Fuel Cells with Titanate Based Fuel Electrodes Using Reformate Fuel	['Anke Hagen', 'Jens Ole Christensen', 'Bhaskar Reddy Sudireddy']	Journal of the Electrochemical Society	2023
CORDA, OpenAlex , OpenAIRE	NewSOC & RUBY & REACTT	Article	A multiscale model validated on local current measurements for understanding the solid oxide cells performances	['G. Sassone', 'Manon Prioux', 'E. Da Rosa Silva', 'Maxime Hubert', 'Bertrand Morel', 'Jérôme Laurencin']	Journal of power sources	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Transition metals in Ni/GDC for the reversible solid oxide cell operation: Optimization of the Mo-Au-Ni synergy and further enhancement via substitution of Mo with Fe	['Dimitrios K. Niakolas', 'Labrini Sygellou', 'Fotios Zaravelis', 'Athina Souvalioti']	Electrochimica acta	2023
CORDA, OpenAlex , OpenAIRE	NewSOC	Article	Electrophoretic deposition of MnCo2O4 coating on solid oxide cell interconnects manufactured through powder metallurgy	['Mari Carmen Monterde', 'J.A. Calero', 'Marc Torrell', 'Federico Smeacetto', 'Antonio Gianfranco Sabato', 'Albert	Materials & design	2023

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				Tarancón', 'Elisa Zanchi', 'Lucile Bernadet']		
CORDA, OpenAlex , OpenAIRE	OUTFOX	Article	Solid Oxide Stack Development at Elcogen	['Antonio Alfano', 'Matti Noponen', 'Jouni Puranen', 'Hanna Granö-Fabritius']	ECS transactions	2023
CORDA, OpenAlex , OpenAIRE	RH2IWER	Article	A multi-criteria approach for comparing alternative fuels and energy systems onboard ships	['G.N. Montagna', 'Daria Bellotti', 'S. Piccardo', 'Massimo Rivarolo']	Energy conversion and management. X	2023
CORDA, OpenAlex , OpenAIRE	RUBY & SWITCH	Article	Fast online diagnosis for solid oxide fuel cells: Optimisation of total harmonic distortion tool for real-system application and reactants starvation identification	['Vanja Subotić', 'Hamza Moussaoui', 'Gerald Hammerschmid', 'Jan Van herle']	Journal of power sources	2023
CORDA, OpenAlex , OpenAIRE	SH2APED	Article	CFD Simulations of Hydrogen Tank Fuelling: Sensitivity to Turbulence Model and Grid Resolution	['Hanguang Xie', 'Sergii Kashkarov', 'Dmitriy Makarov', 'Vladimir Molkov']	Hydrogen	2023
CORDA, OpenAlex , OpenAIRE	SH2APED	Article	Breakthrough safety technology of explosion free in fire self-venting (TPRD-less) tanks: The concept and validation of the microleaks-no-burst technology for carbon-carbon and carbon-glass double-composite wall hydrogen storage systems	['Sergii Kashkarov', 'Dmitriy Makarov', 'Vladimir Molkov']	International journal of hydrogen energy	2023

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CORDA, OpenAlex , OpenAIRE	SH2APED	Article	Effect of TPRD diameter and direction of release on hydrogen dispersion and jet fires in underground parking	['Dmitriy Makarov', 'Donatella Cirrone', 'Volodymyr Shentsov']	Journal of energy storage	2023
CORDA, OpenAlex , OpenAIRE	SH2APED	Article	CFD Model of Refuelling through the Entire HRS Equipment: The Start-Up Phase Simulations	['Dmitriy Makarov', 'Hazhir Ebne-Abbasi', 'Vladimir Molkov']	Hydrogen	2023
CORDA, OpenAlex , OpenAIRE	SHERLOHC K	Article	First principles-based approaches for catalytic activity on the dehydrogenation of liquid organic hydrogen carriers: A review	['Mesfin Redi', 'Kingsley Onyebuchi Obodo', 'Dmitri Bessarabov', 'Yedilfana Setarge Mekonnen', 'Desalegn Nigatu Gemechu', 'Ahmed Mohammed']	International journal of hydrogen energy	2023
CORDA, OpenAlex , OpenAIRE	SHERLOHC K	Article	Evaluation of acetophenone as a novel alcohol-cycloalkane bifunctional liquid organic hydrogen carrier (LOHC)	['Gérard Gébel', 'Parviz Hajiyev', 'Florian D'Ambra', 'Emmanuel Nicolas', 'Julia G. Levy', 'Vincent Faucheux', 'Thibault Cantat']	International journal of hydrogen energy	2023
CORDA, OpenAlex , OpenAIRE	SO-FREE	Article	Scenario Evaluation of Reversible Solid Oxide Cells Integrated with Local Renewable Energy Sources: Assessment of Different Coupling Applications	['Massimiliano Della Pietra', 'Francesco Marino', 'Viviana Cigolotti', 'Francesca Santoni', 'Elio Jannelli', 'Andrea Monforti Ferrario']	ECS transactions	2023

CORDA, OpenAlex , OpenAIRE	SO-FREE	Article	Performance Evaluation of an Anode-Supported Solid Oxide Fuel Cell Short-Stack Operating with Different Hydrogen-Natural Gas Blends as Stationary Combined Heat and Power System	['Antonio Alfano', 'Francesco Marino', 'Julius Stenius', 'Matti Noponen', 'Viviana Cigolotti', 'Francesca Santoni', 'Raphael Neubauer', 'Andrea Monforti Ferrario']	ECS transactions	2023
CORDA, OpenAlex , OpenAIRE	WASTE2WATTS	Article	Hydrogen Sulphide and Carbonyl Sulphide Removal from Biogas for Exploitation in High-Temperature Fuel Cells	['Andrea Lanzini', 'Francesca Santoni', 'Sonia Fiorilli', 'Stephen J. McPhail', 'Marta Gandiglio', 'Marco Pagani', 'P. Gislon', 'Elena Rozzi']	Waste and biomass valorization	2023
CORDA, OpenAlex , OpenAIRE	WINNER	Book chapter	Interconnects and coatings	['Elena Stefan', 'Belma Talic', 'Yngve Larring']	IOP Publishing eBooks	2023
CORDA, OpenAlex , OpenAIRE	WINNER	Book chapter	Tubular protonic ceramic electrolysis cells and direct hydrogen compression	['Einar Vøllestad']	IOP Publishing eBooks	2023
JU Data Collection	GAIA	Article	ORR Activity and Voltage-Cycling Stability of a Carbon-Supported PtxY Alloy Catalyst Evaluated in a PEM Fuel Cell	P. A. Loichet Torres, Y.-S. Li, C. Grön, T. Lazaridis, P. Watermeyer, N. Cheng, C. H. Liebscher, H. A. Gasteiger	Journal of the Electrochemical Society	2023

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JU Data Collection	HYPSTER	Conference paper	Mechanical stability of a salt cavern used for hydrogen storage	INERIS, BROUARD CONSULTING, STORENGY (Djizanne, H., Brouard B., & Hévin G.)	In the Proceedings of 15th ISRM Congress 2023 & 72nd Geomechanics Colloquium. Challenges in Rock Mechanics and Rock Engineering, 09 ? 14 October, 2023.	2023
JU Data Collection	HYPSTER	Conference paper	The regulatory framework of geolocial storage of hydrogen in salt caverns	INERIS, INOVYN, ESK (Weinberger B., Djizanne H., Pique S., Lahaie F., Bannach A., Wagler T., Stevenson R.and Applewhite R.)	ITCH - International Conference on Hydrogen Safety Hysafe taking place on 19th-21st September 2023 in Québec	2023
JU Data Collection	HySelect	Conference paper	HySelect: Efficient water splitting via a flexible solar-powered Hybrid thermochemical-Sulphur dioxide depolarized Electrolysis Cycle	Project Consortium	European Fuel Cells and Hydrogen Conference 2023	2023
JU Data Collection	JIVE	Conference paper	State of play of Performance of FCBs (Fuel Cell Buses) and HRS (Hydrogen Refuelling Infrastructures)	Vanessa Roderer, Klaus Stolzernburg	Zero Emission Bus Conference	2023
JU Data Collection	JIVE & JIVE 2	Conference paper	Status of Testing Fuel Cell Buses and their Hydrogen Filling Stations	Katharina Buss, Stefan Eckert, Vanessa Roderer, Klaus Stolzenburg		2023
JU Data Collection	PROMETEO	Conference paper	Green Hydrogen Production by Means of Solar Heat and Power in High Temperature Solid Oxide Electrolyzers	Alberto Giaconia , Massimiliano Della Pietra, Pablo Moreno, Matteo Testi, Stefan	Proceedings of the Australian Hydrogen Research Conference 2023	2023

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				Diethelm, Manuel Romero Alvarez, Matteo Robino, Jan van Herle, Barbara Morico, Joey Dobrée	(AHRC 2023) 8-10 February 2023	
JU Data Collection	PROMETEO	Article	Techno-economic analysis of solar hydrogen production via PV power/concentrated solar heat driven solid oxide electrolysis with electrical/thermal energy storage	Yumeng Zhang, Zhuo Wang, Zhiyu Du, Yue Li, Meng Qian, Jan Van herle, Ligang Wang	Journal of Energy Storage	2023
JU Data Collection	RoRePower	Article	Robust remote power supply (RoRePower)	Jari Kiviaho, Jyrki Mikkola, Markus Münch, Daniele Penchini, Matthias Boltze, Michael Spirig, Mari Tuomaala	EFCF 2022: Proceedings of the European Electrolyser & Fuel Cell Forum 2022, 5-6 July, Lucerne, Switzerland	2023
JU Data Collection	SO-FREE	Article	Performance Evaluation of an Anode-Supported Solid Oxide Fuel Cell Short-Stack Operating with Different Hydrogen-Natural Gas Blends as Stationary Combined Heat and Power System,	A.Monforti Ferrario, F.Santoni, F.Marino, A.Alfano, J. Stenius, M.Noponen, R.Neubauer, V.Cigolotti.	ECS transaction	2023
JU Data Collection	TeacHy	Conference paper	Up-Skilling the European Fuel Cell and Hydrogen Work Force	R.Steinberger-Wilckens, Y.Al-Sagheer	Proceedings of the EFCF 2023, 4 to 7 July 2023, Lucerne	2023
JU Data Collection	HYPSTER	Conference paper	Hypster : 1st Demonstrator for hydrogen storage in France	STORENGY, INERIS	Solution Mining Research Institute	2023

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					Fall Technical on 2-3 october 2023	
OpenAIRE, OpenAlex	REACTT	Article	Fast Online Diagnosis for Solid Oxide Fuel Cells: Optimization of Total Harmonicdistortion Tool for Real-System Application and Reactants Starvation Identification	Hamza Moussaoui; Gerald Hammerschmid; Jan Van herle; Vanja Suboti?	Journal of Power Sources	2023
OpenAIRE, OpenAlex	REACTT	Article	Model-Free VRFT-Based Tuning Method for PID Controllers	Damir Vran?i?; Paulo Moura Oliveira; Pavol Bisták; Mikulá? Huba	Mathematics	2023
OpenAIRE, OpenAlex	REACTT	Article	Multiscale Modelling of Solid Oxide Cells Validated on Electrochemical Impedance Spectra and Polarization Curves	Giuseppe Sassone; Eduardo Da Rosa Silva; Manon Prioux; Maxime Hubert; Bertrand Morel; Aline Léon; Jérôme Laurencin	ECS Transactions	2023
TIM		Article	Experimental deconvolution of resistance contributions in commercial solid oxide cells with Ni-CGO electrode	['Jelle Heijne', 'Anke Hagen', 'Aiswarya Krishnakumar Padinjarethil']	Electrochimica acta	2023
TIM		Article	Multiscale analysis of Ni-YSZ and Ni-CGO anode based SOFC degradation: From local microstructural variation to cell electrochemical performance	['Anke Hagen', 'Aiswarya Krishnakumar Padinjarethil', 'Fiammetta Rita Bianchi', 'Bárbara Bosio']	Electrochimica acta	2023

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TIM		Article	Structural and Reactivity Effects of Secondary Metal Doping into Iron-Nitrogen-Carbon Catalysts for Oxygen Electroreduction	['Mathias Primbs', 'Fang Luo', 'Moulay Tahar Sougrati', 'Xingli Wang', 'Peter Strasser', 'Frédéric Jaouen', 'Andrea Zitolo', 'David A. Cullen', 'Aaron Roy', 'Anastassiya Khan']	Journal of the American Chemical Society	2023
TIM	CRESCENDO	Article	Oxygen Reduction Reaction Activity in Non-Precious Single-Atom (M–N/C) Catalysts–Contribution of Metal and Carbon/Nitrogen Framework-Based Sites	['Kyung-Wan Nam', 'Basit Ali', 'Asad Mehmood', 'Anthony Kucernak', 'Mengjun Gong']	ACS catalysis	2023
TIM		Article	GIS-based analysis of rock salt deposits' suitability for underground hydrogen storage	['Leszek Lankof', 'Radosław Tarkowski']	International journal of hydrogen energy	2023
TIM		Article	Pore-scale imaging of hydrogen displacement and trapping in porous media	['Damien Freitas', 'Ian B. Butler', 'Samuel Krevor', 'Niklas Heinemann', 'Eike Marie Thaysen', 'Katriona Edlmann', 'Aliakbar Hassanpouryouzband', 'Fernando Alvarez-Borges', 'Robert Atwood']	International journal of hydrogen energy	2023

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TIM	Article	11–23% Cr steels for solid oxide fuel cell interconnect applications at 800 °C – How the coating determines oxidation kinetics	['Jan-Erik Svensson', 'T.E. Chausson', 'Mareddy Jayanth Reddy', 'Jan Froitzheim']	International journal of hydrogen energy	2023
TIM	Article	Investigation of coated FeCr steels for application as solid oxide fuel cell interconnects under dual-atmosphere conditions	['Jan-Erik Svensson', 'Alberto Visibile', 'Mareddy Jayanth Reddy', 'Jan Froitzheim']	International journal of hydrogen energy	2023
TIM	Article	Lattice Boltzmann simulation of liquid water transport in gas diffusion layers of proton exchange membrane fuel cells: Impact of gas diffusion layer and microporous layer degradation on effective transport properties	['Patrick Sarkezi-Selsky', 'Schmies, Henrike', 'Thomas Jahnke', 'Latz, Arnulf']	Journal of power sources	2023
TIM	Article	Oxygen Reduction Reaction Activity in Non-Precious Single-Atom (M-N/C) Catalysts–Contribution of Metal and Carbon/Nitrogen Framework-Based Sites	Mengjun Gong, Asad Mehmood, Basit AliKyung-Wan Nam & Anthony Kucernak	American Chemical Society	2023
TIM	Article	PEMFC performance decay during real-world automotive operation: Evincing degradation mechanisms and heterogeneity of ageing	['Andrea Baricci', 'Laure Guétaz', 'Andrea Bisello', 'Andrea Casalegno', 'Elena Colombo']	Journal of power sources	2023

5.3.3 Publications of 2024 (complementing AAR 2024)

TABLE 42. ADDITIONAL PUBLICATIONS OF 2024

Source	Project Acronym	Publication Type	Title	Authors	Publication Title	Year
CORDA	ELVHYS	Conference paper	Hydrogen safety for systems at ambient and cryogenic temperature: a comparative study of hazards and consequence modelling	Cirrone D., Makarov D., Molkov V.,	Proceedings of the 15th International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions (ISHPMIE), Naples, 10-14 June 2024	2024
CORDA	StaSHH	Conference paper	StasHH - Standard-Sized Heavy-duty Hydrogen	['Zenith, Federico']	Road Transport Research Conference	2024
CORDA	AMON	Article	Analysis and optimization of solid oxide fuel cell system with anode and cathode off gas recirculation	Xinyi Wei, Shivom Sharma, Jan Van herle, Franois Marchal	Renewable and Sustainable Energy Reviews	2024
CORDA	ANDREAH	Article	Carbon-Free H2 Production from Ammonia Decomposition over 3D-Printed Ni-Alloy Structures Activated with a Ru/Al2O3 Catalyst	Cristina Italiano, Gabriel Marino, Minju Thomas, Benjamin Hary, Steve Nardone, Simon Richard, Assia Saker, Damien Tasso, Nicolas Meynet, Pierre Olivier, Fausto Gallucci, Antonio Vita	Processes	2024

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CORDA	ANDREAH	Article	Carbon Molecular Sieve Membrane Reactors for Ammonia Cracking	Valentina Cechetto, Gaetano Anello, Arash Rahimalimamaghani, Fausto Gallucci	Processes	2024
CORDA	CRAVE-H2	Article	A Comprehensive Overview of Technologies Applied in Hydrogen Valleys	Michael Bampaou, Kyriakos D. Panopoulos	Energies	2024
CORDA	ELVHYS	Other	Design and operation of liquid hydrogen storage tanks	Claussner L., Ustolin F., Scarponi G. E.	Chemical Engineering Transactions	2024
CORDA	ELVHYS	Other	A dynamic of safety barriers effectiveness in fire protection of cryogenic storage tanks	Schiaroli A., Scarponi G. E., Liu Y., Ustolin F., Cozzani V.	Chemical Engineering Transactions	2024
CORDA	ELVHYS	Article	System Resilience of a Liquid Hydrogen Terminal During Loading and Unloading Operations	Lucas Claussner, Federico Ustolin	IFAC-PapersOnLine	2024
CORDA	ELVHYS	Article	Consequence Analysis of a Bunkering Facility for Liquid Hydrogen Loading and Unloading	Alice Schiaroli, Alessandro Campari, Nicola Paltrinieri, Valerio Cozzani, Federico Ustolin	Volume 2: Structures, Safety, and Reliability	2024
CORDA	ELVHYS	Other	Hazard identification of liquid hydrogen in transfer operations, Chemical Engineering Transactions	Aneziris O., Koromila K., Nivolianitou Z., Venetsanos A.	Chemical Engineering Transactions	2024

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CORDA	ELVHYS	Other	Analysis of accidental hydrogen releases in the glass manufacturing industry	Schiaroli A., Baldassarri A., Ustolin F.	Chemical Engineering Transactions	2024
CORDA	FCH2RAIL	Article	The FCH2RAIL Project: A Demonstration of a Modular Fuel Cell Hybrid Power Pack	Florian Khlkamp, Moritz Schenker, Johannes Pagenkopf, Holger Dittus, Sebastian Herwartz-Polster, Abraham Fernndez Del Rey, Maider Varela	Transportation Research Procedia	2024
CORDA	FCH2RAIL	OTHER	FCH2RAIL deliverable D7.4 - Complementary gaps in analysis framework	Esteban Rodriguez Muoz, Beatriz Nieto Caldern		2024
CORDA	FURTHER-FC	Article	Effect of high-boiling point solvents on inkjet printing of catalyst layers for proton exchange membrane fuel cells	Qingying Zhao, Tobias Morawietz, Pawel Gazdzicki, K. Andreas Friedrich	Electrochimica Acta	2024
CORDA	FURTHER-FC	Article	Tracking the Evolution of Ionomer Film and Catalyst Material to Unravel PEMFC Performance Degradation	Florian Chabot, Porcar Lionel, Laure Gutaz, Sbastien Rosini, Arnaud Morin	Journal of The Electrochemical Society	2024
CORDA	FURTHER-FC	Article	Characterizing PEM fuel cell catalyst layer properties from high resolution three-dimensional digital images, part III: Contact angle distribution	Mohamed Ahmed-Maloum, Michel Quintard, Marc Prat	International Journal of Hydrogen Energy	2024
CORDA	FURTHER-FC	Article	Characterizing PEM fuel cell catalyst layer properties from high resolution three-dimensional digital images, Part II: Oxygen effective diffusion	Mohamed Ahmed-Maloum, Jol Pauchet, Michel Quintard, Marc Prat	International Journal of Hydrogen Energy	2024

			and proton effective conductivity tensors			
CORDA	FURTHER-FC	Article	Characterizing PEM fuel cell catalyst layer properties from high resolution three-dimensional digital images, part I: A numerical procedure for the ionomer distribution reconstruction	Mohamed Ahmed-Maloum, Thomas David, Laure Guetaz, Arnaud Morin, Jol Pauchet, Michel Quintard, Marc Prat	International Journal of Hydrogen Energy	2024
CORDA	H2Future	Article	Impact of large-scale hydrogen electrification and retrofitting of natural gas infrastructure on the European power system	Germn Morales-Espaa, Ricardo Hernndez-Serna, Diego A. Tejada-Arango, Marcel Weeda	International Journal of Electrical Power & Energy Systems	2024
CORDA	HySelect	Other	Bench-scale advanced system design for hydrogen production using SO2 depolarized electrolyser	Pragya Narayana Prasad, Raghavendra Iyer, Neha Garg, Michael Gasik, Annukka Santasalo-Aarnio	IX Symposium on Hydrogen, Fuel Cells and Advanced Batteries 2023	2024
CORDA	HySelect	Other	Hydrogen production efficiency in SO2 Depolarized Electrolyser - Impact of proton electrolyte membrane	Pragya Narayana Prasad, Neha Garg, Michael Gasik, Annukka Santasalo-Aarnio	European Hydrogen Energy Conference 2023	2024
CORDA	HySelect	Other	Methodology development for SO2 crossover mitigation in sulphur dioxide depolarized electrolyzer	Raghavendra Iyer	Aalto University	2024
CORDA	MEAsureD	Article	Thermal stability and microstructure of fluorine-free hydrophobic coatings of gas diffusion layers for fuel cell applications	Florian Tritscher, Alexander Pranter, Fabio Blaschke, Werner Napetschnig, Maximilian Fuchs, Eduardo Machado-Charry, Viktor Hacker, Merit Bodner	Frontiers in Energy Research	2024

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CORDA	MultiPLHY	Article	Component analysis of a 25-cell stack following 6.7 kh of high temperature electrolysis	J. Aicart et al	Int. journal of Hydrogen Energy	2024
CORDA	NICOLHy	Other	Modelling Fire Response of Cryogenic Liquid Hydrogen Tanks Equipped with Multilayer Insulation (MLI) Systems	Davide Camplese, Giordano Emrys Scarponi, Robert Eberwein, Aliasghar Hajharir, Frank Otremba, Valerio Cozzani	CHEMICAL ENGINEERING TRANSACTIONS	2024
CORDA	NICOLHy	Other	Experimental Research Of A Tank For A Cryogenic Fluid With a Wall Rupture In a Fire Scenario	Robert Eberwein, Aliasghar Hajhariri, Davide Camplese, Giordano Emrys Scarponi, Valerio Cozzani, Frank Otremba	Proceedings of 15th International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions (ISHPMIE)	2024
CORDA	RUBY	Thesis Dissertation - Master	Diagnosis and prognosis of proton exchange membrane fuel cells by machine learning. Electric power	Damien Chanal		2024
CORDA	SHERLOHCK	Article	Evaluation of bimetallic Pt-Co and Pt-Ni catalysts in LOHC dehydrogenation	K. Alconada, V. L. Barrio	International Journal of Hydrogen Energy	2024
CORDA	ShipFC	Article	Review on the Safe Use of Ammonia Fuel Cells in the Maritime Industry	Michail Cheliotis, Evangelos Boulougouris, Nikoletta L Trivyza, Gerasimos Theotokatos, George Livanos, George Mantalos, Athanasios Stubos, Emmanuel Stamatakis, Alexandros Venetsanos	Energies	2024

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CORDA	Ship FC	Article	Safety and Reliability Analysis of an Ammonia-Powered Fuel-Cell System	Nikoletta L Trivyza, Michail Cheliotis, Evangelos Boulougouris, Gerasimos Theotokatos	Safety	2024
CORDA	SUSTAINCELL	Article	Comparative life cycle analysis of electrolyzer technologies for hydrogen production: Manufacturing and operations	Xinyi Wei, Shivom Sharma, Arthur Waeber, Du Wen, Suhas Nuggehalli Sampathkumar, Manuele Margni, Franois Marchal, Jan Van herle	Joule	2024
CORDA	SUSTAINCELL	Article	Cationic groups in polystyrene/O-PBI blends influence performance and hydrogen crossover in AEMWE	Linus Hager, Maximilian Schrodt, Manuel Hegelheimer, Julian Stonawski, Pradipkumar Leuaa, Christodoulos Chatzichristodoulou, Andreas Hutzler, Thomas Bhm, Simon Thiele, Jochen Kerres	Chemical Communications	2024
CORDA	TRIERES	Conference paper	Optimal Res-Electrolyser Coupling- A Flexible Technoeconomic Assessment Tool	N. Skordoulias, S. Karellas, D.V. Lyridis, E, Stamatakis, E. Zoulias	Munich Hydrogen Symposium 2024	2024
CORDA	TRIERES	Review	A Review of Alternative Processes for Green Hydrogen Production Focused on Generating Hydrogen from Biomass	Aikaterina Paraskevi Damiri, Emmanuel Stamatakis, Spyros Bellas, Manos Zoulias, Georgios Mitkidis, Anestis G. Anastasiadis, Sotiris Karellas, George Tzamalis, Athanasios Stubos, Theocharis Tsoutsos	Hydrogen	2024
CORDA	TRIERES	Article	FLEXIBLE TECHNO-ECONOMIC ASSESSMENT TOOL FOR OPTIMAL ELECTROLYSIS-RES COUPLING	Nikolaos Skordoulias, Sotirios Karellas, Vasiliki Kontou	37th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems (ECOS 2024)	2024

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CORDA	UnLOHCked	Other	Are LOHCs the Key?	Valerie Meille, V. Laura Barrio	Industry Perspective	2024
CORDA, OpenAlex, OpenAIRE	AMON	Article	Multiscale multiphysics modeling of ammonia-fueled solid oxide fuel cell: Effects of temperature and pre-cracking on reliability and performance of stack and system	['Omid Babaie Rizvandi', 'Rafael Nogueira Nakashima', 'Javid Beyrami', 'Henrik Lund Frandsen', 'Arash Nemati']	Applied energy	2024
CORDA, OpenAlex, OpenAIRE	BRAVA	Article	Synthetic design of active and stable bimetallic PtTi nanoparticle electrocatalysts for efficient oxygen reduction at fuel cell cathodes	['Jiasheng Lu', 'Sören Selve', 'Raffaele Amitrano', 'Stefanie Kühl', 'Peter Strasser', 'Thomas Merzdorf', 'Johannes Schmidt', 'Antonia Herzog']	Journal of materials chemistry. A	2024
CORDA, OpenAlex, OpenAIRE	BRAVA & HIGHLANDER	Article	Oxygen Reduction Reaction Activity and Stability of Shaped Metal-Doped PtNi Electrocatalysts Evaluated in Gas Diffusion Electrode Half-Cells	['Jiasheng Lu', 'C. Günther', 'Sören Selve', 'Adrian F. Baumunk', 'Ulrich Gernert', 'Nicolai Schmitt', 'Raffaele Amitrano', 'Peter Strasser', 'Bastian J. M. Etzold', 'Shlomi Polani', 'Malte Klingenhof', 'Lujin Pan']	ACS applied materials & interfaces	2024
CORDA, OpenAlex, OpenAIRE	COSMHYC DEMO	Article	The COSMHYC Project Series: Innovative Hydrogen Compression Solutions	['David Colomar', 'Alberto Martinez-Abenojar', 'Rami Chahrouri', 'Antoine Jeanmougin']	Chemie-Ingenieur-Technik/Chemieingenieurtechnik	2024

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CORDA, OpenAlex, OpenAIRE	eGHOST & SH2E	Article	Towards suitable practices for the integration of social life cycle assessment into the ecodesign framework of hydrogen-related products	['Javier Dufour', 'Felipe Campos-Carriedo', 'Diego Iribarren']	Sustainable production and consumption	2024
CORDA, OpenAlex, OpenAIRE	eGHOST & SH2E	Article	Methodological and practical lessons learned from exploring the material criticality of two hydrogen-related products	['Álvaro García-Díaz', 'Javier Dufour', 'Felipe Campos-Carriedo', 'Diego Iribarren', 'Fernando Calvo-Rodríguez']	Resources, conservation and recycling	2024
CORDA, OpenAlex, OpenAIRE	ELVHYS	Article	Risk-Based Inspection and Maintenance of a Liquid Hydrogen Bunkering Facility	['Nicola Paltrinieri', 'Valerio Cozzani', 'Alice Schiaroli', 'Antonio Alvaro', 'Federico Ustolin', 'Alessandro Campari']	43rd International Conference on Ocean, Offshore & Arctic Engineering (OMAE 2024), Singapore, 9-14 June 2024	2024
CORDA, OpenAlex, OpenAIRE	ELVHYS	Article	LES model of flash-boiling and pressure recovery phenomena during release from large-scale pressurised liquid hydrogen storage tank	['Tanin Kangwanpongpan', 'Dmitriy Makarov', 'Vladimir Molkov', 'Donatella Cirrone']	International journal of hydrogen energy	2024
CORDA, OpenAlex,	e-SHyIPS	Article	Planing Hull Hydrodynamic Performance Prediction Using LincoSim Virtual Towing Tank	['Francesco Salvadore', 'Raffaele Ponzini', 'Ermina Begović', 'C. Bertorello']	Journal of marine science and engineering	2024

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Open AIRE						
CORDA, Open Alex, Open AIRE	FLEX 4H2	Article	Numerical Investigation of Reheat Hydrogen Flames in the Sequential-Combustion Stage of a Heavy-Duty Gas Turbine	['Tarjei Heggset', 'Birute Wood', 'Ole Meyer', 'Andrea Ciani', 'Andrea Gruber']	ASME	2024
CORDA, Open Alex, Open AIRE	H2tALENT	Article	Determination of photovoltaic hydrogen production potential in Portugal: a techno-economic analysis	['Hugo Silva', 'Jorge Arigony Neto', 'Samir Touili', 'Ahmed Alami Merrouni']	Frontiers in energy research	2024
CORDA, Open Alex, Open AIRE	Haeolus	Article	A Unified Control Platform and Architecture for the Integration of Wind-Hydrogen Systems Into the Grid	['Valerio Mariani', 'Davide Liuzza', 'Muhammad Bakr Abdelghany', 'Oreste Riccardo Natale', 'Luigi Glielmo']	IEEE transactions on automation science and engineering	2024
CORDA, Open Alex, Open AIRE	Haeolus	Article	Hierarchical model predictive control for islanded and grid-connected microgrids with wind generation and hydrogen energy storage systems	['Valerio Mariani', 'Davide Liuzza', 'Muhammad Bakr Abdelghany', 'Luigi Glielmo']	International journal of hydrogen energy	2024
CORDA, Open	HELIOS	Article	Real Time, Spatially Resolved Methodology for Flame Dynamics	['Antonio Ferrante']	Volume 4: Controls, Diagnostics, and Instrumentation	20

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Alex, Open AIRE			Investigation by Means of Fast Imaging and Image Processing			24
CORDA, Open Alex, Open AIRE	HIGGS	Article	Enabling the injection of hydrogen in high-pressure gas grids: Investigation of the impact on materials and equipment	['Ekain Fernandez', 'Virginia Madina', 'Alberto Cerezo', 'M. Dolores Storch de Gracia', 'V. Gil', 'Sanchez-Lainez, Javier', 'Jorge Aragón']	International journal of hydrogen energy	2024
CORDA, Open Alex, Open AIRE	HyLICAL	Article	Magnetocaloric effect in the Laves phases RCo2 (R = Er, Ho, Dy, and Tb) in high magnetic fields	['Oliver Gutfleisch', 'J. Wosnitza', 'M. Straßheim', 'T. Niehoff', 'C. Salazar Mejía', 'Tino Gottschall', 'Franziska Scheibel', 'A. Yu. Karpenkov', 'Konstantin Skokov', 'Wei Liu', 'Eduard Bykov']	Journal of alloys and compounds	2024
CORDA, Open Alex, Open AIRE	HyLICAL	Article	A matter of performance and criticality: A review of rare-earth-based magnetocaloric intermetallic compounds for hydrogen liquefaction	['Oliver Gutfleisch', 'Nuno M. Fortunato', 'Alex Aubert', 'Tino Gottschall', 'Franziska Scheibel', 'Konstantin Skokov', 'Wei Liu', 'Allan M. Döring', 'Hongbin Zhang', 'Eduard Bykov', 'Benedikt Beckmann']	Journal of alloys and compounds	2024
CORDA, Open Alex, Open AIRE	HyP3D	Article	3D printing of reversible solid oxide cell stacks for efficient hydrogen production and power generation	['Ana Martos', 'Marc Torrell', 'Walter Zambelli', 'S. Márquez', 'Radostin S. Pavlov', 'Marc Núñez', 'Albert Tarancón', 'Simone Anelli', 'J.J. Brey', 'Lucile Bernadet']	Journal of power sources	2024

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CORDA, OpenAlex, OpenAIRE	HyP3D	Article	Single-step fully 3D printed and co-sintered solid oxide fuel cells	['Àlex Morata', 'Marc Torrell', 'Natalia Kostretsova', 'Federico Smeacetto', 'Marc Núñez', 'Albert Tarancón', 'Simone Anelli', 'Arianna Pesce']	Journal of materials chemistry. A	2024
CORDA, OpenAlex, OpenAIRE	HyUsPRe	Article	Development and calibration of a bio-geo-reactive transport model for UHS	['Sebastian Hogeweg', 'Vadim Bobrov', 'Leonhard Ganzer', 'Birger Hagemann']	Frontiers in energy research	2024
CORDA, OpenAlex, OpenAIRE	IMMORTAL	Article	Influence Factors of Platinum Dissolution in Proton Exchange Membrane Fuel Cells: A Sensitivity Study	['Julian Stiegeler', 'Severin Vierrath', 'Thilo Lehre', 'Leonidas Tsikonis', 'Thomas Mittermeier']	Journal of the Electrochemical Society	2024
CORDA, OpenAlex, OpenAIRE	RH2IWER	Article	A FEASIBILITY STUDY FOR ZERO-EMISSION PASSENGER BOATS FOR INLAND WATERWAYS BASED ON HYDROGEN FUEL CELLS	['G.N. Montagna', 'Thomas Lamberti', 'Stefano Barberis', 'Massimo Rivarolo']	34th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems (ECOS 2021)	2024
CORDA, OpenAlex,	RUBY	Article	LT-PEM Fuel Cells diagnosis based on EIS, clustering, and automatic parameter selection	['Nadia Yousfi Steiner', 'Didier Chamagne', 'Marie-Cécile Pera', 'Damien Chanal']	IEEE transactions on vehicular technology	2024

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CORDA, Open Alex, Open AIRE	SH2APED	Article	CFD model of refuelling through the entire equipment of a hydrogen refuelling station	['Dmitriy Makarov', 'Hazhir Ebne-Abbasi', 'Vladimir Molkov']	International journal of hydrogen energy	2024
CORDA, Open Alex, Open AIRE	SH2APED	Article	Distributed fiber optic strain sensing for structural health monitoring of 70 MPa hydrogen vessels	['Marcus Schukar', 'Mathias Breithaupt', 'Bin Wang', 'Aleksander Wosniok', 'Paul Woody', 'Andreas Kriegsmann']	E-Journal of nondestructive testing	2024
CORDA, Open Alex, Open AIRE	SH2APED	Article	Numerical simulations of the critical diameter and flame stability for hydrogen flames	['M. Kazemi', 'S. Brennan', 'Vladimir Molkov']	International journal of hydrogen energy	2024
CORDA, Open Alex, Open AIRE	SH2E	Article	Life-cycle assessment of hydrogen systems: a systematic review and meta-regression analysis	['Javier Dufour', 'Eleonora Bargiacchi', 'Diego Iribarren', 'Gonzalo Puig-Samper']	Journal of cleaner production	2024
CORDA, Open	SH2E	Article	Life cycle costing approaches of fuel cell and hydrogen systems: A literature review	['Andreas Schonhoff', 'Wilhelm Kuckshinrichs', 'Yuki Ishimoto', 'Christina Wulf']	International journal of hydrogen energy	20

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Alex, Open AIRE						2 4
CORDA, Open Alex, Open AIRE	SH2E	Article	Environmental and material criticality assessment of hydrogen production via anion exchange membrane electrolysis	['Javier Dufour', 'Elke Schropp', 'Felipe Campos-Carriedo', 'Gabriel Naumann', 'Christian Immanuel Bernäcker', 'Diego Iribarren', 'Matthias Gaderer']	Applied energy	2 0 2 4
CORDA, Open Alex, Open AIRE	SH2E	Article	A parametric life cycle framework to promote sustainable-by-design product development: Application to a hydrogen production technology	['Javier Dufour', 'Felipe Campos-Carriedo', 'Diego Iribarren', 'Paula Pérez-López']	Journal of cleaner production	2 0 2 4
CORDA, Open Alex, Open AIRE	SHERLOHCK	Article	Evaluation of bimetallic Pt–Co and Pt–Ni catalysts in LOHC dehydrogenation	['V.L. Barrio', 'K. Alconada']	International journal of hydrogen energy	2 0 2 4
CORDA, Open Alex, Open AIRE	SHERLOHCK	Article	Enhancing perhydrobenzyltoluene dehydrogenation performance with Co, Mo and Mn metal oxides: A comparative study with Pt/Al2O3 catalyst	['V.L. Barrio', 'K. Alconada']	Applied catalysis. B, Environmental	2 0 2 4
CORDA,	ShipFC	Article	Effect of the Active Metal on the NOx Formation during Catalytic	['Gunther Kolb', 'Tobias Weißenberger', 'Helmut Pennemann', 'Ralf Zapf']	Catalysts	2 0

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Open Alex, Open AIRE			Combustion of Ammonia SOFC Off-Gas			2 4
CORDA, Open Alex, Open AIRE	SUSTAINCELL	Article	Sulfonamide-Sulfonimide Copolymers as Novel, Fluorine-Lean Type of Proton Exchange Membranes for Fuel Cell Application	['Maximilian Wagner', 'Jochen Kerres', 'Simon Thiele', 'Leon Brinke']	Chemistry	2 0 2 4
CORDA, Open Alex, Open AIRE	SWITCH	Article	Performance assessment of a 25 kW solid oxide cell module for hydrogen production and power generation	['Marc P. Heddrich', 'Marius Tomberg', 'Syed Asif Ansar', 'Dirk Ullmer', 'Matthias Metten', 'Santiago Salas Ventura', 'Marc Riedel', 'Diana-María Amaya-Dueñas']	International journal of hydrogen energy	2 0 2 4
CORDA, Open Alex, Open AIRE	THOTH2	Article	Hydrogen blending effect on fiscal and metrological instrumentation: A review	['Tecla Carrubba', 'Nadia Cerone', 'Rémy Maury', 'Matteo Robino', 'Viviana Cigolotti', 'Diana Enescu', 'Alessandro Guzzini', 'Fares Ben Rayana', 'Adrian Dudek', 'Paweł Kułaga', 'Alessandro Cigni', 'Vito Fernicola', 'Cesare Saccani', 'Monika Gajec', 'P. Gislon', 'Marco Pellegrini']	International journal of hydrogen energy	2 0 2 4
CORDA, Open Alex, Open AIRE	UnLOHCked	Article	Feasibility of induction heating for the dehydrogenation of liquid organic hydrogen carriers	['Hendrik G. Kruger', 'Henning M. Krieg', 'Rudaviro Garidzirai', 'Dmitri Bessarabov', 'Danae Ford', 'Phillimon Modisha']	International journal of hydrogen energy	2 0 2 4

CORDA, OpenAlex, OpenAIRE	WASTE2WATTS	Article	Analysis of the performances of a solid oxide fuel cell fed by biogas in different plant configurations: An integrated experimental and simulative approach	['Domenico Borello', 'Francesca Santoni', 'Davide Pumiglia', 'G. Tamburrano', 'Andrea Monforti Ferrario']	International journal of hydrogen energy	2024
CORDA, OpenAlex, OpenAIRE	WINNER	Article	Fracture toughness and slow crack growth behaviour of metal-proton conducting ceramic composites	['Peyman Khajavi', 'Henrik Lund Frandsen', 'Ragnar Kiebach', 'Federico Palmerini', 'Stéven Pirou']	Journal of the European Ceramic Society	2024
OpenAIRE, TIM, OpenAlex	CHANNEL	Article	Tailoring high-performance catalyst architectures via 'accessional ionomer coatings' for anion exchange membrane water electrolysis	['Meital Shviro', 'Jochen Friedrich', 'Kaiyue Lou', 'Lu Xia']	International journal of hydrogen energy	2024

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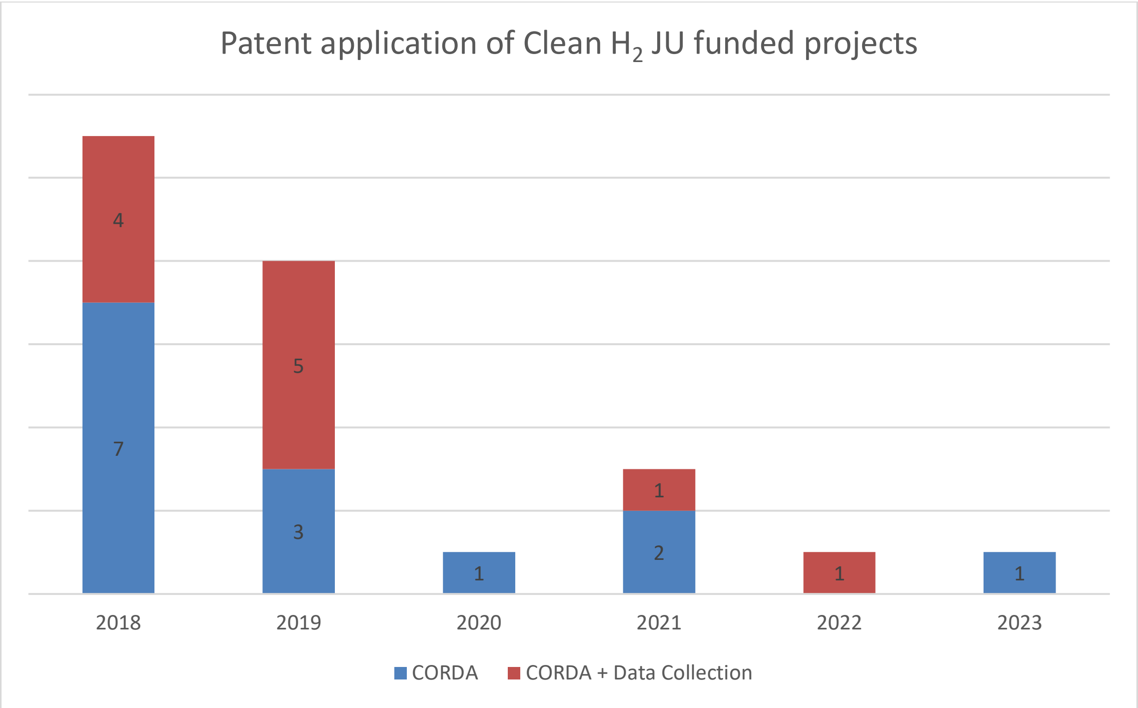
5.4 *Patent from projects*

FIGURE 30. PROJECT PATENTS IDENTIFIED IN 2024



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5.4.1 Information extracted from CORDA

TABLE 43. PATENT INFORMATION TAKEN FROM CORDA

Project number	Project acronym	Patent application title	Patent appl. name	Patent appl. date	Patent awarded	Patent No	Link
671403	INNO-SOFC	Protection arrangement and method of solid oxide cells	Elcogen Oy	14/03/2018	YES	US10535883B2	https://patents.google.com/patent/US10535883B2/en?q=TI%3d(Protection+arrangement+and+method+of+solid+oxide+cells)&patents=false&oq=TI%3d(Protection+arrangement+and+method+of+solid+oxide+cells)
826379	HYDROSOL-beyond	GAS-SOLID PHASE REACTION	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS & DEUTSCHES ZENTRUM FUR LUFT - UND RAUMFAHRT EV	19/07/2005	YES	EP1712517	https://worldwide.espacenet.com/patent/search/family/36636469/publication/WO2006108769A1?q=WO2006108769
101007223	SHERLOHCK	METHOD FOR OPERATING A REACTOR, WHICH COMPRISES A CATALYST MATERIAL, FOR CATALYTICALLY STORING OR RELEASING HYDROGEN GAS, AND SYSTEM COMPRISING SUCH A REACTOR	HYDROGENIOUS LOHC TECHNOLOGIES GMBH	05/10/2023	YES	DE102022210824A1C01B3/0015(EP); C01B3/22(EP);C01B2203/0277(EP);	https://patents.google.com/patent/DE102022210824A1/en?oq=DE102022210824A1C01

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671403	INNO-SOFC	SEALING ARRANGEMENT AND METHOD OF SOLID OXIDE CELL STACKS	Elcogen Oy	17/07/2014	YES	EP3170219	https://patents.google.com/patent/EP3170219A1/en?oq=EP3170219
671473	D2Service	Heat Exchanger and Method for Manufacturing a Heat Exchanger Core with Manifold	Bosal Emission Control Systems Nv	19/04/2018	YES	US1fin9873B2	https://patents.google.com/patent/US11359873B2/en?q=TI%3d(Heat+Exchanger+and+Method+for+Manufacturing+a+Heat+Exchanger+Core+with+Manifold)&patents=false&oq=TI%3d(Heat+Exchanger+and+Method+for+Manufacturing+a+Heat+Exchanger+Core+with+Manifold)
700101	Giantleap	Inrichting voor het koppelen van een trekkend voertuig met een te trekken voertuig	VDL Enabling Transport Solutions BV	06/02/2018	YES	NL2020382B1	https://patents.google.com/patent/NL2020382B1/nl?q=TI%3d(Inrichting+voor+het+koppelen+van+een+trekkend+voertuig+met+een+te+trekken+voertuig)&patents=false&oq=TI%3d(Inrichting+voor+het+koppelen+van+een+trekkend+voertuig+met+een+te+trekken+voertuig)
700667	SOSLeM	Recursive, Time-Series-Based Method for Determining the State of an Electrochemical Reactor	AVL List GmbH	27/11/2018	YES	US20200386818A1	https://patents.google.com/patent/US20200386818A1/en?q=TI%3d(Recursive%2c+Time-Series-Based+Method+for+Determining+the+State+of+an+Electrochemical+Reactor)&patents=false&oq=TI%3d(Recursive%2c+Time-Series-Based+Method+for+Determining+the+State+of+an+Electrochemical+Reactor)
700667	SOSLeM	Method for Determining an Operating State of an Electrochemical System	AVL List GmbH	07/12/2018	YES	AT520682B1	https://patents.google.com/patent/AT520682B1/en?q=TI%3d(Method+for+Determining+an+Operating+State+of+an+Electrochemical+System)&patents=false&oq=TI%3d(Method+for+Determining+an+Operating+State+of+an+Electrochemical+System)
779644	TAHYA	Composite Pressure Vessel with Reinforced Inner Liner and Process for the Production Thereof	Plastic Omnium New	26/06/2019	YES	EP3814673B1	https://patents.google.com/patent/EP3814673B1/en?q=TI%3d(Composite+Pressure+Vessel+with+Reinforced+Inner+Liner+and+Process+for+the+Production+Thereof)&patents=false&oq=TI%3d(Co

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			Energies France SAS				mposite+Pressure+Vessel+with+Reinforced+Inner+Liner+and+Process+for+the+Production+Thereof)
779644	TAHYA	Composite Pressure Vessel with Boss Connector	Plastic Omnium Advanced Innovation and Research SA	26/06/2019	YES	US11015762B2	https://patents.google.com/patent/US11015762B2/en?q=TI%3d(Composite+Pressure+Vessel+with+Boss+Connector)&patents=false&oq=TI%3d(Composite+Pressure+Vessel+with+Boss+Connector)
779644	TAHYA	Tank Liner Having Two Cylindrical Sections	Plastic Omnium New Energies France SAS	26/06/2019	YES	US11506335B2	https://patents.google.com/patent/US11506335B2/en?q=TI%3d(Tank+Liner+Having+Two+Cylindrical+Sections)&patents=false&oq=TI%3d(Tank+Liner+Having+Two+Cylindrical+Sections)
101007182	SH2APED	End Fitting for a Pressurised Fluid Reservoir	Plastic Omnium New Energies France SAS	14/01/2021	NO	EP4090877A1	https://patents.google.com/patent/EP4090877A1/en?q=TI%3d(End+Fitting+for+a+Pressurised+Fluid+Reservoir)&patents=false&oq=TI%3d(End+Fitting+for+a+Pressurised+Fluid+Reservoir)
875118	NEWELY	Composite ion-exchange membrane, method for preparing the same, and use thereof	KIST	11/06/2020	YES	KR20210153842A	https://patents.google.com/patent/KR20210153842A/en?q=TI%3d(%E2%80%AFComposite+ion-exchange+membrane%2c+method+for+preparing+++the+same%2c+and+use+thereof+)&patents=false&oq=TI%3d(%E2%80%AFComposite+ion-exchange+membrane%2c+method+for+preparing+++the+same%2c+and+use+thereof)
875118	NEWELY	Polymer grafted with cationic groups as side chain, preparation method thereof, and anion exchange membrane made of the same	KIST, Technion	27/01/2021	YES	KR20220108630A	https://patents.google.com/patent/KR20220108630A/en?q=TI%3d(%E2%80%AFPolymer+grafted+with+cationic+groups+as+side+chain%2c+preparation+method+thereof%2c+and+anion+exchange++membrane+made+of+the+same)&patents=false&oq=TI%3d(%E2%80%AFPolymer+grafted+with+c

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							ationic+groups+as+side+chain%2c+preparation+method+thereof%2c+and+anion+exchange++membrane+made+of+the+same)

5.4.2 Additional information on patents, complementing the partial information on CORDA

TABLE 44. ADDITIONAL PATENT INFORMATION FROM PREVIOUS CLEAN HYDROGEN JU DATA COLLECTIONS

Project number	Project acronym	Patent application title	Patent applicant name	Patent application date	Patent awarded	Publication No	Link
700266	Cell3Ditor	Method and machine for producing parts made of ceramic or metallic material by additive manufacturing	3DCERAM	20/06/2018	YES	EP3444049B1	https://patents.google.com/patent/EP3444049B1/en?q=TI%3d(Method+and+machine+for+producing+parts+made+of+ceramic+or+metallic+material+by+additive+manufacturing)&patents=false&oq=TI%3d(Method+and+machine+for+producing+parts+made+of+ceramic+or+metallic+material+by+additive+manufacturing)
700266	Cell3Ditor	Method and machine for producing at least one part in at least one ceramic and/or metal material by additive manufacturing	3DCERAM	20/06/2018	YES	EP3444050B1	https://patents.google.com/patent/EP3444050B1/en?q=TI%3d(Method+and+machine+for+producing+at+least+one+part+in+at+least+one+ceramic+and%2for+metal+material+by+additive+manufacturing)&patents=false&oq=TI%3d(Method+and+machine+for+producing+at+least+one+part+in+at+least+one+ceramic+and%2for+metal+material+by+additive+manufacturing)
700266	Cell3Ditor	Method of manufacturing pieces by the technique of	3DCERAM	15/02/2018	YES	KR102039061B1	https://patents.google.com/patent/KR102039061B1/en?q=TI%3d(Method+of+manufacturing+pieces+by+the+technique+of+additive+manufacturing+by+pasty+process+with+an+improved+supply+of+paste+and+manufacturing+machine+for+implementing+the+method)&patents=false&oq=TI%3d(Meth

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		additive manufacturing by pasty process with an improved supply of paste and manufacturing machine for implementing the method					od+of+manufacturing+pieces+by+the+technique+of+additive+manufacturing+by+pasty+process+with+an+improved+supply+of+paste+and+manufacturing+machine+for+implementing+the+method)
700266	Cell3Ditor	Electrochemical cell device for use in a SOFC and/or a SOEC and methods for operating a SOFC or a SOEC by using thereof	ICREA, IREC	18/06/2019	YES	EP3754768A1	https://patents.google.com/patent/EP3754768A1/en?q=TI%3d(Electrochemical+cell+device+for+use+in+a+SOFC+and%2for+a+SOEC+and+methods+for+operating+a+SOFC+or+a+SOEC+by+using+thereof)&patents=false&oq=TI%3d(Electrochemical+cell+device+for+use+in+a+SOFC+and%2for+a+SOEC+and+methods+for+operating+a+SOFC+or+a+SOEC+by+using+thereof)
735918	INLINE	Kalibrierverfahren für einen Projektor	Profactor Gmbh	07/05/2019	YES	AT522320B1	https://patents.google.com/patent/AT522320B1/en?q=TI%3d(Kalibrierverfahren+f%C3%BCr+einen+Projektor)&patents=false
700355	HyGrid	Carbon molecular sieve membrane and its use in separation processes	TUE Tecnalia	19/10/2019	YES	EP4072715A	https://www.patentguru.com/EP4072715A
700355	HyGrid	Method for low hydrogen content separation from a natural gas mixture	TUE Tecnalia	09/12/2019	YES	US20210339190A1	https://www.patentguru.com/US20210339190A1
826204	DOLPHIN	Procédé de fabrication d'un guide d'écoulement	CEA	20/12/2021	YES	EP4016677A1	https://patentimages.storage.googleapis.com/04/31/13/bb1f9368ef6a02/EP4016677A1.pdf

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		pour réacteur électrochimique					
735918	INSIGHT	Fuel cell stack, indicator fuel cell, fuel cell system and method for determining degradation of a fuel cell stack	AVL	2019	YES	AT522869A1	https://patents.google.com/patent/AT522869A1/en?oq=AT522869+
735918	INSIGHT	Procedure for providing an indicator	AVL	25/10/2018	YES	AT521864A2	https://patents.google.com/patent/AT521864A2/en?oq=AT521864
875088	CHANNEL	Cathode catalyst (NiMo) for water electrolysis	Norwegian University of Science and Technology (NTNU)	9/11/2022	NO		Application No. 2216708.4 at UK Intellectual Property Office

5.4.3 Additional patents collected from the Clean Hydrogen JU data collection exercise for 2025, complementing the information on CORDA

Not applicable

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5.5 Scoreboard of Horizon 2020 legacy Key Performance Indicators *(If relevant)*

In the two subsections below one can find the Horizon 2020 legacy KPIs, that were reported for the FCH 2 JU in its Annual Activity Reports. When a row has a grey shade, it means that either the reported value is the same as the one reported in AAR2021 and is not expected to change in the future or that it is not relevant any more as there are no more Calls for H2020 after 2020. A third table, concerning the KPIs specific to FCH 2 JU has been omitted as it is not relevant anymore. It's last reporting can be found in AAR2022.

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5.5.1 *Scoreboard of common KPIs*[84]

TABLE 45. SCOREBOARD OF COMMON KPIS

	H2020 KPI number	KPI	Type of data required	Results H2020[85] (Calls 2014-2020)
INDUSTRIAL LEADERSHIP	12	SME - Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years)	Number of SMEs that have introduced innovations to the company or market	120
	13	SME - Growth and job creation in participating SMEs	Turnover of company, number of employees	Turnover of SMEs at most recent reporting: EUR 7,788.6 Mil No of employees at SMEs at most recent reporting: 82,877 employees
SOCIETAL CHALLENGES	14	Publications in peer-reviewed high-impact journals	Publications from relevant funded projects (as reported in CORDA)	614 publications in peer-reviewed journals
	15	Patent applications and patents awarded in the area of the JTI	Patent application number (combined sources, aligned with Section **Error! Reference source not found.**)	23 patents awarded and 12 patent pending applications
	16	Number of prototypes testing activities and clinical trials	Reports on prototypes, and testing activities, clinical trials	Nr of prototypes: 721 Nr of testing activities: 759 Nr of clinical trials: 1
	17	Number of joint public-private publications in projects	Properly flagged publications data (DOI) from relevant funded projects (as reported in CORDA)	131 Joint Public/Private (not reported in CORDA anymore)
	18[86]	New products, processes and methods launched on the market	Project count and drop-down list enabling choice of the type of processes, products and methods	Nr of projects with: New products: 81 New processes: 42 New methods: 35

[84] Based on Annex II to Council Decision 2013/743/EU. Source: CORDA, unless otherwise noted.

[85] Data were extracted from CORDA on 21st February 2024.

[86] This indicator is not legally compulsory but covers several additional specific indicators requested for more societal challenges by the services in charge.

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	H2020 KPI number	KPI	Type of data required	Results H2020[85] (Calls 2014-2020)
EVALUATION	NA	Time to inform (TTI) all applicants of the outcome of the evaluation of their application from the final date for submission of completed proposals	Number and % of information letters sent to applicants within target Average TTI (calendar days) Maximum TTI (calendar days)	-
	NA	Redress after evaluations	Number of redresses requested	-
GRANTS	N/A	Time to Grant (TTG) measured (average) from call deadline to signature of grants	Average TTG in calendar days Maximum TTG in calendar days	-
GRANTS	NA	Time to grant (TTG) measured (average) from call deadline to signature of grants	Number and % of grants signed within target	-

5.5.2 Indicators for monitoring cross-cutting issues [87]

TABLE 46. INDICATORS FOR MONITORING CROSS-CUTTING ISSUES

Number	Definition/Responding to question	Type of data required	AAR 2022 (CALLS 2014-2020)[88]
2.1	Total number of participations by EU-27 Member States + the UK	Nationality of H2020 applicants and beneficiaries (number)	EU-27 + UK Application Participations 3197 Grant Participations 1458 Application Participants 1329 Grant Participants 715

[87] Based on Annex III to Council Decision 2013/743/EU; source: CORDA, unless specified otherwise.

[88] The figures concern the maximum EU contribution for 133 projects, not including ELECTROU which was terminated very early. Data were extracted from CORDA on 04th March 2025.

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<table>
<tr><td>2.2</td><td>Total amount of EU financial contribution by EU-27 Member State + the UK (EUR million)</td><td>Nationality of H2020 beneficiaries and corresponding EU financial contribution</td><td>In EUR million per country (total EUR 579.45 million):
<table>
<tr><td>AT</td><td>24.27</td><td>ES</td><td>39.22</td><td>LV</td><td>1.12</td></tr>
<tr><td>BE</td><td>22.48</td><td>FI</td><td>18.81</td><td>MT</td><td>0.03</td></tr>
<tr><td>BG</td><td>0.39</td><td>FR</td><td>88.63</td><td>NL</td><td>53.02</td></tr>
<tr><td>CY</td><td>0.17</td><td>HR</td><td>0.72</td><td>PL</td><td>1.06</td></tr>
<tr><td>CZ</td><td>1.46</td><td>HU</td><td>0.02</td><td>PT</td><td>0.76</td></tr>
<tr><td>DE</td><td>149.55</td><td>IE</td><td>0.28</td><td>RO</td><td>0.26</td></tr>
<tr><td>DK</td><td>27.53</td><td>IT</td><td>54.67</td><td>SE</td><td>9.67</td></tr>
<tr><td>EE</td><td>0.76</td><td>LT</td><td>0.13</td><td>SI</td><td>3.63</td></tr>
<tr><td>EL</td><td>6.15</td><td>LU</td><td>1.64</td><td>UK</td><td>73.02</td></tr>
</table></td></tr>
<tr><td>N/A</td><td>Total number of participations by Associated Countries</td><td>Nationality of H2020 applicants and beneficiaries (number)</td><td>Associated Countries
<table>
<tr><td>Application Participations
350
Grant Participations
157</td><td>Application Participants
146
Grant Participants
83</td></tr>
</table></td></tr>
<tr><td>N/A</td><td>Total amount of EU financial contribution by Associated Country (EUR million)</td><td>Nationality of H2020 beneficiaries and corresponding EU financial contribution</td><td>In EUR million per country (total EUR 46.06 million):
<table>
<tr><td>CH</td><td>14.52</td></tr>
<tr><td>IL</td><td>0.24</td></tr>
<tr><td>IS</td><td>1.07</td></tr>
<tr><td>NO</td><td>32.33</td></tr>
<tr><td>TR</td><td>0.85</td></tr>
<tr><td>UA</td><td>0.06</td></tr>
</table></td></tr>
<tr><td>3.1</td><td>Share of EU financial contribution going to SMEs (Enabling and industrial tech and Part III of H2020)</td><td>Number of H2020 beneficiaries flagged as SMEs

% of EU contribution going to beneficiaries flagged as SMEs</td><td>
<table>
<tr><td colspan="3">SME beneficiaries</td></tr>
<tr><td>Grants participations
351
(22 %)</td><td>Grant participants
170
(21 %)</td><td>Funding
EUR 172.3 mil. (28 %)</td></tr>
</table></td></tr>
<tr><td>6.1</td><td>Percentage of women participants in H2020 projects</td><td>Gender of participants in H2020 projects</td><td>26 % (12.587 women)</td></tr>
<tr><td>6.2</td><td>Percentage of women project coordinators in H2020</td><td>Gender of MSC fellows, ERC principal investigators and scientific coordinators in other H2020 activities</td><td>39/133 (29 %)</td></tr>
</table>

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<table>
<tr><td>6.3</td><td>Percentage of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc.</td><td>Gender of members of advisory groups, panels, etc.</td><td>Scientific Com: 3/9 (33.3 %)
SRG: 9/42 (21.4 %)
Evaluators: N/A</td></tr>
<tr><td>7.1</td><td>Share of third-country participants in H2020</td><td>Nationality of H2020 beneficiaries</td><td><table><tr><td colspan="3">Third Countries</td></tr><tr><td>Grants participations</td><td>Grant participants</td><td>EU Funding</td></tr><tr><td>14</td><td>13</td><td>EUR 0.28 mil.</td></tr></table></td></tr>
<tr><td>7.2</td><td>Percentage of EU financial contribution attributed to third-country participants</td><td>Nationality of H2020 beneficiaries and corresponding EU financial contribution</td><td>0.04 %</td></tr>
<tr><td>9.1</td><td>Share of projects and EU financial contribution allocated to IAs</td><td>Number of IA proposals and projects properly flagged in the WP; follow-up at grant level</td><td>Number: 36 / 133 (28.2%)
Funding: EUR 359.672 / EUR 625.381 (57.51 %)</td></tr>
<tr><td>9.2</td><td>Within the IAs, share of EU financial contribution focused on demonstration and first-of-a-kind activities</td><td>Topics properly flagged in the WP; follow-up at grant level</td><td>EUR 359.6 / EUR 880
(40.9%)</td></tr>
<tr><td>N/A</td><td>Scale of impact of projects (high technology readiness level - TRL)</td><td>Number of projects addressing TRL between (2-3, 4-6, 5-7)</td><td>Based on TRL specified in the topic (project start)<table><tr><th>TRL</th><th># projects</th></tr><tr><td>2</td><td>14</td></tr><tr><td>3</td><td>30</td></tr><tr><td>4</td><td>28</td></tr><tr><td>5</td><td>15</td></tr><tr><td>6</td><td>11</td></tr><tr><td>7</td><td>10</td></tr><tr><td>8</td><td>1</td></tr><tr><td>unspecified</td><td>24</td></tr></table></td></tr>
<tr><td>11.1</td><td>Percentage of H2020 beneficiaries from the private-for-profit sector</td><td>Number of and % of the total H2020 beneficiaries classified by type of activity and legal status</td><td>Participations: 947 / 1564 (61 %)
Participants: 544/ 810 (67 %)</td></tr>
<tr><td>11.2</td><td>Share of EU financial contribution going to private-for-profit entities (Enabling and industrial tech and Part III of Horizon 2020)</td><td>H2020 beneficiaries classified by type of activity; corresponding EU contribution</td><td>EUR 437.79 mil (70 %)</td></tr>
</table>

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<table>
<tr><td>12.1</td><td>EU financial contribution for public-private partnerships (PPP) (Art. 187)</td><td>EU contribution to PPP (Art. 187)</td><td>EUR 665,000,000, with additional
EUR 95,000,000 for administrative costs
(article 3 of FCH 2 JU founding regulation)</td></tr>
<tr><td rowspan="3">12.2</td><td rowspan="3">PPPs leverage: total amount of funds leveraged through Art. 187 initiatives, including additional activities, divided by the EU contribution</td><td>Total funding made by private actors involved in PPPs</td><td rowspan="3">See section 1.2.4</td></tr>
<tr><td>- in-kind contribution already committed by private members in projects selected for funding</td></tr>
<tr><td>- additional activities (i.e. research expenditure/investment of industry in the sector, compared to previous year)</td></tr>
<tr><td>13.3</td><td>Dissemination and outreach activities other than peer-reviewed publications [conferences, workshops, press releases, publications, flyers, exhibitions, training, social media, websites, communication campaigns (e.g. radio, TV)]</td><td>A drop-down list allows for selection of the type of dissemination activity. Number of events, funding amount and number of persons reached thanks to the dissemination activities</td><td>Activities as reported by the projects during the Clean Hydrogen data collection exercise of 2024 for the reporting year of 2023 respectively:
<table>
<tr><th>Dissemination activities (excl. Scientific Publications)</th><th>2024</th></tr>
<tr><td>Total Activities</td><td>573</td></tr>
<tr><td>Conferences/Events (Presentations)</td><td>146</td></tr>
<tr><td>Meetings (with policy stakeholders/working groups, etc)</td><td>302</td></tr>
<tr><td>Education & Training Activities</td><td>125</td></tr>
</table>
<table>
<tr><th>EU Research Days</th><th>2023 (81 projects)</th></tr>
<tr><td>Websites</td><td>80</td></tr>
<tr><td>Twitter accounts</td><td>27</td></tr>
<tr><td>LinkedIn accounts</td><td>19</td></tr>
</table>
</td></tr>
<tr><td>14.2</td><td>Proposal evaluators by country</td><td>Nationality of proposal evaluators (at pool level)</td><td>N/A
(no more H2020 evaluations)</td></tr>
</table>

14.3	Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	N/A (no more H2020 evaluations)
N/A	Participation of RTO[3]s and universities in PPPs (Art. 187 initiatives)	Number of RTOs participations in funded projects and % of the total	300 / 1564 (19 %)
		Number of universities participations in funded projects and % of the total	205 / 1564 (13 %)
		% of budget allocated to RTOs and to universities	RTO: EUR 99.3 million (16 %) HES: EUR 49.4 million (8 %)
N/A	The aim is to ensure that research projects funded are efficiently compliant with provisions on ethics	% of proposals not granted because of non-compliance with ethical rules/proposals invited to grant (target 0 %); time to ethics clearance (target 45 days)	N/A
N/A	Error rate	% of representative error; % residual error	H2020: Representative: -2.77% Residual: -0.51%
N/A	Implementation of *ex-post* audit results	Number of cases implemented; in total EUR million; of cases implemented/total cases	H2020: # closed participations: 92 Percentage of implementation: 85.31%

5.6 Scoreboard of Horizon Europe common Key Impact Pathway Indicators (KIPs)[89]

TABLE 47. SCOREBOARD OF HORIZON EUROPE COMMON KIP INDICATORS

Key Impact Pathway[90]	Short-term	Medium-term	Longer-term	Detail per action or globally for 2024
Towards scientific impact				
1-Creating high-quality new knowledge	Publications -Number of peer-reviewed scientific publications resulting from the Programme	Citations -Field-Weighted Citation Index of peer-reviewed Publications resulting from the Programme	World-class science -Number and share of peer-reviewed publications resulting from the projects funded by the Programme that are core contribution to scientific fields	
2-Strengthening human capital in R&I	Skills -Number of researchers involved in upskilling (training, mentoring/coaching, mobility and access to R&I	Careers -Number and share of upskilled researchers involved in the Programme with	Working conditions -Number and share of upskilled researchers involved in the Programme with improved	

[89] (based on Annex V to Regulation 2021/695/EU)

[90] NB: For some of those KIPs the data will not be available in the short or even medium term.

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	infrastructures) activities in projects funded by the Programme 879 researchers	increased individual impact in their R&I field	working conditions, including researchers' salaries	
3-Fostering diffusion of knowledge and open science	Shared knowledge Share of research outputs (open data/publication/software etc.) resulting from the Programme shared through open knowledge infrastructures	Knowledge diffusion - Share of open access research outputs resulting from the Programme actively used/cited	New collaborations -Share of Programme beneficiaries which have developed new transdisciplinary/transsectoral collaborations with users of their open access research outputs resulting from the Programme	
Towards societal impact				
4-Addressing Union policy priorities and global challenges through R&I	Results -Number and share of results aimed at addressing identified Union policy priorities and global challenges (including SDGs) (multidimensional: for each identified priority) Including: Number and share of climate-relevant results aimed at delivering on the Union's commitment under the Paris Agreement	Solutions -Number and share of innovations and research outcomes addressing identified Union policy priorities and global challenges (including SDGs) (multidimensional: for each identified priority)Including: Number and share of climate-relevant innovations and research outcomes delivering on Union's commitment under the Paris Agreement	Benefits -Aggregated estimated effects from use/exploitation of results funded by the Programme on tackling identified Union policy priorities and global challenges (including SDGs), including contribution to the policy and law-making cycle (such as norms and standards) (multidimensional: for each identified priority) Including: Aggregated estimated effects from use/exploitation of climate-relevant results funded by the Programme on delivering on the Union's commitment under the Paris Agreement including contribution to the policy and law-making cycle (such as norms and standards)	
5-Delivering benefits and impact through R&I missions	R&I mission results - Results in specific R&I missions (multidimensional: for each identified mission)	R&I mission outcomes Outcomes in specific R&I missions (multidimensional: for each identified mission)	R&I mission targets met - Targets achieved in specific R&I missions (multidimensional: for each identified mission)	Not applicable for the JUs
6-Strengthening the uptake of R&I in society	Co-creation -Number and share of projects funded by the Programme where Union citizens and end-users contribute to the co-creation of R&I content	Engagement -Number and share of participating legal entities which have citizen and end-users engagement mechanisms in place after the end of projects funded by the Programme	Societal R&I uptake -Uptake and outreach of co-created scientific results and innovative solutions generated under the Programme	
Towards technological / economic impact				
7-Generating innovation-based growth	Innovative results - Number of innovative products, processes or	Innovations -Number of innovations resulting from the projects funded	Economic growth -Creation, growth & market shares of	

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	methods resulting from the Programme (by type of innovation) & Intellectual Property Rights (IPR) applications	by the Programme (by type of innovation) including from awarded IPRs	companies having developed innovations in the Programme	
8-Creating more and better jobs	Supported employment - Number of full time equivalent (FTE) jobs created, and jobs maintained in participating legal entities for the project funded by the Programme (by type of job)	Sustained employment - Increase of FTE jobs in participating legal entities following the project funded by the Programme (by type of job)	Total employment -Number of direct & indirect jobs created or maintained due to diffusion of results from the Programme (by type of job)	
9- Leveraging investments in R&I	Co-investment -Amount of public & private investment mobilised with the initial investment from the Programme	Scaling-up -Amount of public & private investment mobilised to exploit or scale-up results from the Programme (including foreign direct investments)	Contribution to '3 % target' - Union progress towards 3 % GDP target due to the Programme	

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5.7 Horizon Europe Partnership common Key Performance Indicators[91]

TABLE 48. COMMON KPI BASELINE VALUES, RESULTS FOR 2024 AND TARGETS FOR 2027

N°	Criterion addressed	Proposed common indicators	Baseline	Results for 2024	Target 2027
1	**Additionality**	Progress towards (financial and in-kind) contributions from partners other than the Union – i.e. committed vs. actual			
2	**Additionality/ Synergies**	Additional investments triggered by the EU contribution, including qualitative impacts related to additional activities	N/A	3	N/A
3	**Directionality**	Overall (public and private, in-kind and cash) investments mobilised towards EU priorities	100% towards Grean Deal	100% towards Grean Deal	100% towards Grean Deal
4	**International visibility and positioning**	International actors involved[92]	68	83	N/A
5	**Transparency and openness**	Share & type of stakeholders and countries invited/engaged[93]	Please see Table A below	Please see Table B below	N/A
6	**Transparency and openness**	No and types of newcomer members in partnerships and their			

[91] (based on an interim report published on 21 June 2021 (Commission Experts' report, Section 5 and Appendix 1 https://op.europa.eu/en/publication-detail/-/publication/6b63295f-d305-11eb-ac72-01aa75ed71a1/language-en/format-PDF/source-215872593)

[92] An effort has been made to report on this indicator despite certain unclarity on its exact definition. We expect its reporting will be improved in the future, after the JUs have received better guidance, leading to possible changes in the reporting methodology. For AAR24, AAR23 and similar to AAR22, the JU reports on the international (non-EU, non-Associated countries) applicants in JU Calls for Calls 2022, Call 2023 and Call 2024. For the baseline the figure during the whole period of H2020 is reported. This selection allows for comparability and the possibility to provide a baseline. It is important to note that compared to 2022 the number of associated countries has increased.

[93] An effort has been made to report on this indicator despite certain unclarity on its exact definition. We expect its reporting will be improved in the future, after the JUs have received better guidance, leading to possible changes in the reporting methodology. For AAR24 and similar to AAR23 and AAR22, the JU reports on the project beneficiaries in JU for Calls 2022, Call 2023 and Call 2024. For the baseline the figure during the whole period of H2020 is reported. This selection allows for comparability and the possibility to provide a baseline.

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N°	Criterion addressed	Proposed common indicators	Baseline	Results for 2024	Target 2027
		countries of origin (geographical coverage)			
7	**Transparency and openness**	No and types of newcomer beneficiaries in funded projects (in terms of types and countries of origin)	Please see Table C below	Please see Table D below	N/A
8	**Coherence and synergies**	Number and type of coordinated and joint activities with other European Partnerships	N/A	Coordinated call for proposals: 0 Systemic collaboration: 3 Ad hoc collaboration:5	N/A
9	**Coherence and synergies**	Number and type of coordinated and joint activities with other R&I Initiatives at EU /national/regional/sectorial level	Coordinated calls for proposals: 1 Hydrogen valleys: 3 Co-funding: 9	Coordinated call for proposals: 0 Hydrogen valleys: 18 Co-funding: 3 Formal collaboration: 10 Ad-hoc collaboration: 10 Various activities: 4	N/A
10	**Coherence and synergies**	Complementary and cumulative funding from other Union funds (Horizon Europe, National funding, ERDF, RRF, Other cohesion policy funds, CEF, DEP, LIFE, other) and national funding	6.88%	0	N/A
11	**International visibility and positioning**	Visibility of the partnership in national, European, international policy/industry cycles			

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5.8 Scoreboard of Key Performance Indicators specific to Clean Hydrogen JU[94] - Operational

TABLE 49. SCOREBOARD OF KPIS SPECIFIC TO THE CLEAN HYDROGEN JU

[94] Following the implementation of the KPIs certain issues were identified and corrected. Thus the KPI definitions, the exact methodologies followed, units reported, etc. may have changed, following also the related SRIA amendment in 2024. A detailed description methodology followed will be published on the Clean Hydrogen JU website (https://www.clean-hydrogen.europa.eu/knowledge-management/strategy-map-and-key-performance-indicators_en).

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KPI Name		Unit of measurement	Baseline	Actual 2024[1]	Target 2023	Target 2025	Target 2027	Ambition 2030	Status
Resources (input), processes and activities									
1. Supporting climate neutral and sustainable solutions	1a. Hydrogen end-use solutions in hard to abate sectors	% of JU budget	2.5[2]	28%	15	30	40		On track
	1b. Circular and sustainable solutions	% of JU budget	< 1[2]	12%	5	10	15		On track
2. Early research projects		% of budget	10[2]	16%	10	10	10		On track
3. Demonstration projects		# of projects	43[2]	34	20	40	60		On track
4. Education and training		# of projects	4[2]	17	2	4	6		On track
5. Monitoring technology progress		*Qualitative indicator*	N/A	Please see section 1.5.1.1	N/A	N/A	N/A		On track
6. Supporting EC in H2 market uptake		*Qualitative indicator*	N/A	Please see Section 1.7.4.2	N/A	N/A	N/A		On track
Outcomes									
7. Environmental impact and sustainability	7a. Reduction in the use and increase in the recycling rate of Critical Raw Materials (CRM)	% of CRM relevant KPIs reached	0	N/A[5]	N/A	75[6]	75	100	N/A[5]
	7b. Improvement in the quality of Life Cycle Assessments (LCA)	Quality of LCA submitted by projects (rating in %)	60[2]	N/A[5]	N/A	65	70	75	N/A[5]

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KPI Name		Unit of measurement	Baseline	Actual 2024[1]	Target 2023	Target 2025	Target 2027	Ambition 2030	Status
Resources (input), processes and activities									
8. Capital cost of hydrogen applications	8a. Capital cost of electrolysers	% reduction across electrolyser technologies	100	N/A[5]	N/A	65	55	45	N/A[5]
	8b. Capital cost of heavy-duty road applications	Cost of FC module CAPEX in €/kilowatt	1,500	N/A[5]	N/A	420	290	100	N/A[5]
9. Research and Innovation Synergies		# of projects	5[2]	9	5	10	20		On track
10. Public perception of hydrogen		*Qualitative indicator*	N/A		N/A	N/A	N/A		
11. Total persons trained		# of persons in thousands	5[2]	N/A[5]	N/A	110	160	240	N/A[5]
12. Patents and publications		# of patents / publications	12[2]/ 289	23 / 391	17/ 100	20/ 400	25/ 450		On track[7]
13. Promoting cross-sectoral solutions		% of budget	15[2]	18	10	15	25		On track[3]
Impacts* (KPIs reporting progress of hydrogen sector at EU level, to which the JU is contributing)									
14. Expected avoided emissions		Million tonnes of CO2-eq/year	0.085	0.91[8]	N/A	N/A	N/A	223	Off track[9]
15. Deployment of electrolysers		Gigawatt	0.077	0.4[8]	4	6	10	40	Off track[9]
16. Market uptake of clean hydrogen		Mt of clean hydrogen consumed	0.008	0.04[10]	0.7	1	2	10	Off track[9]
17. Total cost of producing renewable hydrogen		€/kg	8	6.86[8]	6.5	5.5	4.5	3	On track

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KPI Name		Unit of measurement	Baseline	Actual 2024[1]	Target 2023	Target 2025	Target 2027	Ambition 2030	Status
Resources (input), processes and activities									
18. Size of private hydrogen sector	18a. Activity in terms of companies	# of companies	300	1,413[8]	1,000	1,500	2,000	-	On track
	18b. Activity in terms of projects in the pipeline (ongoing or under construction)	# of Projects	50	309[8]	200	500	800	-	On track[9]
	18c. Electrolyser manufacturing capacity	GW/year	1	10.2[8]	5	17.5	30	-	Off track[10]

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Text space below the table:

* The set of KPIs under "impact" report the progress of the hydrogen sector at EU level, to which the JU is contributing. Targets for KPI-14 to KPI-17 are based on the relevant ambition set in EU's Hydrogen Strategy. Targets for KPI-18a and KPI-18b are based on current trends and expectations for the sector, while KPI-18c reflects the 2025 target mentioned in the Joint Declaration signed between the European Commission and the European electrolysers manufacturers in May 2022. **For this set of KPIs, the status refers to Europe as a whole and not on the individual performance of the JU, helping to identify where more effort should also be placed by the JU in the coming years.** [1] The latest values available by end of 2024 are reported. For KPIs (#1-4, 9, 13) these reflect the signed grants of Call 2022, Call 2023 and Call 2024. For the KPIs on project results (#7, 8 and 11) there is nothing to report yet, as the first grants where only signed in 2022. For KPI 12 the latest data are reported, as reported in this Annual Activity Report of the JU (AAR 24). All KPIs on impacts (14-18) come from the latest available data on the European Hydrogen Observatory. For the qualitative KPIs (#5-6, 10), these are described in AAR24. [2] Baseline refers to the achievement over the lifetime of the predecessor partnership (FCH 2 JU). [3] First relevant project was signed only in first half of 2022, more are expected to be signed the coming years. Results will become available gradually as the projects advance, mostly towards the end of the projects. [4] Target for 2025 measured against SRIA 2024 targets, while targets for 2027 and 2030 measured against SRIA 2030 targets. [5] https://www.clean-hydrogen.europa.eu/projects-repository/hypop_en [6] Reported figures come from Annex 5 of the Annual Activity Report and refer to awarded patents. Current source of data is eGrants and the Clean Hydrogen JU data collection, but it is considered

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incomplete, especially in relation to patents. The JU is currently working with JRC and external sources to improve the data collection methodology concerning this series.

[7] Calculated from the European Hydrogen Observatory; data from 2024. KPI-17 was calculated using the methodology proposed by the Observatory contractors.

[8] KPIs 15-16 are off track, and thus KPI 14 which is directly linked to them, as despite the ambitiousness of the Hydrogen Strategy hydrogen technologies require more time and research to be ready for commercialisation and scaling up. Nevertheless, the significant funding planned via the European Hydrogen Bank and other European, regional and national instruments may be able to turn this around in the coming years. This can be further supported by the activities of the Clean Hydrogen JU, which although may have a limited direct impact to these deployment figures due to its small budget compared to the ambition, it can play an important role in increasing the technology readiness of the hydrogen solutions, allowing their faster market uptake.

[9] Expected to be on track in 2025, based on project announcements.

[10] KPI-16 the value is only for hydrogen based on electrolysis. However, in case that "clean hydrogen" can also encompass blue hydrogen and other low-carbon hydrogen types, then the correct number is 0.1Mt.

5.9 *Scoreboard of Key Performance Indicators specific to Clean Hydrogen JU – Administrative*

TABLE 50. ADMINISTRATIVE KPIS SPECIFIC TO THE CLEAN HYDROGEN JU

Field	KPI name	Unit of measurement	Results for 2024

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HR	Vacancy rate (%)	Vacancy rate (%)	Vacancy rate= 3.84 %
JU EFFICIENCY	Time to sign (TTS) grant agreements from the date of informing successful applicants (information letters)	Average TTS in calendar days Maximum TTS in calendar days	Average TTS: 127 days Maximum TTS: 320 days (after approval of a request for GAP extension by the consortium)
	Administrative budget: Number and % of total of late payments	Number and % of total of late payments	% of late payments: 2.62% Number of late payments: 12

5.10 IKAA Report

TABLE 51. IKAA REPORT FOR YEAR *2024 (UPDATED ON 4 JUNE 2025)*

ADDITIONAL ACTIVITIES REPORT DETAILED CERTIFIED IKAA FOR 2024		
Description of the AA	**Type of contributor**	**Certified IKAA value for 2024 (€)**
A.Pre-commercial trials and field tests	Private members	3,493,038.78
B. Proof of concept	Private members	43,753,362.90
C. Improvement of existing production lines for up-scaling	Private members	76,477,268.23
D. Large scale case studies	Private members	225,812,416.85

E. Awareness-raising activities on hydrogen technologies and safety measures	Private members	726,875.00
F. Uptake of results from projects into products, further exploitation and activities within the research chain either at higher TRLs or in parallel strands of activity	Private members	227,295,357.99
G. The research and innovation activities or projects with a clear link to the Strategic Research and Innovation Agenda, and co-funded under national or regional programmes within the Union	Private members	114,632,702.83
H. Other, contributing to the JU objectives	Private members	5,878,764.45
TOTAL CERTIFIED IKAA		**698,069,787.03**

TOTAL CERTIFIED IKAA 2024: BREAKDOWN PER COUNTRY	
Country	**Value(€)**
AT	7,609,608.82
BE	9,612,258.29
CZ	1,025,974.00
DE	488,486,659.92
ES	1,719,846.88
FI	8,056,637.86
FR	31,788,060.13
GR	2,015,426.07
IT	1,992,042.45
NL	5,064,654.40
NO	100,022,862.00
SE	11,213,560.90
UK	27,795,300.83
Others	1,666,894.48

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TOTAL CERTIFIED IKAA	698,069,787.03

ADDITIONAL ACTIVITIES REPORT DETAILED CERTIFIED IKAA FOR 2024		
Description of the AA	**Type of contributor**	**Certified IKAA value for 2024 (€)**
A. Pre-commercial trials and field tests	Private members	3,493,038.78
B. Proof of concept	Private members	43,753,362.90
C. Improvement of existing production lines for up-scaling	Private members	76,477,268.23
D. Large scale case studies	Private members	225,812,416.85
E. Awareness-raising activities on hydrogen technologies and safety measures	Private members	726,875.00
F. Uptake of results from projects into products, further exploitation and activities within the research chain either at higher TRLs or in parallel strands of activity	Private members	227,295,357.99
G. The research and innovation activities or projects with a clear link to the Strategic Research and Innovation Agenda, and co-funded under national or regional programmes within the Union	Private members	114,632,702.83
H. Other, contributing to the JU objectives	Private members	5,878,764.45
TOTAL CERTIFIED IKAA		**698,069,787.03**

TOTAL CERTIFIED IKAA 2024: BREAKDOWN PER COUNTRY	
Country	**Value(€)**
AT	7,609,608.82

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BE	9,612,258.29
CZ	1,025,974.00
DE	488,486,659.92
ES	1,719,846.88
FI	8,056,637.86
FR	31,788,060.13
GR	2,015,426.07
IT	1,992,042.45
NL	5,064,654.40
NO	100,022,862.00
SE	11,213,560.90
UK	27,795,300.83
Others	1,666,894.48
TOTAL CERTIFIED IKAA	**698,069,787.03**

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
A Pre-commercial trials and field tests		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe’s 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union’s ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	0.00
B To contribute to the implementation of the 2020 European Commission’s Hydrogen Strategy for a climate neutral Europe	Private members	8,117.00
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	544,524.71
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	1,514,037.79
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	1,081,208.04
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union’s hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	345,151.24
SUB TOTAL (A)		**3,493,038.78**
B Proof of concept		
	Private members	1,281,696.88

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
B. Proof of concept		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	1,281,696.88
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	744,257.29
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	255,557.42
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	407,731.76
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	40,313,916.14
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	393,852.77
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	356,350.64
SUB TOTAL (B)		**43,753,362.90**
C Improvement of existing production lines for up-scaling		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the	Private members	0.00

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050		
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	1,114,561.45
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	56,997,508.75
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	0.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	17,812,865.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	552,333.03
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	0.00
SUB TOTAL (C)		**76,477,268.23**
D Large scale case studies		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	171,662,786.50
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	41,652,210.96

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	0.00
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	8,429.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	0.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	10,473,564.32
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	2,015,426.07
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00
SUB TOTAL (D)		**225,812,416.85**

E Awareness-raising activities on hydrogen technologies and safety measures		
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	186,791.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	452,639.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	87,445.00
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
SUB TOTAL (E)		**726,875.00**
F Uptake of results from projects into products, further exploitation and activities within the research chain either at higher TRLs or in parallel strands of activity		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	748,211.51
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	276,852.22
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	221,137,051.90
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	44,351.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	4,940,022.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	127,172.36
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	21,697.00
SUB TOTAL (F)		**227,295,357.99**
G The research and innovation activities or projects with a clear link to the Strategic Research and Innovation Agenda, and co-funded under national or regional programmes within the Union		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people,	Private members	32,167,722.70

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050		
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	0.00
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	631,289.04
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	30,958,900.64
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	50,183,937.67
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	514,087.43
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	176,765.35
SUB TOTAL (G)		**114,632,702.83**
H Other, contributing to the JU objectives		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	676,130.80
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	1,789,591.47
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	1,274,153.00

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	0.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	2,138,889.18
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	0.00
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00
SUB TOTAL (H)		**5,878,764.45**

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	0.00
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	8,117.00
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	544,524.71
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	1,514,037.79
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	1,081,208.04
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	345,151.24
SUB TOTAL (A)		**3,493,038.78**
Proof of concept		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	1,281,696.88

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	744,257.29
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	255,557.42
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	407,731.76
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	40,313,916.14
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	393,852.77
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	356,350.64
SUB TOTAL (B)		**43,753,362.90**
Improvement of existing production lines		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	0.00
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	1,114,561.45

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	56,997,508.75
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	0.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	17,812,865.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	552,333.03
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	0.00
SUB TOTAL (C)		**76,477,268.23**
D Large scale case studies		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	171,662,786.50
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	41,652,210.96
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	0.00
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	8,429.00

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	0.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	10,473,564.32
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	2,015,426.07
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00
SUB TOTAL (D)		**225,812,416.85**

E Awareness-raising activities on hydrogen technologies and safety measures		
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	186,791.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	452,639.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	87,445.00
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00
SUB TOTAL (E)		**726,875.00**
of results from projects into products, further exploitation and activities within the research chain either at higher TRLs or in parallel strands of activity		

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	748,211.51
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	276,852.22
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	221,137,051.90
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	44,351.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	4,940,022.00
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	127,172.36
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	21,697.00
SUB TOTAL (F)		**227,295,357.99**
research and innovation activities		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	32,167,722.70

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	0.00
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	631,289.04
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	30,958,900.64
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	50,183,937.67
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	514,087.43
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	176,765.35
SUB TOTAL (G)		**114,632,702.83**
Other, contributing to the JU objectives		
A To contribute to the objectives set out in the communication from the Commission of 17 September 2020 on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people, the European Green Deal and the European Climate Law by raising the Union's ambition on reducing greenhouse gas emissions to at least 55 % below 1990 levels by 2030, and climate neutrality at the latest by 2050	Private members	676,130.80
B To contribute to the implementation of the 2020 European Commission's Hydrogen Strategy for a climate neutral Europe	Private members	1,789,591.47
C To strengthen the competitiveness of the Union clean hydrogen value chain, with a view to supporting, in particular for SMEs, the acceleration of the market entry of innovative competitive clean solution	Private members	1,274,153.00

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DETAILED CERTIFIED IKAA FOR 2024		
Detailed description of the AA	**Type of contributor**	**Certified value AA for 2024 (in €)**
D To stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications	Private members	0.00
E Improve, through research and innovation, including activities related to lower TRLs, the cost-effectiveness, efficiency, reliability, quantity and quality of clean hydrogen solutions, including production, distribution, storage and end uses developed in the Union	Private members	2,138,889.18
F Strengthen the knowledge and capacity of scientific and industrial actors along the Union's hydrogen value chain while supporting the uptake of industry-related skills	Private members	0.00
G Carry out demonstrations of clean hydrogen solutions with a view to local, regional and Union-wide deployment, aiming to involve stakeholders in all Member States and addressing renewable production, distribution, storage and use for transport and energy-intensive industries as well as other applications	Private members	0.00
H Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions, in particular through cooperation with other European partnerships under Horizon Europe	Private members	0.00
SUB TOTAL (H)		5,878,764.45

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TOTAL IKAA 2021-2024 (Evolution 2022-2024 - Value in €)		
Planned IKAA	**Reported IKAA with pending certification**	**Certified IKAA**
2,340,295,000.00	**717,225,292.31**	**1,437,967,026.62**

5.11 Draft/final annual accounts (Optional)

The annual accounts are provided in a separate document, which is officially handed over to the budgetary authorities, the European Court of Auditors and the external auditors.
They are also published on the Clean Hydrogen JU website.

5.12 Materiality criteria

The '**materiality**' concept provides the Executive Director with a basis for assessing the importance of the weaknesses/risks identified and thus whether those weaknesses should be subject to a formal reservation to the Executive Director's declaration. The same materiality criteria are applicable to the FP7 and H2020 programmes.

When deciding whether or not something is material, **qualitative and quantitative** terms have to be considered.

In **qualitative** terms, when assessing the significance of any weakness, the following factors are taken into account:

- the nature and scope of the weakness;
- the duration of the weakness;
- the existence of compensatory measures (mitigating controls that reduce the impact of the weakness);
- the existence of effective corrective actions to correct the weaknesses (action plans and financial corrections) that have had a measurable impact.

In **quantitative** terms, in order to make a judgement on the significance of a weakness, the potential maximum (financial) impact is quantified.

Although the JU control strategy is of a multiannual nature (i.e. the effectiveness of the JU's control strategy can only be assessed at the end of the programme, when the strategy has been fully implemented and the errors detected have been corrected), the Executive Director is required to sign a declaration of assurance for each financial year. In order for them to determine whether to qualify the declaration of assurance with a reservation, the effectiveness of the JU's control system has to be assessed not only for the year of reference but, more importantly, from a multiannual outlook.

The **control objective** for the JU is to ensure that the **residual error rate** – the level of errors that

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remain undetected and uncorrected – does not exceed 2 % by the end of the JU programme. Progress towards this objective is to be (re)assessed annually, in view of the results of the implementation of the *ex post* audit strategy. If the residual error rate is not below 2 % at the end of a reporting year within the programme's life cycle, a reservation would be added. Nevertheless, apart from the residual error rate, the Executive Director may also take into account other management information at their disposal to identify the overall impact of a weakness and determine whether or not it leads to a reservation.

If an adequate calculation of the residual error rate is not possible, for reasons not involving control deficiencies, the consequences are to be assessed quantitatively by estimating the likely exposure for the reporting year. The relative impact on the declaration of assurance would then be considered by analysing the available information on qualitative grounds and considering evidence from other sources and areas (e.g. information available on error rates in more experienced organisations with similar risk profiles).

Considering the crucial role of *ex post* audits in the JU's control system, measuring their effectiveness requires checking whether the scope and results of these audits are sufficient and adequate to meet the control objectives.

Effectiveness of controls

The **starting point** of determining the effectiveness of the controls in place is the representative error rate, expressed as a percentage of errors in favour of the JU detected by *ex post* audits measured with respect to the amounts accepted after *ex ante* controls.

According to the JU *ex post* audit strategy approved by the Governing Board, the representative error rate will be based on the simple average error rate (AER) for a stratified population, from which a representative sample has been drawn according to the following formula:

$$AER\% = \frac{\Sigma\ (err)}{r} = RepER\%$$

Where:

- ***Σ (err)*** = the sum of all individual error rates of the sample (in %) (only those errors in favour of the JU will be taken into consideration);
- ***n*** = the sample size.

The second step is the calculation of the **residual error rate**.

To take into account the impact of the *ex post* controls, this error level is to be adjusted by subtracting:

- errors detected and corrected as a result of the implementation of audit conclusions;
- errors corrected as a result of the extrapolation of audit results to non-audited contracts with the same beneficiary.

This results in a residual error rate, which is calculated by using the following formula:

$$RepER\% = \frac{(RepER\% \times (P - A) - (RepERsys\% \times E)}{P}$$

Where:

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- ***ResER%*** = the residual error rate, expressed as a percentage;
- ***RepER%*** = the representative error rate, or error rate detected in the representative sample, in the form of the AER, expressed as a percentage and calculated as described above (*AER%*);
- ***RepERsys%*** = the systematic portion of the *RepER%* (the *RepER%* is composed of complementary portions reflecting the proportion of 'systematic' and 'non-systematic' errors detected) expressed as a percentage;
- ***P*** = the total amount in euro of the auditable population
- ***A*** = the total of all audited amounts, expressed in euro;
- ***E*** = the total non-audited amounts of all audited beneficiaries, comprising the total amount, expressed in euro, of all non-audited validated cost statements for all audited beneficiaries, excluding those beneficiaries for which an extrapolation is ongoing.

This calculation will be performed on a point-in-time basis, meaning that all the figures will be provided as of a certain date.

5.13 Results of technical review (optional)

Not applicable

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5.14 List of acronyms

AEMEL anion exchange membrane electrolyser

AEL alkaline electrolysis

AFIF alternative fuel infrastructure facility

AFIR Alternative Fuels Infrastructure Regulation

AWP annual work plan

BEV battery electric vehicle

CAPEX capital Expenditure

CAS Common Audit Service

CEN European Committee for Standardization

CENELEC European Committee for Electrotechnical Standardization

CERT-EU Computer Emergency Response Team for the EU Institutions, bodies and agencies

CHP combined heat and power

CIC Common Implementation Centre

CRM Customer Relationship Management

CRaS common representative sample

D&E dissemination and exploitation

DG Directorate-General

DG DIGIT Directorate-General for Informatics

EAFO European Alternative Fuels Observatory

ECA European Court of Auditors

EHSP European Hydrogen Safety Panel

EHS&CP European Hydrogen Sustainability and Circularity Panel

E&Y Ernst & Young

FC fuel cell

FCEB fuel cell electric bus

FCEV fuel cell electric vehicle

FCH fuel cells and hydrogen

FCHO Fuel Cell Hydrogen Observatory

FP7 seventh framework programme

GA grant agreement

GB Governing Board

GHG greenhouse gas

GO Guarantee of Origin

H2020 Horizon 2020

HRP Horizon Results Platform

HRS hydrogen refuelling station

IAS Internal Audit Service

ICF internal control framework

IKAA in-kind contributions in additional activities

IKOP in-kind contributions in operational activities

IMO International Maritime Organization

IPHE International Partnership for Hydrogen and Fuel Cells in the Economy

ISO International Organization for Standardization

JIVE Joint initiative for hydrogen vehicles across Europe

JRC Joint Research Centre

JTI Joint Technology Initiatives

JU Joint Undertaking

KER key exploitable result

KM knowledge management

KPI key performance indicator

LCA life cycle assessment

LH2 liquid hydrogen

LOHC liquid organic hydrogen carrier

MAWP multiannual work programme

MEA membrane electrode assembly

m-CHP micro-scale combined heat and power

OLAF European Anti-Fraud Office

OPEX operational expenditure

PACE Pathway to a Competitive European Fuel Cell micro-Cogeneration Market

PCC Proton Conducting Ceramic

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PCCEL Proton Conducting Ceramic Electrolysis

PDA project development assistance

PEM proton exchange membrane

PEMEL proton exchange membrane electrolyser

PNR pre-normative research

PO programme office

QES qualified electronic signature

R & D research and development

R&I research and innovation

RCS regulations, codes and standards

RCS SCG Regulations, Codes and Standards Strategy Coordination Group

RED Renewable Energy Directive

SMEs small and medium-sized enterprises

SoA state of the art

SOC system-on-a-chip

SOEC solid oxide electrolyser cell

SOEL solid oxide electrolysis

SOFC solid oxide fuel cell

SRG States Representatives Group

SRIA strategic research and innovation agenda

SyGMa System for Grant Management

Sysper Système de gestion du personnel

TEN-T Trans-European Transport Network

TRL technology readiness level

TRUST Technology Reporting Using Structured Templates

TTP time to pay

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