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ANNEX to GB decision no CleanHydrogen-GB-2023-07

CONSOLIDATED ANNUAL ACTIVITY REPORT

YEAR 2022

In accordance with Article 26 of Council Regulation (EU) No 2021/2085 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 (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
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 R&I for investments, 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 to the 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 Commission's policy guidance and supervision, contribute to the

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	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) (c) support the Commission, including through technical expertise, in its international initiatives on the hydrogen strategy, such as the International Partnership on the Hydrogen Economy (IPHE), Mission Innovation and the Clean Energy Ministerial Hydrogen Initiative
Legal Basis	Established under the 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 559/2014, (EU)
Executive Director	Mirela Atanasiu, Executive Director *ad interim*
Governing Board	Chair: Melissa Verykios Vice-chair: Rosalinde van der Vlies Governing Board (3 representatives of the European Commission, 6 representatives of the Industry Grouping and 1 representative of the Research Grouping) 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 2022[1]	Commitment appropriations[2]: EUR 313.8 million, of which EUR 305.8 million for operational activities and EUR 8 million for administrative expenditure Payment appropriations[3]: EUR 117.8 million, of which EUR 109.7 million for operational activities and EUR 8.1 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 8.4 million, subsequently amended to include the increase of revenues and expenditure related to the new Programme under Horizon Europe and unused appropriations from prior years

[3] Voted payment appropriations were EUR 53.2 million and the amendment increased the amount -as a result of the new Programme and - to cover the planned call for proposals launched in 2022, aimed to implement the SRIA

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Budget implementation / execution	Commitments: EUR 311,165,396 (99 % of appropriations): • Title 1: EUR 3,835,059 (97%) • Title 2: EUR 2,596,007 (62%[4]) • Title 3: EUR 304,632,423 (99%) Payments: EUR 77,438,313 (65 % of appropriations[5]) • Title 1: EUR 3,802,401 (96%) • Title 2: EUR 2,128,287 (52%) • Title 3: EUR 71,505,991 (65%)
Grants / Tenders / Prizes	309 grants signed for a total value of EUR 1,174.5 million at the end of 2022[6] Three operational tenders for a total value of EUR 2,774 million and administrative tenders for a total value of EUR 883,000 at the end of 2022[7]
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 for proposals launched in 2022: 1 with 2 deadlines Number of proposals submitted: 153 Number of eligible proposals: 143 Number of proposals granted: 27 (for the first deadline of the call 2022-1, 20 grants were signed in December 2022, the 7 remaining ones in 2023)

[4] The budget for administrative expenditure for 2022 included works to be accomplished in the premises of the Clean Hydrogen JU. As it was still uncertain if the JU would be seated in the White Atrium building after 2024, due to the ongoing negotiated procedure launched for premises in accordance with the Financial Regulation Annex I Article 11(g), this expenditure has been postponed to 2023; the budget also included a commitment for external support services to the operational activities, the service contract is expected to be signed in Q2 2023 thanks to the reactivation of appropriations initially planned to be used in Q4 2022.

[5] This 65% low payment execution is due to the fact that the first call of Horizon Europe had 2 deadlines (call 2022-1 with deadline 31 May 2022 & call 2022-2 with deadline 20 September 2022) and the payment execution, mainly prefinancing payments, is spread over 2 years, 2022 and 2023. Out of the 27 grants of the 1st deadline, call 2022-1, 20 first grants were signed in December 2022. The 7 remaining ones were signed in January 2023 and the grants of the 2nd deadline, call 2022-2, will be signed in 2023. In order not to jeopardise the signature of grants until that date, the Clean Hydrogen JU decided to keep payment appropriations to be in a position to pay pre-financing to related beneficiaries

[6] Under the three framework programmes: FP7, H2020 and Horizon Europe

[7] For the year 2022 only

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	Global project portfolio (since setting up of the JU): 289[8] signed projects from FCH JU and FCH 2 JU legacy (of which 78 are ongoing[9]) and 20 signed projects under the first call for proposals of Horizon Europe (all in implementation)
Participation, including SMEs	Total number of beneficiaries in funded projects: 1,241, of which: • number of SMEs = 24% • SME funding = 26% • number of large private for-profit companies = 49 %

[8] Including two cancelled grants

[9] No final payments was made as of 31 December 2023

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FOREWORD

The year 2022 marked the first full year of operations of the Clean Hydrogen Joint Undertaking. After establishing the necessary advisory bodies and approving the SRIA, we have launched the biggest call for proposals in the history of the Joint Undertaking, with a total budget of EUR 300 million. At the same time, we prepared also the 2023 call together with our three partners, with a budget of EUR 195 million. Together, the two calls represent nearly half of the Clean Hydrogen Joint Undertaking's overall budget, which aims to frontload the programme to reach the ambitious European targets for hydrogen and fuel cells.

The 2022 call had two topics on hydrogen valleys allowing for big and small valleys. The call was very successful, and we have received many hydrogen valley proposals. Thanks to the additional EUR 200 million in the REPowerEU, we were able to prepare the award of nine hydrogen valleys (big and small) proposals that passed the evaluation criteria, which was eventually approved at the end of January 2023. Several new hydrogen valleys are located in central, eastern and southern Europe, which is necessary to achieve a good overall balance in the EU.

Looking back a couple of years ago, hydrogen was a niche, now it is at the top of everyone's agenda in the EU with many legislations and regulations being drafted. Many announced JU initiatives found their roots in the previous Joint Undertakings like the hydrogen valleys, the EU Hydrogen Week or the Hydrogen Bank. The seeds are planted to develop a European knowledge hub for hydrogen. Solid synergies are established between various EU programs. So I am confident that the Clean Hydrogen JU will be successful in the future to achieve the programme objectives.

This success is achieved thanks to the hard work and dedication of many people, passionate to tackle climate change: the colleagues in the European Commission, the members of the Governing Board, the States Representatives Group, the Stakeholders Group and the many people who give their valuable inputs on our plans and activities.

Mirela Atanasiu

Clean Hydrogen JU Executive Director ad interim

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EXECUTIVE SUMMARY

The year 2022 was the first year of operations of the Clean Hydrogen JU, successor to the FCH 2 JU since November 2021. It was an exceptional year with outstanding achievements.

The Clean Hydrogen JU launched the first call for proposals on Hydrogen under Horizon Europe, with a total value of EUR 300 million. A total of 41 topics were part of the call for proposals, including 10 for renewable hydrogen production, 11 for hydrogen storage and distribution, 8 for transport and 4 for heat and power. In addition, 5 projects addressed for cross-cutting issues, 2 hydrogen valleys and 1 strategic research challenge. Six topics were considered as flagships with a focus on hydrogen production (multi-megawatt electrolysers in industrial applications), transport (deploying 100s of heavy-duty trucks and inland waterway vessels across the TEN-T corridors) and Hydrogen Valleys (large and small-scale). Research activities covered the whole hydrogen value chain. It resulted in 20 new projects with grant agreements signed and seven additional projects ready to be signed in early 2023, and 15 more proposed to enter the grant agreement preparation phase.

The operations under H2020 continued with 68 projects in execution. In total, at the end of 2022, the portfolio of projects of the Clean Hydrogen JU counted 88 ongoing projects addressing production, distribution, storage, and a variety of uses in the fields of energy, mobility and heavy industry.

The ongoing projects of the Clean Hydrogen JU have already exhibited a number of achievements. These include the commissioning and start of operation of a 10 MW PEM electrolyser in the Shell Rhineland Refinery in Germany, significant improvement of the measured stack efficiency for low temperature electrolysis up to 83%, reduced platinum loading in high performance automotive MEAs, cumulative deployment of 113 HRS and over 200 hydrogen buses across Europe, as well as contribution to the drafting of numerous regulations, codes and standards.

To reinforce and accelerate the capacity of EU to produce clean hydrogen, the Horizon Europe investments to the Clean Hydrogen JU were toped-up with EUR 200 million from Horizon Europe through the RePowerEU Communication from the Commission[10] in May 2022, completed by the same amount from private stakeholders, to double the number of Hydrogen Valleys. A total of 21 proposals were submitted under the Hydrogen Valley topics of the Call 2022 with 9 proposals scoring above the threshold.

The governance of the Clean Hydrogen JU was also set up in accordance with the provisions of the Single Basic Act (founding regulation). The Governing Board established in the end of 2021 held three meetings in 2022. The new advisory bodies, namely the Stakeholders Group (SG) and the States Representatives Group (SRG), were established in accordance with the provisions of the Single Basic Act, and each held three meetings -. The SRG also prepared and submitted its first annual Report- on national and regional policies and programmes related to hydrogen.

Knowledge management activities continued to improve the annual Programme Review exercise, this year focusing more on enriching the content of the Programme Review Report and separating from the more technically focused JRC Programme Technical Assessment Report. In parallel, the smooth continuation of the Fuel Cell and Hydrogen Observatory platform was ensured with the signing of a new contract for the Observatory, foreseeing improved services and larger data sets. Finally, in view of the growing demand for a single platform integrating all hydrogen related information, the JU developed the

[10] COM(2022) 230 final

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concept and architecture for the Clean Hydrogen Knowledge Hub, to be procured in 2023.

The JU continued to support efforts towards dissemination of project results and their exploitation, by promoting the platforms and tools setup by the European Commission. According to the data provided by 94 active projects on their activities[11], 73 projects reported 302 dissemination activities, 50 projects reported 78 exploitation activities, while 73 projects reported 141 exploitable results. The Programme Office also had major achievements in the area of procurement with seven calls for tender launched and concluded in 2022, resulting in new contracts or framework contracts signed with third-parties, enabling the JU to develop studies and specific projects in various fields.

Budget execution was 99% for operational commitments and 79% for administrative commitments. For payments, budget execution -reached65% -of the operational budget. This low payment execution is due to the timing of the call for proposals launched in March 2022 under Horizon Europe, with a first deadline by end May 2022, leading to a maximum time-to-grant target by end January 2023. To avoid jeopardising the signature of grants until that date, the Clean Hydrogen JU decided to keep payment appropriations to be in a position to pay pre-financing to related beneficiaries.

In the area of Communication, the forum of the Joint Undertaking has developed into an integrated Hydrogen Week, with an exhibition and conferences held simultaneously showcasing products and solutions, addressing political messages and visions, and presenting research projects and achievements, including the Forum of the Hydrogen Alliance. It also includes a platform for discussions with the wider scientific community, through a scientific advisory workshop gathering their independent opinions and advice. The fifth edition of the Clean Hydrogen Partnership awards, announced during the European Hydrogen Week, celebrated the best innovation, success story, project outreach and, for the first time, included a prize for the recently established European Hydrogen Valleys.

Given the partnership's objective of increasing public and private awareness, acceptance and uptake of clean hydrogen solutions, a public opinion survey was launched in 2022 to analyse and assess European citizens' attitudes towards and level of knowledge of hydrogen technologies and determine a baseline for monitoring changes in public opinion over time. This is an important step for the future communication activities of the Partnership.

Another communication achievement is the increased outreach that the Partnership has obtained through its media and social media channels, with a number of subscribers and followers that continues to grow, and with a new media campaign that goes beyond paid advertising and targets a wider group, in countries that traditionally had shown a lower interest in hydrogen technology developments.

In accordance with Article 13 of the SBA, the Joint Undertakings reviewed their back-office arrangements: with the support of an external consultancy firm to obtain an independent view, the JUs jointly acknowledged the need to reinforce their already existing cooperation and identified 21 synergies, which were prioritised along four main areas: Accounting, Infrastructure management (ICT and facility), Procurement and Human Resources management. The Governing Board of the Clean Hydrogen JU endorsed the conclusions of the joint back-office arrangements study and approved the related action plan in November 2022, tasking the Programme Office to further implement the agreed- arrangements.

[11] Data collected in 2022 for the year 2021

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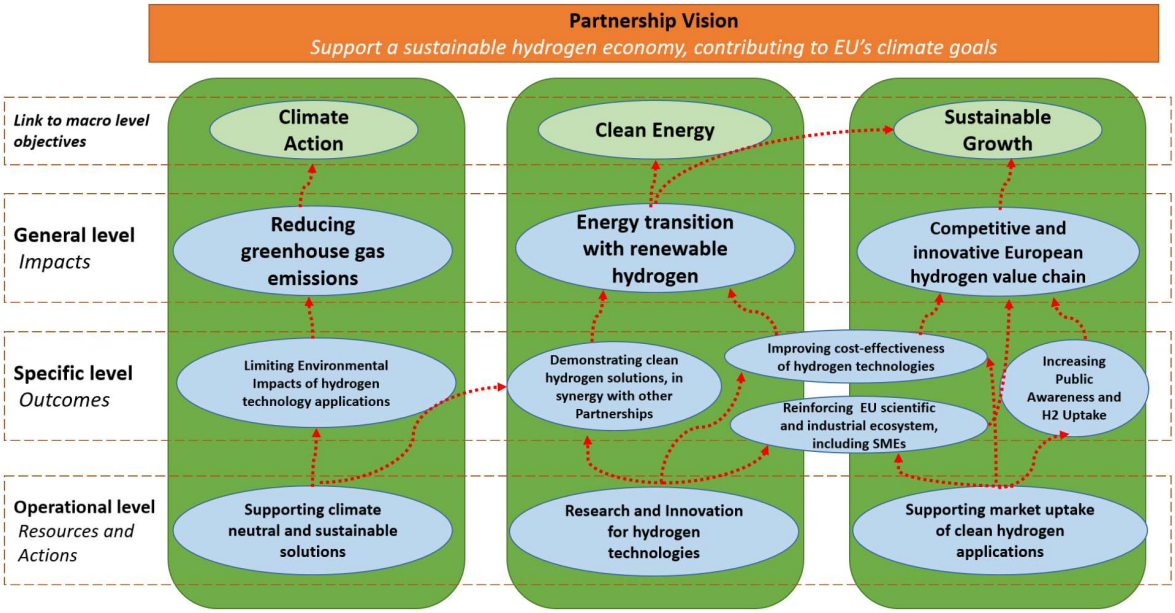
1 IMPLEMENTATION OF THE ANNUAL WORK PROGRAMME FOR 2022

1.1 Key objectives for 2022, associated risks and corrective measures

1.1.1 Progress towards the achievement of the Clean Hydrogen JU objectives

The Clean Hydrogen JU aims to accelerate the development and deployment of the European value chain for safe and sustainable clean hydrogen technologies, 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, playing an important role in the implementation of its roadmap towards climate neutrality.

In order to prepare the implementation strategy of the Programme, the Clean Hydrogen JU prepared a Strategy Map to map its large number of (often high level) objectives to more specific ones12. This facilitated the identification of the necessary actions over the lifetime of the JU, necessary to meet its objectives. The Strategy Map links the resources of the JU and the actions taken (operational objectives / indicators) towards concrete outcomes (specific objectives / indicators) and directly to one (or more) of the general objectives and intended impacts of the Clean Hydrogen JU, which would contribute in turn to one or more high-level objectives of the Union. The figure below presents the JU's strategy map, linking actions with expected outcomes and intended impacts.



Source: Clean Hydrogen JU

FIGURE 1. STRATEGY MAP OF THE CLEAN HYDROGEN JU.

[12] 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 explained in Section 1.7 below, the fact that the first Call of the Clean Hydrogen JU was only published in 2022 and the first projects signed their grant agreements only end 2022- early 2023, does not provide sufficient evidence to report on all of the JU's KPIs. Nevertheless, even in its first year, some important steps have already been performed towards its objectives:

The Clean Hydrogen JU aligned to its new objectives by using its majority of its Call 2022 budget to support climate neutral and sustainable solutions (as measured by KPI-1). From a dedicated budget spent by its predecessors, the Clean Hydrogen JU in its first Call deadline 2022-1 spent about 62% to support either end-use solutions in hard to abate sectors (51%) or circular sustainable solutions (11%).

The first Call of Clean Hydrogen JU targeted both low and high TRL projects, balancing support in the two categories. For Call deadline 2022-1, 40% of the Call budget was directed to early research projects, and another 38% to demonstrations projects.

In terms of the overall hydrogen landscape, although deployment levels are still quite low, both electrolytic hydrogen capacity and market uptake of clean hydrogen doubled between 2020 and 2022.

1.1.2 Operational risks, mitigation and corrective measures

1.1.2.1 Risk assessment in 2022

Risk management is a crucial part of the strategic decision-making process. Robust risk management frameworks help to ensure that the EU budget is used effectively and efficiently, that potential barriers to achieving objectives are identified in a timely fashion and that appropriate mitigation action is taken. All members of staff share responsibility for risk management. The Executive Director is accountable to the Governing Board and is ultimately responsible for the management of the JU's activities and the achievement of its objectives and must ensure that the JU's critical risks are known and appropriately managed ([13]).

1.1.2.2 Relationship with the internal control framework

On 16 August 2018, the Governing Board adopted a new internal control framework 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 internal control framework. Risk assessment is one of the five key internal control framework components and consists of four principles:

- No 6 – the organisation specifies objectives with sufficient clarity to enable the identification and assessment of risks relating to objectives;
- No 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;
- No 8 – the organisation considers the potential for fraud in assessing risks to the achievement of

([13]) Article 19(4)(t) of the SBA.

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objectives;

- No 9 – the organisation identifies and assesses changes that could significantly impact the system of internal control.

1.1.2.3 Risk identification and assessment

In October 2022, in continuation of the practice of the JU in previous years, an annual risk assessment exercise was conducted for the purpose of identifying, analysing and responding to key risks (including fraud risks) across all the areas of responsibility of the JU's Programme Office (PO), and of establishing the baseline for the 2023 annual work programme.

The risk identification started with the assessment of the relevance of the risks identified in the previous risk-assessment exercises (i.e. in the scope of the risk assessment for the 2022 AWP) and continued with the identification of any new relevant risks (e.g. new risks related to new mandate and new objectives of the Clean Hydrogen JU under the Horizon Europe Framework Programme).

The aim of this annual exercise was to identify risks that could hinder achieving the objectives of the JU, including (among others) operational, financial and compliance risks.

During the exercise, the following aspects of all the risks presented in the 2022 AWP were assessed (in view of post-COVID, conflict in Ukraine, RePowerEU and a new mandate of the JU, in particular):

- Relevance of the risk: Is the risk still present? Has it materialised?
- Rating the risk: Did the rating (in terms of impact/likelihood) increase or decrease?
- Relevance and fulfilment of the action plan: Should we continue/expand/reduce action plans?

Based on the discussions, the risks were either removed (when considered no longer relevant) or modified, while the action plans were reviewed for adequacy and completeness. Table 1 below provides a summary of the outcome of the exercise on risks and fulfilment of the action plans, as of 31 December 2022.

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Risk Level	Objective	Indicators	Risk Identified in AWP 2022	Action Plan – as identified for 2022	Action plan – status of fulfilment
HIGH	All objectives	All indicators	Risk of not meeting H2020 and Horizon Europe objectives due to insufficient manpower, as in the upcoming years, the Programme Office will be running two framework programmes simultaneously, H2020 in the peak of implementation, Horizon Europe with increased 50% of the budget (approx. one third to be committed in the first year), with only two additional FTEs for 2022 - 2027. Risk of unclear arrangements of the common back office planned to be in place in 2023 which can result in resources inefficiencies, -duplication of work or even staff leaving. (e.g. DG BUDG has already resigned from the role of the accountant of the Clean Hydrogen JU for 2022.)	Use of service contracts for support activities, increased coordination and efficiency gains through synergies with other joint undertakings. Discussion with the GB on the adequacy of the current staff establishment plan supported with a real workload analysis for the entire organisation. Together with other joint undertakings, Clean Hydrogen JU will participate in a common study for the back-office arrangements with an external provider to assess efficiencies and potential gains of the planned back-office arrangements.	The risk to not reach the objectives continues to be present. An annual report on the JUs for 2021 issued by ECA in November 2022[14] confirmed that the headcount issue is becoming critical for the JUs and may present significant risk in reaching the overall ambitious objectives of the Clean Hydrogen JU. Back-office itself is not a risk anymore. However, it does not provide a solution to headcount issue. The framework contract for technical assistance services is in place, the signature of the specific contract is planned for early 2023. One additional SNE position was approved by the Commission and is under recruitment in 2023. The key element for an effective and efficient implementation of the Horizon Europe objectives is in the manpower. In that respect, the JU will continue to report to the Governing Board and will continue to seek guidance.

[14] https://www.eca.europa.eu/Lists/ECADocuments/JUS_2021/JUS_2021_EN.pdf

Risk Level	Objective	Indicators	Risk Identified in AWP 2022	Action Plan – as identified for 2022	Action plan – status of fulfilment
MEDIUM	Supporting market uptake of clean hydrogen applications	Indicator 5	Risk that Clean Hydrogen JU is unable to manage and to report on EU hydrogen research in accordance with its mandate.	A continuous expansion of the data sources will be sought, including collaboration with entities that can contribute to this e.g. via exchange of information and administrative agreements. The contracts for the FCHO and H2V will be expanded, with more data being collected. Moreover, it will be investigated how to better organise the collected data and ensure their consistency, improve their visualisation and their accessibility by the stakeholders or the public in general, possibly by having one single platform hosting all the different individual platforms supported by the JU, with additional capabilities as necessary.	In 2022, a study and proposal was formulated on how to gather the data and knowledge for creating a Knowledge Hub. In the AWP 2023, a dedicated budget of EUR 2.5 mil. is assigned for a public tender in order to build the knowledge hub, which should contain and store all data, information and create knowledge necessary to monitor the progress and report on the impact of the Clean Hydrogen JU programme. Process of the exact definition of the KPIs and KIPs is ongoing and in this respect, the Clean Hydrogen JU continues dialogue with the central EC services.
MEDIUM	Financial reporting objectives	Representative error rate	Due to limitation of H2020 and Horizon Europe ex-ante controls (trust-based approach with minimum amount of default checks in H2020), representative error rate for Clean	Clean Hydrogen JU has introduced an annual analytical risk – assessment at the beneficiary level and subsequent introduction of the targeted ex-ante controls for the projects / beneficiaries	The Clean Hydrogen JU, in 2022, has reviewed the entire population of its beneficiaries in H2020 grants. The list was scrutinized for several risk-based criteria. The top

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Risk Level	Objective	Indicators	Risk Identified in AWP 2022	Action Plan – as identified for 2022	Action plan – status of fulfilment
			Hydrogen JU may increase. Consequently, there is a risk of obtaining a qualified opinion and of not getting the discharge from the European Parliament due to fact that the Court of Auditors' threshold for a residual representative error rate stays at the level of 2%. (NB: H2020 ex-ante control strategy envisaged level of the residual error rate in the range between 2-5%. Horizon Europe audit strategy has not been defined yet.)	with higher identified inherent risk, in line with the internal risk monitoring guidance. Clean Hydrogen JU continues to apply feedback from ex-post audits and lessons learnt on ex-ante controls. Continuation of the financial webinars for beneficiaries with higher inherent and control risks. Follow up action after the webinars via reinforced monitoring. Clean Hydrogen JU will explore the possibility of adding lump sum payments in the future.	beneficiaries15, never audited before, with a risk profile of a newcomer or an SME, in particular, were flagged for the risk-based audits. The remaining top "risky" beneficiaries (amount of EC contribution in all signed Clean Hydrogen JU grants > 1 mil. EUR) were invited to fill in a brief self-assessment questionnaire for the most common errors in the H2020 reporting (based on the results of ex-post audits). Based on their replies, Clean Hydrogen JU has organized bilateral financial webinars, with focus and concentration on the legality and regularity aspects of the most important costs elements in their budget. The outcome of the webinars and

[15] Top beneficiaries of the Clean Hydrogen JU are considered to be those beneficiaries who cumulatively represent 80% of the committed EC budget in the Clean Hydrogen JU grants

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Risk Level	Objective	Indicators	Risk Identified in AWP 2022	Action Plan – as identified for 2022	Action plan – status of fulfilment
					additional information have been used for all the upcoming REPAs and a follow-up questions, where necessary, were incorporated into requests for clarifications. Error rate reduction, clearly observed for the 2022, can further confirm effectiveness and efficiency of this exercise.
MEDIUM	Synergies with other partnerships	Indicator 9	Risk of missing synergies with other partnerships and other EC programmes or MS/regional funds for hydrogen technologies due to insufficient coordination	The Programme Office considers it is in its mandate to coordinate the synergy efforts required by the SBA, building on the extensive experience in implementing such synergies in the preceding JU. Forthcoming Stakeholders Group should be the required structure for the Clean Hydrogen partnership, to propose and follow-up on synergies with the Programme Office in an effective manner.	The risk has been assessed by the IAS and reported as one of the crucial risks for the Clean Hydrogen JU in their recent Strategic Internal Audit Plan (SIAP) for 2023 - 2025. The IAS will assess the risk further during their fieldwork planned for 2023. The Clean Hydrogen JU, in 2022, has signed a cooperation agreement with the European Innovation Council (EIC). A cooperation agreement with the

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Risk Level	Objective	Indicators	Risk Identified in AWP 2022	Action Plan – as identified for 2022	Action plan – status of fulfilment
					Clean Aviation JU and with other EU bodies is being prepared. Two success stories on synergies in 2022 were realized (one with the Clean Aviation JU and another with CEF (AFIF) In 2022, a public procurement has been finalised to enhance cooperation and synergies with the managing authorities of the EU funds of the member states. The objective, in 2023, is to identify and potentially sign at least ten MoCs (memorandum of cooperation) or equivalent documents. In 2022, the Stakeholders Group was set up and started their work according to their new mandate.

TABLE 1. FULFILMENT OF THE ACTION PLANS AS OF 31 DECEMBER 2022 (AS IDENTIFIED IN THE AWP FOR 2022)

The outcomes of the 2022 risk assessment workshop on new or continuing risks for 2023 are included in the 2023 AWP.

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1.2 Research & Innovation activities/achievements

1.2.1 Overview of R&I Activities

The Programme of the Clean Hydrogen Joint Undertaking has been structured to cover all aspects of the hydrogen value chain (Table 2). Its main focus will be on research and innovation actions on renewable hydrogen production, but also hydrogen transmission, distribution and storage, alongside stationary and transport end-use technologies, with a strong emphasis on "circularity and safety by design".

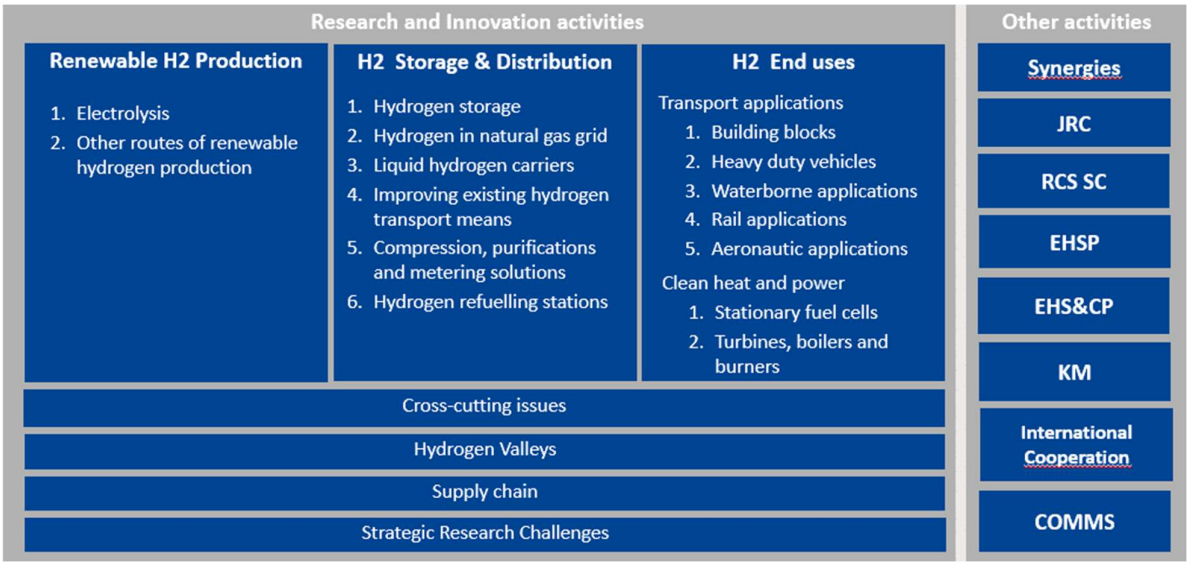

TABLE 2. OVERVIEW OF THE CLEAN HYDROGEN JU ACTIVITIES

In line with the new programme structure of the Clean Hydrogen JU, explained in the SRIA[16], projects on-going in 2022 or finished[17] have been assigned to seven Pillars:

- Pillar 1: Hydrogen Production,
- Pillar 2: Hydrogen Storage and Distribution,
- Pillar 3: Hydrogen End Uses – Transport
- Pillar 4: Hydrogen End Uses – Clean Heat and Power,
- Pillar 5: Cross-Cutting Issues,
- Pillar 6: Hydrogen Valleys,
- Pillar 7: Hydrogen Supply Chains.

For the scope of the Annual Programme Review[18] for 2022, JRC further split these Pillars into a set of Research Areas, as presented in Table 3 below.

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

[17] Additionally, there is also Pillar 8 (Strategic Research Challenges), with no pre-existing projects falling under it.

[18] https://www.clean-hydrogen.europa.eu/knowledge-management/annual-programme-review_en

PILLARS	RESEARCH AREAS	RESEARCH TOPICS
1) Hydrogen Production	1 - Low temperature electrolysis	Projects targeting AEL, PEMEL and AEMEL
	2 - High-temperature electrolysis (incl. co-electrolysis)	Projects targeting SOEL and Proton Conducting Ceramic Electrolysis (PCCEL)
	3 - Other hydrogen production methods	Projects covering reformer development for distributed hydrogen production and thermochemical hydrogen production are covered in this review
2) Hydrogen storage and distribution	4 - Aboveground storage	Projects addressing optimisation and deployment of large- scale solid state storage solution
	5 - Underground storage	Projects targeting the feasibility, risks and impact of H_2 underground storage
	6 - H_2 in the natural gas grid	Project assessing the effect of H_2 on transmission (High pressure) Natural Gas (NG) pipelines
	7 – Liquid H_2 carriers	Project focusing on the improvement of the roundtrip efficiency of conversion and system cost
	8 - Compression, purification and metering solutions	Projects demonstrating feasibility of direct separation of H_2 from NG and material research on proton conducting ceramic electrochemical cells (PCC)
	9 - H_2 refuelling stations	Projects addressing reliability and availability issues indicated by operation of existing Hydrogen Refuelling Stations (HRSs)
	10 - Hydrogen transportation (pipelines, road transport and shipping)	*currently not covered by any projects*
	11 - Hydrogen distribution (pipelines)	*currently not covered by any projects*
3) Hydrogen end uses - transport	12 - Building Blocks	Projects focusing on material, design and system optimisation for LT and HT PEMFC
	13 - Heavy Duty Vehicles	Projects addressing optimisation of BoP components and architectures design to meet Heavy-Duty Vehicles (HDV) needs.
	14 - Waterborne Applications	Project focusing on improving access to the market for hydrogen, its derivatives and Fuel Cells (FCs),

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		initially on smaller vessels
	15 - Rail Applications	Projects with the objective of enabling hydrogen to be recognised as the leading option for trains on non-electrified routes or partially electrified routes
	16 - Aviation	Projects addressing optimisation of Balance of Plant (BoP) components and architectures design to meet aviation needs.
	17 – Bus/Coaches	Projects with the objective to improve the deployment of hydrogen in this segment.
	18 - Cars	Projects with the objective to improve the deployment of hydrogen in this segment.
4) Hydrogen end uses – Energy	19 - m-CHP	Project exploring the deployment of PEMFC and SOFC for micro-Cogeneration
	20 - Commercial Size CHP	Demonstration projects for commercial size CHP using SOFC and HT PEMFC
	21 – Industrial Size CHP	Project exploiting PEMFC technology at industrial size
	22 – Off-grid/back up/genset	Demonstration projects exploring the application of Proton Exchange Membrane (PEM), Solid-Oxide and Alkaline hydrogen technologies (FC and electrolysers)
	23 – Next generation degradation and performance & Diagnostic	Exploration projects for utilization of biogas fed with a SOFC-CHP system and use of Electrochemical Impedance Spectroscopy (EIS) technology for monitoring & diagnostic purposes.
5) Cross-cutting topics	24 - Sustainability, Life Cycle Sustainability Assessment (LCSA), recycling and eco-design	Projects addressing needs to define guideline for sustainability assessment
	25 - Education and Public Awareness	Projects aiming to increase the knowledge on H_2 technology at educational level (schools /universities)
	26 - Safety, Pre-Normative Research (PNR) and Regulations, Codes and Standards (RCS)	Projects focusing on improving knowledge on H_2 risk of utilization and definition of protocol for permitting
6) Hydrogen	27 – H_2 Valleys	Projects aiming to develop a hydrogen integrated

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Valleys		system when favourable conditions at industrial or geographical point of view
7) Hydrogen Supply Chains	28 – Manufacturing for stationary applications	Projects addressing optimisation of materials and/or BoP components and architectures design to meet stationary application needs.
	29 – Manufacturing for transport applications	Projects addressing optimisation of BoP components and architectures design to meet transport application needs.

TABLE 3. PILLARS OF R&I ACTIVITIES

1.2.2 Research & Innovation achievements and impact of the Clean Hydrogen JU projects

The projects funded under the previous programmes have advanced significantly the hydrogen technologies, as highlighted also in the Programme Review Report 2022[19], and pave the way for further advance under the Clean Hydrogen JU programme. All projects mentioned were funded by H2020, as there were no activities or projects started under Horizon Europe in 2022. An overview of the main achievements per pillar follows:

Pillar 1 - Hydrogen Production

The projects in Pillar 1 contribute towards achieving the techno-economic objective of making hydrogen production from renewables competitive and enabling the scale-up of these technologies. Improvements in efficiency and cost reduction are required across all hydrogen production routes.

In **Low-Temperature Electrolysis Research Area**, for both Alkaline and PEM electrolysers the projects have focused on three main features that the electrolysers should develop, showing significant progress:

a) provide reliable green hydrogen production solutions to decarbonise industrial processes, like steel plants (H2FUTURE[20]), refineries (REFHYNE[21]) and food industries (DEMO4GRID[22]);

b) achieve a rapid response time (in the order of a few seconds) to participate in the primary and secondary grid balancing markets, demonstrated by DEMO4GRID, H2FUTURE and REFHYNE;

c) upscale the electrolysers to a multi-MW level, with demonstration projects exhibiting in 10 years a significant increase of electrolyser capacity (6), while in parallel reducing the required funding per MW of electrolyser installed, that is due to economies of scale, increased commitment from beneficiaries and reduction in CAPEX.

[19] https://www.clean-hydrogen.europa.eu/media/publications/programme-review-report-2022_en
[20] https://cordis.europa.eu/project/id/735503
[21] https://cordis.europa.eu/project/id/779579
[22] https://cordis.europa.eu/project/id/736351

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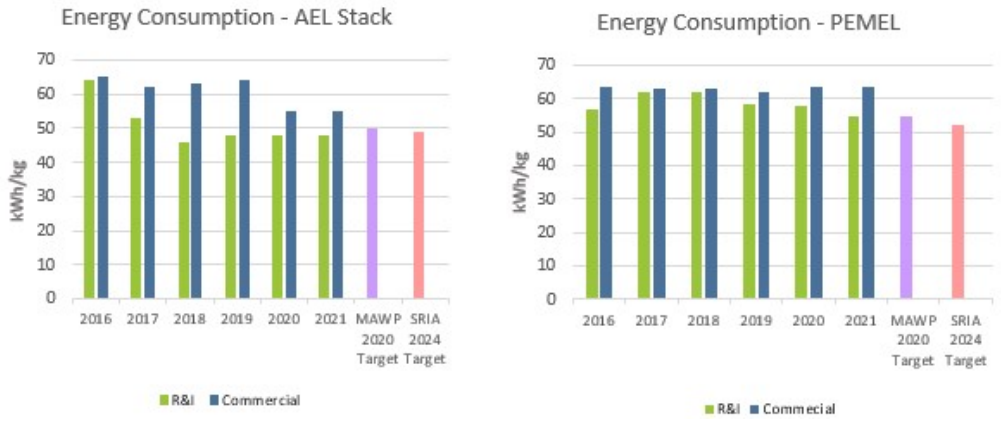
Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 2. UPSCALING LOW TEMPERATURE ELECTROLYSER CAPACITY OVER THE LIFE OF THE JU

Moreover, the R&I projects funded by the JU have contributed to improving several techno-economic parameters of the low temperature electrolysers, most importantly reaching all the MAWP 2020 targets for PEM electrolysers. The improvement in terms of energy consumption both for AEL and PEMEL is depicted in Figure 3, also comparing the annual achievements of the R&I electrolysers versus the commercial ones, which are the ones used in the HRS-related projects[23].



Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 3. ENERGY CONSUMPTION BETWEEN R&I AND COMMERCIAL PROJECTS OF BOTH ALKALINE AND PEM ELECTROLYSERS

[23] Commercial projects refer to data coming from transport projects using commercial electrolysers for the production of hydrogen for their HRS. The bars indicate the best values reported per year (not the best value up until that year). Note also that almost in all cases there were better values than the ones depicted in the graphs, but which cannot be reported due to confidentiality reasons. Finally, in some cases the values do not come from one project, but are the result of averaging, to respect the confidentiality aspects

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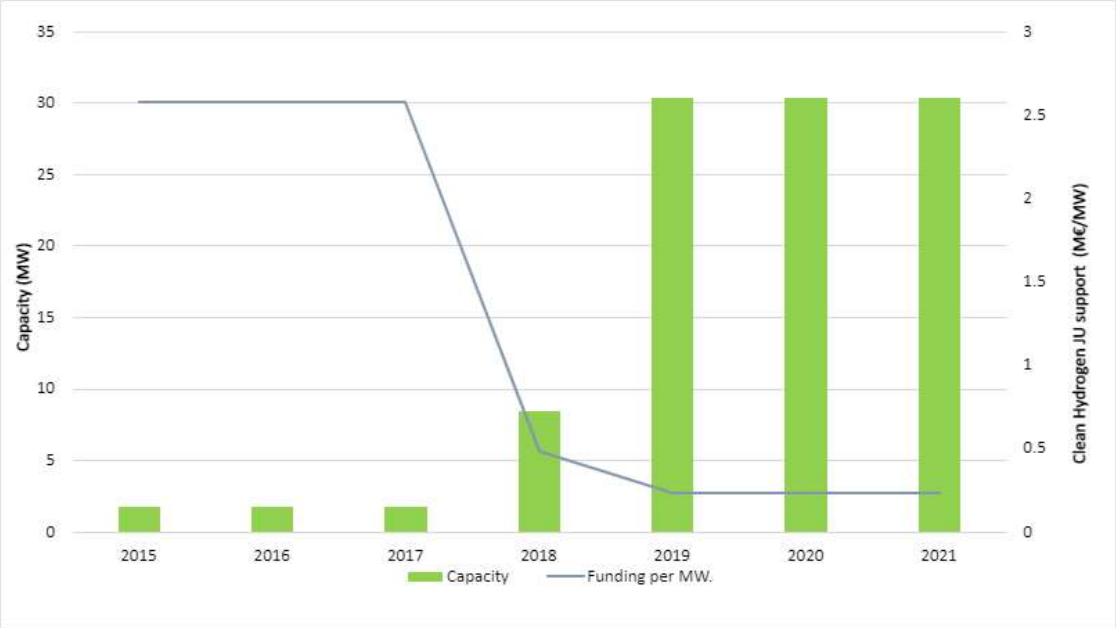
AEMEL is currently at a low TRL level and cannot presently achieve the performance and durability of other water electrolysis technologies. The JU with the Call FCH-02-4-2019 "New Anion Exchange Membrane Electrolysers" approved and funded three projects (CHANNEL[24], ANIONE[25] and NEWELY[26]) to provide the material and design breakthroughs necessary for this technology to fulfil its potential. In general, they managed to achieve most of their goals at the component level, with promising data on novel membranes, electrocatalysts and combined as Membrane Electrode Assemblies (MEA), raising expectations for further exploitation if the materials developed can show enhanced performance and durability, when functioning in the short-stack format.

High-Temperature Electrolysis Research Area covers mainly the SOEL technology. The EU appears to be maintaining a leading role with the development and commercialisation of SOEL, with both low and high TRL projects. Significant progress against most technical KPIs have been made in the previous programme. Several projects are currently at a relatively early stage and the JU overall funding in HT electrolysis compared to the number of installed R&I MW is decreasing, therefore demonstrating the progress already made, as shown in Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

Figure 4.



Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 4. EVOLUTION OF HIGH TEMPERATURE ELECTROLYSIS FUNDING PER MW

[24] https://cordis.europa.eu/project/id/875088
[25] https://cordis.europa.eu/project/id/875024
[26] https://cordis.europa.eu/project/id/875118

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Reversibility of SOEL technology is technically interesting: when renewable energy is available the system produces green hydrogen as an electrolyser but can also generate electricity in a reverse fuel cell (SOFC) mode (project SWITCH[27]). It can also contribute to improve energy efficiency using the waste heat in industrial processes (GrInHy2.0[28], MULTIPLHY[29]). Reversibility still needs to be fully justified by the use cases.

Also, PCCEL technology is developed by the projects GAMER[30] and the recent project WINNER[31] (which started in January 2022). GAMER has developed advanced tubular PCEL technology and is currently building a 10kW system, while the high degradation rates prevented the scaling up so far. The project published its findings in Nature Materials[32].

Many electrolysers are currently in operation under JU projects, demonstrating business cases suitable for different type of industries (refineries, steel making etc) and ancillary services:

- A 3.2 MW pressurised AEL in Austria is commercially setup and demonstrated in March 2022 under the project **DEMO4GRID**[33] to provide hydrogen (for heavy-duty vehicles), heat and grid balancing services.
- A 2.5 MW PEMEL, directly connected with a 45 MW wind farm in a remote area of Norway started operation officially in June 2022. **Haeolus**[34] project can produce up to 1 tonne of hydrogen a day (at 30 bar and 60°C) and is combined with a storage tank and a 120 kW fuel cell for re-electrification. The project achieved the targets for electrolyser efficiency and cost per kW.
- A 6 MW PEM electrolyser system installed at the Voestalpine steel plant in Linz in 2019 by the project **H2FUTURE**, providing also grid balancing services. The installation achieved a stack efficiency target up to 83%, and an operational range of 17-100%. The target production rate of 1,200 Nm^3/h was reached. Due to the ancillary services, H_2 production costs are reduced by 25-45%.
- A 10 MW PEM electrolyser from ITM is operating since the beginning of 2022 in the Shell Rhineland Refinery in Wesseling, Germany, by the project **REFHYNE**. It supplies the refinery with 4,000 kg of green hydrogen a day (at 20 bar pressure). Based on these results and experience, a new scaled-up 100 MW installation is being considered (and supported/funded by the H2020 Green Deal call)**.**
- Two "game changer" projects were supported aiming for PEM electrolysers operating at high

[27] https://cordis.europa.eu/project/id/875148
[28] https://cordis.europa.eu/project/id/826350
[29] https://cordis.europa.eu/project/id/875123
[30] https://cordis.europa.eu/project/id/779486
[31] https://cordis.europa.eu/project/id/101007165
[32] Vøllestad, E., Strandbakke, R., Tarach, M. et al. Mixed proton and electron conducting double perovskite anodes for stable and efficient tubular proton ceramic electrolysers. Nat. Mater. 18, 752–759 (2019). https://doi.org/10.1038/s41563-019-0388-2
[33] The project is building on the outcomes of the ELYGRID and ELYNTEGRATION projects
[34] https://cordis.europa.eu/project/id/779469

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pressures and current densities. The **NEPTUNE**[35] project reached individual targets (single cell operation at 4 or even 8 A/cm^2, reaching 100 bar at stack level), while still working to reach all targets at the same time at stack level.

- Also, the **PRETZEL**[36] project developed cost-efficient Vacuum Plasma Spray Systems (VPS), coated bi-polar plates, and Porous Transfer Layer (PTL) which were tested up to 6 A/cm^2 and showed a cell efficiency of 77% at a 25 kW stack. Stable high-pressure operation was achieved at 75 bar, and higher-pressure levels seem feasible. Moreover, GKN manufactured novel porous current distributors (PCD) by sintering a titanium powder micro porous layer onto titanium expanded metal sheets, increasing PEMEL efficiency very significantly by over 20% at 4 A/cm^2 compared to state-of-the-art mesh type PCDs[37]. The Ti-GKN PCD component was publicised and commercialised and is now available as a product, sparking the interest of several potential customers.
- The world's biggest HT SOEL at a capacity of 720 kW is demonstrated since August 2021 by the project **GrInHy2.0.** The installation uses steam coming from industrial waste heat at a Salzgitter steel mill. The production rate capacity has been increased to the full capacity of 18 kg H_2/h, having achieved also the target of 84% of lower heating value (LHV) efficiency and investment cost below 4,500 €/(kgH_2/d). In parallel the project conducted long-term stack testing which will be continued in the follow-up MULTIPLHY project, which will be the world's largest high-temperature electrolysis system (2.6 MW) installed in an industrial environment.

Finally, **in the Research Area of Other Routes of Renewable H_2 Production**, all other renewable hydrogen production technologies are of lower TRL compared to electrolysis. The JU is supporting alternative routes to electrolysis for renewable hydrogen production for example project **BIOROBURplus**[38] in reforming of CO2-containing biogas and **HYDROSOL-beyond**[39] in demonstrating solar thermochemical hydrogen production, while addressing a number of technical challenges regarding the durability and stability of the materials operating at temperature over 1,000°C.

Pillar 2 - Hydrogen Storage and Distribution

Hydrogen storage and distribution technologies represent the cornerstone for building the necessary logistics infrastructure to store and transport hydrogen over different distances. This would ideally be from areas with large renewable potential to demand centres across Europe, as highlighted by the European Hydrogen Strategy. In parallel, the RePowerEU plan envisions the import of 10 million tonnes of clean hydrogen by 2030. There are various options to transport and store hydrogen, with the SRIA calling for a pluralistic approach with respect to the technologies to be investigated and supported. This is also in line with a recently published JRC Technical Report[40] mentioning that there is no single optimal hydrogen delivery solution across every transport scenario. The most cost-effective way to deliver

[35] https://cordis.europa.eu/project/id/779540
[36] https://cordis.europa.eu/project/id/779478
[37] According to tests performed at DLR
[38] https://cordis.europa.eu/project/id/736272
[39] https://cordis.europa.eu/project/id/826379
[40] Ortiz Cebolla, R., Dolci, F. and Weidner Ronnefeld, E., Assessment of hydrogen delivery options, EUR 31199 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-56421-8, doi:10.2760/869085, JRC130442

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renewable hydrogen depends on distance, amount, final use, and whether there is infrastructure already available. Therefore, several technologies need to be developed, which will then be used to serve as building blocks of the EU-wide (and global) logistical infrastructure: Aboveground Storage, Underground Storage, Injection of Hydrogen in the natural gas grid, Liquid Hydrogen Carriers, Compression, Purification and Metering Solutions and Hydrogen Refuelling Stations.

The JU projects under this Pillar are demonstrating significant advances in many different technologies and research areas.

- **HyCARE**[41] is testing a small-scale prototype hydrogen storage tank based on solid state storage solutions, aiming for a round trip efficiency of 70%, for a total of around 40 kg of hydrogen.
- **HyStorIES**[42] is exploring publicly available data of different types of potential porous media in Europe in a geological database. This will help to identify how many of the gas fields in Europe are likely to be suitable for hydrogen storage.
- **HySTOC**[43] successfully demonstrated a LOHC delivery chain in Finland of a total of 1 860 kg of hydrogen transported over 500 km. Hydrogenious is planning to commercialise the technology, using benzyltoluene (BT).
- **HyGrid**[44] project is successful in most of its targets. The Pd-based membranes have been produced, meeting the target specifications. Carbon molecular sieve membranes (CMSM) have also been successfully tested. Very high hydrogen purities have been reached with a CMSM at lower hydrogen concentration, this seems to be the preferable option at high pressures (> 30 bar). Also, the cost target has already been met with the current system.

The targets for cost of purification and energy consumption for separation have been reached by different projects and for different technologies. Therefore, more work is needed, as these targets would have to be reached together (e.g. by the same project for the same technology).

The JU has funded the installation of 113 HRS up to date (planned, deployed and decommissioned units) including cars, buses and material handling vehicles (MHV) demonstration projects. The average HRS availability in 2021 for cars was 89% and for buses 97%, surpassing the MAWP 2020 target (96%), but also on track to meet the SRIA 2024 target of 98%. The EU HRS availability system[45], an initiative funded by the JU, offers a portal providing live-status information regarding each HRS in Europe, as shown in Figure 5. Apart from the Covid implications impact that disrupted temporarily the trend in 2020, there is a significant increase in 2021 in thousands refuellings and H2 quantities used.

[41] https://cordis.europa.eu/project/id/826352
[42] https://cordis.europa.eu/project/id/101007176
[43] https://cordis.europa.eu/project/id/779694
[44] https://cordis.europa.eu/project/id/700355
[45] https://h2-map.eu/

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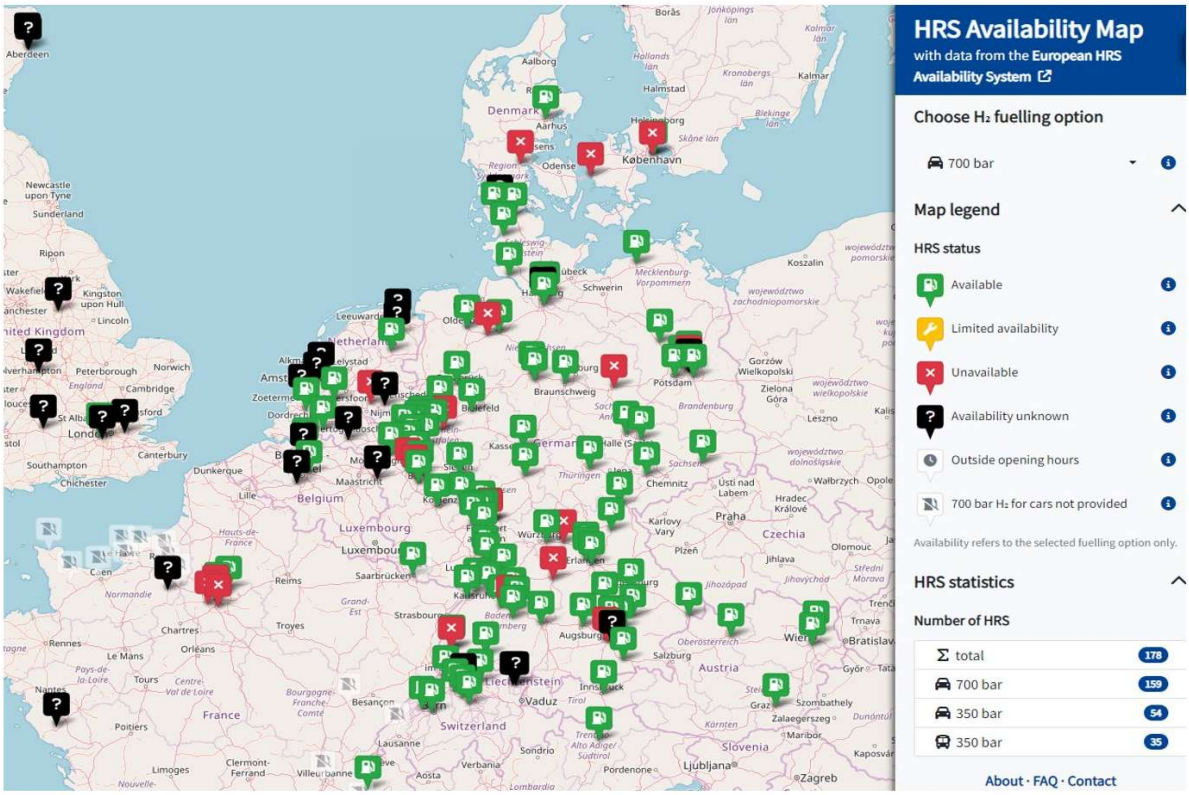
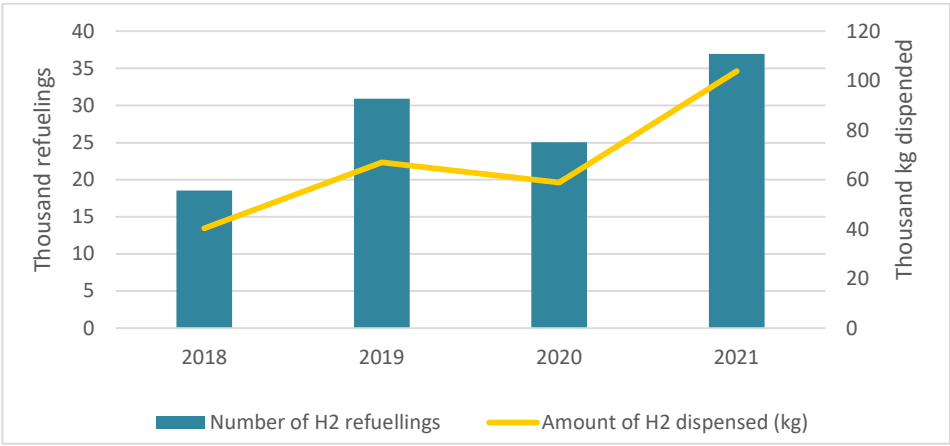


Source: HRS Availability Map (snapshot 25.10.2022)

FIGURE 5. AVAILABILITY DATE FROM THE HRS AVAILABILITY MAP



Source: Clean Hydrogen JU

FIGURE 6. NUMBER OF H2 REFUELLING FOR CARS WITH THE AMOUNT OF H2 DISPENSED

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Pillar 3 - Hydrogen End Uses – Transport

Significant effort has been made in the context of the previous JU programmes to develop, validate and demonstrate technologies for FC material handling vehicles, FC buses and FCEV passenger cars that can be considered ready for market deployment. Still, solutions in sectors such as heavy-duty vehicles, off-road and industrial vehicles, trains, shipping and aviation need further development and demonstration. Pillar 3 encompasses both research projects and demonstration initiatives to fulfil these objectives and is divided into seven research areas: Building blocks (FC stack and FC system technology, on board hydrogen storage), heavy duty vehicles, waterborne applications, rail applications, aviation, buses, coaches and cars.

The prominent accomplishments of JU projects under Pillar 3 can be summarised as follows:

- **GAIA**[46] managed to deliver a high Beginning of Life (BoL) power density without increasing platinum loading, reducing the Pt-specific power density from 0.45 g Pt/kW (e.g. VOLUMETRIQ) to 0.25 g Pt/kW, which is currently running a durability test to confirm the promising results.
- The composite wrapped tank with a polyethylene liner of **TAHYA**[47] obtained an outstanding gravimetric efficiency of 6.5% setting the state-of-art and meeting JU's SRIA target in 2024. Also, CAPEX for TAHYA is calculated at 450 EUR/kg H_2, better than SRIA target for 2024 (500 EUR/kg H_2). Finally, three patents related to the tank design and its manufacturing have been submitted.
- Four refuse FCTs (out of 14) from project **REVIVE**[48] are already in operation and the remaining ones will be deployed in the coming months. The HRSs in Gothenburg and Groningen started operation in 2021 while Breda and Antwerp HRSs opened, respectively in April and May 2022.
- **3EMOTION**[49] has deployed all 29 FCBs: 10 buses in London, 6 in Rotterdam and the South Holland province, 7 in Versailles, 3 in Pau and 3 in Aalborg, demonstrating the operability of buses from four different manufacturers with two different fuel cells systems. The buses are largely meeting their targets on hydrogen consumption and availability (collectively covered 741,113 km with 64.16 tonnes of hydrogen tanked).
- Combined **JIVE**[50] and **JIVE 2**[51] are deploying over 300 FCBs in 22 cities across Europe, the largest deployment in Europe to date. JIVE has ordered all the 142 planned buses and 121 are in operation, while JIVE 2 has ordered all 156 buses originally planned, has 98 buses in operation and expects to have the committed fleet delivered in 2023. While FCBs are established, there is a need to advance the technology for longer distances to cover inter-urban and regional routes.

[46] https://cordis.europa.eu/project/id/826097
[47] https://cordis.europa.eu/project/id/779644
[48] https://cordis.europa.eu/project/id/779589
[49] https://cordis.europa.eu/project/id/633174
[50] https://cordis.europa.eu/project/id/735582
[51] https://cordis.europa.eu/project/id/779563

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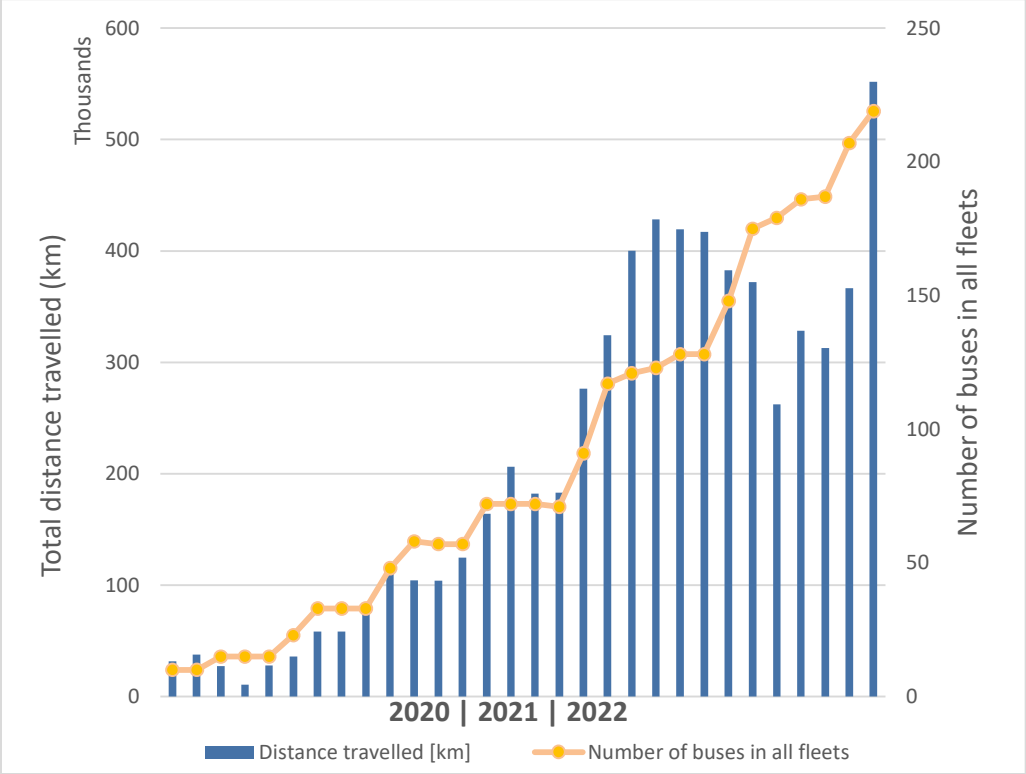

Source: Clean Hydrogen JU

FIGURE 7. TOTAL DISTANCE DRIVEN PER MONTH BY BUSES OF JIVE AND JIVE 2 PROJECTS AND TOTAL NUMBER OF BUSES BETWEEN 2020 TO 2022.

The H2ME initiative (**H2ME**[52] and **H2ME 2**[53] projects) is the largest European deployment to date for hydrogen mobility, planning to deploy more than 1,400 vehicles in 8 countries and 49 HRS in 6 countries. The project H2ME 2 alone has deployed 311 vehicles and 29 new HRSs in Germany, Scandinavia, France and the United Kingdom.

The 180 FCEVs planned and already in operation (60 in Paris, 60 in London and 60 in Copenhagen) under project **ZEFER**[54] are demonstrating viable business cases for captive fleets of FCEVs (taxi, private hire and police services). Figure 8 depicts the cumulative distance driven by the vehicles deployed by the H2ME, H2ME2 and ZEFER demos. In particular, the deployment of FCEV taxi fleets within H2ME 2 and ZEFER has helped to improve the business case of FCEVs and hydrogen refuelling stations.

[52] https://cordis.europa.eu/project/id/671438
[53] https://cordis.europa.eu/project/id/700350
[54] https://cordis.europa.eu/project/id/779538

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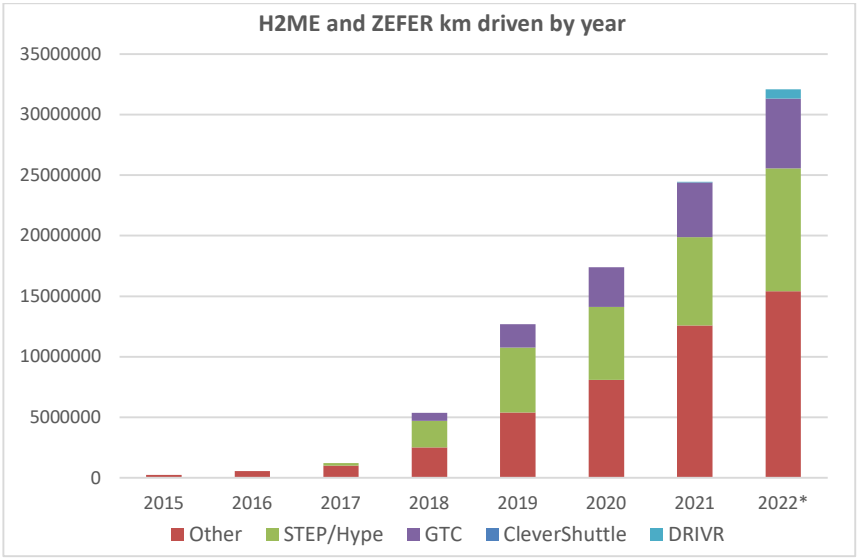

Source: Clean Hydrogen JU

FIGURE 8. CUMULATIVE DISTANCE DRIVEN BY DIFFERENT TYPES OF VEHICLES FROM 2015 TO 2022, BASED ON THE H2ME, H2ME2 AND ZEFER DEMO PROJECTS

According to the TRUST[55] database, the deployed 776 cars (running in 2021) drove at least 9 million kilometres (km) with a reported consumption of 96.9 tonnes of hydrogen. In total, until 2021, JU-funded cars have driven a total of almost 29.8 million km[56] and consumed over 297.6 tonnes of hydrogen, avoiding emissions of about 2,217 tonnes of CO_2. The average 2021 fuel consumption of 1.12 kilogramme (kg) per 100 km is lower than the MAWP 2020 target (1.15 kg per 100 km) and on track to achieve the 2024 target of 1.1 kg per 100 km. The average vehicle availability exceeded 99% in 2020, which means that the expected MAWP 2020 targets for availability (98%) and fuel cell system durability (6,000 hours) have also been accomplished[57].

The total number of JU funded HRS is 113[58] including FCEVs, FCBs and MHVs demo projects. Twenty (20) H2ME 70 MPa refuelling stations are integrated in petrol forecourts. In 2021, 77 HRS had already been deployed (64 were reported in 2020). Some of the HRS from finished projects continue operation under the running projects (HyFIVE stations in H2ME, SWARM Zaventem in ZEFER, HYTRANSIT[59] Kittybrewster and Frenchen HRS supporting the operation of JIVE's FCBs).

Waterborne applications: In Europe several projects that aim to demonstrate fuel cell powered vessels

[55] https://www.clean-hydrogen.europa.eu/knowledge-management/annual-data-collection_en#trust
[56] It is expected to increase above 35 million kms in 2022
[57] Another remarkable point for car demonstration projects in 2021 is their excellent synergies, not only limited to the sharing of findings and lessons learnt. For instance, HRSs are used by both H2ME and ZEFER, which contributed to increased utilisation at certain stations in London and Paris. Both projects also jointly disseminated their activities at certain events such as roundtables with policy makers, thus increasing impact.
[58] Including 2 discontinued stations.
[59] https://cordis.europa.eu/project/id/303467

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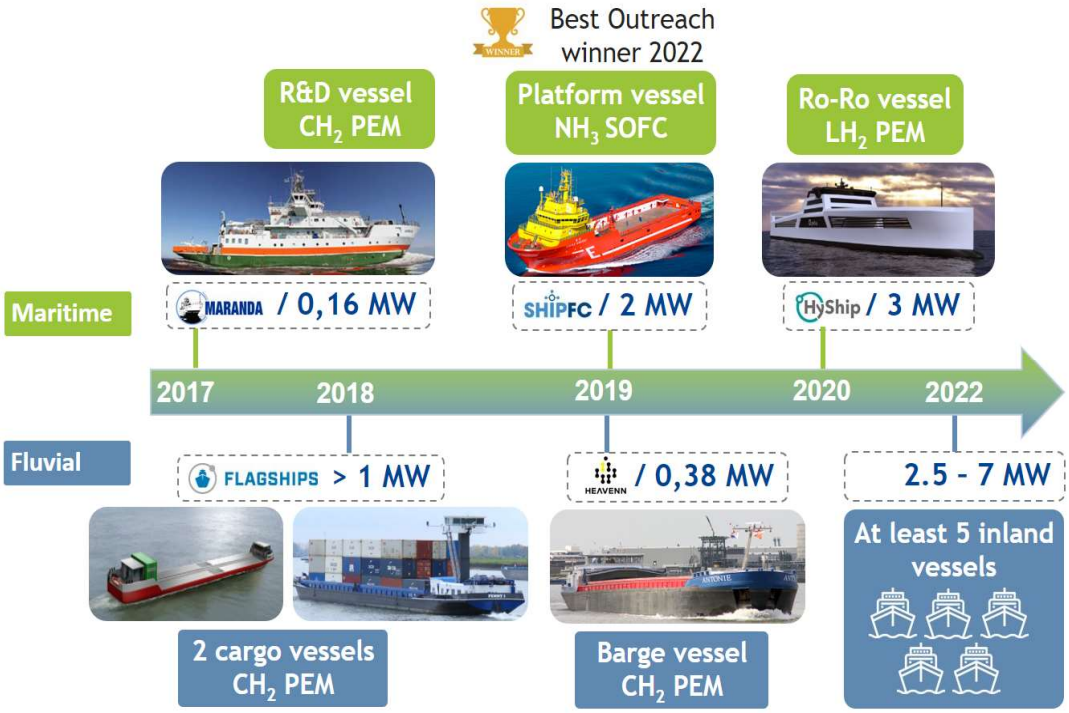
are on-going[60]. Bunkering of hydrogen (or ammonia as alternative carrier) is to be developed together with fuel cell ships. The bunkering technology has to be adapted to both liquid and compressed hydrogen and there are some pilot initiatives for hydrogen supply in ports have been launched[61]. There is a strong trend towards larger vessels and hydrogen delivery by ships, as shown in Figure 9. Demonstration projects are important to speed up standards for waterborne applications.



Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 9. TOWARDS LARGER VESSELS AND H_2 DELIVERY BY SHIPS

Pillar 4: Hydrogen End Uses – Clean Heat and Power

The overall goal of this Pillar is to support European supply chain actors to develop a portfolio of solutions providing clean, renewable and flexible heat and power generation for all end users' needs and across all system sizes; from domestic systems all the way to large-scale power generation plants. Preferential

[60] In the Clean Hydrogen JU project MARANDA (https://cordis.europa.eu/project/id/735717), the PEMFC is fed with hydrogen while ShipFC (https://cordis.europa.eu/project/id/875156) use ammonia and SOFC. At present, there are not commercial fuel cell ships, however a number of projects are demonstrating the use of hydrogen (both compressed and liquefied) in ferries and ships. The vessels for FLAGSHIPS (https://cordis.europa.eu/project/id/826215) and HySHIP (https://cordis.europa.eu/project/id/101007205) Clean Hydrogen JU projects are being built and FLAGSHIPS demonstration activities will begin in 2022

[61] Project H2Ports (https://cordis.europa.eu/project/id/826339) is deploying a mobile to station refuel port's machinery and HySHIP vessel is designed to transport LH2 for bunkering other vessels and trucks.

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support will be for solutions running on 100% hydrogen. Moreover, there is still room to support solutions running on a hydrogen mixture in the gas grid (up to 20% within the context of the activities included in this support area) during the transition phase. For gas turbines, to enable a smooth transition and assure backward compatibility with conventional fuels during the transition, support for actions running with different hydrogen admixtures are likely to be required to facilitate the development process and to achieve the final goal of 100% hydrogen turbines. Stationary fuel cells, as well as gas turbines, boilers and burners are applications proposed to be supported according to the SRIA with turbines, boilers and burners as new elements. Pillar 4 is divided into seven research areas: micro-CHP, Commercial Size Systems (<100 kW), Industrial Size Systems (>100 kW), Off grid/back up/gensets, PEMFC Technology, SOFC Technology and other research areas.

JU projects demonstrate some interesting outputs under Pillar 4:

- To date, **PACE**[62] accomplished excellent results in comparison to SoA; more than 2.500 units are installed in total, expected to operate seamlessly for a long time (expected 15 years system lifetime with >50% reduction in stack replacement or no stack replacement during a 10-year service plan). In addition, the manufacturing capacity, for some manufacturers, has been proven to reach 2,300 systems/year per original equipment manufacturer (OEM).
- **OxiGEN**[63] achieved direct current efficiency of 50%, while the target of 30% improvement of electrolyte conductivity was overpassed with an intrinsic conductivity 350% higher than the reference. Also, stack durability of 50,000 hours has been achieved.

Figure 0 displays the planned and deployed fuel cells under these two projects, but also in relation to the KfW 433 programme[64] of Germany.

[62] https://cordis.europa.eu/project/id/700339
[63] https://cordis.europa.eu/project/id/779537
[64] https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilie/F%C3%B6rderprodukte/Energieeffizient-Bauen-und-Sanieren-Zuschuss-Brennstoffzelle-(433)/?redirect=365568

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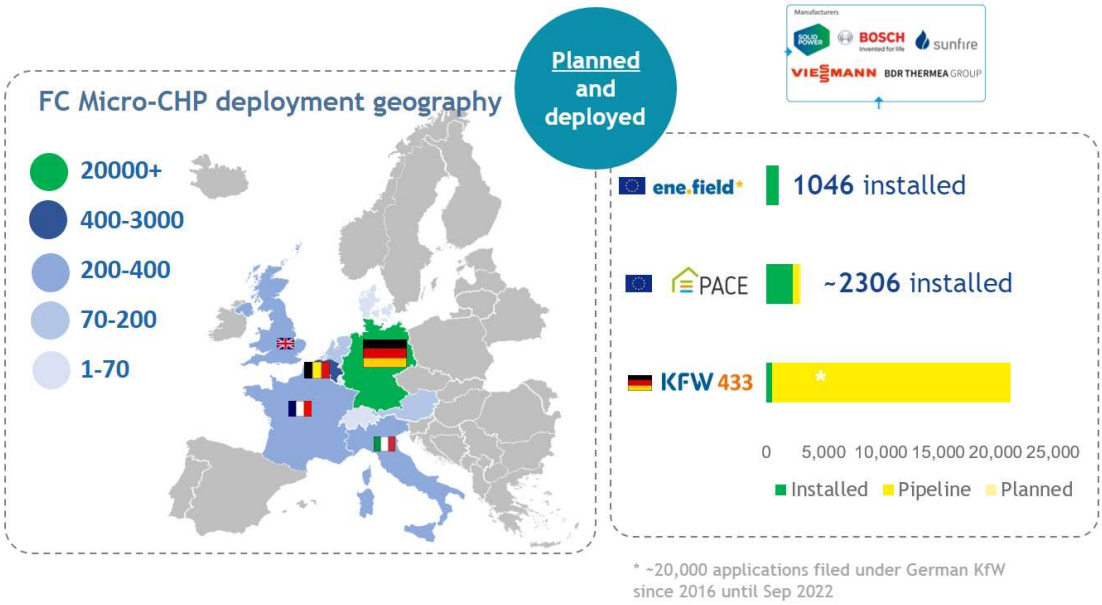

Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 10. PLANNING AND DEPLOYMENT OF FUEL CELLS FOR DOMESTIC HEAT AND POWER

- **EMPOWER**[65] contributed to increase visibility and awareness of the potential of renewable methanol. The project achieved the CAPEX MAWP 2024 target: 2,600 €/kWh were achieved[66] with target being 5,500 €/kWh. Also, stack durability target was achieved.
- **RoRePower**[67] project managed to install 21 off-grid units at sites located in remote areas with harsh climate conditions (from -40 to +50°C), able to give demonstration data. It has achieved several targets, such as: electrical efficiency of > 35% (up to 53% measured in some cases), operation in harsh conditions at -40°C, long-term desulphurisation of 15 month.

Pillar 5 - Cross-Cutting Issues

The cross-cutting activity area contains specific supporting activities, structured around three research areas: (a) Sustainability, LCSA, recycling and eco-design, (b) Education and public awareness, and (c) Safety, PNR and RCS. An outline of the major outcomes of the on-going projects in 2022 consists of:

- **BEST4Hy**[68] already delivered some laboratory results: Pt recovery via hydro-metallurgic process, the dismantling of the MEA gaseous phase, and the recovery of Ni-YSZ anode components by Hydrothermal Treatment (HTT) and Hydro Metallurgical Technology (HMT).

[65] https://cordis.europa.eu/project/id/646476
[66] An even lower number was reported in TRUST but was declared confidential.
[67] https://cordis.europa.eu/project/id/824953
[68] https://cordis.europa.eu/project/id/101007216

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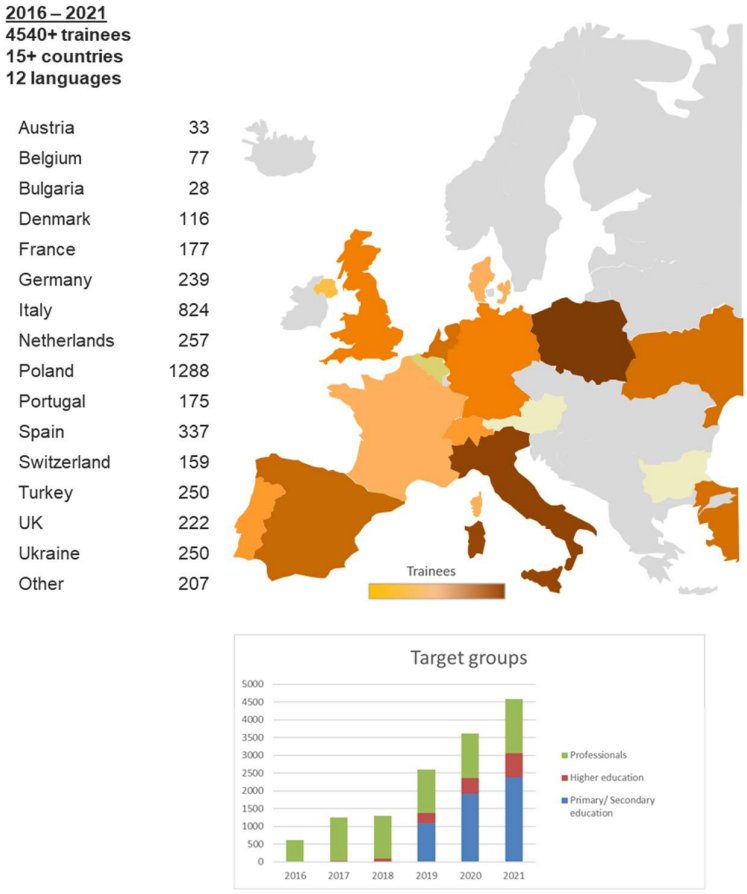
- **AD ASTRA**[69] has already achieved a publication record of 20 peer-reviewed articles.
- The **Training focus area** has produced a complete range of tools to train and educate all stakeholders and players along the technology value chain[70], which is depicted in Figure 11. However, the COVID-19 crisis and the related lockdown measures in several countries have severely hindered the achievements of the education targets on the individual projects and this is reflected in overall programme figures for this year, as shown in Figure 12.



Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 11. TRAININGS ACROSS EUROPE AND TARGET GROUPS

[69] https://cordis.europa.eu/project/id/825027

[70] A recent example is project NET-TOOLS (2017-2020), which developed e-learning platform for scientific training purposes, and KNOWHY (2014-2018) which offers trainings for technicians and workers. Part of their achievements have been a useful starting base for TEACHY. Part of the deliverables produces by TEACHY will probably uploaded on the NET-TOOLS online platform. The project FCHGO is a first of its kind in the frame of the FCH 2 JU, but it finds similarities with the Erasmus+ initiative HYSCHOOLS (2017-20), which developed as well educational and online resources on hydrogen for schools. In addition, HY2GREEN, another Erasmus+ project, had as one of objectives an innovative training program to develop the technical skills required for by a hydrogen ecosystem

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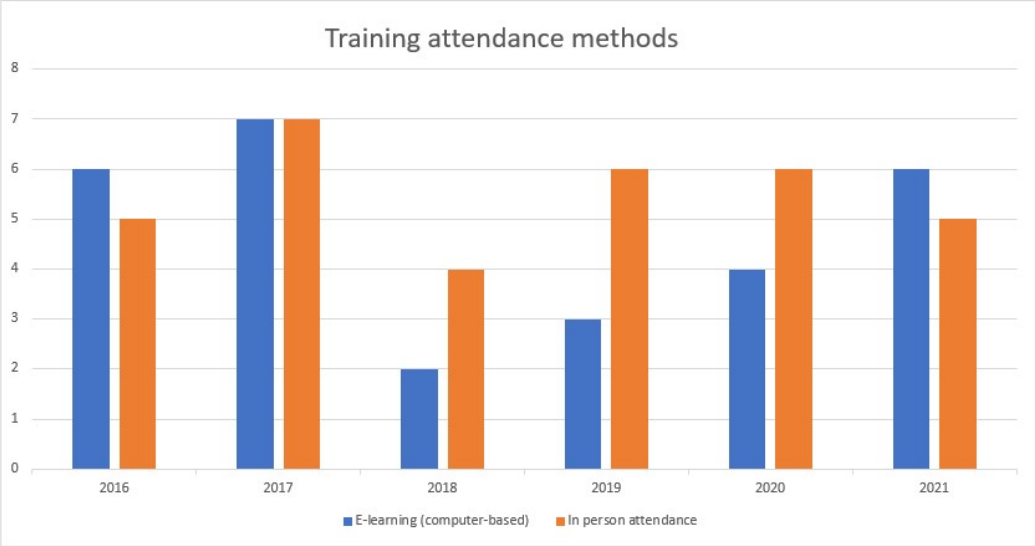

Source: Clean Hydrogen JU

FIGURE 12. TYPE OF TRAINING ATTENDANCE METHODS PER YEAR

An important role is played by the **Fuel Cell and Hydrogen Observatory**[71] **(FCHO),** which has become a reference provider of structured data and indicators for stakeholders, professional operators and general public. It addresses the concern that arose after the completion of projects regarding the lack of long-term availability of training and materials, by providing an updated list of courses and training materials[72].

Project **THYGA**[73] experts are already contributing to revisions of the existing standards and/or drafting of new standards based on PNR results. The affected standards are part of the European RCS framework covered by the Gas Appliances Regulation 2016/426. For example, one of them is the standard EN 437 Test gases – Test pressures – Appliance categories, which needs substantial modification before being used for certifying gas appliances when working at high hydrogen concentrations.

A mature LH2 technology is considered an enabler for the delivery and storage of large quantities of hydrogen. Project **PRESLHY**[74] has set an important advancement in our understanding of the behaviour of released liquid and cryogenic hydrogen, offering a better understanding of liquid and cryogenic spills and their consequences to the environment has generated recommendations for modification of the ISO standard 15916:2015 on Basic considerations for the safety of hydrogen systems (updating work by the WG 29 of the ISO/TC 197).

The capacity to produce and deliver hydrogen with the required quality for end uses is a critical element

[71] https://www.fchobservatory.eu/observatory

[72] For example, by gathering and rationalising results and data of projects, it overcomes their fragmentation caused by their temporary filing on individual websites and platforms

[73] https://cordis.europa.eu/project/id/874983

[74] https://cordis.europa.eu/project/id/779613

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for a successful deployment, especially in mobility. Project **HYDRAITE**[75] has progressed towards the quality assurance along the supply chain and facilitated the establishment of three European laboratories able to perform the required analyses.

In 2021, based on the results of PNR projects, the working group on low temperature electrolysers has published the report on harmonisation of testing protocols for low temperature electrolysis[76]. In the same year, the working group on high temperature electrolysers has published an electrolysis vocabulary[77].

A general frame based on safety principles has been adopted to extract quantitative data and general returns of experience from the database HIAD2.0[78]. The resulting paper has received the "best paper award" by the International Conference on Hydrogen Safety 2021.

RCS/PNR project	Standardisation body/document addressed	Impact on RCS framework
HYDRAITE	ISO 19880-9 - Sampling for fuel quality analysis EN 17124:2018 and ISO 14687:2019	Three certified labs are now able to perform the analyses required by EN 17124:2018 and ISO 14687:2019. Gas sampling techniques protocols at the refuelling station provided to WG 33 for the drafting of the ISO 19880-9. Input delivered also to the Working Group WG 27 (H2 quality) and WG 28 (quality control) of the ISO/TC 197, and to ISO/TC 158 on gas analysis.
ID-FAST[79]	IEC/TC 105, AHG1, working towards a NWIP for a standard on AST protocols for SOFC and PEMFC	The project has published protocols for PEMFC degradation assessment, which can be used by IEC/TC 105. Two partners are active in the AHG11 and responsible for the integration of project results into an International Electrochemical Commission (IEC) TR document.
AD ASTRA	IEC/TC 105, AHG1, working towards a NWIP for a standard on Accelerated Stress Tests (AST) protocols for SOFC and PEMFC	The project has published protocols for SOFC degradation assessment, which can be used by IEC/TC 105. A partner is member of AHG11 and responsible for the integration of project results into an IEC TR document. The expected NWIP was not submitted because the group concluded that it is too early for an international standardisation of testing procedures. The SOFC and Solid Oxide Electrolyser Cell (SOEC) technology still requires widespread acceptance.

[75] https://cordis.europa.eu/project/id/779475
[76] G. Tsotridis, A. Pilenga, *EU harmonised protocols for testing of low temperature water electrolysers,* EUR 30752 EN, Publications Office of the European Union, Luxembourg, 2021
[77] T. Malkow, A. Pilenga, D. Blagoeva (editors), *EU harmonised terminology for hydrogen generated by electrolysis*, EUR 30324 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-21041-2
[78] Hydrogen Incidents and Accidents Database
[79] https://cordis.europa.eu/project/id/779565

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		Nevertheless, AHF11 will further exist, collecting new evidence and paving the way to a future standard.
PRHYDE[80]	New ISO 19885-3 Gaseous hydrogen — Fuelling protocols for hydrogen-fuelled vehicles — Part 3: High flow hydrogen fuelling protocols for heavy duty road vehicles	PRHYDE has provided results to ISO/AWI 19885-3, which is under preparation by the ISO/TC 197 WG24
THYGA	Gas Appliances Regulation 2016/426. It refers to several harmonised standards, one of which is EN 437 Test gases – Test pressures – Appliance categories	Assessment of the applicability of the GAR regulation to H2NG blends. Recommendations to modify EN 437 and review of several related harmonised standards mentioned by the Gas Appliances Regulation.
PRESHLY	Update of ISO TR 15916:2015 Basic considerations for the safety of hydrogen systems	Project results were used in ISO/TC 197/ WG29 Sub-task 2, in updating the ISO/AWI TR 15916 (the coordinator led this sub-task). The originally foreseen revisions of ISO 13984:1999 and ISO 13985:2006, on LH2 land vehicles, were abandoned, because the project results are of a too general character to be used for these very specific standards.
HyTunnel-CS[81]	Recommendations to first responders and standardisation bodies. Local/national rules for parking in garages and accessing tunnels and underpasses.	A recommendations report to standardisation bodies is one of the final deliverables. The most probable recipient will be the CEN/CENELEC JT6/WG 3 (hydrogen safety) for a future standard on built environment safety. Recommendations to all stakeholders for safer use of hydrogen vehicles in underground transportation systems
e-SHyIPS[82]	IMO IGF code, guidelines for hydrogen storage on ship.	Results will contribute to the ongoing work at IMO in updating the IGF Code. However, the project does not seem to be able to formally intervene at IMO MEPC level, and this risk to reduce the chance of an impact.
MultHyFuel[83]	Guidelines for the design and construction of multi-fuels refuelling stations.	The work will facilitate the permitting process for multi-fuels stations. Updating HyLaw, a repository of applicable administrative and legal permitting rules.

TABLE 4. STANDARDISATION IMPACTS OF PNR/RCS/SAFETY PROJECTS

[80] https://cordis.europa.eu/project/id/874997
[81] https://cordis.europa.eu/project/id/826193
[82] https://cordis.europa.eu/project/id/101007226
[83] https://cordis.europa.eu/project/id/101006794

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Pillar 6 - Hydrogen Valleys

A Hydrogen Valley is a defined under this programme as a geographical area, city, region or industrial area where several hydrogen applications are combined together and integrated within a Hydrogen ecosystem.

Hydrogen Valleys are hydrogen ecosystems that cover a specific geography. Their footprint can range from a local or regional focus (e.g. a major port and its hinterland) to a specific national or international region (e.g. a transport corridor along a major European waterway). Across their geographic scope, Hydrogen Valleys cover multiple steps in the hydrogen value chain, ranging from hydrogen production (and often even dedicated renewables production) to the subsequent storage of hydrogen and distribution to off-takers via various modes of transport. Hydrogen Valleys, usually showcase the versatility of hydrogen by ideally supplying - several sectors in their geography such as mobility, industry and energy end uses. Thus, Hydrogen Valleys are clusters where various final applications are combined together into an integrated hydrogen ecosystem that consumes a significant amount of hydrogen, improving the economics behind the project. They typically also include several subprojects that make up the larger Valley "portfolio".

This concept has gained momentum and is now one of the main priorities of industry and the EC for scaling-up hydrogen deployments and creating interconnected hydrogen ecosystems across Europe. As highlighted by the European Hydrogen strategy, Hydrogen Valleys will develop especially around local hydrogen production facilities. Their advantage can be in the sharing of a dedicated hydrogen infrastructure for industrial and transport applications, and electricity balancing, but also for the provision of heat for residential and commercial buildings.

At the end of 2022, the Clean Hydrogen JU was funding three relevant projects, in the Orkney islands (BIG HIT[84]), in the Netherlands (HEAVENN[85]) and in Majorca (GREEN HYSLAND[86]), shown in Figure 13. All these projects are centred on the production of hydrogen from renewable sources. Further funding of valleys will follow in 2023 with the new calls of the Clean Hydrogen JU.

[84] https://cordis.europa.eu/project/id/700092
[85] https://cordis.europa.eu/project/id/875090
[86] https://cordis.europa.eu/project/id/101007201

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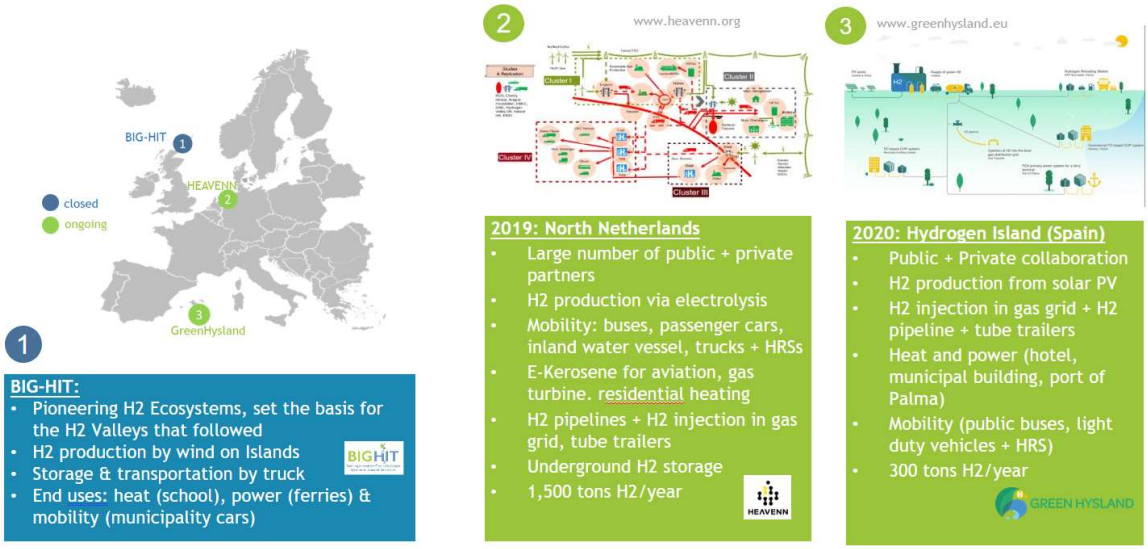

Source: EU Hydrogen Research Days including Programme Review, 27-28 October 2022

FIGURE 13. OVERVIEW OF THE THREE HYDROGEN VALLEYS SUPPORTED BY THE CLEAN HYDROGEN JU

Pillar 7 - Hydrogen Supply Chains

The objective of Pillar 7, as indicated in the SRIA, is to define and support the activities needed to strengthen the overall supply chain related to hydrogen technologies, recently identified by the EC as a strategic value chain for the European Union. Considering the expected steep increase of hydrogen demand and production in the next years and towards 2050, a considerable increase in the number of active companies is required along the supply chain. Supply chain includes everything from processing the raw materials into specialised materials (e.g. electro-catalysts), production of components and sub-system to system integration. The supply chain is also complemented by the wider view of the value chain approach vis-à-vis creation of jobs, added value to economy and industry competitiveness.

A first study on the EU supply/value chain for hydrogen and fuel cell technologies was conducted by the JU in 2019, identifying weaknesses and proposing appropriate solutions[87]. A new study – building on the 2019 one – was signed in December 2022, with the aim to reassess the hydrogen supply chains, update the list of EU actors and identify the strengths, potential gaps and vulnerabilities in the supply. Additional information on suppliers of FC systems and components, as well as service providers is also to be found in the FCHO. The supply chain of hydrogen-based technologies is still under development and consists mainly of relatively small entities. About 300 European companies contribute to the development of

[87] Value added of the hydrogen and fuel cell sector in Europe, FCH 2 JU, 2019

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hydrogen technologies and many more are involved in various steps of the hydrogen supply chain[88].

The JU has supported a long series of projects on supply chain. Three of them are still on-going, dedicated to manufacturing. Despite the progress achieved so far, more effort is needed to cover a wide range of aspects, ranging from processing of raw materials, to manufacturing of specialised materials, to manufacturing of high quality and low-cost components in a large scale, to further recycling and waste management, just to name some of the steps. An important factor is also the training and education of human resources prepared to deal with the problematics of the different supply chain steps. The recent outcomes under this Pillar can be summarised as follows:

- **MAMA-MEA**[89] focused on new manufacturing techniques for the catalyst coated membrane (CCM) capable of exceeding the production volume of 1 GW/year, which brings about considerable improvement in materials utilisation and the reduction in use of critical raw materials and scrap, simplifying the manufacturing process, while delivering power density on par with state-of-the-art parts.
- The main European stack manufacturers (Sunfire, Haldor Topsoe, Elcogen and Ceres Power) in the H2020 C2Fuel project[90] are currently using the model developed by **LOWCOST-IC**[91]**.** The project is opening a new way to reduce SOFC cost with a deep investigation on new cheaper materials. Also, the diagnostic tools to investigate material degradation processes developed by LOWCOST-IC project can be implemented in commercial products.
- **INN-BALANCE** managed to develop highly efficient and reliable fuel cell BoP components, reducing the cost of current market products in Fuel Cell System (FCS), and to integrate a stable supply chain for car manufacturing and system integration. The project partners reported during the exploitation workshops that actions will be taken after project end to further develop the INN-BALANCE components to reach other key markets and higher TRL levels to achieve fast commercialisation.
- A new web application developed in the project **INN-BALANCE** by partner Fundación AYESA allowing users to visualise the relative costs of each module and component of the INN-BALANCE automotive fuel cell system and see the benefits of a manufacturing- oriented design approach[92].

[88] 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 to fill in the existing gaps and mitigate vulnerabilities and be always one step ahead the other global players

[89] https://cordis.europa.eu/project/id/779591

[90] https://c2fuel-project.eu/

[91] https://cordis.europa.eu/project/id/826323

[92] The web application is free of charge and can be used by everyone to emphasize the close links between the application and the INN-BALANCE. The application can be accessed by clicking on following link: https://cost-evaluation.innbalance-fchproject-eu/public/main

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1.2.3 Financial Support under the Research and Innovation programmes of the EU

Before the establishment of the Clean Hydrogen JU, its predecessors FCH JU (2007-2013) and FCH 2 JU (2014-2020) have supported and funded 287 projects[93] in total, with a combined budget of more than EUR 1 billion, complemented by almost an equal funding from non-EU sources (e.g.: regional, national, or private funding). In 2022, 58 FP7 and H2020 projects were still ongoing[94].

In line with the ambition and the objectives set for the Clean Hydrogen JU, the EU almost doubled its budget in comparison to its predecessors, supporting it with over EUR 1 billion for the period from 2021 to 2027. As a result, under Horizon Europe the overall Clean Hydrogen JU programme budget, including estimated private investment from the private members of the JU, will be reaching approximately EUR 2 billion. Additionally, under the RePowerEU Plan, the EC decided in May 2022 to top up the budget of the Clean Hydrogen JU with an amount of EUR 200 million to double the number of Hydrogen Valleys and accelerate hydrogen projects.

Framework Programme	Percentage	Total EC contribution in million EUR - TARGET	Number of funded grants
FP7 (2007-2013)	21%	470	154
H2020 (2014-2020)	28%	665	133
Horizon Europe (2021 -2027)	51%	1,200	In progress
Total:	**100%**	**2,335**	

Source: Clean Hydrogen JU

TABLE 5. SEQUENCE OF DEPLOYED BUDGET (INCLUDING FORESEEN FUNDING FOR HYDROGEN VALLEYS FROM REPOWER EU PLAN)

Under the Horizon Europe Programme, the Clean Hydrogen JU inherited the technological achievements and funding expenditures of the previous Programmes. The cumulative budget invested in the projects supported by the FCH JU and FCH 2 JU programmes (154 projects under FP7 and 132 projects under Horizon 2020) per year per fund origin is displayed in Figure 14.

[93] Excluding two cancelled grants

[94] No final payment has been made until 31 December 2022

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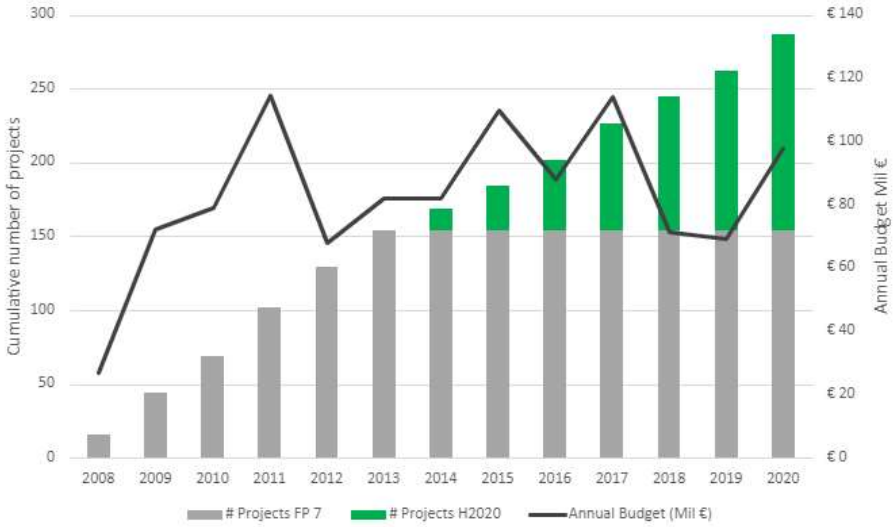

Source: Clean Hydrogen JU

FIGURE 14. NUMBER OF CLEAN HYDROGEN JU SUPPORTED PROJECTS AND ANNUAL BUDGET CALLS 2008-2020.

Due to the different structure of the Clean Hydrogen JU Programme compared to its predecessors in terms of Research and Innovation Pillars[95], all previous projects were redistributed to the seven Pillars of the new Programme[96]. This way it is possible to have comparable figures and results over the whole lifetime of the JU and its predecessors and to be able to monitor them consistently using the new monitoring framework of the JU. In summary, the overall split of the Clean Hydrogen JU funding can be summarised in Figure 15:

[95] The previous structure foresaw two Innovation Pillars, one for Energy and one for Transport, plus two additional types of projects / activities, the overarching projects and the cross-cutting activities

[96] There is also an eighth Pillar, the one on the Strategic Research Challenges, which is not relevant to past projects.

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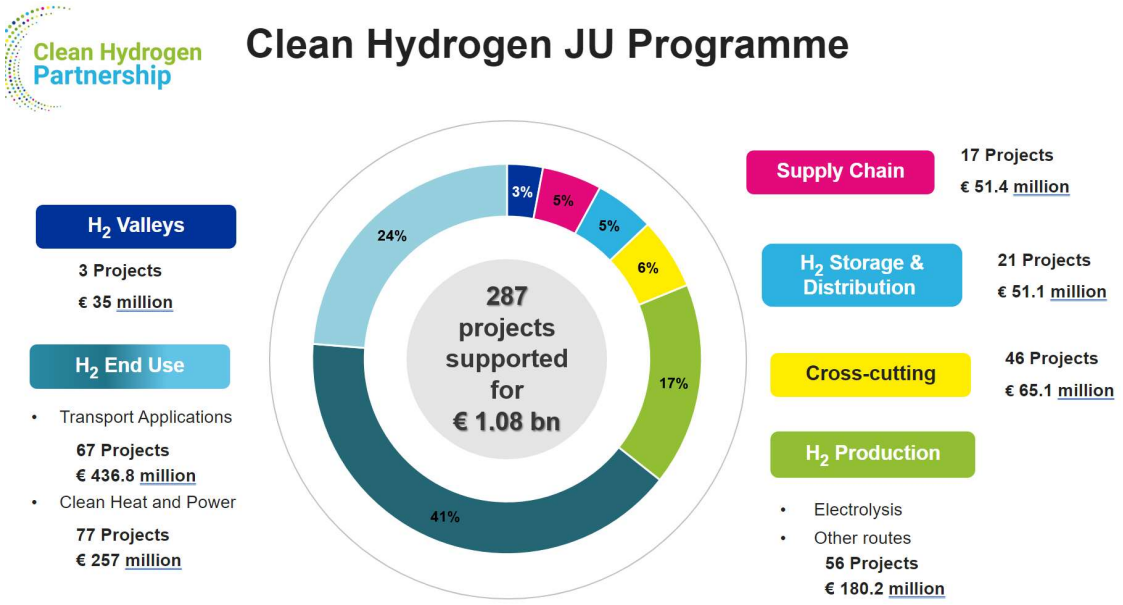
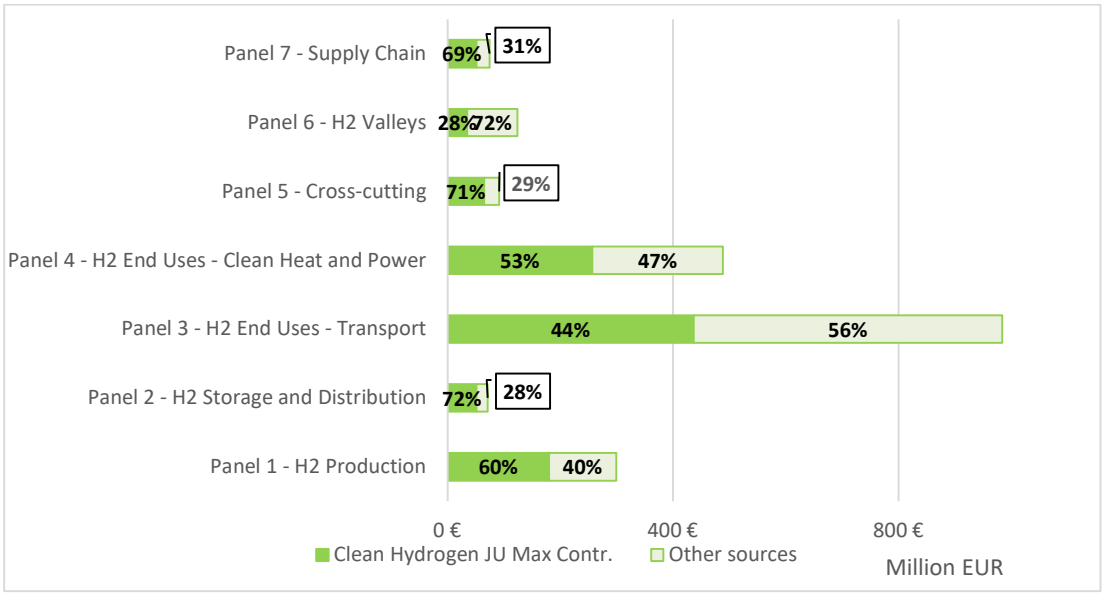


Source: Clean Hydrogen JU

FIGURE 15. OVERALL STRUCTURE OF THE CLEAN HYDROGEN JU PROGRAMME AND THE PILLARS FOR THE CURRENT REVIEW (PROJECT CALL YEARS 2008 – 2020)

The total cost of projects supported by the predecessors of the Clean Hydrogen JU so far is presented in an aggregate form in Figure 16:



Source: Clean Hydrogen JU

FIGURE 16. PERCENTAGE OF TOTAL FUNDS CONTRIBUTED BY CLEAN HYDROGEN JU AND OTHER ENTITIES.

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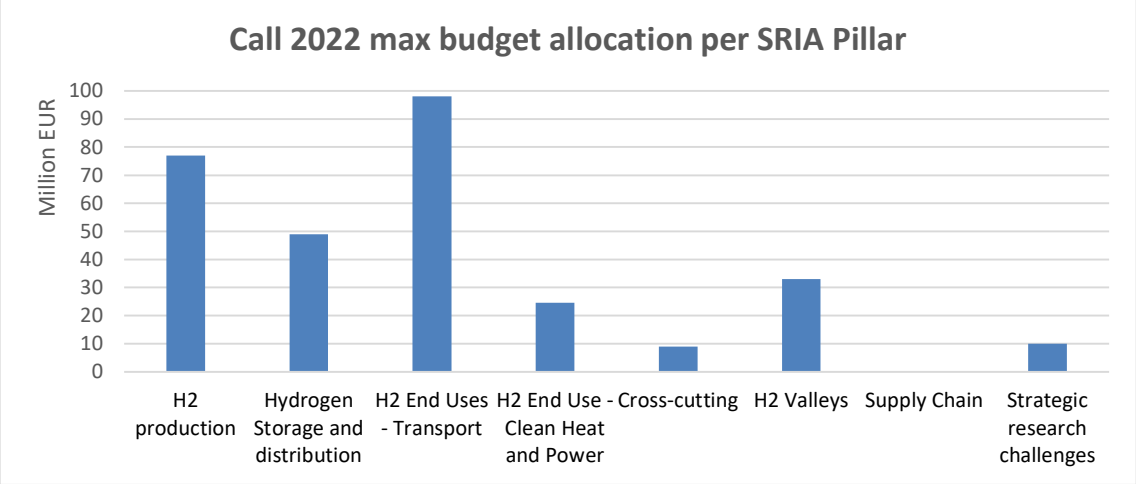
Following the Council Regulation (EU) 2021/2085[97] of November 2021, Clean Hydrogen JU published the first call for [proposals in 2022 for an indicative total budget of EUR 300.5 million[98]. The call addressed key strategic priorities as identified by the members of the Clean Hydrogen JU, considering the views of the wider scientific community and relevant stakeholders. It encompassed different areas of research and innovation within the objectives of the Clean Hydrogen JU. The foreseen total budget of EUR 300.5 million for the 2022 call was allocated per Pillar as follows (Figure 17). For more information please also see sections 1.3 and 1.4.



Source: Clean Hydrogen JU

FIGURE 17. CLEAN HYDROGEN JU CALL FOR PROPOSAL 2022 MAXIMUM BUDGET ALLOCATION PER SRIA PILLAR

Combined with the previous Programmes, Figure 18 visualises the budget allocation across all Programmes including call for proposals 2022-1[99] that were signed end of 2022 and early 2023:

[97] 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 (https://eur-lex.europa.eu/eli/reg/2021/2085/oj)

[98] The amount corresponding to Call 2022 will not be necessarily the same amount of those signed, as this depends on the evaluation and the final GAPs to be signed

[99] The actual funding amount and number of projects in relation to Call 2022 depends on the final evaluation of the proposals for each Topic and the signing or not of the relevant grants

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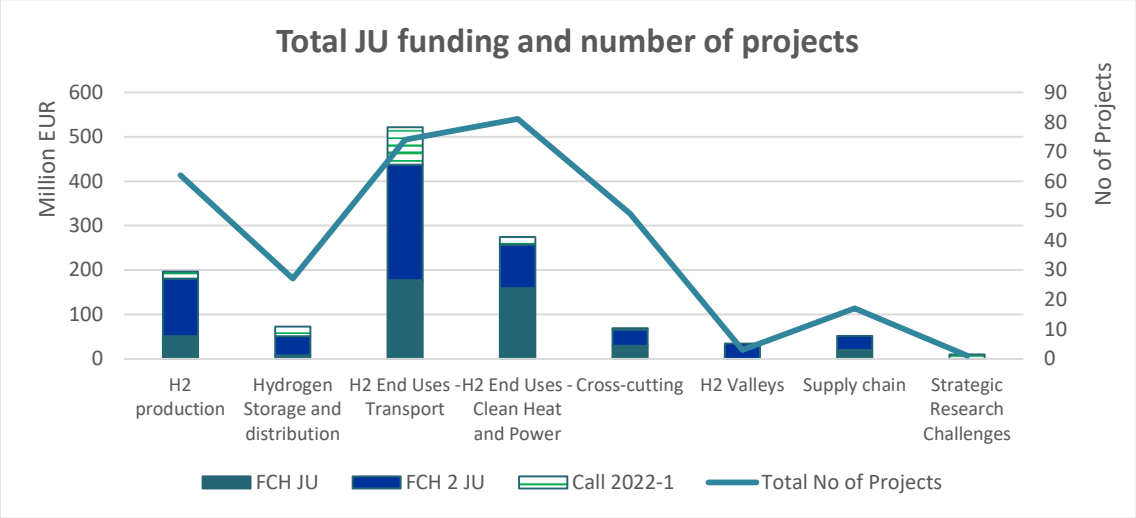

Source: Clean Hydrogen JU

FIGURE 18. TOTAL JU FUNDING PER PILLAR AND TOTAL NUMBER OF PROGRAMMES, INCLUDING CALL 2022-1

1.2.4 Information on quantitative and qualitative leverage effects, including on committed and actually provided financial and in-kind contributions

A key objective and measure of the public-private partnership lies in the capacity to leverage private funding. Horizon 2020 Regulation[100] aimed to achieve a greater impact on research and innovation by combining Horizon 2020 and private sector funds within public- private partnerships in key areas where research and innovation could contribute to the Union's wider competitiveness goals, leverage private investment, and help tackle societal challenges.

Contributions from JU Members other than the Union – H2020 targets, commitments and actual performance (situation as at 31 December 2022) – Amounts in EUR million				
Nature		**Target**	**Committed - pending certification**	**Validated / Certified**
Financial contributions (FC) of the members to Clean Hydrogen JU (other than the Union) administrative costs, 2014–2022	Industry Grouping	16.34		12.73[101]
	Research Grouping	2.66		2.07
Total FC for 2014 - 2022		***19.00***		***14.80***

[100] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOL_2014_169_R_0007&from=FR

[101] The target is until end 2024 (H2020 legal basis), when the JU will still have contribution from the members (EC and private members) under H2020 for the contribution to running costs

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In-Kind contributions to Operational Activities (IKOP) for 2014 - 2022		76.00	138.76	51.74
In-Kind contributions to Additional Activities (IKAA) for 2014 - 2022		285.00		1,039.05
Total In-Kind contributions for 2014 -2022		***361.00***		***1,090.79***
TOTAL all contributions from private members for 2014 -2022		**380.00**	**138.76**	**1,105.59**

TABLE 6. H2020 CONTRIBUTIONS FROM JU MEMBERS OTHER THAN THE EU: TARGETS, COMMITMENTS AND ACTUAL PERFORMANCE TO DATE – SITUATION AS OF 31 DECEMBER 2022

The Council regulation establishing the FCH 2 JU[102] explicitly mentioned the minimum target leverage effect over the whole 2014–2020 period as 0.57[103]. In the actual performance, industry and research members' overall contributions already reached levels much higher (EUR 1.1 billion) than the anticipated targets for the in-kind contributions in the H2020 legal basis (EUR 361 million) or the EU contribution to H2020 programme (EUR 665 million) itself.

Expressed in terms of a leverage effect (1.105 / 665 = 1,66), the certified in-kind contributions and received cash contributions far more exceeded an initial target of 0.57 (almost three times higher than anticipated) set in the H2020 legal basis.

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

Horizon Europe Regulation[104] requires that the financial or in-kind contributions from members other than the Union should be at least equal to 50 % and may reach up to 75 % of the aggregated joint undertaking budgetary commitments.

Due to high amount of certified IKAA, the IKAA planning, and certification exercise was discontinued in 2021 for the H2020, shifting the focus to the new Horizon Europe programme, its strategic policy objectives and quantitative targets.

Due to major simplifications introduced in H2020 programme, the certification exercise for H2020 IKOP is still ongoing (via CFS certificates which are only due after end of each project), with estimated amount close to additional EUR 140 million to be certified in the following years.

[102] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.169.01.0108.01.ENG

[103] Total minimum contribution from members other than the EU (EUR 380 million) divided by the total EU contribution (EUR 665 million)

[104] 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 (OJ L 170, 12.5.2021, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32021R0695)

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Contributions from JU Members other than the Union – Horizon Europe targets, commitments and actual performance (situation as at 31 December 2022) – Amounts in EUR million				
Nature		**Target[105]**	**Committed – pending certification**	**Validated / Certified**
Financial contributions (FC) of the members to Clean Hydrogen JU (other than the Union) administrative costs, 2021–2022	Industry Grouping	25.97		0.00
	Research Grouping	4.23		0.00
Total FC for 2021 - 2022		***30.19***		***0.00***
In-Kind contributions to Operational Activities (IKOP) for 2021 - 2022		n/a	2.06[106]	0.00
In-Kind contributions to Additional Activities (IKAA) for 2021 - 2022			520.77	121.07[107]
Total In-Kind contributions for Horizon Europe		***969.81***	***522.83***	***121.07***
TOTAL all contributions from private members for Horizon Europe		**1,000.00**	**522.83**	**121.07**

- Table 7. Horizon Europe contributions from JU members other than the EU: targets, commitments and actual performance – situation as of 31 December 2022The Council Regulation for Horizon Europe does not establish leverage effect targets. However, it does establish an overall objective for 1:1 matching of the Union financial contribution to the Clean Hydrogen Joint Undertaking of up to EUR 1 billion with a total contribution of up to EUR 1 billion[108] of private contributions, consisting of: Contributions to administrative expenditure up to EUR 30.19 million;
- In-kind contributions to operational activities and in-kind contributions to additional activities with an overall target of up to EUR 969.81 million (i.e. there is no individual target for IKOP or IKAA, the overall target is considered at their aggregated level of EUR 1 billion).

In 2022, via a signature of 20 new grant agreements from the Call 2022 from the Horizon Europe, private members committed around EUR 2[109] million in IKOP (out of EUR 3.54 million of total private

[105] Targets as defined by the COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021

[106] The actual IKOP commitments are expected to increase significantly in the beginning of 2023 after signature of all grants from the Call 2022. By closure date of the AAR, as of 22 May 2023, there were 16 additional grants (from the Call 2022) signed with total value of committed private contributions of EUR 88.10 million

107 Certified IKAA values are expected to increase significantly after completion of the certification exercise in 2023. At the time of the closure of the AAR as of 22 May 2023, the certification process was ongoing

[108] Article 77, 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

[109] Please see the footnote above about actual levels of IKOP as of 22 May 2023

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contributions, including non-members). Same as in the H2020, any committed IKOP will only be certified towards the end of the framework programme, via CFS/CCS certificates which are due with the last reporting period of the projects.

In 2022, the Governing Board of the Clean Hydrogen JU, approved the first IKAA plan related to Horizon Europe for more than EUR 500 million. Same as in the H2020, the Clean Hydrogen JU has put in place an annual IKAA certification by an independent audit body appointed by the entity concerned, therefore the IKAA will get certified on an annual basis[110].

At the time of establishment of the Annual Activity Report, the IKAA certification exercise for the previous year was still ongoing.

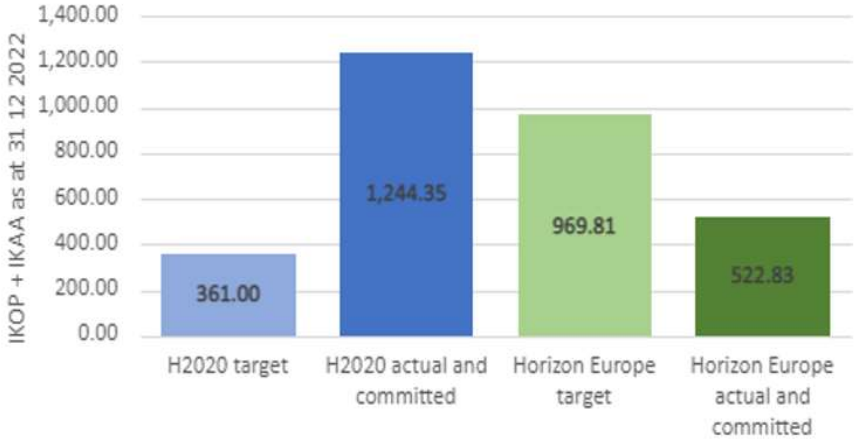

FIGURE 19. IN-KIND CONTRIBUTIONS AS OF 31 DECEMBER 2022

The graph above shows an overview of the level of in-kind contributions in two major, simultaneously running framework programmes at the Clean Hydrogen JU in the year 2022. Building on experience and on success of the H2020, and taking into account the level of already committed in-kind contributions for the Horizon Europe programme, the Clean Hydrogen JU is confident that the private members will be able to fulfil (and even exceed) the required 1:1 quantitative matching of the union contributions.

For the qualitative matching of the strategic objectives of the Clean Hydrogen JU, the in-kind contributions in the projects (IKOP) are following the same objectives as set in the annual work programmes[111].

The in-kind contributions in additional activities (IKAA), in order to be approved by the governing board of the Clean Hydrogen JU, must be directly linked to the activities of the Clean Hydrogen Joint Undertaking and contributing to its objectives[112]. More details on the in-kind contributions can be found in section 2.4.

[110] According to Article 11 of the COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021, the private members shall report by 31 May each year at the latest to their respective governing board on the value of their in-kind contributions

[111] IKOP levels are calculated as a difference between the total eligible costs and a maximum grant amount per participating member of the Hydrogen Europe / Hydrogen Europe Research in Horizon Europe projects of the Clean Hydrogen JU

[112] Reference to Article 78 of the COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021

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Combined with the previous Programmes, the following table and graph visualise the overall achievements of matching of public and private investments across all Programmes.

	Members' contributions as per Founding Regulations and legal decisions			
TARGETS	EU cash (a)	Other members IKOP and cash (b)	Other members' IKAA (c)	Total (d) =(a)+(b)+(c)
FP7	470	450	N/A	920
H2020	665	95	285	1,045
Horizon Europe	1,000		1,000	2,000
Total target for 3 MFFs	**2,135**		**1,830**	**3,965**

	Members' contributions as of 31 December 2022						
ACTUALS	EU cash (e)	Other members IKOP validated and cash (f)	Other members IKOP reported but not validated (g)	IKAA certified (h)	Total (i)=(f)+(g)+(h)	Achievement rate with IKAA (j)=(i)/(d)	Achievement rate without IKAA (k)=(e+f+g)/(a+b)
FP7	426.47	467.91	10.72	N/A	905.09	98%	98%
H2020	573.07	66.54	47.25	1,039.00	1,725.86	165%	90%
Horizon Europe	46.96	0	0	121.07	168.03	8%	2%
Total actual for 3 MFFs	**1,046.49**	**534.45**	**57.97**	**1,160.07**	**2,798.98**		

TABLE 7. TOTAL MEMBERS CONTRIBUTIONS IN FP7, H2020 AND HE FOR THE CLEAN HYDROGEN JUI (IN EU MILLION) – TARGETS VERSUS ACTUALS

The achievements rates of FP7 and H2020 programmes are expected still to increase once more IKOP certifications are received[113]. For Horizon Europe programme, only cash and IKOP commitments were

[113] For the ongoing projects, the IKOP certification is only due together with the last reporting period. IKAA certification for the FP7 programme is not applicable as the concept of the additional activities was only introduced in the H2020 legal basis. H2020 IKAA certifications were (due to fulfilment of targets) discontinued in 2021, shifting the focus on Horizon Europe programme. IKAA follows an annual certification regime with a reporting deadline of 31 May 2023 for the year 2022. At the time of the preparation of the AAR for 2022 the IKAA certification was still ongoing, therefore the full achievements of 2022 will only be reported later in 2023

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available as of December 2022[114], no actual grant related costs were incurred, as the newly signed grants would start as of 1 January 2023. Cash contributions from private members for 2021 and 2022 were fully covered by H2020 commitments. Partial results of the IKAA certifications for 2022 IKAA plan were already available, starting to demonstrate continuous funding engagement of the private members of the JU already for the Horizon Europe programme.

The graph below illustrates overall commitments available at the moment of the drafting of the AAR (from 16 additional grants from the Call 2022 which were signed early in 2023) and represent situation as of 31 May 2023.

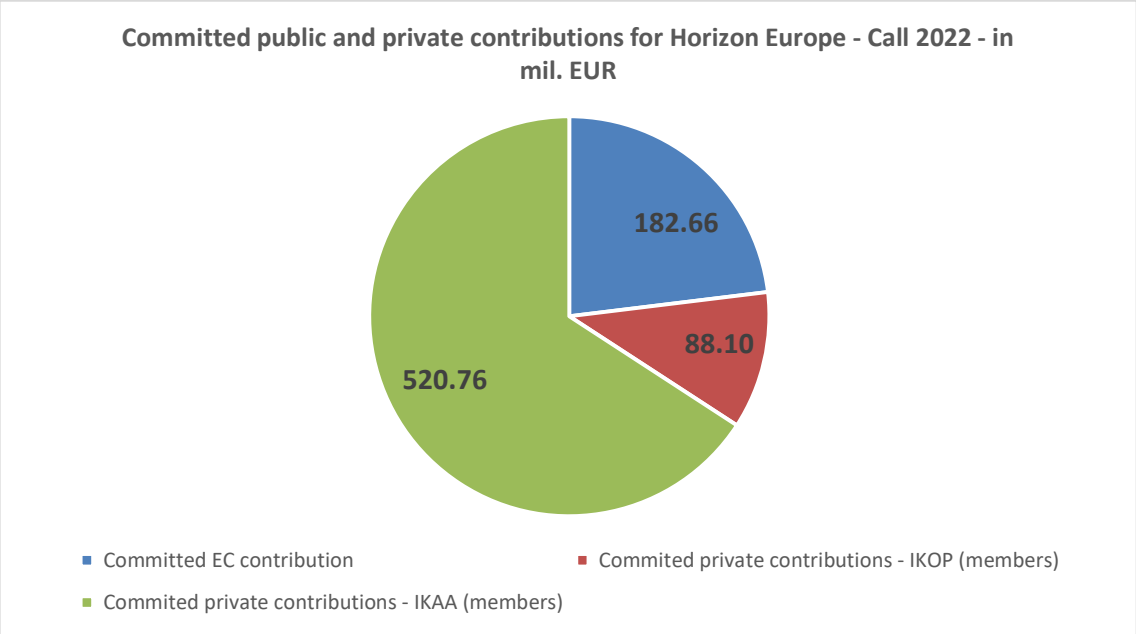

TABLE 8. COMMITTED PUBLIC AND PRIVATE CONTRIBUTIONS FOR HORIZON EUROPE – CALL 2022 – IN EUR MILLION

In summary as of 31 May 2023 (including elements in the pipeline) it can be concluded that for every single euro invested by the European Commission an investment of about 3 EUR is invested by the private sector, meaning that not only the JU is a critical instrument to ensure EU leadership on R&D for hydrogen technologies, but also is a very efficient use of public money.

[114] Committed IKOP from 20 newly signed Horizon Europe grants of EUR 2.06 million and cash contributions as per Horizon Europe legal basis

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1.3 Calls for proposals, grant information and other funded actions

1.3.1 Calls for proposals 2022 and grant information

1.3.1.1 Information on Calls for proposals 2022

In 2022, the Clean Hydrogen JU published one call for proposals, with two different deadlines and related budget allocated as follows:

	Budget (EUR mill)	Publication	Deadline
HORIZON-JTI-CLEANH2-2022-1	179.50	01 March 2022	31 May 2022
HORIZON-JTI-CLEANH2-2022-2	121.00	01 March 2022	20 September 2022
Overall indicative budget	**300.50**		

The call for proposals was published on 01 March 2022 and, in accordance with the AWP 2022, included 41 topics, distributed amongst areas of activity of the JU as below:

1. Renewable Hydrogen Production: 10 Topics
2. Hydrogen Storage and Distribution: 11 Topics
3. Transport: 8 Topics
4. Heat and Power: 4 Topics
5. Cross-cutting: 5 Topics
6. Hydrogen Valleys: 2 Topics
7. Strategic Research challenges: 1 Topics

On 15 March 2023, a public on-line information day was organised. Overall (at both deadlines) the 2022 call for proposals received 153 proposals, with 143 proposals satisfying the eligibility and admissibility criteria. Distribution of the 153 proposals, according to areas and call topic, is provided below:

PROPOSAL STATISTICS (numbers)						
Call	**Area**	**Topic**	**submitted**	**Inadmissible**	**Ineligible**	**Eligible**
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-01	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-02	2	0	0	2
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-03	10	0	0	10

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PROPOSAL STATISTICS (numbers)						
Call	**Area**	**Topic**	**submitted**	**Inadmissible**	**Ineligible**	**Eligible**
HORIZON-JTI-CLEANH2-2022-2	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-04	6	0	0	6
HORIZON-JTI-CLEANH2-2022-2	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-05	1	0	0	1
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-06	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-07	3	2	1	0
HORIZON-JTI-CLEANH2-2022-2	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-08	3	0	1	2
HORIZON-JTI-CLEANH2-2022-1	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-09	2	0	0	2
HORIZON-JTI-CLEANH2-2022-2	Renewable Hydrogen Production	HORIZON-JTI-CLEANH2-2022-01-10	4	1	1	2
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-01	4	0	0	4
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-02	6	0	0	6
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-03	2	0	0	2
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-04	10	0	0	10
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-05	5	0	0	5
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-06	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-07	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-08	3	0	0	3

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PROPOSAL STATISTICS (numbers)						
Call	**Area**	**Topic**	**submitted**	**Inadmissible**	**Ineligible**	**Eligible**
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-09	1	0	0	1
HORIZON-JTI-CLEANH2-2022-1	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-10	1	0	0	1
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Storage and Distribution	HORIZON-JTI-CLEANH2-2022-02-11	0	0	0	0
HORIZON-JTI-CLEANH2-2022-2	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-01	1	0	0	1
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-02	6	0	0	6
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-03	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-04	0	0	0	0
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-05	2	1	0	1
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-06	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-07	2	0	0	2
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Transport	HORIZON-JTI-CLEANH2-2022-03-08	2	0	0	2
HORIZON-JTI-CLEANH2-2022-2	Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2022-04-01	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2022-04-02	5	0	0	5
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2022-04-03	2	0	0	2
HORIZON-JTI-CLEANH2-2022-1	Hydrogen End Uses: Heat and Power	HORIZON-JTI-CLEANH2-2022-04-04	4	0	0	4

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PROPOSAL STATISTICS (numbers)						
Call	**Area**	**Topic**	**submitted**	**Inadmissible**	**Ineligible**	**Eligible**
HORIZON-JTI-CLEANH2-2022-2	Cross-cutting	HORIZON-JTI-CLEANH2-2022-05-01	10	0	1	9
HORIZON-JTI-CLEANH2-2022-1	Cross-cutting	HORIZON-JTI-CLEANH2-2022-05-02	2	0	0	2
HORIZON-JTI-CLEANH2-2022-2	Cross-cutting	HORIZON-JTI-CLEANH2-2022-05-03	3	0	0	3
HORIZON-JTI-CLEANH2-2022-1	Cross-cutting	HORIZON-JTI-CLEANH2-2022-05-04	1	0	0	1
HORIZON-JTI-CLEANH2-2022-1	Cross-cutting	HORIZON-JTI-CLEANH2-2022-05-05	7	0	0	7
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Valleys	HORIZON-JTI-CLEANH2-2022-06-01	8	2	0	6
HORIZON-JTI-CLEANH2-2022-2	Hydrogen Valleys	HORIZON-JTI-CLEANH2-2022-06-02	13	0	0	13
HORIZON-JTI-CLEANH2-2022-1	Strategic Research challenge	HORIZON-JTI-CLEANH2-2022-07-01	1	0	0	1
		Grand Total	153	6	4	143

TABLE 8. PROPOSAL STATISTICS: ELIGIBILITY AND ADMISSIBILITY OF RECEIVED PROPOSALS FOR THE 2022 CALL FOR PROPOSALS

38 out of the 41 topics have received eligible and admissible proposals.

The 143 eligible and admissible proposals submitted gathered 1.524 participations from legal entities established in 61 different countries. The breakdown by country where the legal entity is established, and by participant type, in particular SMEs and newcomers is provided in the table below:

Country	Number of participants	Requested EU Contribution (€)	Country	Number of participants	Requested EU Contribution (€)
AE	2	-	KZ	1	108,500
AT	19	9,228,252	LT	11	7,426,724
AU	2	-	LU	15	7,814,249
BA	1	35,000	LV	6	1,039,600

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Country	Number of participants	Requested EU Contribution (€)	Country	Number of participants	Requested EU Contribution (€)
BE	58	44,751,682	LY	3	272,245
BG	42	32,614,449	MA	9	1,657,874
CA	1	293,750	ME	1	139,375
CH	32	-	MK	1	24,962
CI	1	2,350,000	MT	2	379,900
CV	1	121,875	MU	1	99,375
CY	6	911,353	MZ	2	141,844
CZ	14	3,663,868	NA	1	100,000
DE	171	114,822,595	NG	2	223,375
DK	41	24,907,587	NL	106	67,850,882
DZ	1	32,500	NO	35	23,407,062
EE	20	10,462,513	NZ	1	24,772
EG	3	310,400	PL	34	16,231,570
EL	71	46,892,370	PT	22	8,874,508
ES	106	64,093,089	RO	11	2,387,329
FI	59	53,805,068	RS	3	235,000
FR	183	92,214,824	RW	2	268,700
GH	2	722,125	SE	27	26,100,655
HR	16	8,485,707	SI	24	13,636,466
HU	3	337,125	SK	6	935,688
IE	17	8,974,459	TN	5	857,000
IL	19	16,612,003	TR	50	21,605,085
IN	1	51,956	UA	9	3,178,859
IS	1	253,125	UK	55	27,855,638
IT	173	91,475,195	US	1	13,700
KE	3	619,410	ZA	8	1,523,241
KR	1	-			
			Grand Total	**1524**	**863,456,471.64 €**

TABLE 9. DISTRIBUTION OF PARTICIPATION AND REQUESTED EU CONTRIBUTION BY COUNTRY

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The distribution of the 1.524 legal entities participations is as follows:

Entity type	Number of participants by entity type	Participant Requested EU Contribution
Higher or Secondary Education	267	93,693,174.63 €
Other	91	40,272,673.50 €
Private for Profit	851	586,931,002.42 €
Public Body	43	16,149,472.71 €
Research Organisation	272	126,410,148.38 €
Grand Total	**1524**	**863,456,471.64 €**

TABLE 10. DISTRIBUTION OF PARTICIPATION AND REQUESTED EU CONTRIBUTION BY TYPE OF ENTITY

Out of the 1.524 participations of legal entities, 312 where originating from SME (20.5%) accounting for 23.2% of the total participant requested EU contribution (200,050,922.91 €).

Moreover, 942 of these participations correspond to "newcomers" (61.8%), i.e. entities that are for the first time applying to an individual joint undertaking or its preceding initiative.

Out of the 143 eligible and admissible proposals, 89 (62.2 %) passed all the evaluation thresholds of the call and were placed in either main lists or reserve lists. The exact distribution of the retained proposals and budget per topic is provided in the table below:

Topic	Eligible proposals	Main list	Reserve list	Cumulative Requested EU Contribution (main list)	Available Budget in topic
HORIZON-JTI-CLEANH2-2022-01-01	3	1	1	2,543,398.75 €	2,500,000.00 €
HORIZON-JTI-CLEANH2-2022-01-02	2	1	0	2,497,013.75 €	2,500,000.00 €
HORIZON-JTI-CLEANH2-2022-01-03	10	2	4	5,153,361.00 €	5,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-04	6	2	3	3,999,622.50 €	4,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-05	1	1	0	5,295,799.25 €	6,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-06	3	1	1	3,982,105.00 €	4,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-07	0	0	0	0.00 €	9,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-08	2	1	0	18,344,576.38 €	18,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-09	2	1	0	3,023,324.00 €	6,000,000.00 €
HORIZON-JTI-CLEANH2-2022-01-10	2	1	0	20,000,000.00 €	20,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-01	4	1	2	2,607,481.00 €	2,500,000.00 €

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Topic	Eligible proposals	Main list	Reserve list	Cumulative Requested EU Contribution (main list)	Available Budget in topic
HORIZON-JTI-CLEANH2-2022-02-02	6	1	2	2,499,428.75 €	2,500,000.00 €
HORIZON-JTI-CLEANH2-2022-02-03	2	1	1	4,999,979.00 €	5,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-04	10	1	4	2,989,671.25 €	3,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-05	5	1	3	2,941,312.75 €	3,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-06	3	1	0	6,497,480.00 €	6,500,000.00 €
HORIZON-JTI-CLEANH2-2022-02-07	3	1	2	2,500,000.00 €	2,500,000.00 €
HORIZON-JTI-CLEANH2-2022-02-08	3	1	1	4,617,386.00 €	5,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-09	1	1	0	3,996,015.00 €	4,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-10	1	1	0	3,999,382.00 €	8,000,000.00 €
HORIZON-JTI-CLEANH2-2022-02-11	0	0	0	0.00 €	7,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-01	1	1	0	3,487,156.00 €	7,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-02	6	2	4	6,390,751.25 €	6,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-03	3	1	0	29,991,489.00 €	30,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-04	0	0	0	0.00 €	5,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-05	1	1	0	14,998,543.00 €	15,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-06	3	1	2	19,986,841.75 €	20,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-07	2	1	0	9,457,204.50 €	10,000,000.00 €
HORIZON-JTI-CLEANH2-2022-03-08	2	1	1	4,942,898.75 €	5,000,000.00 €
HORIZON-JTI-CLEANH2-2022-04-01	3	1	1	6,606,098.26 €	7,000,000.00 €
HORIZON-JTI-CLEANH2-2022-04-02	5	1	1	3,998,030.00 €	4,000,000.00 €
HORIZON-JTI-CLEANH2-2022-04-03	2	1	1	5,499,822.50 €	5,500,000.00 €
HORIZON-JTI-CLEANH2-2022-04-04	4	2	0	8,162,705.00 €	8,000,000.00 €
HORIZON-JTI-CLEANH2-2022-05-01	9	1	4	1,062,754.50 €	1,000,000.00 €
HORIZON-JTI-CLEANH2-2022-05-02	2	1	1	1,999,998.75 €	2,000,000.00 €
HORIZON-JTI-CLEANH2-2022-05-03	3	1	0	2,999,156.25 €	3,000,000.00 €
HORIZON-JTI-CLEANH2-2022-05-04	1	1	0	1,997,361.00 €	2,000,000.00 €
HORIZON-JTI-CLEANH2-2022-05-05	7	1	1	999,995.00 €	1,000,000.00 €

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Topic	Eligible proposals	Main list	Reserve list	Cumulative Requested EU Contribution (main list)	Available Budget in topic
HORIZON-JTI-CLEANH2-2022-06-01	6	1	1	24,999,995.73 €	25,000,000.00 €
HORIZON-JTI-CLEANH2-2022-06-02	13	1	6	7,999,999.14 €	8,000,000.00 €
HORIZON-JTI-CLEANH2-2022-07-01	1	1	0	9,993,657.00 €	10,000,000.00 €
Grand Total	143	42	47	268,061,793.76 €	300,500,000.00 €

TABLE 11. RETAINED PROPOSALS AND REQUESTED EU CONTRIBUTION PER TOPIC FOR THE 2022 CALL FOR PROPOSALS

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 (268 M €) should be considered as contributing to the HE (and H2020) objective to contribute at least 35% of the expenditure to climate objectives.

1.3.1.2 Information on Grant Agreement Preparation[115]

In September 2022, the Clean Hydrogen JU informed the applicants on the outcome of the evaluations of the first deadline of the call HORIZON-JTI-CLEANH2-2022-1. Two proposals made requests for a review (redress) under this call, none of which led to the re-evaluation or change in the ranked lists established during the evaluation process.

All consortia were informed of the evaluation results at the same time, 92 days after the closure of the call, well in advance of the TTI[116] target fixed in the General Annexes of the Horizon Europe - Work Programme 2021-2022 (153 days). Immediately after the information had been sent, preparation of the grant agreements (GAs) for 27 proposals began. 20 out of the 27 GAs were signed in 2022 (day 215) within an average of 202 days and before the time to grant (TTG) target fixed in the General Annexes to the Horizon Europe - Work Programme 2021-2022, i.e. 245 days after the closure of the call for proposals. The remaining 7 GA were signed in 2023, one of them after the TTG of 245 days, after approval of the request by the consortium to extend the GA preparation.

CALL	PROPOSAL NUMBER	ACRONYM	TTI	TTS	TTG
HORIZON-JTI-CLEANH2-2022-1	101101418	24_7 ZEN	92	138	230
HORIZON-JTI-CLEANH2-2022-1	101101318	ADVANCEPEM	92	97	189
HORIZON-JTI-CLEANH2-2022-1	101101521	AMON	92	100	192

[115] Following the evaluations of the call HORIZON-JTI-CLEANH2-2022-2 in Autumn 2022, applicants were informed in January 2023. Therefore the Grant Agreement Process for this call is not reported in AAR 2022, and shall in turn be covered in the AAR of 2023

[116] Time to inform (TTI) all applicants of the outcome of the evaluation of their application from the final date for submission of completed proposals

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HORIZON-JTI-CLEANH2-2022-1	101101409	BRAVA	92	89	181
HORIZON-JTI-CLEANH2-2022-1	101101404	COCOLIH2T	92	148	240
HORIZON-JTI-CLEANH2-2022-1	101101381	ELVHYS	92	100	192
HORIZON-JTI-CLEANH2-2022-1	101101427	FLEX4H2	92	94	186
HORIZON-JTI-CLEANH2-2022-1	101101446	H2Accelerate TRUCKS	92	149	241
HORIZON-JTI-CLEANH2-2022-1	101101517	H2REF-DEMO	92	98	190
HORIZON-JTI-CLEANH2-2022-1	101101462	HELIOS	92	92	184
HORIZON-JTI-CLEANH2-2022-1	101101346	HIGHLANDER	92	99	191
HORIZON-JTI-CLEANH2-2022-1	101101447	HQE	92	100	192
HORIZON-JTI-CLEANH2-2022-1	101101452	HYPRAEL	92	103	195
HORIZON-JTI-CLEANH2-2022-1	101101461	HyLICAL	92	96	188
HORIZON-JTI-CLEANH2-2022-1	101101274	HyP3D	92	96	188
HORIZON-JTI-CLEANH2-2022-1	101101498	HySelect	92	112	204
HORIZON-JTI-CLEANH2-2022-1	101101469	JUST-GREEN AFRH2ICA	92	92	184
HORIZON-JTI-CLEANH2-2022-1	101101407	NIMPHEA	92	99	191
HORIZON-JTI-CLEANH2-2022-1	101101415	OPTHYCS	92	89	181
HORIZON-JTI-CLEANH2-2022-1	101101439	OUTFOX	92	138	230
HORIZON-JTI-CLEANH2-2022-1	101101433	PEMTASTIC	92	138	230
HORIZON-JTI-CLEANH2-2022-1	101101504	PROTOSTACK	92	98	190
HORIZON-JTI-CLEANH2-2022-1	101101358	RH2IWER	92	170	262
HORIZON-JTI-CLEANH2-2022-1	101101443	RHeaDHy	92	98	190
HORIZON-JTI-CLEANH2-2022-1	101101422	ROAD TRHYP	92	105	197
HORIZON-JTI-CLEANH2-2022-1	101101479	SUSTAINCELL	92	97	189
HORIZON-JTI-CLEANH2-2022-1	101101540	THOTH2	92	148	240

TABLE 12. INFORMATION ON GRANT AGREEMENT PREPARATION OF CALL **HORIZON-JTI-CLEANH2-2022-1**

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The 27 projects listed above include 279 participations from 213 participants for the total Clean Hydrogen JU max contribution of EUR 155,0919,233.00. This amount was distributed by participant category as follows:

Entity type	Number of entities	Maximum EU Contribution
Higher or Secondary Education	30	11,040,598.50 €
Other	10	1,750,153.75 €
Private for Profit	134	99,724,027.01 €
Public Body	3	139,500.00 €
Research Organisation	36	42,364,953.75 €
Grand Total	**213**	**155,019,233.01 €**

TABLE 13. BREAKDOWN OF PARTICIPATION AND CONTRIBUTION BY PARTICIPANT CATEGORY IN EUR

The 27 projects include 42 SME participants (19.7%) amounting to 15,396,964.75€ of funding. 104 of the 213 participants correspond to "newcomers" (48.8%), i.e. entities that are for the first-time beneficiaries of a grant awarded by an individual joint undertaking or its preceding initiative.

In terms of country participations, participants from 19 EU Member States or Associated Countries are participating in the 27 projects and have received funding. In addition, entities from 7 third countries are participating. The figures below indicate the distribution of the participants and the Clean Hydrogen JU contribution by country.

Country	Number of entities participating	Maximum EU Contribution
Australia	1	0
Austria	3	442,250.00 €
Belgium	9	2,806,281.00 €
Czechia	1	202,500.00 €
Denmark	8	7,458,977.50 €
Estonia	1	270,000.00 €
Finland	4	5,261,462.25 €
France	40	25,784,331.50 €
Germany	26	38,844,194.13 €
Greece	7	3,070,261.25 €
Ireland	1	1,273,538.75 €
Italy	32	25,069,766.00 €
Kenya	1	69,035.00 €

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Mauritius	1	99,375.00 €
Morocco	1	70,000.00 €
Netherlands	21	19,948,376.88 €
Norway	5	6,267,377.25 €
Poland	6	1,020,342.50 €
Romania	2	272,750.00 €
Slovakia	1	176,937.50 €
South Africa	1	63,750.00 €
Spain	16	12,561,614.50 €
Sweden	3	3,986,112.00 €
Switzerland	11	0
United Kingdom	10	0
United States	1	0
Grand Total	**213**	**155,019,233.01€**

TABLE 14. NUMBER OF ENTITIES PARTICIPATING AND CLEAN HYDROGEN JU CONTRIBUTION BY COUNTRY

Evaluations of the second deadline of the call have also taken place in November 2022, with information on the outcome to all applicants in January 2023.

1.3.2 Other funded actions

Operational calls for tenders in 2022

In accordance with its 2022 AWP, the Clean Hydrogen JU launched operational procurement procedures via either open calls for tenders or direct contracts with Members on the following topics:

1. "*European Hydrogen Observatory*" – reference number CLEANHYDROGEN/OP/CONTRACT 320

   The objective of this contract is to ensure the smooth and improved replacement of the already existing FCHO platform by the European Hydrogen Observatory (referred as the "new Observatory" or the "Observatory"), and its further enhancement, for the period that the service contract will remain in force. The primary role of the new Observatory will be to act as a central point for information on hydrogen, aiming to sustain and further enhance the current position of FCHO as the main reference for information on fuel cells and hydrogen technologies and applications for Europe.

   The procurement activities include an open call for tender for services, as well as a separate direct contract with its Member Hydrogen Europe in accordance with article 43.4 of the Financial Rules of the Clean Hydrogen JU, treated separately under point 2 below.

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The contract resulting from the open procedure was signed on 13 December 2022 for a period of 48 months and a budget of EUR 1,349,975.40. It included provisions for a set of deliverables per task, such as the collaboration platform, the database of the underpinning online platform, the new website, manuals, regular data collection and updates, annual reports, as w ell as communication material.

2. "*Provision of data and services in support of the European Hydrogen Observatory and monitoring of the hydrogen sector*" – reference number Clean Hydrogen/OP/Contract 332.

   The objective of this contract is the acquisition of services that will ensure the periodic delivery of predefined, up-to-date and validated datasets to the Contracting Authority, to support the regular update of the information presented by the European Hydrogen Observatory (hereinafter referred as the "new Observatory" or the "Observatory"). The goal is to support the role of the new Observatory as the EU's one-stop source of information for hydrogen, aiming to sustain and further enhance the current position of FCHO as the reference point for information on fuel cells and hydrogen technologies and applications for Europe.

   The procurement activities under this point were the result of a separate direct contract with the Members of the JU, in accordance with article 43.4 of the Financial Rules of the Joint Undertaking.

   The resulting framework contract was signed on 13 December 2022 for a maximum period of 48 months initial duration of 12 months automatically renewed 3 times for 12 months each for a maximum amount covering all purchases of EUR 650,000.00.

3. "*Study on Sustainable Supply chain and Industrialisation of Hydrogen Technologies*" – reference number CleanHydrogen/OP/CONTRACT 324

   Building on the previous FCH 2 JU studies on supply/value chain, the scope of this study is to reassess the hydrogen supply chains, update the list of EU actors (e.g. manufactures, research centres, etc.) for each step of the supply chain and identify the strengths, potential gaps and vulnerabilities in the supply.

   The contract resulting from this open procedure was signed on 20 December 2022 for a duration of 18 months and a total value of EUR 549,159.82.

4. "*Study on Opportunities for cooperation on clean hydrogen with neighbouring countries and regions, in particular Ukraine*" - call for tender proposed under the form of a direct contract for services with member Hydrogen Europe, following article 43.4 of the Financial Rules of the Clean Hydrogen Joint Undertaking.

   The study was not launched in 2022 and was consequently transferred to the public procurements to be carried out in 2023.

   The study was added to the AWP 2022 in the third annual quarter, via the second Amendment to the AWP 2022, adopted through the Governing Board Decision CleanHydrogen-GB-2022-06 of 05/08/2022.

   Although the drafting of tender specifications for the study was initiated during 2022, because of the sensitive nature of this study numerous iterations with colleagues at the European Commission have been necessary. As a result, the publication and finalisation were postponed to 2023.

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Operational calls for tenders from AWP 2021

1. "*Technical Assistance to generate Synergies with Member States and Regions*" – reference number CleanHydrogen/OP/Contract 301.

   The study was foreseen in the AWP 2021; its publication and finalisation were postponed to 2022, as reported in the corresponding section of the Clean Hydrogen JU's AAR 2021.

   The contractor was tasked to assess technical, financial and legal expertise and commitments that Member States and Regions have in place in terms of their Hydrogen Roadmaps, which could be used as input in any public policy (strategic plan) or project related -to hydrogen and further link them to the funding and financing sources required to enable the underlying deployment of hydrogen technologies (and in view of establishing possible synergies with the JU's funding).

   The contract resulting from this open procedure was signed on 13 December 2022 for a maximum duration of 14 months and a total value of EUR 225,060.00.

1.4 Evaluation procedures and outcomes

The AWP 2022 includes one call for proposals with two deadlines. The evaluation of proposals with the first deadline of the call HORIZON-JTI-CLEANH2-2022-1 was carried out between June and July 2022, and those with the second deadline of the call HORIZON-JTI-CLEANH2-2022-2 between October and November 2022. The proposals have been evaluated by a total of 108 participations of external experts, with 84 unique experts, some of them contracted in both calls: 59 in HORIZON-JTI-CLEANH2-2022-1 and 49 in HORIZON-JTI-CLEANH2-2022-2. In addition, three Vice-Chairs were appointed per call deadline to assist with management of the entire evaluation process, including quality controller task.

For each call deadline, the evaluation procedure was observed by 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).

In terms of statistics, out of the 84 individuals' external experts, 26 were female (30.9%). Regarding the nationality of experts, 18 nationalities were represented as follows:

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FIGURE 21. NATIONALITIES OF EXPERTS

The Clean Hydrogen JU informed the applicants on the outcome of the evaluation of the call 2022-1 in Sept 2022, and two proposals requested a review (redress), neither of which led to re-evaluation or change in the ranked lists established in the evaluation process. The info on call 2022-2 evaluations outcome was in January 2023.

1.5 Follow-up of activities linked to past calls

1.5.1 Knowledge Management

1.5.1.1 Annual Programme Review

The annual Programme Review Exercise continued to be centre of the knowledge management activities of the Clean Hydrogen JU. Its purpose is to monitor the implementation of the JU Programmes to ensure that they are aligned with the strategy and objectives set out in the founding regulations, i.e. the SBA for the current Clean Hydrogen JU, as further elaborated in its SRIA for the programming period 2021-2027. It was performed in a similar manner as for its predecessors, FCH JU and FCH 2 JU, and their respective founding Regulations and multi-annual work plans.

In 2022, certain important changes were introduced in the methodology of the Programme Review compared to previous years, with the aim to broaden the scope of the Programme Review and adapt it to the new requirements of the Clean Hydrogen JU programme. Nevertheless, at the core of the Programme Review still remained the Annual Programme Technical Assessment performed by the JRC, together with the annual event, the EU Research Days[117] - previously Programme Review Days - and the publication of the Clean Hydrogen JU project fiches (previously published as posters).

[117] https://www.clean-hydrogen.europa.eu/knowledge-management/annual-programme-review/eu-research-days_en

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The biggest change was associated with the Programme Review Report 2022[118], published at the end of the year. In the past the Programme Review Report mainly summarised the findings of the JRC Technical Assessment. In 2022, a clear separation was introduced between the more high-level Programme Review Report, targeting more the non-technical audience, and the more technical and detailed Annual Programme Technical Assessment Report (APTAR) drafted by JRC[119].

JRC's APTAR expanded its contents, including additional sections on the technology state of the art for each of the Programme Review Pillars, a gap analysis and a historical analysis for two of the Pillars, as well as extended recommendations for each Pillar and the Programme.

Similarly, the JU's Programme Review Report provided the main highlights of the APTAR, complemented by an analysis of the JU funding since 2008 and the views of the wider scientific community – collected during the EU Research Days – on the strategic and technological priorities to be addressed by the Clean Hydrogen JU[120]. It also included one section on relevant studies commissioned by the JU and major reports of international bodies and one more on the observed technological, economic and societal barriers to market entry[121]. Considering all the above information, the Program Review closed by reporting on the progress towards the JU's strategic objectives through the relevant KPIs defined in its SRIA. The inclusion of all these topics in the Programme Review Report, allow it to go beyond the simple monitoring of the Programme, but become also an important input (or feedback-loop) for the next Annual Work Programmes and the identification of research areas and topics for the forthcoming Calls.

The Programme Review Days were also extended to EU Hydrogen Research Days, as now apart from providing an excellent visibility platform for projects and technological developments achieved in the sector, they were also acting as a platform for the wider scientific community to express its opinions and views on the Programme of the Clean Hydrogen JU. This was achieved by inviting experts from the wider scientific community in each panel, with the intention to challenge the JU and its projects in terms of their strategic and technological objectives, while also showing in practice openness to the wider scientific community and its views. The Clean Hydrogen JU aims to further improve this process the coming years (to address related SBA requirements).

All the above have as a starting point the Clean Hydrogen JU's annual data collection exercise, which kickstarts the Programme Review each calendar year. Quantitative and qualitative data are gathered from all on-going projects activities in the previous calendar year. The submission of the data is performed through TRUST, concerning technology related indicators, and through an EU Survey. The data collection covered 98 projects, of which 2 began under FP7 and 96 under H2020. The data collection exercise was once again completed successfully, with all projects answering the questionnaires and providing timely input on most of the queries. The data were then analysed internally and by JRC to provide a detailed view on the projects' results and achievements.

[118] Fuel Cells and Hydrogen 2 Joint Undertaking, Programme review report 2022, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2843/656001

[119] The report is not available to the public, as it has been marked sensitive and is under limited distribution.

[120] As requested by Article 82 (d) of the SBA.

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

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1.5.1.2 Fuel Cell and Hydrogen Observatory (FCHO)

The JU contributes towards the monitoring of the deployment of hydrogen technologies, the adoption of related policies and academic activities and research results through the Fuel Cells & Hydrogen Observatory (FCHO)[122]. FCHO 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 contract for the FCHO ended in April 2022, but only after a last update of the data on the platform was performed, accompanied with a new set of reports. In the end of 2022, a new contract was signed for the Observatory, following a public procurement procedure with the goal of the smooth replacement of the FCHO by the European Hydrogen Observatory (EHO) and its further enhancement, in line with the objectives and activities of the Clean Hydrogen JU.

Considering the importance of acquiring high quality validated data for EHO, while recognising the key position of private members Hydrogen Europe and Hydrogen Europe Research in the collection of such data for their own uses, a separate contract was also signed with these two parties. The main objective of the contract is the acquisition of services that will ensure the periodic delivery of predefined, up-to-date and validated datasets to the JU, to support (and complement) the regular update of EHO.

1.5.1.3 Knowledge Management Tools and Clean Hydrogen Knowledge Hub

The Programme Office of the JU continued to use and further develop the tools used in its predecessor FCH 2 JU 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), as well as the databases and tools developed internally to better manage information for supporting the operations of the JU.

As all the above-mentioned tools and platforms are independent and accessed separately, in 2022 the Programme Office investigated whether a new – single - platform could be introduced, integrating the existing tools and platforms, and further enhancing their capacity. Such a platform would include a data collection tool (TRUST), as well as an extended (project) database fed by many different sources, analysis capabilities and strong reporting and visualisation capabilities. It would also integrate or host the existing platforms supported by Clean Hydrogen JU, such as FCHO, H2V and the HRS availability map.

Following an architecture feasibility study[123] that was performed in 2022 to answer these questions, it was decided to proceed to the development of a single platform, the Clean Hydrogen Knowledge Hub, that will encompass and enrich all the available tools/platforms and offer additional capabilities. The study identified the best architectures for the Clean Hydrogen Knowledge Hub and how they can be developed from the current state. Based on the results of the study and the identified preferred architectures, the Clean Hydrogen JU will proceed in 2023 in procuring services for the development of the Clean Hydrogen Knowledge Hub.

[122] https://www.fchobservatory.eu/

[123] Study procured under the BEACON FWC of DIGIT under the title "*Supporting the Clean Hydrogen JU to setup up a Hydrogen Knowledge Hub*"

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1.5.2 Feedback to Policy

The Clean Hydrogen JU is contributing to the activities of several services in the European Commission. 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 as well as to 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[124]) and other international bodies, active participation in the meetings, providing written technical input and ensuring that fuel cells and hydrogen technologies are properly represented. It also includes feedback from projects and studies to the EC in contribution to relevant energy, transport, industrial, R&I and clean air policy files.

In 2022, the Clean Hydrogen JU Programme Office continued to reinforce the collaboration with policy makers in the European Commission by providing input, under ad-hoc requests or in a more structured manner.

The new Framework for Feedback to Policy is the main initiative to support evidence-informed policy design and evaluation. Prepared and piloted by the Common Implementation Centre, the new Framework aims to support and coordinate the process within the Climate, Energy and Mobility cluster in Pillar II of the Programme. A new structure started being set in 2022, with the establishment of Joint Teams and new processes and tools to support implementation, to be further developed and enhanced in 2023.

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

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

1.6.1 Support to EU Policies

Support to Energy policies: Hydrogen Guarantees of Origin

The JU continued to work on developing a Guarantee of Origin (GO) Scheme for Green and Low-Carbon Hydrogen, an effort that started back in 2014 with the first 'CertifHy' project. A procurement procedure was launched in 2020 and a Framework Contract signed in order to pursue the following key objectives:

- Support and accelerate the establishment of harmonised and mutually recognised GO schemes for renewable and non-renewable hydrogen across Member States while ensuring compliance with article 19 of the RED II[125].

[124] 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.
[125] Directive (EU) 2018/2001 (recast) on the promotion of the use of energy from renewable sources

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- Design a hydrogen certification system that is able to demonstrate compliance with RED II targets on the share of renewables following the specific requirements that are applicable in each case.

In 2022, the on-going procurement continued this work in what can be considered as the third phase of CertifHy.

CertifHy has become an observing member of the Association of Issuing Bodies (AIB) and has sought to advance harmonization and efficiency in the implementation of certification schemes across Europe. Notable progress in this regard has been made in the last year.

Firstly, CertifHy has assisted in creating a framework that can be used by EU Member States seeking to implement their own national H2 GO Scheme for disclosure purposes. Though many Member States are awaiting the CEN Standard before finalising the design of their schemes; certain Member States are moving ahead without awaiting the standard, such as the Netherlands. In this case, the appointed Issuing Body – VertiCer – decided to use CertifHy Non-Governmental Certificates (NGC) Scheme as a framework for its own scheme, referring to CertifHy for parts on renewability and GHG footprint methodologies. Indeed, a harmonized calculation of GHG emissions is especially important to avoid any market distortion. CertifHy wishes to make the framework of the NGC scheme available to all Competent Authorities and Issuing Bodies wishing to implement their own national schemes. In this way, CertifHy is sharing the knowledge and expertise acquired in the development of the NGC scheme and accelerating the implementation of the market for national H2 GOs.

Secondly, CertifHy is actively participating in discussions around a harmonised approach for reporting requirements in the Union Database (UDB) for demonstrating compliance with RED II targets for transport fuels that will ensure a link with GOs used for disclosure. CertifHy is actively contributing to these discussions through the AIB Gas Scheme Group.

Finally, for countries where national H2 GO schemes do not exist (most EU Member States today), CertifHy proposes the use of the CertifHy NGC scheme for consumer disclosure. The NGC Scheme continues to be used by economic operators. 2022 marked a true milestone with over 100 000 NGC certificates issued since the beginning of the existence of the registry.

The CertifHy Consortium has also been working towards the development of a first version of the CertifHy Voluntary Scheme for Renewable Fuels of Non- Biological Origins (RFNBOs). Nine documents today have been drafted and form the Voluntary Scheme documents – they detail all requirements for economic operators in terms of management systems, procedures, requirements for certification bodies as well as the requirements and criteria for RFNBO production (mass balance systems, traceability, GHG emissions requirements and renewability).

CertifHy has already had the opportunity to “test” its Voluntary Scheme documents on a concrete case-study in the context of a certification pilot for a RFNBO production plant in The Netherlands. During the pilot, the CertifHy Certification Body and auditor (TÜV SÜD) used the CertifHy Voluntary Scheme documents to assess whether or not the planned production plans and processes would ensure the production of RED II RFNBO-compliant volumes. The process of going through the certification exercise helped to clarify what parts of the CertifHy Voluntary Scheme documents needed further clarification or work.

CertifHy will continue to push for harmonization between certification schemes for disclosure at a European level, through its participation and contributions within the AIB and by seeking recognition of

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the CertifHy NGC Scheme by the AIB. In the spirit of facilitating the implementation of hydrogen GO Schemes in Europe, it will continue to offer the framework of the CertifHy NGC Scheme for any Member State wishing to design its own national GO scheme. This will again, go in the way of harmonization. It is to be noted that there is a clear understanding that economic operators wishing to certify their hydrogen production for disclosure purposes can use the NGC Scheme unless there is an effective and implemented GO scheme in the Member State in which production takes place.

SET Plan and ERA-net

The Clean Hydrogen JU continued following and contributing as necessary to the SET-Plan activities, in particular Action 6 "Energy Efficiency in Industry" and Action 8 on "Renewable Fuels and Bioenergy" where the JU is participating in the Core Group. In discussions on the revision of the SET Plan that took place in late 2022 it is likely that a separate Action will be launched on Clean Hydrogen.

In addition, in the beginning of 2022 the Clean Hydrogen JU contributed to the green hydrogen R&I European Research Area (ERA) pilot action during the drafting of their Strategic Research and Innovation Agenda (SRIA)[126].

Support to Transport Policies

Regarding maritime policies, in February 2022, the Clean Hydrogen JU co-organised a standardisation workshop with CEN/CENELEC and JRC on hydrogen as a fuel for maritime transport, with the involvement of moderators from DG MOVE (sea-going vessels) and CESNI/CCNR (fluvial vessels).

In addition, the on-going study on "hydrogen for ports and industrial coastal areas" performed by Deloitte has continued to progress with the forecast of hydrogen production, storage and supply in ports including an analysis on the impact of the RePowerEU (April 2022). DG ENER is member of the Advisory Board of the study and consequently following and aiming to use its results in the development of next related policies.

The tender 'Study on impact of deployment of battery electric vehicles (BEV) and fuel cells electric vehicles (FCEV) infrastructure' was implemented during the second half of 2021 and first half of 2022. Via the steering group representatives of the industry as well as of the European Commission (DG MOVE) were involved in the study. One of the key findings of the study was that a combined deployment of infrastructure for hydrogen and pure battery mobility would lead to a lower cost compared to the scenario where only one of the two technologies was to be pursued. Again, these results were considered especially in the development of the AFIR (Alternative Fuel Infrastructure Regulation).

Support to Industrial Policy

In 2022, a call for tender was prepared, launched and concluded for a 'study on sustainable supply chain and industrialisation of hydrogen technologies' to update the EU manufactures list and find potential gaps / bottlenecks in the supply along the hydrogen value chain technologies. Following the tenders evaluation and award decision, the contract was signed with Monitor Deloitte in December 2022. The study will run

[126] https://www.bmbf.de/bmbf/en/news/new-strategic-agenda-for-european-hydrogen-economy.html

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for about 16 months, until April 2024. DG RTD and DG GROW agreed to be members of the Steering Committee alongside representative of Hydrogen Europe and Hydrogen Europe Research. The output of this study is expected to complement similar initiatives within the Commission, such as the Annual Competitiveness Progress Report or on critical materials for strategic technologies.

The JU has participated in meetings of the European Clean Hydrogen Alliance Working Group (ECHA WG) Standardization, and contributed to the Roadmap on Standardization127, published in March 2023. Moreover, JU has also contributed to the CEOs roundtables of the Alliance and provided updates on the status of different technologies, receiving also feedback from the broader industry for future work-programmes.

Furthermore, it is worth to note that the JU has joined and actively contributed to the activities of the CEN-CENELEC SFEM WG H2 Task Force 'Hydrogen quality needs for industrial uses', preparing the online survey[128] for the collection of inputs from stakeholders.

1.6.2 Collaboration with JRC – Rolling Plan 2022

The EC's JRC undertakes high-quality research in the FCH field, which is of considerable relevance to the implementation of JU activities. In 2016, a Framework Contract between the JU and JRC was drawn up for the duration of Horizon 2020 programme. The scope of this Framework Contract covers the activities the JRC provides at the level of the JU programme. As in the end of 2022 this Framework Contract would come to an end, a new Framework Contract was drawn up for the period 2023-2029, which was signed on the 29th of November 2022.

The activities of JRC under these Framework Contracts are further outlined in annual Rolling Plans, which also detail the specific deliverables to be provided against payment. The annual Rolling Plan 2022 constituted part of the AWP 2022, with a budget of EUR 695,000 foreseen from the JU operational budget[129]. The JRC activities covered by the Framework Contract were planned and agreed between the JRC and the PO, with the involvement of one representative each from Hydrogen Europe and Hydrogen Europe Research.

In line with the JRC's mission, these support activities have primarily contributed 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.

JRC's direct contribution to implementing the RCS strategy

The electrolysis harmonisation activities were continued with the development and finalisation of two

[127] https://ec.europa.eu/docsroom/documents/53721

[128] https://www.clean-hydrogen.europa.eu/media/news/survey-hydrogen-quality-industrial-applications-2022-09-30_en

[129] JRC needed more resources than originally anticipated (EUR 838 100), but it was not possible to increase the indicative budget of EUR 695 000 foreseen in AWP 2022. Therefore, JRC issued a payment note only for the anticipated budget.

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deliverables involving the expert working group for their comments and feedback on the two draft reports prior to the public stakeholder consultation.

The first report[130], published in January 2023 is proposing a harmonised way of assessing energy performance of high temperature steam electrolysis single cells and short stacks. The second report[131], published in May 2023, concerns harmonised protocols assessing performance and durability of stacks and systems for high temperature steam electrolysis.

In addition, the JRC continued to support the research community for the manufacturing and testing of the ZERO∇CELL single cell test hardware. Until 15th December 2022, the page with the ZERO∇CELL - documentation had 617 views and 168 downloads and JRC has been contacted by 13 companies and organisations requesting information and/or assistance for hardware preparation. Testing activities for Ballard are foreseen for 2023.

JRC's contribution to programme monitoring and assessment

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

The JRC has performed the 2022 Annual Programme Technical Assessment (APTA). The purpose of the APTA is to ensure that the JU Programme is aligned with the strategy and objectives set out in its Council Regulation(s) and the Strategic Research and Innovation Agenda (SRIA) or MAWP (for the FCH JU). The JRC's 2022 APTA Report summarises the findings from the assessment of the projects in the Pillars (projects are grouped according to the Pillars of the SRIA).

Many changes were made to the content of the Programme Assessment compared to previous years. In 2022, the report also included a short section describing the technology state of the art for each of the Pillars, a gap analysis and an historical analysis was provided for two of the Pillars (1 and 4). The progress performed by the projects towards achieving the MAWP 2020 state of the art (SoA) targets for the Key Performance Indicators (KPIs) was assessed, in addition to the SRIA 2020 targets. Recommendations specific to each Pillar were provided, as well as general and cross-cutting recommendations in the final chapter.

JRC's contribution to sustainability

In 2022, JRC supported the Clean Hydrogen JU concerning sustainability activities on different areas, such as:

- JRC.D.3 and JRC.C.1 provided support to the projects funded under the 2020 call on life cycle-based activities (i.e., SH2E, Best4Hy, and eGhost projects).
- JRC.C.2 and JRC.C.1 supported the working group 2 of CertifHy on the methodology to allocate greenhouse gas emissions from hydrogen technologies.

As in previous years, the JRC analysed the LCA deliverables submitted by JU projects. JRC prepared a report

[130] https://publications.jrc.ec.europa.eu/repository/handle/JRC128292
[131] https://publications.jrc.ec.europa.eu/repository/handle/JRC129387

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on the sustainability of hydrogen transport options, where it compared the life cycle environmental performance of different hydrogen delivery pathways. JRC also formulated a procedure for developing datasets related with hydrogen value chain to be shared in a Life Cycle Inventory database dedicated to FCH technology data on the Life Cycle Data Network (LCDN).

Finally, JRC prepared the summary report of the Workshop on the Environmental Impacts of Hydrogen, co-organised by the Clean Hydrogen Joint Undertaking[132].

JRC's contribution to safety and safety awareness

JRC operates two databases dedicated to hydrogen related incidents: the Hydrogen incidents and Accidents database HIAD 2.0 is a public repository, a tool for every customer interested in lesson learned and in safety analyses of the hydrogen supply chain and its end sue applications.

The Hydrogen Events and Lessons LEarNed (HELLEN) is a repository of events occurring during the life of Clean Hydrogen JU projects. Its access is restricted and is a tool for the monitoring and control of safety during the execution of the programme. The JRC is collecting and analysing all reported incidents and informs the Programme Office through the annual report.

Following discussions between JRC and the JU, it was decided to re-locate the two databases onto a new online platform, with possible transfer of ownership. Meanwhile, JRC worked on improving the event data collection process and updating the relevant databases. The latest version can now on be considered as the reference database, based on which a new online front version can be developed.

Finally, JRC contributed in 2022 to the EHSP activities, in particular to the updating of EHSP documents and to a workshop on projects safety plans.

1.6.3 Cooperation, synergies and cross-cutting themes and activities

1.6.3.1 Synergies implemented via the call for proposals

This section illustrates how the synergies foreseen during the planning and programming stages in relation to the AWP 2022, materialised in concrete actions.

Since the early stages of preparation of the topics included in the call for proposals 2022, the Clean Hydrogen JU interacted with the members of its Stakeholder Group as well as with a number of European partnerships, 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 JU – this cooperation faced different formats but managed to take their views into account, to the extent possible, in the design of the call for proposals. In addition and to the extent possible, the Clean Hydrogen JU took into account information received internally during the preparation of Horizon Europe Work Programme 2021-22. All these allowed to identify synergies on an ad-hoc basis and avoid potential overlaps during the drafting process of the Call.

For the 2022 call for proposals flagship topic on heavy-duty vehicles, synergies with the Connecting Europe Facility for the Hydrogen Refuelling Infrastructure have been planned and are expected to be

[132] https://publications.jrc.ec.europa.eu/repository/handle/JRC130362

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implemented. In practice this means that the successful Clean Hydrogen JU proposal for the deployment of 150+ heavy duty trucks across TEN-T corridors (project H2Accelerate TRUCKS) will have to be complemented by several successful projects submitted under the Connecting Europe Facility for Transport[133] (CEF Transport), which will lead to the deployment of the required refuelling infrastructure (for example the project GREATER4H[134]).

For all flagship topics in the call for proposals 2022 and specially for Hydrogen valleys, applicants were encouraged (in the topic description) 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 clustering with other projects within Horizon Europe or funded under other EU, national or regional programmes, or having 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, also for the Hydrogen Valleys topics, the call for proposals 2022 included a provision for the awarding of Seals of Excellence to applications exceeding the evaluation thresholds set out in this work programme but which cannot be funded due to lack of budget available to the call. The Seal of Excellence is seen as a tool to improve the chances of sound proposals, otherwise not selected, to find alternative funding in other Union programmes, including those managed by national or regional Managing Authorities.

Finally, the projects selected in the Call 2022 are expected to deliver the synergies foreseen in each of the specific topics (as described in the topic text). Examples included synergies with the Clean Aviation JU for the aviation topics, with Zero Emission Waterborne Transport partnership for the flagship project on inland waterways vessels, with Processes for Planet, P4P for the industrial applications topics, etc.

This good collaboration was not restricted just to Call 2022, but an effort was made to enlarge such co-operation and synergies with other European Partnerships and programmes (at programming and implementation levels) also for the coming years. In 2022, this included ad-hoc dialogues but also wider consultations on possible call 2023 topics with the States Representatives Group and Stakeholders Group of the JU. The JU has also been active in trying to understand the overlaps and possible synergies with the funding provided in other parts of Horizon Europe (in particular with Custer 4 and 5 of the Horizon Europe WP23-24). In addition, synergies with and support to regions and Member States (and other countries) is foreseen through the governance[135] of the JU as well as via a number of dedicated activities such as the JU Project Develop Assistance (PDA) initiative[136].

[133] https://cinea.ec.europa.eu/programmes/connecting-europe-facility/transport-infrastructure_en
[134] https://cinea.ec.europa.eu/system/files/2022-09/CEF-T-2021-AFIF_Cut-off%202_Selected%20projects_0.pdf
[135] Via the States Representative Group
[136] https://www.clean-hydrogen.europa.eu/media/news/15-european-regions-will-receive-project-development-assistance-2023-01-15_en

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1.6.3.2 Delivering synergies via Collaborations with other programmes, agencies and partnerships

In 2022, the Clean Hydrogen JU has remained proactive in defining and in some cases formalising and materialising means for collaboration with other EU Programmes, European partnerships, EU agencies, initiatives and actions with the potential for synergy with its research and innovation agenda.

In particular, regular exchanges with other European partnerships have taken place either through the Stakeholders Group or bilaterally on an ad-hoc basis between the teams working in the Clean Hydrogen JU and those supported by other partnerships and/or programmes. An example of the latter are the regular exchanges between the Clean Hydrogen JU and the Clean Aviation JU for the coordination of the activities, both JUs implementing, bridging the gap between the projects supported by each of the JUs or use of common experts for the evaluation of the hydrogen for aviation topics of both JUs.

In 2022 the JU has worked also very closely with EISMEA to ensure synergies among the EIC Work Programmes and the Clean Hydrogen JU call for proposals, in particular for low TRL activities. The formalisation of the JU collaboration with EISMEA was reflected in a joint Letter of Intent[137] that was signed by both organisations in November 2022, in relation to EIC WP/grants, including reporting in TRUST for monitoring the technology performance and develop follow-up topics to exploit promising low TRL results.

Also in 2022, the Clean Hydrogen JU supported the Key Digital Technologies (KDT) JU in the integration of hydrogen activities in their call for proposal 2023.

Exchanges have also taken place at a working level with Executives Agencies and Commission services implementing other parts of Horizon Europe and other Programmes. In relation to the projects supported by other parts of Horizon Europe the JU has been regularly in touch with colleagues at HADEA following the hydrogen projects implemented by this Agency[138]. The JU participated in the kick-off meetings of HADEA's hydrogen projects. As much as possible similar information has been captured on hydrogen projects supported by other Executives Agencies like CINEA (energy and transport) and EISMEA (EIC funded projects).

In relation to the Innovation Fund, 2022 saw a collaboration both with DG CLIMA and CINEA for the preparation of a workshop looking at creating synergies between the Innovation Fund and Horizon 2020 projects[139].

At Member States level, the Clean Hydrogen JU has kept regular exchanges with German NOW body140 on key strategic areas such as Hydrogen Valleys. But also with representatives of other MS, mainly via the JU States Representative Group (SRG) e.g. feedback provided during the Clean Hydrogen JU AWP/Call 2023 drafting process.

[137] https://eismea.ec.europa.eu/news/european-innovation-council-and-smes-executive-agency-eismea-and-clean-hydrogen-joint-undertaking-2022-11-25_en

[138] Mainly projects supported under topics include in Horizon Europe WP topics included in Cluster 4 for the co-programmed partnerships P4P and Clean Steel

[139] Workshop took place in Feb 2023. Details will be reported in the Annual Activity Report for 2023

[140] https://www.now-gmbh.de/en/

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1.6.3.3 Supporting regions and Member States

In view of setting up a structured cooperation mechanism between the JU and Managing Authorities of Member States and Regions, 2022 saw the signature of a contract implemented via an open public procedure with the main objective of facilitating the identification and implementation of synergies on research and innovation activities between the Clean Hydrogen JU and managing authorities of Member States and Regions[141].

Moreover, the Project Development Assistance (PDA) for Regions with a focus on Cohesion Countries, Outermost Regions and Islands has also started in 2022[142], building on the success of the previous initiative[143] where 11 regions/cities have received similar assistance. The main activities concerned the preparation and launching of an Expression of Interest for regions as well the selection of the (15) regions to be supported. Finally, in collaboration with Mission Innovation 2.0, the Clean Hydrogen JU has continued to support the activities of the Hydrogen Valley platform[144]. An update report on Hydrogen Valleys and the Mission Innovation Hydrogen Valley Platform was published on 22 September 2022 and presented in the 13th Clean Energy Ministerial and 7th Mission Innovation (CEM13/MI7) ministerial in Pittsburgh, USA (September 21-23)[145]. In addition, 2022 saw the preparatory work that was needed for the launching of the platform planned in 2023.

1.6.3.4 Openness of the Clean Hydrogen JU

In addition to the cooperation and synergies mentioned in the above sections, specific activities were included in 2022 to preserve the openness of the JU activities in line with the SBA and the Clean Hydrogen JU strategic document, SRIA.

The JU has made no exception to the open calls principle for neither one of its calls, and the call launched in 2022 by the Clean Hydrogen JU followed this exact same approach.

As per the rules stated in the Horizon Europe Regulation[146], 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 2022, including evaluation and award procedures, were managed according to, and the proposals complied with, the General Annexes to the Horizon Europe Work Programme 2021-2022 that applied mutatis mutandis to the call covered in the AWP 2022 (with the exceptions introduced in the specific topic conditions).

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

[142] https://www.clean-hydrogen.europa.eu/media/news/applications-project-development-assistance-pda-now-open-2022-09-05_en

[143] https://www.clean-hydrogen.europa.eu/get-involved/regions-hub/clean-hydrogen-ju-pda-regions_en

[144] https://h2v.eu/

[145] https://gceaf.org/

[146] 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

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In line with the SBA[147], an additional condition was included for some topics to require that at least one partner in the consortium must be a member of either of the JU Private Members (Hydrogen Europe or Hydrogen Europe Research). This requirement concerned 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, in accordance with the SRIA of the JU, namely section 5.2. Conditions for participation and eligibility for funding. However, none of these additional conditions has changed the open nature of the call.

When implementing the AWP2022, a number of measures were implemented to attract newcomers to the JU activities.

Concerning the call for proposals, several dedicated Info Days took place in different countries including those with a historical limited participation on EU R&I programmes .

Such type of activities contributed to increase the coverage of some of the topics such as the Hydrogen Valleys, for which the Call 2022 attracted proposals covering Valleys across 5 of the EU 13 countries (out of the 19 countries covered by the H2 Valleys proposals). In addition, the Project Development Assistance that the JU launched in 2022 targets Cohesion Countries, Outermost Regions and Islands. The launch of EoI led to support 15 regions out of which 10 are located in EU13.

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.

Whilst most of the PNR activities in the JU Programme will be implemented as part of the activities within Horizontal Activity 1: 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 has set up a Regulations, Codes and Standards Strategy Coordination (RSC SC) Task Force, composed 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.

Following a series of bilateral meetings among the organisations involved in the RCS SC Task Force, the Task Force kicked off its activities in November 2022, reviewing and scoping the tasks entrusted to the group. The operational activities of the RCS SC TF are expected to start in 2023, contributing to steering and coordination of the RCS-related matters in the JU and maximising the impact of the JU Programme in this field.

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

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1.6.5 European Hydrogen Safety Panel (EHSP)

The European Hydrogen Safety Panel (EHSP)[148], initiative 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 - 15 experts in 2022 - 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 JU.

The following sections provide a summary of the activities performed by the EHSP in 2022, grouped per task force.

D.1 Support at the project level

ESHP activities under this category aim at coordinating a package of measures to avoid any accidents by integrating safety learnings, expertise, and planning in the JU-funded projects by ensuring that all projects address and incorporate the state-of-the-art in hydrogen safety appropriately.

In 2022, the EHSP has updated the guidance document for the Safety Planning and Management in EU hydrogen and fuel cell projects published in 2021[149], in view of keeping supporting EU projects to incorporate state-of-the-art hydrogen safety by integrating safety learnings, expertise and planning. The updated document is expected to be published in early 2023 and includes, among others, additional information on the project safety documentation, additional safety principles/ strategies, additional sources of information on the Regulations Codes and Standards relevant to hydrogen, additional safety guidelines and recommendation, etc.

Moreover, the EHSP activities in 2022 have continued with the assessment of all JU projects from a safety-related perspective. Building on this assessment, several safety plans of JU-funded projects have been reviewed, providing recommendations for their improvement where necessary. Besides, the EHSP has continued providing support in case a project consortium did not have its own safety expertise or wishes an independent view.

D.2 Support at the programme level

EHSP works under this category include a set of activities intrinsically linked with the activities of the previous task force but with a broader and cross-cutting dimension, focused on the JU Programme itself and how safety-related aspects can be enhanced within the overall programme and activities.

In 2022 the EHSP has organised a webinar on 'Safety Planning and Management in EU hydrogen and fuel cell projects', with 100+ attendees, to provide guidance on safety planning, monitoring, and reporting for hydrogen and fuel cell projects in Europe. Moreover, the EHSP has further developed a procedure for an

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

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

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incident response aiming at providing a structured response to any incident or safety threat to a project. Besides, the EHSP is keeping contact with the International Association IA HySafe, the U.S. Hydrogen Safety Panel (HSP) traditionally supported by U.S. DOE's Fuel Cell Technologies Office, and the Hydrogen Council, seeking synergies and topics of mutual interest. For example, the EHSP participated in a "Safe H2" group meeting held in the context of an IPCEI spill over effects activity.

D.3 Data collection and assessment

As learning from others is an essential element of a high-level safety culture, activities in this category are centred on the collection and analysis of hydrogen safety-related data to derive lessons learned and provide further general recommendations to all stakeholders. Together with fundamental safety research and applied studies, one of the most fruitful methods used in industry to develop and improve safety strategies for a specific technology is the return of experience obtained from its previous deployments. In the case of hydrogen, previous scarce penetration in the market and society does not yet allow for reliable statistics to be generated and in-depth knowledge about incidents and near misses is still lacking. It is, therefore, important to collect and structure all available information on accidental hydrogen behaviour along its supply chains, up to end uses, to maximise the lessons learned from the past and develop future-proof safety strategies to help ensure safe handling of hydrogen and inform standards and regulations.

In close collaboration with the JRC, the EHSP has continued to enlarge the HIAD 2.0 database in 2022. The number of validated events in 2022 is 741, and the overall quality of the published events has also been improved.

Besides, the EHSP has conducted statistical analysis to identify trends in the type of incident/accident, origin, causes, severity, and violation of relevant safety principles, etc. The gathered statistics informed the subsequent analysis to derive lessons learned and formulate recommendations that can be drawn from the events to improve hydrogen safety in different sectors. In 2022, the EHSP has worked on a new document with the Statistics, lessons learnt and recommendations from the analysis of the Hydrogen Incidents and Accidents Database (HIAD 2.0), last report published in 2021[150], which is expected to be finalised in 2023. Last, the EHSP has completed the collection of the phenomenological models, risk assessment approaches and computational fluid dynamics (CFD) models developed from JU projects and elsewhere by the international hydrogen safety community, initiated in 2021. The comprehensive lists of phenomenological models, risk assessment approaches and CFD models for hydrogen safety engineering application have been compiled with links to relevant published documents in a report, 'EHSP Guidance on Hydrogen Safety Engineering' which is expected to be published in early 2023.

D.4 Public outreach

Framed within the context of the intended broad information exchange, in 2022 the EHSP has continued organising regular meetings with the communication team of the JU Programme Office and has continued reviewing and updating the EHSP webpage on the website of the Clean Hydrogen Joint Undertaking[151].

[150] https://www.clean-hydrogen.europa.eu/get-involved/european-hydrogen-safety-panel-0/reference-documents-ehsp_en

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

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Moreover, in cooperation with the Joint Research Centre (JRC) of the European Commission, the EHSP has organised two webinars[152] on 'Safety planning and management in EU hydrogen and fuel cell projects' on April 2022 (aligned with the JU 2022 call for proposals) and a 'Webinar on CFD for hydrogen safety analysis' in December 2022, with 100+ attendees each.

Last, outreach activities of the EHSP in 2022 have included presentations at several events, such as in the European Hydrogen Energy Conference 2022, in Madrid, Spain, 18-20 May 2022, where the EHSP chaired the parallel session on hydrogen safety and presented two communications, or in the 10th International Seminar on Fire and Explosion Hazards ISFEH, in Oslo, Norway, 22- 27 May 2022, and has also released a scientific publication in the International Journal of Hydrogen Energy (https://www.sciencedirect.com/science/article/pii/S0360319922012976), sharing the lessons learnt and recommendations from the analysis of the Hydrogen Incidents and Accidents Database (HIAD 2.0) with the scientific community.

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

In 2022, the Clean Hydrogen JU performed a market research for procurement identifying different companies that could offer services in the field of sustainability, circularity and hydrogen. In addition, the following areas of expertise were found as necessary to meet the scope of the EHS&C Panel activities:

- Eco-design and eco-efficiency
- Raw materials and supply chain
- Manufacturing processes, automation and scaling up
- Waste management and recycling
- Hydrogen end uses applications (industrial and transport)
- Techno-economic and social science
- Environment and life cycle assessment.

As part of this tender, an open call for expression of interest is intended to be launch in 2023 to select in agreement with the Clean Hydrogen JU a relevant number of experts covering at least the areas mentioned above. The foreseen activities to be conducted initially by the EHS&C Panel for about 12 months have as scope to support the Clean Hydrogen JU at projects and Programme level and provide input for the communication and public outreach. An additional output will consist of defining a comprehensive multi-annual work plan and set of activities to be adopted in the next JU's Annual Work Programmes (AWPs), which might be carried out by a potential future EHS&C Panel until the end of the JU mandate.

[152] https://www.clean-hydrogen.europa.eu/get-involved/european-hydrogen-safety-panel-0/events-ehsp-0_en

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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, establishment of links with other major FCH related programmes globally and international organisations monitoring the developments in the hydrogen sector is deemed important.

In particular, the relevant international activities of interest include in particular those carried out by the IEA under the Hydrogen Technology Collaboration Program (IEA Hydrogen)[153], Technology Collaboration Programme on Advanced Fuel Cells (IEA AFC) and International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)[154]. In 2022 the Clean Hydrogen JU continued to collaborate closely with the EC representatives in the steering committees of these international agreements/associations, in particular within Task 42 on 'Hydrogen Underground Hydrogen Storage' where the JU hosted the kick-off meeting of the Task in its premises and Task 41 on 'Analysis and Modelling of Hydrogen Technologies', as well as being the main contributor to the bi-annual country report update of IPHE for the European Commission, coordinated by DG GROW.

In 2022, the Clean Hydrogen JU had exchanges with the Department for Energy and Mining of the Government of South Australia, in relation to the training of responders, and with the Hydrogen Council Australia, presenting the JU activities on education and training, the FCHO module on education and training, etc. As result, the collaboration between these initiatives in Australia and the JU projects has been strengthened.

The Clean Hydrogen JU contributed with comments and inputs on a number of important hydrogen publications, including the IRENA Survey - Quality Infrastructure for Green Hydrogen, the IEA Global Hydrogen Review 2022 and peer reviewed IEA's methodology on assessing global demonstration needs for net zero (on advanced electrolysis).

Following the successful and close collaboration of the FCH 2 JU with EC representatives on the Mission Innovation – IC8 and the setting up of the Hydrogen Valley Platform, a platform for exchanges between worldwide initiatives on hydrogen valleys, the Clean Hydrogen JU continued to contribute in this direction. It maintained and further improved the Hydrogen Valleys platform that was established through a 2021 public procurement and contributed also towards the other activities of Clean Hydrogen Mission under MI2.0, aiming to make clean hydrogen cost competitive to the end user by reducing end-to-end costs by 2030. In 2022, significant preparation work for the relaunching of the platform was performed from an IT stand-point, while more hydrogen valleys were identified and added to the platform. Moreover, the Clean Hydrogen JU supported the European Commission in its co-lead activities for the Clean Energy Ministerial and 7th Mission Innovation (CEM13/MI7) ministerial in Pittsburgh, USA in September, by preparing an updated report on the role of Hydrogen Valleys in unlocking the new hydrogen economy. The final version of the Report was presented during CEM13/MI7 and is available for download on the Mission Innovation Hydrogen Valley Platform[155].

Moreover, in 2022 the Clean Hydrogen JU hosted a 2-day Workshop 'Clean Hydrogen JU Expert Workshop on Environmental Impacts of Hydrogen',31 March - 1 April 2022, co-organised together with the European

[153] http://ieahydrogen.org/
[154] http://www.iphe.net/
[155] https://h2v.eu/media/9/download

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Commission, the U.S. Department of Energy's Fuel Cell Technologies Office, the Hydrogen Council, the IPHE, Hydrogen Europe and Hydrogen Europe Research. The online workshop was focused on gaining a better understanding and knowledge of the environmental impacts of hydrogen and hydrogen releases and assessing the need for action in this respect, and had three main objectives:

- Provide further insights on the current/ available knowledge on the environmental impacts of hydrogen (phenomena).
- Share evidence-based information on human-made hydrogen releases (sources, quantities, etc.).
- Support reaching a better understanding and assessing the need for action.

With ca. 200 participants from different regions of the world, the Expert Workshop was an unprecedented international collaboration pioneering activity in this field, engaging some of the top international organizations working on hydrogen. A report[156] summarising the Expert Workshop was drafted by the Joint Research Centre of the European Commission.

1.7 Progress against KPIs

1.7.1 Progress against General HE Key Impact Pathways (KIPs)

Horizon Europe (HE) incorporates a novel approach to capturing and communicating impacts via the Key Impact Pathways (KIPs)[157]. 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.

The nine Key Impact Pathways[158] cover areas of scientific, societal and technological/economic impact. A full list of these KIPs can be found in the table of section 5.6. 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 about which information is collected over time to track and report progress. All the KIPs focus on the impact of the Horizon Europe Programme as a whole.

The KIPs will be calculated and reported via the Horizon Dashboard, based on the continuous reporting of the projects. For the year 2022 there are no results to report yet, as the first grants from Call 2022-1 were only signed in December 2022.

[156] https://publications.jrc.ec.europa.eu/repository/handle/JRC130362

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

[158] 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.

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1.7.2 Progress against HE Common JUs KPIs

Horizon Europe introduces common criteria for all Partnerships:

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

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

In its first interim report[159], the Expert Group focused on developing a framework for reporting and monitoring on 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 identification of required data 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)[160]. The report provides an overview of the new Partnership landscape under Horizon Europe and establishes the basis for assessing their progress in future reports.

The first reporting on the HE Common JU KPIs can found in the table of section 5.7. The methodology followed was based on the guidance of DG R&I, provided through a series of four meetings dedicated for this purpose. Below additional qualitative information for the reported indicators is provided, split per the corresponding criterion they address.

1.7.2.1 Additionality

The main added value of European Partnerships derives from the additional private and/or public R&I investments on EU priorities (additionality) that can be translated into a leverage effect resulting from the Union intervention. The alignment of these investments and contributions towards common objectives

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

[160] 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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(directionality) and the achievement of impacts that cannot be created by other Horizon Europe or national actions alone is 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 5.7.

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

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

1. Technical Assistance Study[161]
2. Project Development Assistance Study[162]
3. Provision of Seals of Excellence to successful Hydrogen Valley projects that could not be funded by the JU

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

1.7.2.2 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 KPIs measuring the criterion of directionality, KPI-3 on overall investments mobilised towards EU priorities, as presented in Annex 5.7. This indicator shows that 100% of the overall investment is mobilised towards the Green Deal and Europe's 2030 climate ambition.

1.7.2.3 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 1.6.7.

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 on national, European and international policy/industry cycles, as presented in Annex 5.7.

In terms of KPI-4, a very large number of actors was involved in activities of the JU, be it participation in proposal submissions, following events and workshops organised by the JU or reading its publications. As this is a newly introduced KPI, the JU reports (at least for this year) only on the available data of total number of international applicants to the JU Calls, which as can be seen in Annex 5.7, just for Call 2022 has already reached almost two thirds of the total number of international applicants over all FCH 2 JU Calls.

[161] https://etendering.ted.europa.eu/cft/cft-display.html?cftId=11585
[162] https://etendering.ted.europa.eu/cft/cft-display.html?cftId=9759

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In terms of KPI-11, the JU has organised a number of international and national events, made publications and supported hydrogen related web platforms to promote its work, increase its visibility and strengthen the public awareness of hydrogen technologies. These include the 8th International Workshop on Hydrogen Infrastructure for Transportation and the 2-day expert workshop on Environmental Impacts of Hydrogen. The activities are summarised Annex 5.7 and described in more detail in Section 2.1.

1.7.2.4 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 & 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 5.7.

As regards KPI-5, a large number of stakeholders from different countries and of different types was invited and engaged in activities of the JU, be it participation in proposal submissions and projects, being members of the governance structure of the JU or participating in the panels and groups supported by the JU. As this is a newly introduced KPI, the JU will report (at least for this year) only on the total beneficiaries to the JU Calls (i.e. Call 2022-1), including the type and country of origin of the beneficiaries. So far the Clean Hydrogen JU has 213 beneficiaries from 26 countries, compared to the 804 FCH 2 JU beneficiaries from 44 countries, which indicated a slightly higher number of beneficiaries per million Euro of funding, considering that Call 2022-1 was about one fourth of the Clean Hydrogen JU total budget. In terms of types of beneficiaries, the split among types is similar except for the research organisations which show a much stronger presence in the Clean Hydrogen JU (17% vs 11% in FCH 2 JU), in the detriment mainly of public organisations.

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. In fact more than 70% of the total beneficiaries of FCH 2 JU were new beneficiaries. Nevertheless, it is interesting to see that the Clean Hydrogen JU continues to attract new beneficiaries: almost 50% of its beneficiaries in Call 2022-1 were new, mainly new private for profit companies.

KPI-6 'Transparency and openness' is not applicable to the Clean Hydrogen JU in its current definition as the JU's membership is defined and fixed in the Single Basic Act's Article 75. However, the actions of the Clean Hydrogen JU, especially the calls for proposals, are fully open for participation as Horizon Europe and therefore totally transparent.

1.7.2.5 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

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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 5.7. 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 Stakeholders Group.

The JU has also collaborated with three Partnerships (Clean Aviation, Zero Emission Waterborne Transport, KDT) to prepare call for proposals that their results could be taken up at a later stage from other Partnerships. As the first grants were signed only in December 2022, there is no confirmed co-funded project of the JU so far.

KPI-9 reports on the same topic, but now for other R&I initiatives at EU, national, regional and sectorial level. 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 project so far, although in 2023 the JU is expecting the first coordinated action with CEF aiming at demonstrating heavy-duty vehicles with associated refuelling infrastructure at large-scale and fully paving the way for wider roll-out via other instruments and private investments, as well as a high number of Hydrogen Valleys (which by definition require synergies with other sources of funding).

In terms of other coordinated and joint activities, the Clean Hydrogen JU formalised collaboration with EIC, by signing a letter of intent (see Section 1.6.3.2). At the same time, it also collaborated on an ad-hoc basis with Innovation Fund, NOW (from DE), the Clean Hydrogen Alliance and the European Defence Agency, discussing the possibilities on collaboration and exchanging information on their activities. Moreover, the JU has been preparing to support 15 EU regions and cities through its PDA project (see Section 1.6.3.3 for more details), promoting also hydrogen valleys through the Mission Innovation 2.0 Hydrogen Valley Platform. Finally, it has been collaborating with certain other R&I initiatives through their participation in the Stakeholders Group, such as EURAMET and EERA.

In terms of KPI-10, there are no qualitative data yet to report, as the first grants from Call 2022-1 were only signed in December 2022.

1.7.3 Progress against JU-specific KPIs[163]

1.7.3.1 Resources (input), processes and activities

Already in its first year 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 JU. Three broad

[163] The KPIs are reported in Section 5.8. A complete description of the KPIs and the methodologies can be found in Section 7 and Annex 1 of the SRIA, as well as Section 9 and Annex 1 of the Programme Review 2022.

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areas of activities are identified in the SRIA and the JU's Strategy Map:

- **Supporting climate neutral and sustainable solutions**: the Clean Hydrogen JU is aligned in practice to its new objectives by using its majority of its Call 2022 budget to support sustainable solutions. Although the budget of its predecessors supported about 2.5% of its budget (in total) on either end-use solutions in hard to abate sectors or on circular and sustainable solutions, this has changed radically for the Clean Hydrogen JU. In fact, the largest share of the Call 2022 budget (51%) is planned to support end-use solutions in hard to abate sectors, while an additional 12% should go to circular sustainable solutions. That leads to a total of 62%, compared to a target of 50% for 2027 (over the whole JU budget).
- **Research and Innovation for hydrogen technologies**: the first Call of Clean Hydrogen JU targeted both low and high TRL projects, balancing support in the two categories. For Call 2022-1 40% of the Call budget was directed to early research projects (TRL 2 or 3), much higher than the 10% minimum budget allocation foreseen in the SRIA. At the same time, 4 grants were signed with demonstration or flagship projects (TRL 7 or 8), corresponding to another 38% of Call 2022-1 budget.
- **Supporting market uptake of clean hydrogen applications**: the Clean Hydrogen JU performed a number of activities related to the monitoring of technology progress, as well as 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, as well as supported the Commission, including through technical expertise, in its international initiatives on the hydrogen strategy. These are described in Sections 1.6.4 and 1.6.7. Finally, the Call 2022 included a topic dedicated to raising public understanding of hydrogen and fuel cell technologies. At a time where widely thanks to the JU several hydrogen technologies reached market readiness, it is critical to ensure that the general public gets familiar with these technologies.

1.7.3.2 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 the view to local, regional and Union-wide deployment. The specific level objectives of the JU identify what should be the main direct outcomes and results from the activities of the JU. These should be contributing to the general level impacts of the JU.

The specific objectives of the Clean Hydrogen JU were translated in five specific level outcomes in the JU's Strategy Map:

- Limiting environmental impacts
- Improving cost-effectiveness

  The above two outcomes are linked to the R&I results coming from the projects. As the first grants were only signed on December 2022, no results are available yet to show the progress towards these objectives.
- Synergies with other partnerships

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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.

- Increasing Public Awareness

  Increase 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. Section **Error! Reference source not found.** contains all the relevant details.

  Additionally, Call 2022-2 included a topic on public awareness to start implementing some actions, as a follow-up of the survey's results. Further information will be provided in the next Annual Activity Reports.

- 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[164] continue to show increased activity in terms of academic and research results. In 2022 there were 113 publications from these projects, as well as one more patent was approved, bringing the total of patents approved to 15 and 6 more pending approval.

  In terms of trainings, this outcome is again linked to the R&I results coming from the projects. As there was no project on education and training in Call 2022, 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, Call 2022-1 did not include any projects promoting cross-sectoral solutions. Nevertheless, a number of such projects were included in Call 2022-2, especially in the form of Hydrogen Valleys, which will be reported in the next Annual Activity Report.

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

[164] 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 patent results for a Programme begin being approved only after 3 years after the start of the Programme. For the publications, they will be reported cumulatively as of 2022, with the initial publications stemming from H2020 projects.

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- **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 to the reduction of greenhouse gas emissions. In order to assess the possible impact of supporting such activities, the Clean Hydrogen JU is currently working towards the development of an appropriate methodology for the indicator on expected avoided emissions (i.e. KPI-14), that could reflect this impact.
- **Transition to a clean energy system with renewable hydrogen as one of its main pillars**: the EU's hydrogen strategy[165] have 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 of the hydrogen production meaningful), as well 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 report in Section 5.8 clearly show the high level of ambition considering the very low of deployment and uptake today, but also the high potential of increase, considering that the two indicators doubled in two years, with indications for an even higher increase the coming years based on the planned projects and on-going initiatives.
- **Emergence of a competitive and innovative European hydrogen value chain**: the third area that the Clean Hydrogen JU actions should contribute is in the emergence of a competitive and innovative European hydrogen value chain. The total costs of hydrogen at end-use should be significantly reduced, in order 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, for which again – similar to the first impact O1 - the Clean Hydrogen JU is currently working towards the development of an appropriate methodology.

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 continued during 2022, while starting implementation of the new Programme under Horizon Europe with the first call. Following the best

[165] 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 -relevant targets

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practices already inaugurated by its predecessors, the Clean Hydrogen JU continues to support efforts towards dissemination of project results and exploitation.

1.8.1 Dissemination and Exploitation Internal Guide

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. Since 2021 and following an Internal Audit by IAS in 2020, the Programme Office endorsed an internal D&E Guide to support the project officers in their project monitoring activities, to enhance and customise the D&E monitoring good practices that are already implemented for the projects during and beyond their lifetime. The scope of this guide is to map how the Clean Hydrogen JU is acting and the additional steps foreseen to enhance the monitoring of the D&E in project level. It consists of a list of consecutive steps followed by detailed guidelines in each step to be performed by the Project Officers, that extends from the call for proposals and the Model Grand Agreement166 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 JU performs annually to support the D&E function in programme level and increase the impact of the programme. A training session focused on the new guidance and the implementation of the steps for the POs in March 2022.

1.8.2 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 the Article 28.1 of H2020 MGA, beneficiaries must take measures aiming to ensure 'exploitation' of its results up to four years after the end of a project. However, it remains difficult for the Programme Office to identify and follow up any D&E activities performed by the beneficiaries.

Under the internal D&E guide entered into force in 2021 (see above), the Programme Office continues to address to the project coordinators of completed projects (up to 18 months after), in an effort to motivate them to continue dissemination of their results, to remind them about the existing EC tools and services (like the Horizon Results Platform, the HR Booster etc) available to support them even after the end of the project, and to recommend them to inform the JU of any D&E activities performed and report them through continuous reporting in Compass/SyGMA. In April 2022, the JU formally notified accordingly 8 projects which ended in the second semester of 2020. Also, in December 2022, the JU formally notified 9 more projects that finished in the first semester of 2021.

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

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1.8.3 Horizon Governance

Under the new Dissemination & Exploitation (D&E) Strategy[167] for Horizon Europe established 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 3rd D&E group took place virtually in April 2022 and the 4th D&E group in October 2022. Also, an additional meeting on the D&E Action Plan took place in May 2022. Clean Hydrogen JU is following the meetings closely and is contributing to them accordingly. Apart from the implementation of the Action Plan, the group also discussed the progress and results of the Horizon Results Booster and the inauguration of the Standardisation Booster. As regards the F2P Group, this is discussed under Section 1.5.2.

1.8.4 Horizon Results Platform (HRP)[168]

The HRP is a platform launched by the 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 etc) and help the result owners to exploit them accordingly. By the end of 2022, 11 JU projects have uploaded **26** results in total in the platform (Table 15). Also, 3 more projects (H2Future, HyBalance and INN-BALANCE) are expected to publish exploitable results in the platform. All JU projects are continuously encouraged to upload their exploitable results and increase their visibility (see above).

	Acronym	Call	Programme	Number	Result(s) Link
1	ene.field	FCH-JU-2011-1	FP7	303462	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=303462
2	BIG HIT	H2020-JTI-FCH-2015-1	H2020	700092	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/14554
3	Cell3Ditor	H2020-JTI-FCH-2015-1	H2020	700266	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=700266

[167] 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

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

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4	FCHgo	H2020-JTI-FCH-2018-2	H2020	826247	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=826246
5	Fit-4-AMandA	H2020-JTI-FCH-2016-2	H2020	735607	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=735606
6	HPEM2GAS	H2020-JTI-FCH-2015-2	H2020	700009	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=700008
7	INLINE	H2020-JTI-FCH-2016-2	H2020	735368	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=735367
8	MEMPHYS	H2020-JTI-FCH-2016-2	H2020	735534	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=735533
9	QualyGridS	H2020-JTI-FCH-2016-2	H2020	735486	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=735485
10	TeacHy	H2020-JTI-FCH-2017-2	H2020	779731	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=779730
11	UNIfHY	FCH-JU-2011-1	FP7	299732	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/search;advancedFilters=0;projectId=299732

SOURCE: RTD.G.6TABLE 15: CLEAN HYDROGEN PROJECTS THAT HAVE ALREADY PUBLISHED EXPLOITABLE RESULTS IN THE HORIZON RESULTS PLATFORM

1.8.5 Innovation Radar (IR)

The Innovation Radar is a European Commission initiative to identify high potential innovations and innovators in EU-funded research and innovation projects. The aim is to make information about EU-funded innovations from high-quality projects visible and accessible to the right audiences via the

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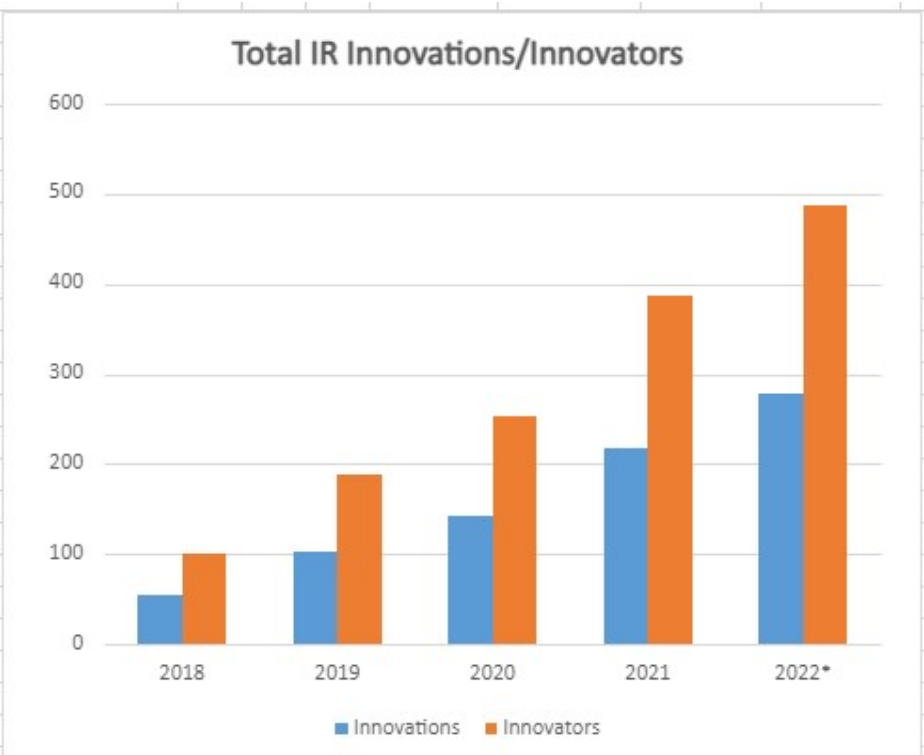
Innovation Radar platform and to encourage the development of a dynamic ecosystem of incubators, entrepreneurs, funding agencies and investors that can help get EU-funded innovations faster to market. The purpose of the Innovation Radar exercise is not only to identify promising actors with the potential to grow, but also to stimulate and propel them to 'make it happen' faster and more efficiently.

Usually during the project mid-term reviews a dedicated expert is mandated to identify and flag potential innovations related to the project objectives, by filling out 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 participate in the IR initiative since its pilot in 2018. So far, innovations of 97 JU projects in total has been analysed: a total of 278 innovations (more than half of which are considered as “very innovative” or “obviously innovative and easily appreciated advantages to customer”), coming from 487 innovators, have been identified and uploaded in the platform. In 2022, 60 additional innovations coming from 101 project participants in 22 of the JU projects, are already included in the platform.



** Estimated*

FIGURE 20. TOTAL NUMBER OF INNOVATIONS ANALYSED AND PRESENTED IN THE INNOVATION RADAR AND THE NUMBER OF INNOVATORS RELATED TO THE CLEAN HYDROGEN JU PROJECTS.

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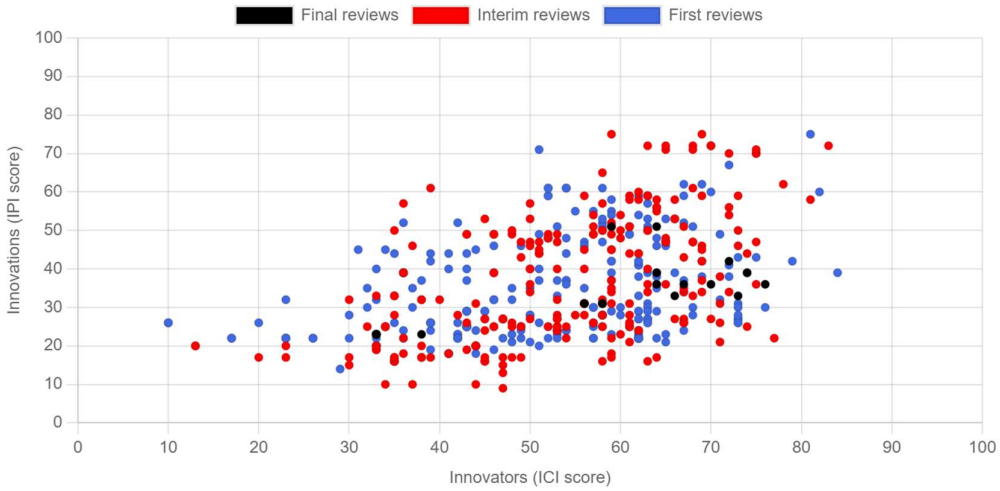

Source: IR Dashboard V2

FIGURE 21. RANKING OF THE DIFFERENT INNOVATIONS BASE ON THEIR INNOVATOR CAPACITY INDEX (ICI) AND INNOVATION POTENTIAL INDEX (IPI).

These innovations are displayed based on the Innovation Radar methodology, between 'exploring', 'business ready', 'market ready' and 'tech ready'. 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 87 innovations that scored above 50 points in the innovation potential indicator, making them ideal first candidates for follow-up actions for exploitation proposals.

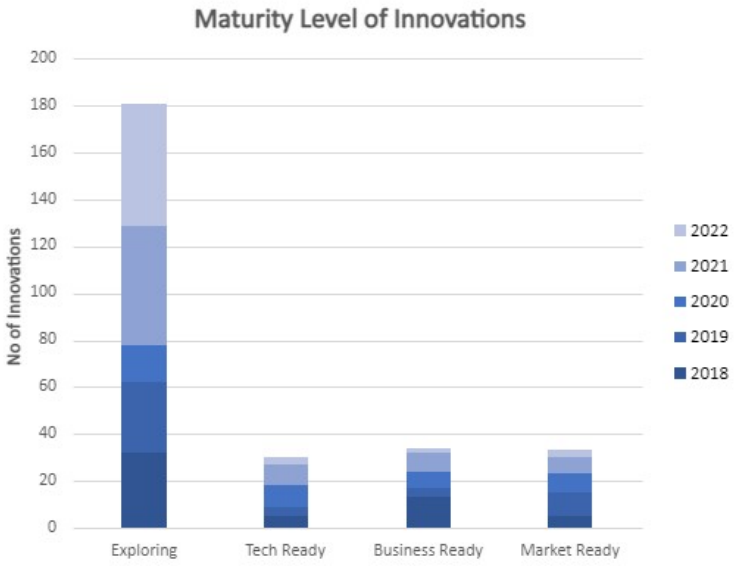

FIGURE 22: CLUSTERING OF INNOVATIONS BASED ON THE MATURITY LEVEL.

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Since the pilot launch of the IR, the Clean Hydrogen JU is collecting valuable feedback to communicate with EC (e.g. DG R&I, DG CONNECT etc) and participates 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.)[169].

1.8.6 D&E Activities of the on-going Projects

During the last two days of the European Hydrogen Week 2022, the Programme Office organised the EU Hydrogen Research Days and Programme Review 2022 (27-28 October 2022). The event is based on the annual data collection exercise organised every year to collect updated information and technological data of the projects that were ongoing during the period of reference (2021). Apart from the TRUST platform to collect descriptive and operational data from the activities of the projects, the other pillar of the exercise is the EU Survey Questionnaire that the projects submit to provide qualitative type of information regarding their main activities. Its purpose is to gather the necessary input to support the in-depth assessment of the progress realised by the Clean Hydrogen JU programme, identify its successes and form recommendations for improvement.

According to the data provided by 94 active projects on their D&E activities and the KERs:

- 73 projects reported 302 dissemination activities;
- 50 projects reported 78 exploitation activities;
- 73 projects reported 141 KE exploitable results.

Dissemination activities in 2021 showed a significant increase (+31.5%), compared to 2020 due to the ease of the measures related to the Covid -19 pandemic. Also, in total 119 scientific publications were reported and 1 additional patent was granted (related to project NEWELY).

As for the type of the reported dissemination activities, participation in conferences showed a remarkable increase with 136 (45.03%) compared to 2020 where only 72 participations (almost 29%) were reported. The projects reported also 76 (25.17%) scientific publications, 37 (12.25%) education and training activities (workshops etc) and 32 (10.6%) meetings.

[169] 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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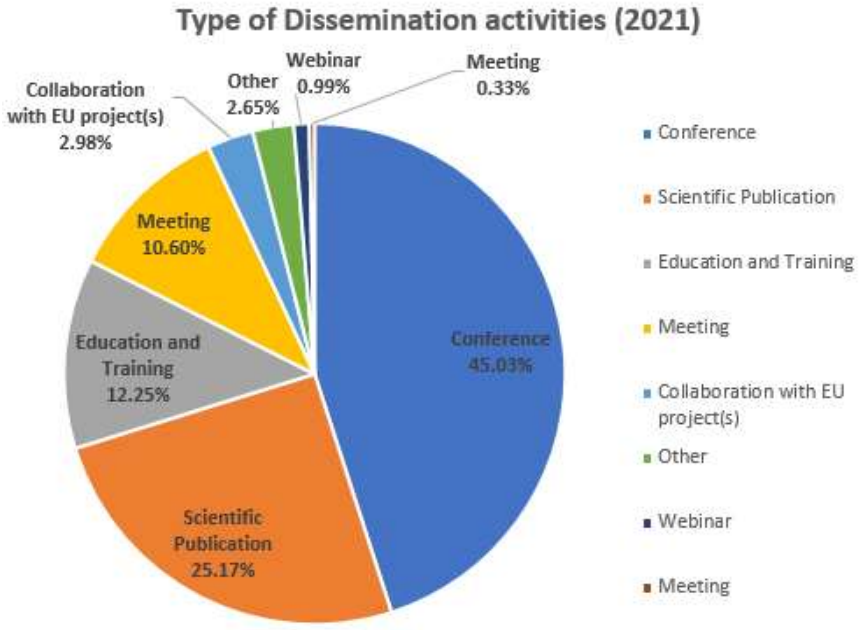

FIGURE 23: TYPE OF THE DISSEMINATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS IN 2021

As regards the target audience of the activities, the vast majority aimed to reach scientific and/or research communities (62.25%) and industry and/or business partners (21.52%). Less than 1/5 of the activities targeted at end-user communities (5.3%), policy makers (5.3%), EU Institutions (1.99%).

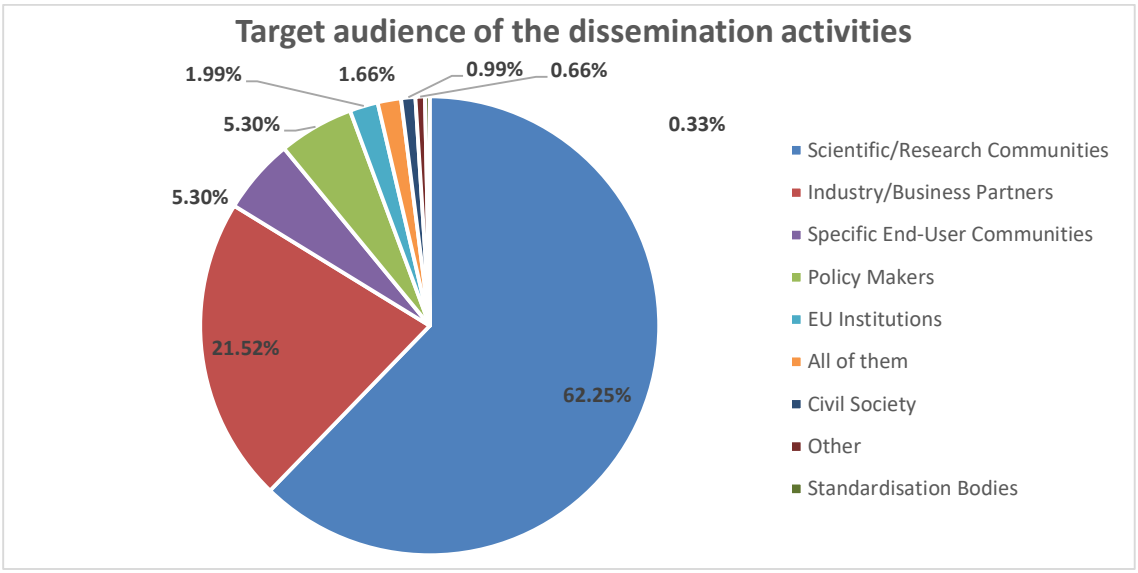

FIGURE 24: TARGET AUDIENCE OF THE DISSEMINATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS IN 2021

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In terms of achievements and/or results in the reference period, according to the available data, 73 projects reported at least one achievement or result during 2021 (141 in total). But outside the reference period, in 2022 17 projects are expecting to show 48 achievements or results.

The project outcomes are classified by the data providers mainly as methods, materials or instruments (36.17%), as products (30.5%) or as designs (12.77%). About 7% of the results are related to infrastructure (e.g. HRSs), while 3.55% is identified as contributing to standards or policy recommendations.

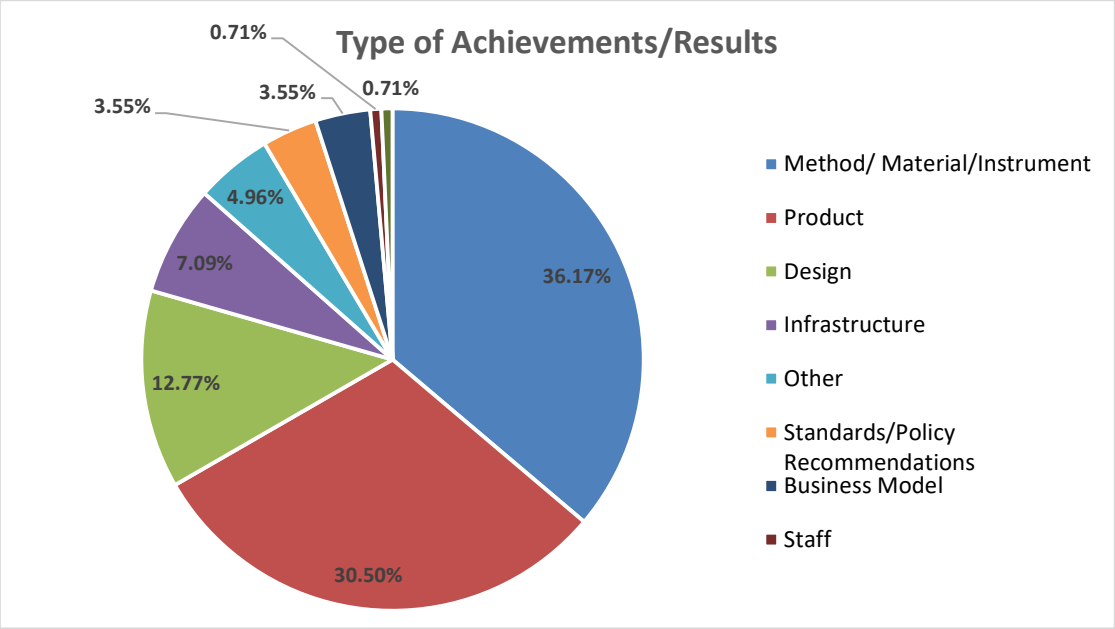

FIGURE 25: RESULT TYPE OF THE OUTCOMES AND PROJECTS RESULTS REPORTED BY THE PROJECTS IN 2021.

As expected by the nature of the programme and the projects funded, most of the exploitable results are related to an emerging market (62.32%) or they have a market creating potential (25.36%), while for a small part of the most innovative activities market doesn't exist yet (9.42%).

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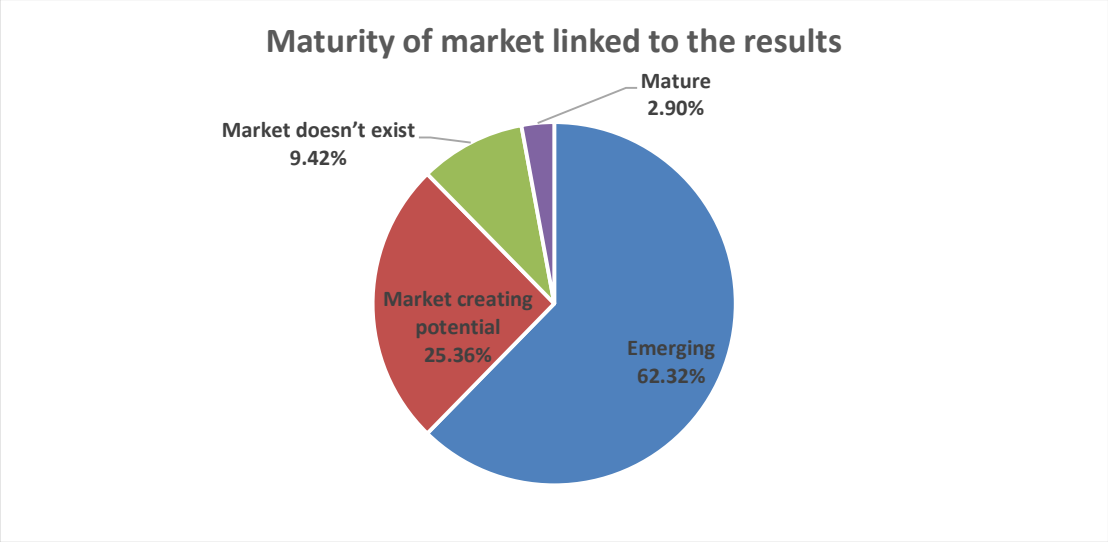

FIGURE 26: MARKET MATURITY LINKED TO THE RESULTS IN 2021.

As regards the steps undertaken towards exploitation, for 59 results (42.45% of all) the projects proceeded in a pilot or demonstration, for 39 (28.06%) they were prototyping in laboratory and for 13 (9.35%) of them they were prototyping in production. Few of them proceeded in market/feasibility study (7), contribution to standards (7), while 13 (9.35%) of them are not related currently to any actions towards exploitation.

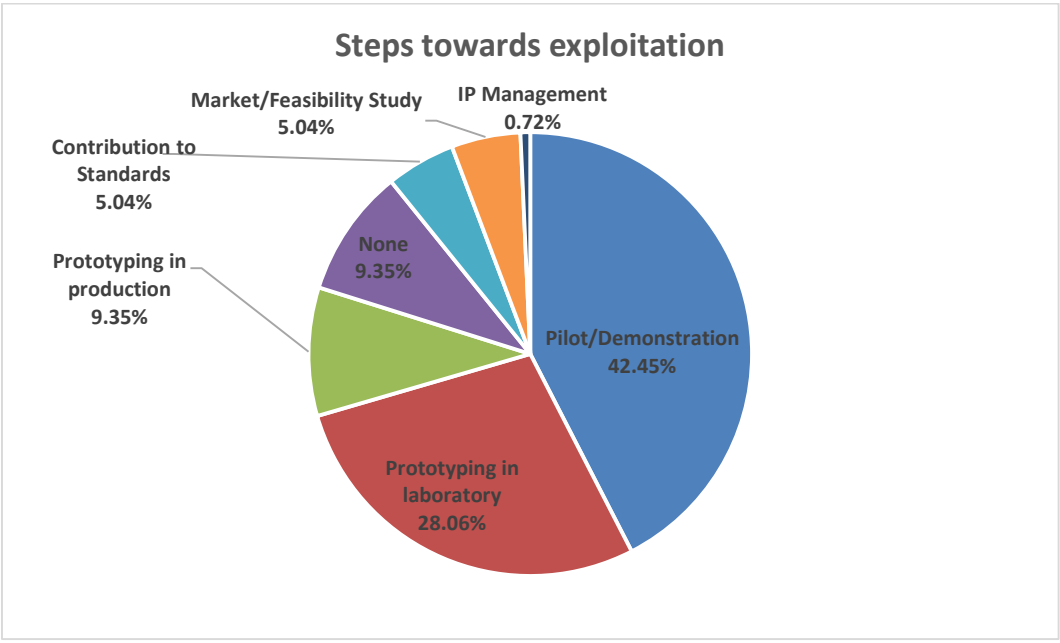

FIGURE 27: STEPS TOWARDS EXPLOITATION OF THE RESULTS IN 2021

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In terms of the expected impact, more than 6 out of 10 (87, 62.14%) of the results are expected to have an impact in the next 1 to 5 years, while 38 (27.14%) of them were expected to have a more imminent impact within 12 months.

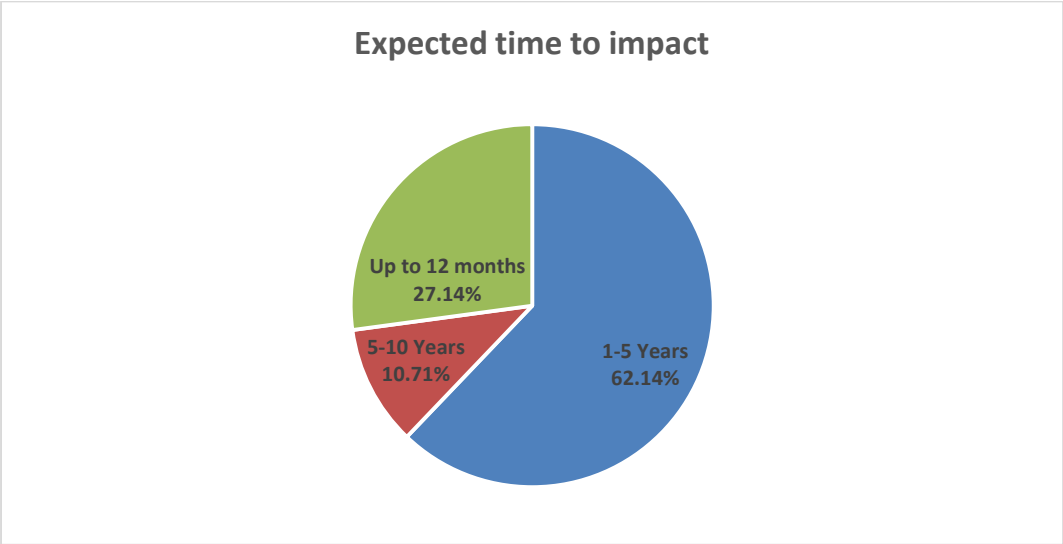

FIGURE 28: EXPECTED IMPACT TIME OF THE EXPLOITATION.

The exploitation activities performed by the projects to support the uptake of the aforementioned results were quite diverse as well: 22.37% of them were related to meetings with user communities, 21.05% with steps towards standardisation, 13.16% with business model/plans, 10.53% with IPR activities etc.

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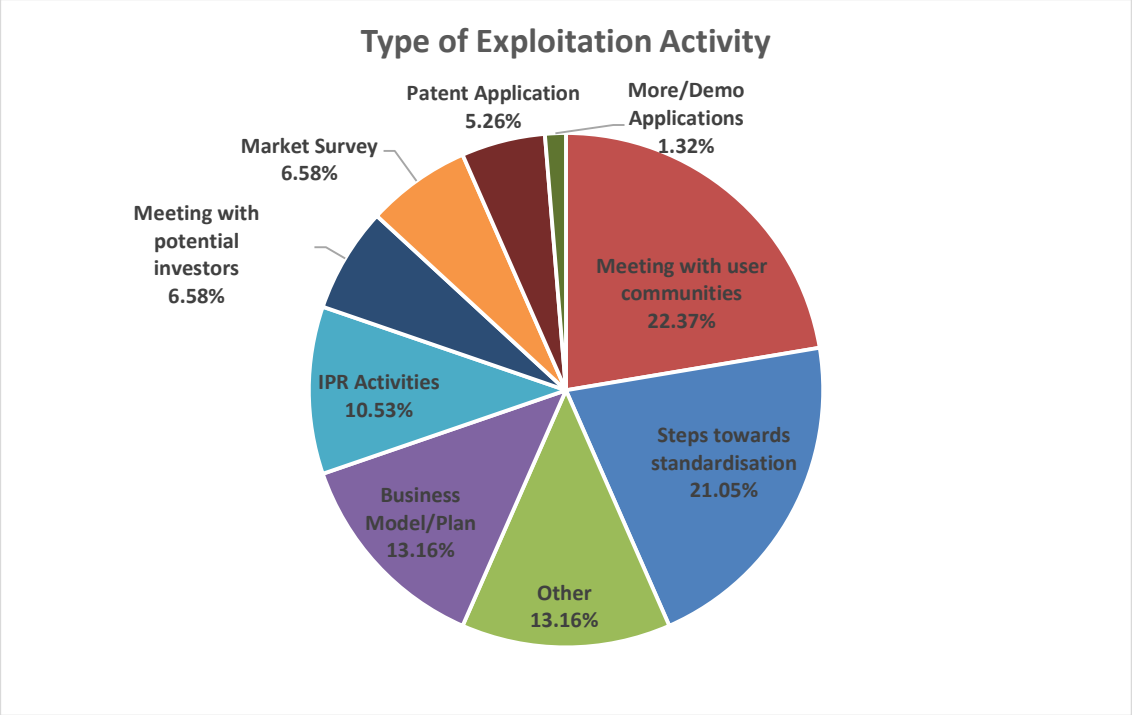

FIGURE 29. TYPE OF THE EXPLOITATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS IN 2021.

As regards the target audience of these activities, the vast majority (60.26%) were addressed to the industry and /or business partners, which indicates that these are the main user communities of the project results (especially those of the low to medium TRL) to advance to the next level. Also, 15.38% of the activities targeted the standardisation bodies and 8.97% the research communities. Finally, some of them are also targeted final users or innovators.

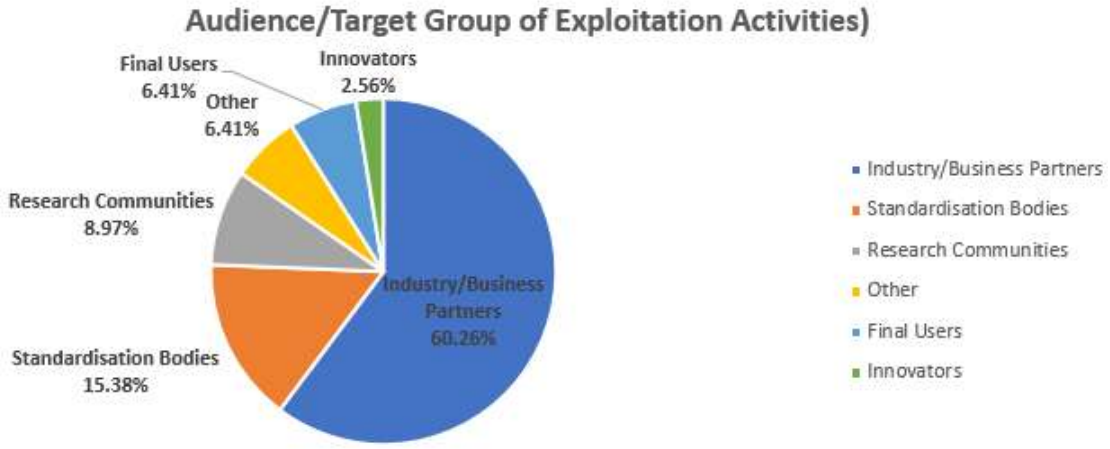

FIGURE 30. TARGET AUDIENCE OF THE EXPLOITATION ACTIVITIES PERFORMED BY CLEAN HYDROGEN JU PROJECTS IN 2021.

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Finally, regardless of the period that the results became exploitable, the main bottlenecks/obstacles identified by most of the projects on the efforts to exploit them are the lack of regulations or standards (20.16%), the lack of financing (16.28%), IPR related issues (9.30%) and lack of labour skills (7.75%). Also, 65 projects identified at least 1 or more obstacles, whereas 6 projects referred that they haven't encountered/identified any obstacles.

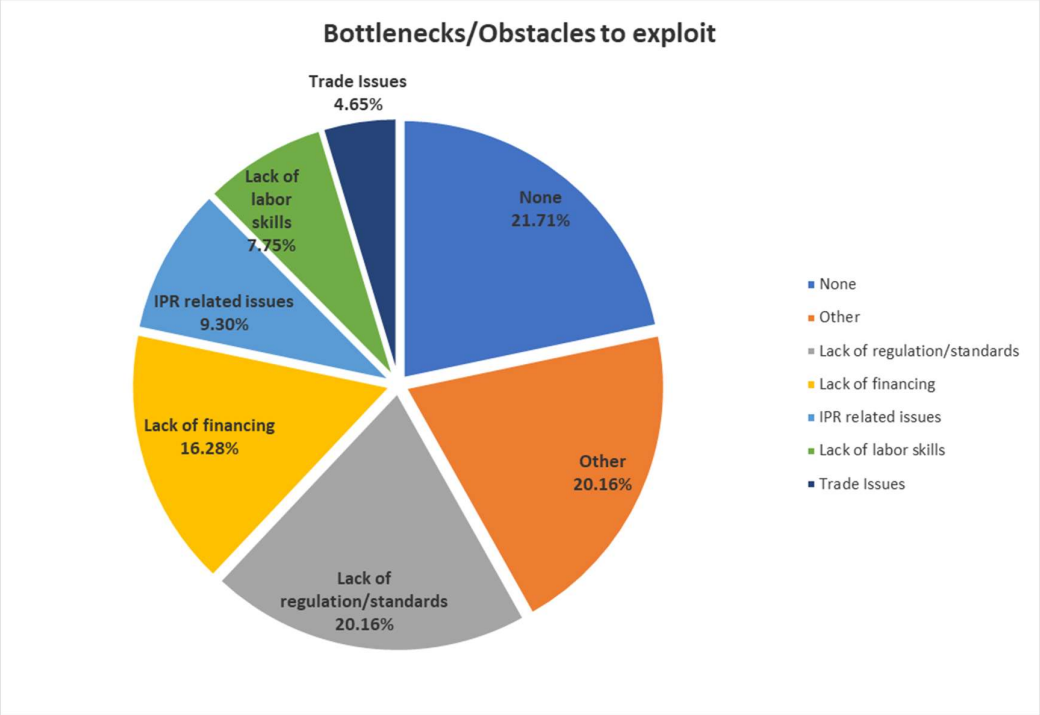

FIGURE 31. BOTTLENECKS AND/OR OBSTACLES THAT HINDER EXPLOITATION OF RESULTS.

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2 SUPPORT TO OPERATIONS

2.1 Communication activities

Communication activities focused in 2022 on the following areas, as described in the Annual Work Plan:

1. Developing the communications strategy for the entire duration of the JU;
2. Consolidating the Clean Hydrogen Partnership brand;
3. Determining the level of awareness and acceptance of hydrogen technologies.
4. Generating media coverage and awareness among various stakeholders by means of a long-term media campaign.

2.1.1 Development of a multiannual communication strategy

A new, multi-annual communications strategy for the 2022-2027 period has been drafted, to ensure a solid strategic framework for communications and the coherence and continuity of the activities. This strategy is intended to guide Clean Hydrogen's communications through changes driven by the new legal obligations, a new brand, a new organisational strategy cycle and social, technological and policy developments. It will be discussed with the JU members in order to be approved during 2023.

2.1.2 Communication media campaign (October – December 2022)

A new contract for the development and implementation of a (social) media campaign started in mid-September 2022 and will continue until June 2023. The Clean Hydrogen Joint Undertaking's media campaign revolved around topics such as, Clean hydrogen technology, Clean Hydrogen Joint Undertaking funding opportunities (calls for proposals and expression of interest for various topics, in particular PDA and Hydrogen Valley projects).

The objectives were to:

- Create a positive narrative around hydrogen, as an important part of the solution to the current energy challenges.
- Earn positive, quality coverage of the Clean Hydrogen Partnership and the breakthroughs and opportunities existing in the hydrogen sector, especially in those countries lagging behind
- Communicate about the first call for proposals of the new JU, inform about the available funds and generate a high number of valuable applications (with a focus on Hydrogen Valleys, as well as the call for expression of interest for PDA.)

In particular, the communication focused on the following issues: PDA, Hydrogen Week, Hydrogen Valleys, and the preparations for the launch of the 2023 call for proposals.

Overview of media in October 2022:

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Coverage of PDA launch in the Spanish press – October 2022

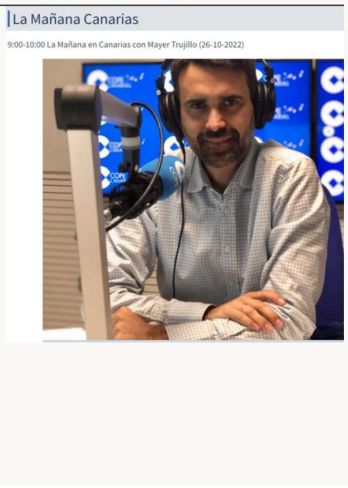

SÁBADO, 8 DE OCTUBRE DE 2022
LA PROVINCIA / DIARIO DE LAS PALMAS

Antonio Aguiló

«Canarias es la candidata ideal para proyectos de hidrógeno»


Canarias7

Canarias tiene una segunda oportunidad con el hidrógeno limpio

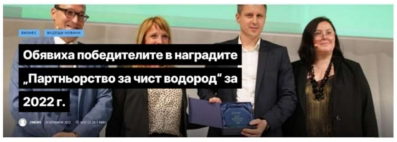

La Mañana Canarias

9:00-10:00 La Mañana en Canarias con Mayer Trujillo (26-10-2022)

N°	DATE	MEDIA	TYPOLOGY	HEADLINE	AUDIENCIE	LINK
ONLINE						
1	10/7/2022	LA PROVINCIA	Tier 1 Regional Newspaper	«Canarias es la candidata ideal para proyectos de hidrógeno	1,101,000	https://www.laprovincia.es/economia/2022/10/08/canarias-candidata-ideal-proyectos-hidrogeno-76994441.html
2	10/7/2022	EL DÍA	Tier 1 Regional Newspaper	«Canarias es la candidata ideal para proyectos de hidrógeno	42,900	https://www.eldia.es/economia/2022/10/08/canarias-candidata-ideal-proyectos-hidrogeno-76994875.html
3	10/26/2022	COPE Canarias	Tier 1 National Radio	Intervention of Antonio Aguilo in the morning news [48:40 - 5	24,000,000	https://www.cope.es/emisoras/canarias/la-manana-canarias/audios/900-1000-manana-canarias-con-mayer-trujillo-26-10-2022-20221026_2090202
PRINT						
1	10/2/2022	CANARIAS 7	Tier 1 Regional Newspaper	Canarias tiene una segunda oportunidad con el hidrógeno lir	47,725	N/A
2	10/6/2022	LA PROVINCIA	Tier 1 Regional Newspaper	«Canarias es la candidata ideal para proyectos de hidrógeno	43,000	N/A
3	10/6/2022	EL DÍA	Tier 1 Regional Newspaper	La Asociación Hidrógeno Limpio ofrece apoyo para solicitar a	37,000	N/A
RADIO						
1	10/26/2022	COPE Canarias	Tier 1 Radio Station	Intervention of Antonio Aguilo in the morning news [48:40 - 5	12,000	https://www.cope.es/emisoras/canarias/la-manana-canarias/audios/900-1000-manana-canarias-con-mayer-trujillo-26-10-2022-20221026_2090202
TOTAL					24,182,625	

Engagement with the press release dissemination announcing the winners of Clean Hydrogen Partnership Awards was high in countries such as Bulgaria and Poland, and also have been covered in Italy and Spain.

Bulgaria



На официална церемония в Брюксел бяха обявени печелившите проекти в наградите „Партньорство за чист водород" за 2022 г., които имат за цел да отличат най-добрите проекти в ЕС в областта на водорода в категориите „Най-добра иновация", „Най-успешен пример", „Най-добра информационна кампания" и „Европейска водородна долина на годината".

Poland

Ogłoszono zwycięzców Nagród Partnerstwa na rzecz Czystego Wodoru 2022

Spain

El Corredor Vasco del Hidrógeno entre los ganadores de los Premios de la Asociación Europea para un Hidrógeno Limpio 2022

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POLAND						
NO	DATE	MEDIA	TYPOLOGY	HEADLINE (translated into EN)	AUDIENCE	LINK
1	9-Nov	Zienalo Gospodarka	ecology / energy	Europe on its way to zero emissions - hydrogen will soon become one of the main pillars of the energy mix - what technologies will be implemented?	29,000	https://zielonagospodarka.pl/europa-w-drodze-do-zero-emisyjnosci-niebawem-wodor-
2	9-Nov	Biznes newseria	business / news	The winners of the 2022 Clean Hydrogen Partnership Awards have been announced	50,700	https://biznes.newseria.pl/biuro-
3	14-Nov	Iszecinek	regional news		152,900	
4	14-Nov	Info Gliwice	regional news	Winners of the 2022 Clean Hydrogen Partnership Awards announced	44,200	https://infogliwice.pl/ogloszono-zwyciezcow-nagrod-partnerstwa-na-rzecz-czystego
5	14-Nov	Terazraciborz	regional news	Winners of the 2022 Clean Hydrogen Partnership Awards announced	5,000	https://terazraciborz.pl/ogloszono-zwyciezcow-nagrod-
6	16-Nov	Bomega.pl	news	Winners of the 2022 Clean Hydrogen Partnership Awards announced	17,400	https://bomega.pl/ogloszono-
SPAIN						
NO	DATE	MEDIA	TYPOLOGY	HEADLINE (translated into EN)	AUDIENCE	LINK
1	10-Nov	hidrogeno-verde.e	energy	El Corredor Vasco del Hidrógenoamong the winners of the European Clean Hydr	5,000	El Corredor Vasco del Hidróger
ITALY						
NO	DATE	MEDIA	TYPOLOGY	HEADLINE (translated into EN)	AUDIENCE	LINK
1	10-Nov	Canale Energia	ecology	Winners of the 2022 Clean Hydrogen Partnership Awards announced	18,400	Assegnati i premi Clean Hydrog
				TOTAL	4,378,900	

2.1.3 European Hydrogen Week

The third edition of the European Hydrogen Week was organised in cooperation with all JU members , in particular Hydrogen Europe on 24-28.10.2022 at Brussels Expo. The event brought together multiple activities: exhibition, policy conferences including the Clean Hydrogen Partnership Forum and the EU Hydrogen Research Days. Over 3200 stakeholders of the hydrogen community were brought together to witness more than 120 exhibitors and 150 speakers covering all elements of the sector's value chain. The event provided policymakers and industry with the opportunity to discuss the state of the hydrogen economy, and for the Clean Hydrogen Partnership to present the results of its various projects.

This event is/was a melting pot of powerful and influential leaders, policy makers, researchers and consumers each looking for the next big thing. Companies could find customers, investors and partners in

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the exhibition area as well as have been able to attend thought-provoking conferences. The activities of the Week consisted of:

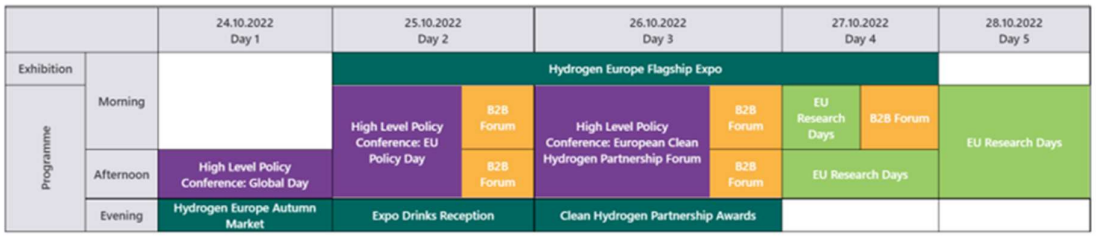

TABLE 16. ACTIVITIES IN EUROPEAN HYDROGEN WEEK

- **Flagship Expo** : The Clean Hydrogen Partnership was present with a booth within the flagship exhibition, which was organised by Hydrogen Europe; attendees could get first-hand information on the latest electrolyser and fuel cell technologies as well as test hydrogen trucks, buses, and cars displayed. A photo gallery is available here.
- The **high-level policy conferences** (including the Clean Hydrogen Partnership Forum) featured panels consisting of some of the most prominent stakeholders in the hydrogen industry and covered the most pressing topics facing this new industry: the need for both urgency and pragmatism in creating the regulatory framework, the unique challenges different sectors face to decarbonise and how hydrogen can help, and how to remain a leader in an industry that has caught the attention of the rest of the world. Day two of the event was highlighted by a visit and speech from Mr. Frans Timmermans, Vice President of the European Commission. A photo gallery is available here.
- The **B2B Forum** managed by Hydrogen Europe ran over 2,5 days, featuring sessions covering all aspects of value chains. **The Clean Hydrogen Partnership Forum** took place on 26 October 2022. The conference focused on Research and Innovation activities in the EU with a dedicated session on Hydrogen Valleys in the framework of the REPowerEU Communication. Several speakers at this year's edition of the Clean Hydrogen Partnership Forum and its Hydrogen Research Days, part of European Hydrogen Week, have called for a faster rollout of hydrogen technology for transport, homes, businesses and industry.
- The **Clean Hydrogen Partnership Awards**, announced on 26 October 2022, celebrate projects that have achieved excellence in clean hydrogen technologies research and innovation. The awards had already become a tradition for the public-private organisation. Now in their fifth year, the awards provided an added incentive for project beneficiaries to bring research and innovation to the market. The 2022 award categories recognised the best innovation, success story, project outreach and, for the first time, the recently established European hydrogen valleys. The finalists for the best innovation awards were selected by the partnership, based on the results in the European Commission's EU Innovation Radar Platform. The public then voted for the winning one. The Clean Hydrogen Partnership selected the winning outreach and valley projects.

  Best Innovation Award electrolysers – the engines of green power

  The winner was the novel anion exchange membrane developed by the NEWELY project.

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BEST INNOVATION AWARD WINNERS: REPRESENTATIVES OF THE NEWELY PROJECT, SIGNE RATSO, EUROPEAN COMMISSION (SECOND FROM LEFT) AND MIRELA ATANASIU, CLEAN HYDROGEN PARTNERSHIP (FAR RIGHT)

The project developed a 2 kW five-cell prototype. The membrane has very good mechanical stability and is set to become the most efficient and cost-competitive AEMWE. AEMWEs combine the best features of alkaline and polymer electrolyte water electrolysers.

Ms. Signe Ratso, Acting Director-General for Research and Innovation at the European Commission, who presented the award for Best Innovation, said she has seen hydrogen reach the status of mainstream technology, from being a niche idea, and that it will continue to play an increasingly important role in the green energy transition.

“Hydrogen will become one of the central pillars of our future clean energy system. Investment in hydrogen R&I is crucial to speed up this deep industrial and societal transition. The Best Innovation Award of the Clean Hydrogen Partnership puts the spotlight on innovative and highly promising solutions that will accelerate this transformation.”

Best Success Story: advancing membrane technology

The GAIA project won the Best Success Story with 523 votes (47 %) of the 1 122 total votes cast by the public.

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GAIA PROJECT'S REPRESENTATIVE, DEBORAH JONES (CENTRE), MELISSA VERYKIOS, CHAIR OF THE GOVERNING BOARD OF CLEAN HYDROGEN PARTNERSHIP (LEFT) AND MIRELA ATANASIU, CLEAN HYDROGEN PARTNERSHIP

GAIA developed and tested advanced electric vehicle fuel cell components that meet stringent durability and performance requirements, taking the technology another step closer to commercial deployment and helping to decarbonise the transport sector.

The project's automotive membrane electrode assemblies (MEAs) achieved a 6 000-hour lifetime and a leading power density of 1.8 W/cm2 at 0.6 V in full-size cell short-stacks.

Best Outreach: reaching out and making waves

The SHIP FC project won the Best Outreach Award, which recognises EU funding beneficiaries who communicate effectively about their project.

REPRESENTATIVES OF SHIPFC RECEIVED THE BEST OUTREACH AWARD FROM THE CLEAN HYDROGEN PARTNERSHIP.

SHIP FC is making the case for zero-emission propulsion for large, long-range vessels. A modular 2 MW fuel cell using ammonia as fuel is being tested on a large construction vessel for at least 3 000

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hours over one year. Socio-technical models and analysis will be performed and feasibility studies conducted on other vessels.

Some of the project's outreach achievements included the attendance at the official project start by senior Norwegian politicians, including former minister of climate and the environment, Ola Elvestuen; representatives from the International Maritime Organisation and the Marine Environment Protection Committee. The event was broadcast on national TV.

The project was also presented at numerous conferences and industrial fairs and featured in the European Maritime Transport Environmental Report 2021 and the European Maritime Safety Agency report. It also has an active LinkedIn account.

European H2 Valley 2022 Award: a triple valley success

The three winning valleys were HEAVENN in the Netherlands, Basque Hydrogen Corridor in Spain (BH2C), and eFarm[170] in Germany.

EUROPEAN HYDROGEN VALLEY AWARD WINNERS RECEIVED THE BEST OUTREACH AWARD FROM PAULINE ROUCH, EUROPEAN COMMISSION (THIRD FROM LEFT) . HERE WITH MIRELA ATANASIU (CENTRE) AND BART BIEBUYCK (FAR RIGHT), FROM THE CLEAN HYDROGEN PARTNERSHIP.

Pauline Rouch, Head of Cabinet at the Directorate-General for Research and Innovation, handed out the award: "Although the concept of hydrogen valleys is relatively recent, it was high time to honour the outstanding efforts of the communities working behind the scenes to bring technology, innovation and entrepreneurship together. The winners today will be an inspiration for many, she said."

Six criteria were used to identify the winning valleys: the extent of value chain coverage, hydrogen production volume, the variety of hydrogen end uses, project finalisation, the stakeholder landscape, and project innovativeness.

[170] Hydrogen valleys | eFarm (h2v.eu)

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- The **EU Hydrogen Research Days** took place on 27-28 October and focused on the progress made by the partnership in hydrogen production, distribution and storage, end-use applications in transport and heat and power, and cross-cutting technologies. Representatives of the wider scientific community were invited to this year's programme review for the first time, to offer independent opinions and advice on the projects funded by the partnership and its overall activities. Discussions about cross-cutting technologies focused on the essential elements needed to ensure their commercialisation. Speakers agreed that the sustainability and safety of hydrogen energy technologies, and public awareness of its benefits are among the essential elements needed to ensure a smooth deployment.
- **European Hydrogen Week – side events**
  - For the first time, the JU had given to its stakeholders the opportunity to be part of the European Hydrogen Week 2022 by organising side events across Europe. The events intended to complement the goals of the week through discussions and presentations around the development of the hydrogen economy across Europe.
  - Local and regional authorities, municipalities, public and private entities were encouraged to share ideas and latest developments within the Hydrogen Community during the entire month of October 2022., with over 20 events taking place throughout Europe[171].

2.1.4 Public opinion Survey

A public opinion survey was conducted in 2022 to examine public awareness and perception of hydrogen. The contract for the implementation of the services was signed in March 2022 for a period of 11 months.

The survey "Awareness of Hydrogen Technologies in European Union", with a sample size of 25,900 people, explored a range of issues, including knowledge and awareness on energy in general and on Hydrogen in particular. It focused also on acceptance, overall awareness and uptake of these technologies, the barriers for uptake, as well as potential myths associated with hydrogen.

In addition to its overall awareness, the study analysed the feelings of the population towards hydrogen, its perceived risks, impact on the environment and on energy dependency. The degree of acceptance and the perception of the population are all parameters that will help to better understand the current issues

[171] https://www.clean-hydrogen.europa.eu/media/news/european-hydrogen-week-side-events-2022-10-03_en

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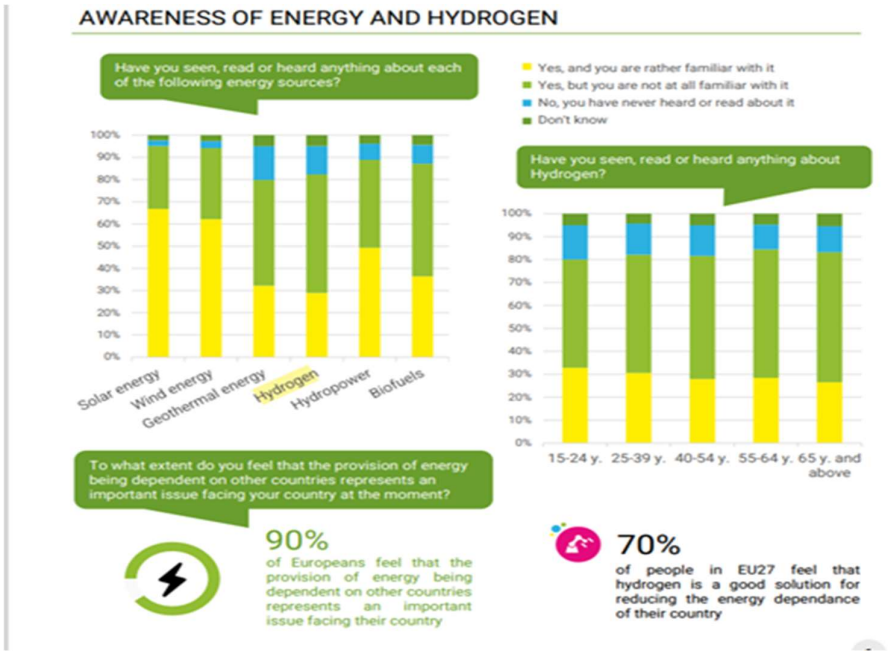
about hydrogen. This will determine to what extent the European population is willing to switch to hydrogen. Furthermore, the survey aims to collect data on the current use of hydrogen by households. The survey will later be used to develop an action plan for increasing the awareness, acceptance and uptake of hydrogen technologies by both public and private sectors, including ways to monitor it during the Clean Hydrogen JU's mandate.

The preliminary outcomes are:

- The results show that there is already a good awareness of hydrogen technology – equivalent to that of other renewable sources such as biofuels or geothermal energy. People see hydrogen as a promising technology for the next generation of energy supply, part of the mix of clean energy solutions. However, only about 8 % of respondents have come into contact with the technology up to now.
- More than 8 respondents out of 10 in the EU have seen, read or heard something about Hydrogen. 29% of the population consider themselves to be rather familiar with hydrogen, 53% have heard of it without further knowledge about it. Only 13% of respondents have never heard about it.
- Currently only 0.4% of the EU population surveyed use a hydrogen-powered car. Yet, 49% of overall respondents answered that they are likely or very likely to switch to a car powered by an alternative source of energy in the next 2 years.

All results are expected to be published with the final report of the tender in 2023.



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2.1.5 Other events

Info day for Call 2022

The Programme Office presented the various call topics and outlined the rules and procedures of the call during its annual info day (which took place online on 15th March 2022) . More information, including the presentations and recording of the event, is available on the dedicated page.

Hannover Messe 2022

Hannover Messe in one of the world's most important industrial showcase fairs for companies. It features innovations in automation, digitalization, electrification, and energy efficiency, the electrical and digital industry is guiding the industrial transition to a climate-neutral circular economy. The 2022 edition took place between 30 May –2 June . Clean Hydrogen Partnership participated in the exhibition with a stand together with NOW GmbH and delivered a presentation in two different sessions in the public and in the technical forum: 'Priorities of the Clean Hydrogen Partnership' and 'Fuel Cells for mobility who is advancing the technology in Europe'.

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Connecting Europe Days – 2022 edition

The 2022 edition of the Connecting Europe Days took place in Lyon between 28th and the 30th of June. This is the European Commission event to discuss transport and mobility, and their role in achieving the ambitious goals set out in the European Green Deal and the Sustainable and Smart Mobility Strategy. Participants have been presented state-of-the art innovations at an exhibition of EU-funded projects, demonstrations of alternative mobility vehicles and automated transport. The Connecting Europe Days were organised together with the French Presidency of the Council of the EU.

The JU participated as part of the Hydrogen Pavilion, and presented its transport and infrastructure projects (H2ME, ZEFER, H2Haul, JIVE, MEHRLIN, REVIVE) as well as its hydrogen valley project Heavenn , alongside other partners – regions in France, and France Hydrogene.

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8th International Workshop on Hydrogen Infrastructure for Transportation

On the 12 and 13 September 2022, Clean Hydrogen Partnership organized and hosted the '8th International Workshop on Hydrogen Infrastructure for Transportation' in cooperation with JRC, (European Commission) NEDO (Japan), NOW (Germany) and DOE (US Department of Energy). During the 2 days event, participants were able to exchange information regarding deployment experiences, best practices and progress on key issues facing hydrogen infrastructure for fuel cell electric heavy-duty vehicles in the US, Europe, Germany and Japan. This annual event convenes stakeholders from industry, government, and academia to facilitate collaboration in early-stage R&D on hydrogen fuelling infrastructure technologies.

European Research and Innovation Days 2022

European Research and Innovation Days is the European Commission's annual flagship Research and Innovation event, bringing together policymakers, researchers, entrepreneurs and the public to debate and shape the future of research and innovation in Europe and beyond. it is the biggest forum in Europe to discuss the future of science and innovation and to co-create solutions with citizens and stakeholders. The event took place online on 28 and 29 September 2022.

The JU participated in the session: 'Repowering the EU with clean energy' which took place on 28 September.

European Sustainable Energy Week 2022

The European Sustainable Energy Week (EUSEW) 2022 took place in a hybrid format between the 26 to the 30 September. The event counted on the participation of public authorities, private companies, NGOs and consumers to promote initiatives to going green and digital for Europe's energy transition.

EUSEW is the biggest annual event dedicated to renewables and efficient energy use in Europe. It includes a series of activities aimed at building a sustainable and secure energy future for Europe.

Clean Hydrogen Partnership participated in several policy sessions: 'Increasing renewable energy production in European Regions and Cities: challenges and opportunities' and 'The commodification of Green H2 for Europe'.

Transport Research Arena (TRA) 14 – 17 November 2022, Lisbon

TRA, the Transport Research Arena, is the largest European research and technology conference on transport and mobility.

TRA is the foremost European transport event that covers all transport modes and all aspects of mobility. In 2022, TRA took place in Lisbon, Portugal. Themed "Moving together – reimagining mobility worldwide", TRA2022 brings together experts from around the world to discuss the -latest innovations and future of mobility and transport, building also on the Portuguese historical legacy and links to overseas transport professionals.

Clean Hydrogen Partnership participated in the exhibition with a stand and organized, together with DG MOVE, an invited session on ports entitled 'Hydrogen Valleys in Coastal Areas – Accelerating the hydrogen economy in Ports'. The session highlighted the importance of hydrogen valleys in coastal areas, how to accelerate the hydrogen economy in ports and their importance towards a green transition.

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Technical webinars

The JU organises each year several technical webinars, on a wide range of topics. In 2022, the following webinars took place:

07 Dec 2022: WEBINAR - Computational Fluid Dynamics (CFD) for hydrogen safety analysis

15 Sept. 2022 Webinar - Launch of the Project Development Assistance for Regions (PDA II)

22 Apr. 2022 WEBINAR - Safety Planning and Management in EU hydrogen and fuel cell projects

2.1.6 Branding

2.1.6.1 Clean Hydrogen Partnership booth

Given the gradual return to in-person events and exhibitions, Clean Hydrogen Partnership developed a modular exhibit booth to participate in exhibitions and fairs.

The main objective of this stand is to present the work of the Clean Hydrogen Partnership by displaying and promoting information about the JU itself, the results of projects and initiatives funded under the JU's umbrella as well as providing information about the hydrogen sector and related EU R&I activities.

Clean Hydrogen Joint Undertaking booth has 16 sqm (4X4m) and includes two screens to display videos and presentations to promote the partnership.

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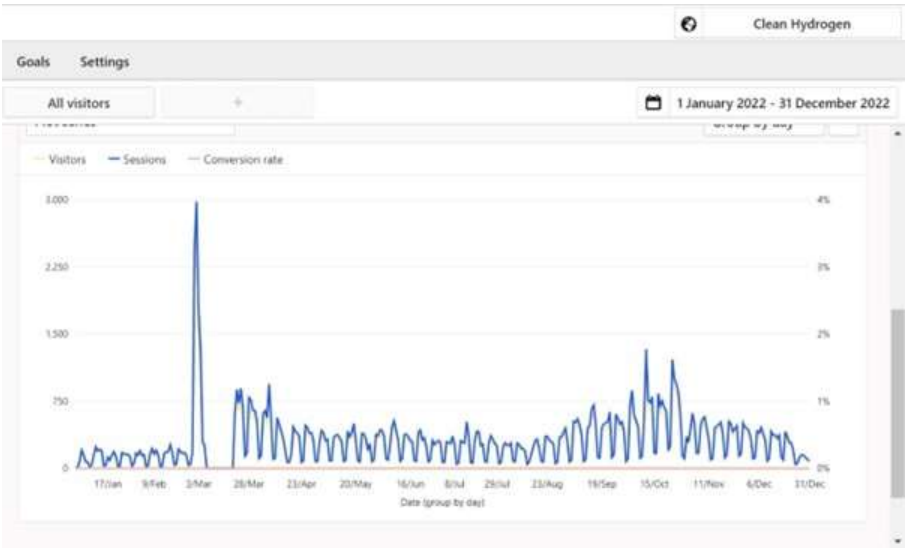
2.1.6.2 Website and social media statistics 2022

The newly launched website www.clean-hydrogen.europa.eu had an increase in audience during 2022.

71.635 visitors engaged during the year, with a peak registered in March 2022, around the launch of the call and the associated info day. Most visitors (10%) were from Germany, followed closely by the visitors from the US and Belgium.

Audience overview 2022 (1 January 2022 – 31 December 2022)

Visitors	Sessions	Page views
71.635	113.799	261.608



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2.1.7 Social media developments 2022

Growth on social media channels continued in 2022 for all the channels , in accordance with the new trends and with the help of regular social media planning.

Twitter: The summary of the Twitter account indicates that the **Clean Hydrogen Partnership** published more tweets per month in 2022 (an average of 26) than in 2021 (an average of 22). As the result also the average number of impressions increased by approximately 25 %. In addition, the number of followers reached more than 8,000 .

The **LinkedIn** account attracted more traffic with 16,900 Page views and 7,122 unique visitors. Now the account has 33,947 total followers, with practically 10.000 new followers gained during the last year.

Monthly newsletters based on the Newsroom platform provided by DG Connect were sent throughout 2022 to a database of 12,908 subscribers. In total 15 newsletters were sent out (13 news alerts containing important updates and 3 full newsletters covering the latest information for the 3 last semesters).

2.2 Legal and financial framework

During 2022, no new procedures were adopted, and no modifications were brought to the existing legal framework, with the exception of data protection, where due to the fact that the number of years of mandate of the data protection officer had expired, a new data protection officer was appointed. In addition, the data protection framework was further updated with new implementing rules, as outlined below.

Data protection

As an EU body applying Regulation (EU) 2018/1725172, in the course of 2022, the JU continued its data protection activities as follows:

- Appointment of a (new) Data Protection Officer;
- Adoption of implementing rules concerning the Data Protection Officer in line with Art. 45.3 of Regulation 2018/1725 ("*Decision of the Executive Director of the CLEAN HYDROGEN JOINT UNDERTAKING laying down implementing rules concerning the Data Protection Officer in application of Regulation (EU) 2018/1725 of the European Parliament and of the Council*");
- Migration and update of the data protection webpage of the Clean Hydrogen JU website, and update of the individual privacy statements published therein;
- Migration and update of the central register of data processing activities.

[172] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC, OJ L 295, 21 November 2018, p. 39.

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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, experts' fees, other service contracts and various office supplies;
- **Title 3** covers expenditure related to the operational activities under the FP7, H2020 and Horizon Europe programmes.

Compared with 2021, the 2022 appropriations related to Titles 1 and 2 increased by 144% in terms of commitments and by 124% in terms of payments, in relation with the launch of the Clean Hydrogen JU. Appropriations related to Title 3 included commitment and payment appropriations for the first call for proposals under Horizon Europe and other operational expenditure such as procurement activities and experts fees.

There were two budget amendments and one budget transfer in 2022. The first amendment introduced revenues related to the new Programme Horizon Europe and the commitment and payment appropriations to cover the corresponding expenditure, as well as the reactivation of H2020 commitment and payment appropriations to cover operational procurement activities and increased needs in communication, service contracts and evaluators due to the launch of the new programme; the second amendment introduced reactivation of commitment appropriations to cover for (part of) experts carrying out mid-term reviews for H2020 projects and studies. An overview of the initial budget and amendments is presented in Table 17.

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Statement of revenue:	Voted budget 2022		Amended budget 1 2022		Amended budget 2 2022	
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	3,368,916	43,187,008	299,753,224	105,027,075	299,753,224	105,027,075
of which Administrative	3,368,916	3,368,916	3,368,916	3,368,916	3,368,916	3,368,916
of which Operational	0	39,818,092	296,384,308	101,658,159	296,384,308	101,658,159
Third countries contribution including EFTA	71,084	911,246	7,391,777	2,497,129	7,391,777	2,497,129
of which Administrative	71,084	71,084	71,084	71,084	71,084	71,084
of which Administrative third countries excluding EFTA						
of which Operational		840,162	7,320,692	2,426,045	7,320,692	2,426,045
Industry financial contribution	3,440,000	3,440,000	3,440,000	3,440,000	3,440,000	3,440,000
of which Administrative	3,440,000	3,440,000	3,440,000	3,440,000	3,440,000	3,440,000
of which Operational						
Other revenue						
SUB-TOTAL REVENUES	6,880,000	47,538,254	310,585,000	110,964,204	310,585,000	110,964,204
Reactivation of unused appropriations from administrative expenditure	0	0	1,209,000	1,209,000	1,209,000	1,209,000
Of which from [YEAR N-3]						
Of which from [YEAR N-2]			876,566	876,566	876,566	876,566
Of which from [YEAR N-1]			332,434	332,434	332,434	332,434
Reactivation of unused appropriations from operational expenditure	1,474,819	5,647,049	1,713,713	5,647,049	2,046,956	5,647,049
Of which from [YEAR N-3]						
Of which from [YEAR N-2]						
Of which from [YEAR N-1]	1,474,819	5,647,049	1,492,043	5,647,049	1,492,043	5,647,049
Of which from [YEAR N]			221,670		554,913	
TOTAL	8,354,819	53,185,303	313,507,713	117,820,253	313,840,956	117,820,253

TABLE 17. BUDGET 2022 – STATEMENT OF REVENUE WITH INITIAL VOTED BUDGET AND AMENDMENTS

2.3.2 Budget execution

Administrative expenditure

The JU's administrative budget execution decreased to 79% (compared to 93% in 2021) in terms of commitment appropriations. This worsening is due to two factors:

- The budget for administrative expenditure for 2022 included works to be accomplished in the premises of the Clean Hydrogen JU. As it was still uncertain if the JU would be seated in the White Atrium building after 2024, due to the ongoing negotiated procedure launched for premises in accordance with the Financial Regulation Annex I Article 11(g), this expenditure has been postponed to 2023;
- The budget also included a commitment for external support services to the operational activities; the service contract is expected to be signed in Q2 2023 thanks to the reactivation of appropriations initially planned to be used in Q4 2022.

Unused appropriations coming from the 2022 budget as well as appropriations becoming available in 2022 from decommitments of previous years will be reactivated either in 2022 through amendments or in 2023 initial or subsequent budget in accordance with the needs and JU's financial rules.

In terms of payments appropriations, the execution rate also decreased to 73% (from 78% in 2021). More specifically, Title 1 commitment and payment rates improved compared to 2021 (commitment rates: 97% in 2022, 95% in 2021, payment rates: 96% in 2022 and 90% in 2021). Staff in active employment comprised 47% of total administrative budget and showed a commitment rate of 97%, showcasing a very good

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planning. Mission budget execution improved to 97% in 2022 (from 19% in 2021) but inter-annual comparison is meaningless due to the specific COVID circumstances of the year 2021.

Title 2, on the other hand, shows a lower execution rate in both commitment and payments rates compared to 2021 (committed: 62% in 2022 and 91% in 2021, paid: 52% in 2022 and 61% in 2021). All budget lines show an execution rate below 90% but mainly two are the budget lines responsible for this low execution in 2022 (see above):

- Investments in immovable property, rental of buildings and associated cost, where some costs for the adaptation of our offices the new hybrid working arrangements were foreseen, but finally not carried out;
- Service contracts, where the Framework Contract for the Technical Assistance to the Programme Office was signed only at the end of December without possibility to sign the specific contract (and the corresponding commitment) before year-end.

Operational expenditure

The budget execution reached 99.63% of commitment appropriations in 2022, mostly due to the global commitment related to the call for proposals launched in March 2022 under Horizon Europe. For Horizon 2020, the budget execution decreased to 84% in commitments (from 98% in 2021) due to a study planned for 2022 that had to be postponed to 2023.

For payments, the execution reached 65%. This low implementation is due to the timing of the call for proposals launched in March 2022 under Horizon Europe, with a first deadline by end May 2022, leading to a maximum time-to-grant target by end January 2023. In order not to jeopardise the signature of grants until that date, the Clean Hydrogen JU decided to keep payment appropriations to be in a position to pay pre-financing to related beneficiaries.

The following table presents more detailed information on the execution of the final budget:

Title Chapter Article Item	Heading	Commitment			Payment		
		Commitment appropriations (in EUR)	Committed (in EUR)	% execution	Payment appropriations (in EUR)	Paid (in EUR)	% execution
1 1	Staff in active employment	3,845,010	3,744,479	97.39%	3,845,000	3,720,141	96.75%
1 2	Expenditure related to recruitment	3,000	706	23.53%	3,000	706	23.53%
1 3	Missions and travel	63,740	61,877	97.08%	60,000	60,000	100.00%
1 4	Sociomedical infrastructure	45,986	24,386	53.03%	44,000	17,943	40.78%
1 5	Entertainment and representation expenditure	6,000	3,611	60.18%	6,000	3,611	60.18%
Total Title 1	Staff expenditure	3,963,736	3,835,059	96.75%	3,958,000	3,802,401	96.07%
2 0	Investments in immovable property, rental of buildings and associated cost	855,000	397,619	46.51%	855,000	345,752	40.44%
2 1	Information technology	551,180	490,674	89.02%	520,000	443,419	85.27%
2 2	Movable property and associated costs	20,000	0	0.00%	20,000	498	2.49%
2 3	Current administrative expenditure	9,000	7,588	84.31%	9,000	8,348	92.76%
2 4	Correspondence, postage and telecommunications	10,000	8,792	87.92%	10,000	8,236	82.36%
2 5	Expenditure on formal and other meetings	50,000	21,824	43.65%	50,000	12,244	24.49%
2 6	Communication costs	995,000	712,096	71.57%	995,000	533,536	53.62%
2 7	Service contracts	892,000	338,340	37.93%	892,000	166,119	18.62%
2 8	Expert contracts and meetings	780,000	619,074	79.37%	780,000	610,136	78.22%
Total Title 2	Infrastructure	4,162,180	2,596,007	62.37%	4,131,000	2,128,288	51.52%
Total Title 1+2	Administrative expenditure	8,125,916	6,431,066	79.14%	8,089,000	5,930,689	73.32%
3 0 0 1	Implementing the research agenda of FCH JU: FP7	18,684	0	0.00%	18,684	0	0.00%
3 0 0 2	Implementing the research agenda of FCH JU: H2020	2,482,605	2,084,383	83.96%	30,166,903	24,545,704	81.37%
3 0 0 3	Implementing the research agenda of FCH JU: HE	303,705,000	302,649,948	99.65%	80,000,000	46,960,288	58.70%
Total Title 3	Operational expenditure	306,206,289	304,734,331	99.52%	110,185,587	71,505,992	64.90%
Total budget implementation		314,332,205	311,165,397	98.99%	118,274,587	77,436,681	65.47%

TABLE 32. BUDGET 2022 – STATEMENT OF EXPENDITURE

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

This section of the AAR builds on and provides more details to overall summary provided in the previous section 1.2.5.

2.3.3.1 H2020 program – contributions from Members other than the Union

The Clean Hydrogen JU legal framework for contributions from members other than the Union was defined in Council Regulation 559/2014 of 6 May 2014 establishing the FCH 2 JU[173].

The following contributions made by JU members other than the EU and their constituent or affiliated entities have been considered:

- Financial contribution 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 the following tables and graphs, please, find detail amounts of the financial and in-kind contributions, including their evolution in time – per year or per H2020 call for proposal.

Financial contribution of the Members to the JU's running costs as of 31 December 2023

Contributions to running costs received by 31 December 2022 / year	Industry grouping	Research grouping	Total
	Cash in EUR mil.	Cash in EUR mil.	Cash in EUR mil.
2014	0.26	0.04	0.30
2015	0.41	0.07	0.48
2016	0.40	0.07	0.47
2017	0.05	0.01	0.06
2018	2.01	0.33	2.34
2019	2.31	0.38	2.68
2020	2.05	0.33	2.38
2021	2.28	0.37	2.65

[173] This legal framework was complemented by methodologies for in-kind contributions in operational activities and for IKAA, agreed by the JU GB on 18 November 2015 and 9 December 2016, respectively. Ref. to: - https://www.clean-hydrogen.europa.eu/about-us/key-documents/kind-additional-activities_en

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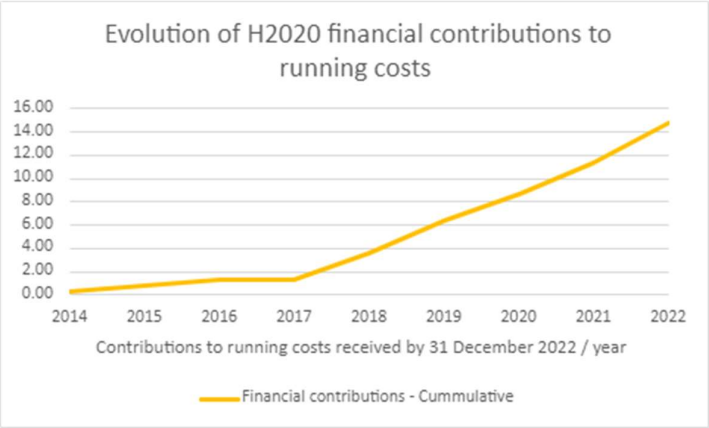
2022	2.96	0.48	3.44
Total 2014 - 2022	**12.73**	**2.07**	**14.80**



In line with the applicable H2020 legal basis, the administrative costs of the JU should not exceed EUR 38 million and should be covered through financial contributions divided on an annual basis between the Union and the Members other than the Union. The Union should contribute 50 %, the Industry Grouping 43 % and the Research Grouping 7 %.

Tables and graph above show the yearly evolution of these financial contributions received by the private members.

The lower amounts of cash contributions until 2017 can be explained by the fact that the administrative costs were also funded by FP7 contributions. This phenomenon will continue to be observed in the following, Horizon Europe programme, where, in the first years, the administrative costs will continue to be funded by H2020 contributions which have not reached yet the targeted amounts.

IKOP

IKOP represents the In-Kind Contributions to operational activities (IKOP) as part of the calls for proposals issued by the JU. Certification of the IKOP for H2020 is still ongoing, as due to major simplifications introduced in the H2020, the certificates for IKOP are only due to be submitted to the JU after the end of the last project reporting period.

Reference of the Project-Call	Total amount of IKOP committed for the project (including certified amount – next column) – in million EUR	Total Amount of IKOP certified until 31 12 2022 (from the overall committed) – in million EUR
Call 2014	32.19	32.19
Call 2015	81.62	7.02

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Call 2016	1.32	7.63
Call 2017	15.21	3.49
Call 2018	19.50	1.41
Call 2019	23.67	0.00
Call 2020	17.00	0.00
TOTAL	**190.50**	**51.74**

TABLE 18. VALUES OF IN-KIND CONTRIBUTIONS TO OPERATIONAL ACTIVITIES (IKOP) EVOLUTION FOR THE H2020 PROGRAMME (COMMITTED AND CERTIFIED)

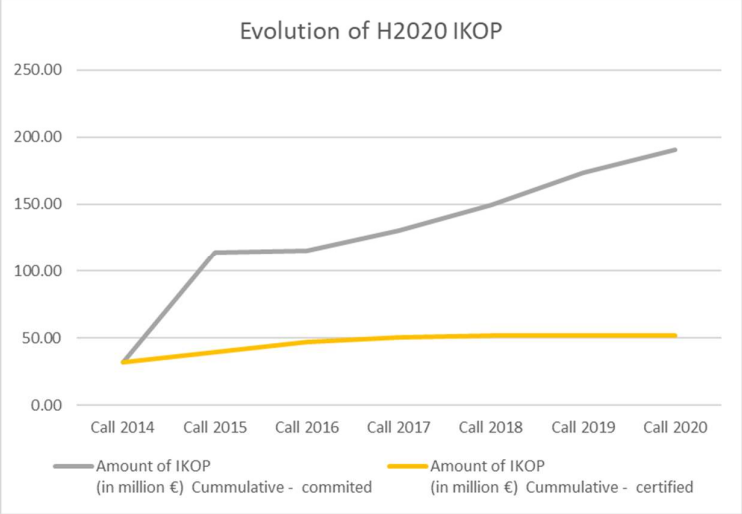

FIGURE 33. CUMULATIVE EVOLUTION OF H2020 IKOP

IKAA

The IKOP in H2020 was complemented by in-kind contribution to Additional Activities. In line with the H2020 regulation laying down the foundation for the partnership, all the beneficiaries had to report additional R&D and deployment investments ("In-Kind Additional Activities" or "IKAA") made outside the JU in order to demonstrate the leverage effect of the programme and the growth of the sector.

Values of IKAA evolution per year	Amount of certified IKAA (in million EUR)
2014/2015	217.56
2016	164.7
2017	107.3
2018	177.5

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2019	209.6
2020	162.5
2021	0
2022	0
TOTAL certified IKAA H2020 programme[174]	**1,039.05**

TABLE 22. VALUES OF IKAA EVOLUTION FOR THE H2020 PROGRAMME ([175])

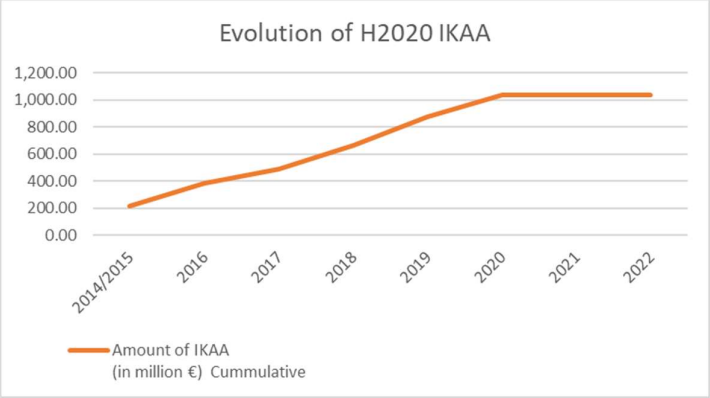

Figure 34. Cumulative evolution of H2020 IKAA. The Additional Activities (IKAA) were defined as actions in Europe contributing to the FCH 2 JU's objectives but undertaken outside its work plan by Hydrogen Europe and Hydrogen Europe Research members.

The latter and their affiliate entities were required to jointly deliver IKAA of at least EUR 285 million across the life span of the FCH 2 JU of 2014-2024. The underlying purpose of the IKAA exercise was hence to demonstrate private investments in the sector and ensure a balanced contribution made by the private and public entities in the context of the partnership.

In order to monitor the process of IKAA planning, reporting and certification on an annual basis, the JU in the H2020 has established a robust IKAA methodology which required regular follow-up and updates on the IKAA status.

Thanks to this process and certificates which were obtained timely from the private partners, the JU was able to demonstrate high level of leverage of the private financing, significantly exceeding originally envisaged target in the Council Regulation. For that reason, the private partners, since 2021 transferred their focus to Horizon Europe programme additional activities.

[174] Due to high amount of certified IKAA, the IKAA planning and certification exercise was discontinued in 2021 for H2020, shifting the focus to the new Horizon Europe programme, its strategic policy objectives and quantitative targets

[175] Owing to the high amount of certified IKAA, the IKAA planning and certification exercise was discontinued in 2021 for the H2020 programme, shifting the focus to the new Horizon Europe programme, its strategic policy objectives and quantitative targets.

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2.3.3.2 Horizon Europe program – contributions from Members other than the Union

The new Council regulation for the Horizon Europe is based on the principles and criteria set out in the Horizon Europe regulation, including openness and transparency, a strong leverage effect and long-term commitments by all the parties involved.

According to the new Council regulation (Article 171), the JUs must organise the continuous monitoring and reporting of the management and implementation of their activities and periodic reviews of the outputs, results and impacts of the funded indirect actions implemented in accordance with Article 50 of and Annex III to the Horizon Europe regulation. That monitoring and reporting is to include (among other things) information on quantitative and qualitative leverage effects, including on financial and in-kind contributions committed and actually provided, visibility and positioning in the international context, and the impact of private sector investments on R&I-related risks.

Annex III to the Horizon Europe regulation requires that the financial or in-kind contributions from members other than the Union should be at least equal to 50 % and may reach up to 75 % of the aggregate JU budgetary commitments. The Union should be in a position to reduce its contribution if members other than the Union fail to fulfil their commitments.

For the Clean Hydrogen JU, specific leverage targets have been defined as follows.

- Union financial contribution (Article 76): 'The Union financial contribution to the Clean Hydrogen Joint Undertaking, including EEA appropriations, to cover administrative and operational costs shall be up to EUR 1,000,000,000, including up to EUR 30,193,000 for administrative costs.'
- Contributions from members other than the Union (Article 77): 'The members of the Clean Hydrogen Joint Undertaking other than the Union shall make or arrange for their constituent or affiliated entities to make a total contribution of at least EUR 1,000,000,000, including up to EUR 30,193,000 for administrative costs, over the period [ending 31 December 2031].
- In the following tables and graphs, please, find detail amounts of the financial and in-kind contributions, including their evolution in time – per year or per Horizon Europe call for proposal.

Financial contributions

In 2022, there were no cash contributions from the private partners related to Horizon Europe programme, since all the administrative costs were funded by H2020 contributions. (We refer to section above).

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IKOP

Values of IKOP evolution – in million EUR		
Reference of the Project-Call	**Total amount of IKOP committed for the project[176]**	**Total Amount of IKOP certified until31 12 2022**
Call 2022-1	88.10	-
TOTAL	**88.10**	**-**

TABLE 19. VALUES OF IKOP DEVELOPMENT

IKOP under the Horizon Europe legal basis continues to be guided by the same principles for reporting, monitoring and certifications as in the previous H2020 framework programme. Clean Hydrogen JU expects the amount of IKOP to be certified later in the programme due to delays in provision of the audit certificates which are only due to be submitted to the JU together with the final report for the last project reporting period.

The amount of EUR 88.10 million committed as IKOP is related to difference between total eligible costs and EC contribution in the first 20 Horizon Europe projects which were signed by the JU by 31 December 2022 and additional 16 grants which were signed in 2023 by the time that the AAR was completed. All the projects will effectively start in the year 2023.

IKAA

Values of IKAA evolution per year	Amount of IKAA (in million EUR)[177]
2021	0.00
2022	121.07
TOTAL certified IKAA Horizon Europe programme	121.07

TABLE 20. VALUES OF IKAA EVOLUTION UNDER THE HORIZON EUROPE PROGRAMME

According to COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe, Hydrogen Europe Industry and Hydrogen Europe Research Members of the Clean Hydrogen Joint Undertaking have submitted their first Additional Activities Plan covering the period of 1 January 2022 – 31 December 2022 as an annex to the Annual Work Plan 2022. For the reporting of the annual additional activities plan annexed to the main part of the work programme, a scope of the additional activities was presented according to categories in line with the Article 78 of the COUNCIL REGULATION (EU) 2021/2085.

[176] Information for the AAR 2022 was updated for the cut-off date of 22 May 2023 to capture the information of committed IKOP for all 36 signed Horizon Europe grants from the Call 2022-1 until this date.

[177] Information for the AAR 2022 was updated for the cut-off date of 22 May 2023 to capture the information of certified IKAA with the cut-off date as set in the Horizon Europe legal basis (31 May 2023)

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The 2022 IKAA Plan[178] included Additional Activities for a total amount of EUR 520.765 million.

In the moment of establishing the annual activity report for the Clean Hydrogen JU, the certification process for the IKAA 2022 was still ongoing, therefore the results of EUR 121.07[179] million as presented in the table above were only indicative and will increase further. The values of the certified contributions for the year 2022 will be reported to the Clean Hydrogen JU Governing Board later in the year 2023.

More detailed information on IKAA for Horizon Europe can be found in the Annex to the AAR.

2.4 Administrative Procurement and contracts

In 2022, in continuation of the JU's practice over the past years, the tender and contract management has included interinstitutional procurement procedures launched by the European Commission or other EU bodies and the resulting multiannual framework contracts. The JU also cooperates with other JUs on tendering needs in order to minimise the administrative effort (see also below in section 2.7.2 on efficiency gains and synergies). As in previous years, most of JU's contracting was carried out under existing multiannual framework contracts, except mainly for operational procurement activities (see procurement studies under Section 1.3.2. Other funded actions). Operational procurement activities, communication, IT services and the signature of a multi-annual framework contract for the provision of technical assistance to operational activities, have been areas with the biggest contract value in 2022. The JU has made intensive use of eTendering, eNotices and eSubmission modules and has started the process of integrating the public procurement management tool –(PPMT) which will be in operation in 2023. The publication, submission and reception of offers and opening stages are now fully digital. In addition, the JU renewed its use of EU Sign allowing a qualified electronic signature (QES) of documents (especially contracts – see below in section 2.5), which had to be implemented again due to the change of legal entity, from the FCH2 JU to the Clean Hydrogen JU, in the end of 2021. The following table provides an overview of the contracts awarded in 2022, 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.

Subject contract	Type of contract	Contractor	Tender procedure (if applicable)	Signature date	amount
Creation of modular booth	Specific contract Clean Hydrogen Partnership/04 implementing Framework Contract OIB.02/PO/2017/063/786	Créaset S.A.	NA	01/09/2022	€ 80,029.56

[178] Adopted by the Clean Hydrogen JU Governing Board on 25 February 2023
[179] Certified figures as of 31 May 2023, as per the IKAA 2022 Final Report for the year 2022

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Hosting and management of server for FCHO platform on Drupal after handover from previous contractor	SPECIFIC CONTRACT N° 17 implementing Framework Contract n° FCH 204 -	REALDOLMEN N.V.	NA	02/06/2022	€ 18,353.00
Managed IT Services 2023	SPECIFIC CONTRACT N° 16 implementing Framework Contract n° FCH 204 -	REALDOLMEN N.V.	NA	01/11/2023	€ 25,018.70
Microsoft annual fee for software licenses scenario C2	Specific contract implementing FWC DIGIT/A3/PO/2017/023 - FCH JU 2022 PO19	Insight Technology Solutions Belgium Inc	NA	01/06/2022	€ 19,658.34
Audits of the annual accounts for the years ending 31/12/2022 and 31/12/2023	Specific contract No 04_16 implementing FWC BUDG/19/PO/01	Ernst & Young Bedrijfsrevisoren/Réviseurs d'Entreprises CVBA/SCRL	NA	14/10/2022	€ 50,797.50
Media planning, buying and monitoring services	Specific contract implementing framework contract COMM-2019-OP-0029-Lot1-1-C-CleanH2-GOPA	GOPA COM.	NA	15/07/2022	€ 108,541.81
Writing, editing and video production services	Specific contract implementing FWC COMM-2019-OP-0029-Lot2 –FCH-22-001	Consortium E2COMMs formed by EUROPEAN SERVICE NETWORK (leader) and ECORYS EUROPE	NA	06/07/2022	€ 51,190.00
Interim services (29/03-28/09/2022)	Framework contract for interim services HR/R1/PR/2019/023	Randstad Belgium NV	NA	29/03/2022	€ 32,443.49

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	- FCH JU 2022 PO10				
Interim services -for knowledge management 26/04/2022-24/10/2022	Framework contract for interim services HR/R1/PR/2019/023 - FCH JU 2022 PO17	Randstad Belgium NV	NA	26/04/2022	€ 37,830.52
Interim - Event organizerfor communications team for period 10/05/2022-09/11/2022	Purchase Order no. PO23 implementing Framework contract HR/R1/PR/2019/23	Randstad Belgium NV	NA	10/05/2022	€ 32,443.49
Interim service for digital communication assistance	Purchase Order PO32 implementing Framework contract HR/R1/PR/2019/23	*Randstad Belgium NV*	NA	07/06/2022	€ 31,214.57
Interim service for personal assistant to - Executive Director and Head of Unit	Purchase Order no 31 implementing Framework contract HR/R1/PR/2019/23	Randstad Belgium NV	NA	20/06/2022	€ 31,214.57
Interim services for the communications team	Purchase Order PO68 implementing Framework contract HR/R1/PR/2019/23	Randstad Belgium NV	NA	27/09/2022	€ 31,460.35
Study on accelerating the deployment of Guarantees of Origin Schemes for Hydrogen and for the design of a Voluntary scheme	Specific contract No.2 implementing Framework contract FCH /OP/ Contract 278	Hinicio SA	NA	15/07/2022	€ 539,210.40
Operation and Maintenance of the European HRS Availability System (E-HRS-AS)	Specific contract No3 implementing Framework contract FCH / Contract 282	Spilett New technologies GmbH	NA	12/03/2022	€ 66,305.00
Operation and Maintenance of the European HRS Availability System	Specific contract No4 implementing Framework contract	Spilett New technologies GmbH	NA	21/03/2022	€ 28,440.00

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(E-HRS-AS)	FCH / Contract 282				
Operation and Maintenance of the European HRS Availability System (E-HRS-AS)	Specific contract No5 implementing Framework contract FCH / Contract 282	Spilett New technologies GmbH	NA	02/05/2022	€ 33,345.00
Operation and Maintenance of the European HRS Availability System (E-HRS-AS)	Specific contract No6 implementing Framework contract FCH / Contract 282	Spilett New technologies GmbH	NA	02/05/2022	€ 68,000.00
Supporting the Clean Hydrogen JU to setup up a Hydrogen Knowledge Hub	Specific contract No1 implementing Framework Contract DIGIT/2020/OP/0005 (BEACON)	Group of economic operators "Consortium of Tremend Benelux SA", represented by Tremend Benelux S.A	NA	08/08/2022	€ 43,000.00
Public opinion survey	FCH / OP / Contract / 307	Gallup International GmbH	OPEN PROCEDURE	15/03/2022	€ 385,000.00
Technical services in support of the Programme	FRAMEWORK CONTRACT CleanHydrogen/OP/ Contract/326	TH!NK E (representing the consortium), Moore Strategy & Operations, Eworx S.A., Steinbeis 2i GmbH and DNV Netherlands BV	OPEN PROCEDURE	12/12/2022	€ 6,500,000.00
Organisation of Hydrogen week 2022	Direct contract for services: Clean	Hydrogen Europe	DIRECT CONTRACT	07/10/2022	€ 314,626.50

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	Hydrogen / Contract 331	AISBL	WITH MEMBER		
Provision Of Data and Services In Support of The European Hydrogen Observatory and Monitoring	Framework contract Clean Hydrogen/OP/Contract 332. And Specific contract No1	Hydrogen Europe AISBL	DIRECT CONTRACT WITH MEMBER	20/12/2022	€ 250,812.50
Catering during Hydrogen week	Direct contract for services: Clean Hydrogen / Contract 336	Biorganic Events SRL	Negotiated procedure	19/10/2022	€ 106,054.50

TABLE 21. LIST OF THE CONTRACTS AWARDED IN 2022

2.5 IT and logistics

The year 2022 was driven by the following specific actions in each of the specific areas defined in the IT multiannual work plan:

Document Management

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

- Following the adoption of the Single Basic Act establishing the Clean Hydrogen JU, the Hermes-Ares-Nomcom (HAN) services and Secretariat General considered this as reorganisation. The reorganisation exercise successfully took place by the Clean Hydrogen JU and DG DIGIT on the first days of January 2022
- Via a Service Level Agreement with DG DIGIT, the Clean Hydrogen JU obtained its own Qualified Seal. This enabled the sealing capability in Ares and made the e-signing with the Qualified Electronic Signature (QES) process leaner, efficient and fully integrated in ARES.
- "Job users" were created and linked with ARES interfaced IT tools – namely eGrants/Compass and PPMT – so that the registration and filling of documents is facilitated
- ARES was interfaced with RETO/COMREF services and therefore the users` information derives directly from SYSPER without any manual intervention

Information Management

The Joint Undertaking continued to use and adopt flagship digital solutions developed by the European Commission as corporate services for grants and procurement, such as:

- The new corporate eProcurement suite: the JU is already using the following modules: Ted Notices for publication in the OJEU, eTendering for preparing he publication of calls for tender, and eSubmission for the electronic submission of offers. In 2022 the Ju started the process of onboarding for PPMT (Public Procurement Management Tool) a web-based application to plan,

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schedule, track and monitor public procurement procedures from early planning up to contract signature;

- SYSPER (Personnel file management) and SYStal (tool for recruitment) are now key assets applications used for Human Resource management. The additional module MIPS for Mission Processing System has been further delayed but with complete the landscape of HR applications soon. We have improved the staff onboarding process for user access rights with a fully automated processes between EUlogin, ARES and SYSper, improving the data quality;
- our web presence was reinforced with a new website compliant with the Europa Web Publishing Platform (EWPP) hosted under the Next-EUROPE platform. This ensures stability and continuity of this essential tool for the external communication and visibility of the JU program. Since the new Clean Hydrogen Partnership website is fully operational, the old website from the legacy FCH JU and FCH 2 JU was archived with the support of the web preservation unit of the publication office;
- A contract for the hosting of the platforms Observatory and Hydrogen Valley has been signed to ensure the handover of the applications to the Joint Undertaking after their developments, and public access to those communication tools.
- The complete deployment of software-as-a-service solutions is finished, with the migration of the previous file repository – M-Files – to a dedicated SharePoint library;
- The JU is engaged in the deployment of Office 365 as a software-as-a-service solution. Teams with unified communications and collaboration features was already deployed in 2021, and SharePoint, OneDrive and Exchange Online – identified as priority assets – have been deployed during 2022.

Digital Transformation Management

Similar to last year, the replacement of in-person meetings with virtual meetings and hybrid conferences was supported by live-transmission from the studio in the White Atrium building and online webstreaming via the Clean Hydrogen website. The last quarter was marked by the organisation and success of the call for tender for ICT managed services from 2023 onwards; and the preparation of the back-office arrangement on ICT services as foreseen in the Single Basic Act (see below section 2.7on efficiency gains and synergies).

The digital workplace for each staff member is constantly modernised:

- JU staff were ensured adequate access to the complete set of European Commission applications for grant management.
- The hardware renewal roll-out was executed as planned together with the necessary license renewal for essential applications such as Slido, Webex, Business Object, Adobe -or Mobile telephony; allowing each staff member more flexibility under the new teleworking working scheme;
- The roles of the Single Point of Contact for COMPASS and Local Authorisations Manager for the IT accounting system (Accrual Based Accounting, ABAC) were again useful to ensure the successful implementation of H2020's 2022 call.
- A close follow-up of the infrastructure-as-a-service solution and managed IT service contracts available to the JU and efficient remote support provided by the IT officer and the service desk has been performed. As indicators supporting the new ICF we can mention the following:

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a. the business continuity operations were in evidence throughout 2022;

b. the quality and performance indicators of the managed IT services and the downtime of the key systems were above the minimum threshold during the 4 year execution of the ICT managed service contract;

c. the JU was not affected by security incidents arising from external cyberattacks.

- The support services was gradually oriented to more self-service functionality to fit the remote working capabilities (reset password/account, remote deployment of applications, etc);
- The use of cloud services and storage was encouraged (Onedrive, remote desktop);

Cybersecurity

To better follow and prepare the future obligations of the new Infosec regulation and the future dedicated role of Cyber Security Officer, the IT Officer joined the dedicated DIGIT ICDT CyberSecurity sub-group.

The regular exercises of phishing campaign, and redteaming for the infrastructure were performed with the support of CERT-EU as part of our development of resilience to cyberattacks. Recommendations for improvement were immediately taken on board and implemented with the help of the ICT managed services provider.

IT Governance

The IT Governance is involved in the Back-Office arrangement for ICT services as foreseen in the Single Basic Act to improve synergies and efficiencies among the new Joint Undertakings for their common digital infrastructure. A list of ICT services and effort estimate has been established by the IT Officers during the last quarter. A concept note for the new back-office arrangement has been approved in November with the “one-stop-shop approach” where one Joint Undertakings would take care and deliver the designed ICT services to the other.

The IT Officer joined each new interinstitutional framework contracts or inter-agency joint procurement of added-value, such as DIGIT TELCO DPS, Microsoft Services, DPS for IT supplies, Princesse III & AMI, OIB Hicop V,

The Joint Undertaking continues to rely on the secure pan-European networks for the Commission, executive agencies and other European institutions. The specific contract under the European Commission framework contract TESTA NG II for the provision of secured telecommunications was signed to enable the continuation of services for all JUs, the European Union Agency for Railways, the European Labour Authority and the Agency for Support for the Body of European Regulators for Electronic Communications. In parallel we started to discuss with DIGIT and within the ICTAC Network on a new technical solution for the hosting of this crucial element of our network topology after March 2024.

The JU is the leading contracting authority for the framework contract for the managed IT services provided for the six JUs hosted in the White Atrium building. The last specific contract for the associated services entered into force on 1 January 2022 and will ensure continuity of services until end April. In the meantime, the call for tender for the updated ICT managed services has been organized with the support of Clean Aviation and awarded to the successor.

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Sound environmental management

The Joint Undertaking plan is transforming the program office into a safe, modern and welcoming place to work, with good quality, sustainable and green solutions.

The Year 2022 saw the delivery and implementation of :

- remote work as integrated way of working;
- more dynamic approaches to the use of office space;
- the use of modern technologies (such as “more wireless, less cables”, Wi-Fi everywhere, connected meeting rooms);
- the use of web/videoconferencing-based meetings as valid sustainable alternative to staff missions and physical meetings, which represents a significant benefit in terms of environmental footprint, efficiency, and work-life balance.

A first meeting rooms was fully equipped with audio and visual equipment’s integrated with the Teams solution for conferences to support the ability to participate in calls, videoconferences, and other collaborative workgroup in hybrid meetings.

Given the increased use of teleworking, the Joint Undertaking has also put in place a failover solution for when a corporate device is damaged or missing by offering to the staff to possibility to work with a virtual desktop solution on private device. The next step is the more modern mobile device management as a temporary environment using Office 365 tools, which was under strong testing in 2022 and is to be released early in 2023.

Logistics

In addition, logistical support has been provided in the context of general administration. This encompasses the management of supply and maintenance of equipment, namely stationery, goods and services for administration, and includes the monitoring of services provided in particular through the Office des Infrastructures de Bruxelles, the Translation Centre and the Publications Office.

As in 2020 the use of web conferences as a communication method increased greatly, with events in hybrid or complete virtual mode. We observed again a shift in costs from business travel to telecommunications. Taking this into account, a special achievement was the implementation of new equipment for videoconferencing in a flexible audiovisual studio where this new kind of events can be organised. It proved to be capable of producing a livestreamed event during the programme review days in November.

2.6 Human Resources management

The Programme Office completed 3 selection procedures in 2022for Project Officers and Legal Assistant; two of these positions were added into the Staff Establishment Plan for the Clean Hydrogen JU following the adoption of the SBA, and one position was due to a staff member having left the JU in 2021. Two staff members left in 2022 and the contract of one SNE came to its end. Consequently, the JU opened a Budget officer and an SNE position, and the selection process for both positions was ongoing at the end of 2022 (the position of Budget Officer was opened jointly with the Global Health EDCTP3 JU to ensure synergies).

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All vacancies mentioned here were external recruitments.

A teambuilding event was held in June 2022, and the monthly staff meetings and the bi-monthly breakfasts were relaunched.

Regarding SysPer, the NDP module is operational, and the scanning of documents has started so they can be uploaded in NDP and linked to each staff member's personal file in Sysper. The STAGE module[180] was tested and an info session on the HR reporting module was held; this module needs to be installed first and the prospect is to use it to support the appraisal and reclassification process.

Several HR policies were updated last year and replaced in our Manual of Procedure. To make it easier to navigate between the procedure and the templates, one document was created which includes the templates.

A bi-weekly meeting was set up with the HR officers of the different JUs to discuss HR topics (see below section 2.7- on efficiency gains and synergies).

Please see below the pie chart for the gender balance of all staff members.

FIGURE 35. GENDER BALANCE OF ALL STAFF MEMBERS.

2.7 Efficiency gains and synergies

The Single Basic Act of the Joint Undertakings[181] establishes that the JUs shall achieve synergies and -and provide horizontal support functions via the establishment of back-office arrangements, operating in identified areas. The SBA also underlines that these synergies should be implemented where screening of resources has proved to be efficient and cost effective, while taking into account as far as possible compliance with the requirement of accountability of each individual authorising officer.-.

[180] Probationary period after recruitment
[181] Article 13, Council Regulation (EU) No 2021/2085, of 19 November 2021

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In order to obtain an independent view on the possible synergies among the JUs and the impact in terms of efficiencies, the JUs together contracted an external consultant to perform a common study on the back-office arrangements (BOA) for the seven areas identified in the SBA, namely: human resource support, legal support, information and communication technologies, accounting (excluding treasury), communication, logistics (events and meeting room management), and support for audit and anti-fraud strategy. The study was finalised in July 2022 and its specific objectives were to:

- Identify areas, or sub-functions of areas, for being operated under Back Office Arrangements, including necessary elements of cost efficiency, risks and opportunities
- Support the JUs to assess the viability (including the screening of resources) of these back-office arrangements.

The study identified 21 potential synergies opportunities among the JUs among all areas covered by Article 13 of the SBA. It concluded that the FTE savings were modest for most synergies, and difficult to realise as most of the concerned services are taken care of by resources also involved in other tasks and functions. However, the study concluded that there were potential benefits in terms of harmonisation of current practices, standardisation of procedures, establishment of critical mass for effective negotiation, coordination and cost savings. Those synergy opportunities were clustered into three main groups:

- Quick wins (14) – Synergies that scale-up the existing collaboration among the JUs, as a result, these should be potentially implemented in a first wave.
- Long-term solutions (5) – These synergies require further reflection on the structuring and planning of their setup and an accurate assessment of the potential benefits, cost-efficiency and risks;
- Low priority opportunities (2) – Synergies which were identified as less feasible/desirable by the Joint Undertakings due to their limitations in terms practical applicability and value.

The largely preferred model for the BOA among JUs is a set-up with one JU and one back-up JU taking the lead dealing in coordinating tasks, organising the work among staff of several JUs and having a clear scope and decision-making power. Example: Back-office arrangement for the provision of accounting services (following DG BUDG decision to terminate the contract with the JUs).

For some synergies, a more flexible option was chosen, with collaboration involving only some JUs, while remaining open for the others to join at a later stage.

The preparation work led to establishment of coordinated plans, prioritising those aspects of the BOA that had the objective to bring most value in the short term. These included, as top priorities, (i) the accounting function (ii) IT management (iii) common synergies regarding the White Atrium occupation, (iv) joint procurement opportunities and (v) HR support. These topics encompass 5 of the 7 areas as per SBA Article 13. This approach was endorsed by the respective Governing Boards.

When these arrangements were presented, the respective Governing Boards stressed the need to have a balanced approach to the BOA implementation ensuring, as a priority, the execution of JUs' core business (ensuring budget execution and call implementation) which is very challenging in the context of a new programme with new legislation, new actors and ambitious timelines due to the delayed launch of the Horizon Europe programme.

In detail, the back-office arrangement that was implemented in 2022 was the BOA on accounting. In addition, three other BOAs have been drafted through signed SLAs (Procurement, HR management) or

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through the documentation of existing mutualisation practices (ICT).

BOA Accounting:

- the JUs took over the Accounting services that until 2022 were provided by DG BUDG. In this BOA EU Rail is the lead JU, and to take into board these services the support of 3 additional Contractual Agents and an External Accounting Services provider was decided. Accounting Officer's services will be provided by 3 JU: CA JU, SESAR3 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 Administration and Finance 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.

BOA Human Resources management

- For what concerns the HR domain, the study recommended to explore synergies by coordinating the management of SYSPER, possibly obtaining a single contract for all JUs, perform joint recruitments, harmonise job profiles and procedures.
- These synergies will allow to obtain a better harmonisation among the JUs, exploiting best practices, achieving efficiency gains and economy of scale. In particular the areas where this BOA will act are: recruitment, legal framework and IT landscape in the HR domain.
- Following the screening of HR resources in each JU, the study also points out no more than marginal FTE gains would be achieved in this area owing to the very limited number of human resources of the JUs.
- These arrangements were presented to the GB and further implementation will happen in 2023, under the lead of CBE JU.

BOA ICT

- The ICT area covers a list of ~50 services (service catalogue) structured in 6 service groups:
  - Inter-JU IT Governance,
  - Management of shared ICT infrastructure,
  - Management of ICT tools, services and contracts,
  - Workplace services provision,
  - Security and compliance management,
  - ICT activities specific per JU.

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- The underlying concept is that, out of the ICT service catalogue, everything that is non-specific to a JU should be managed through the ICT BoA. Therefore, ICT developments and other activities specific to each JU will be under the responsibility of each Executive Director and will not be part of the ICT BoA, that in any case will have to ensure the integrity of the overall ICT architecture.
- It should be noted that mutualisation and centralisation is not new in the ICT function of the JUs. Since 2010, JUs have consistently looked for mutualisation / centralisation / outsourcing of common ICT operations and infrastructure. Therefore, for ICT, in 2022 the JUs started by having a clear status of all these operations and services that are carried out in common, and analysed what could be further centralised.

BOA Procurement

- This BOA has been established with the objective of centralising administrative procurement capability and process to maximise open tenders for award of inter-JUs FWCs and middle value negotiated procedures.
- The focus is on the critical joint administrative procurement such as ICT, building management/corporate services and common support services that will be identified and agreed via joint Public Procurement Planning (PPP).

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3 GOVERNANCE

3.1 Major developments

The year 2022 was the first complete year of operation of the Governing Board of the Clean Hydrogen JU, which was set up at the end of 2021.

Furthermore, the new advisory bodies – namely the Stakeholders Group and the States Representatives Group – were established and in full operation in 2022, in accordance with the provisions of the - -Article 14 of the SBA.

3.2 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 Mr. René Schutte until 25 October, when Ms. Melissa Verykios, representative of the Industry Grouping (Hydrogen Europe) was elected as new Chair. The Vice-Chair is Ms. Rosalinde van der Vlies, Director of Clean Planet at DG Research and Innovation and representative of the Commission.

In September 2022, two representatives from Hydrogen Europe left and were replaced by Mr. Gunnar Groebler (Salzgitter) and Ms. Sopna Sury (RWE Generation SE).

During the year, the Governing Board held three meetings, on 29 March, 30 June and 25 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 March, was mainly dedicated to discussions regarding the Strategic priorities for the call for proposals in 2023, the Programme Office staffing and the update of the Programme Office on the Framework contract with JRC, the Hydrogen Week 2022 concept, the ECA findings (pension contribution), and on synergies.
- The June meeting included a presentation on the JUs Back-Office Arrangement (with a communication from the EC and the presentation of the action plan of the JU EDs), the options and appointment procedure of the Accounting Officer, the draft topics for the 2023 call, the status and GB strategic orientations for synergies, the Strategic discussion on REPowerEU and the planning of the Hydrogen Week.
- In October, the main topics included discussion on the Back-Office Arrangements, approval of the Accounting Officer appointment (decision), approval of the vacancy notice for the Executive Director (decision), and discussion on the draft 2023 AWP including call topics.

The GB also adopted major decisions by written procedure, including:

- CleanHydrogen-GB-2021-01: Approval of 27 April 2022 of the Minutes of the FCH JU GB meeting of 17 December 2021,
- CleanHydrogen-GB-2022-01: Selection of the members of the Stakeholders Group of the Clean Hydrogen JU,
- CleanHydrogen-GB-2022-02: Approval of 25 February 2022 of the Strategic Research and

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Innovation Agenda of the Clean Hydrogen JU,

- CleanHydrogen-GB-2022-03: Approval of 25 February 2022 of the Amended Annual Work Programme of the Clean Hydrogen JU for the year 2022,
- CleanHydrogen-GB-2022-04: Opinion of the Board on the 2021 annual accounts of the Clean Hydrogen JU
- CleanHydrogen-GB-2022-05: Approval of 13 January 2023 of the Minutes of the Clean Hydrogen JU GB meeting of 29 March 2022
- CleanHydrogen-GB-2022-06: Adoption of the 22 August 2022 of the second amendment to the Clean Hydrogen JU Annual Work Plan and Budget for the year 2022
- CleanHydrogen-GB-2022-07: Approval of the Consolidated Annual Activity Report for 2021 including the corresponding expenditure and its assessment.
- CleanHydrogen-GB-2022-07: Approval of the 29 June 2022 of the Consolidated Annual Activity Report for 2021 including the corresponding expenditure and its assessment.
- CleanHydrogen-GB-2022-08: Adoption of the 22 August 2022 of the Code of Conduct applicable to meetings of the Governing Board of the Clean Hydrogen JU
- CleanHydrogen-GB-2022-09: Approval of the 25 August 2022 of the list of actions selected for funding, the reserve lists and the list of rejected proposals under the Clean Hydrogen Joint Undertaking call for proposals with reference HORIZON-JTICLEANH2-2022-1
- CleanHydrogen-GB-2022-10: Meeting Approval of the 25 October 2022 of the vacancy notice for the position of Executive Director of the Clean Hydrogen Joint Undertaking for the period from 2023 to 2031.
- CleanHydrogen-GB-2022-11: Approval of the 7 December 2022 of the Minutes of the Clean Hydrogen JU GB meeting of 30 June 2022
- CleanHydrogen-GB-2022-12: Meeting Approval of 25 October 2022 of the appointment of the Accounting Officer of the Clean Hydrogen JU as of 1st December 2022
- CleanHydrogen-GB-2022-13: Approval of the 9 January 2023 of the list of actions selected for funding, the reserve lists and the list of rejected proposals under the Clean Hydrogen Joint Undertaking call for proposals with reference HORIZON-JTICLEANH2-2022-2
- CleanHydrogen-GB-2022-14: Adoption of the 16 December 2022 of the Annual Work Programme and Budget for 2023 of the Clean Hydrogen JU

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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3.3 Executive Director

Article 19 of the SBA defines the role of the Executive Director as the legal representative and the chief executive responsible for the day-to-day management of the JU, in accordance with the decisions of the Governing Board.

Mr. Bart Biebuyck has been the Executive Director appointed by the JU GB since the 16 May 2016. In 2019, his contract was extended until May 2023.

In preparation for the end of the current Executive Director's contract, the Governing Board approved the vacancy notice for Executive Director for the period from 2023 to 2031 during its 25 October meeting (see above).

3.4 States Representatives Group

In 2022, the States Representatives Group was established in accordance with the provisions of the SBA. New SRG Members were nominated by the Permanent Representations to the EU, towards the DG Research and Innovation which forwarded the information to the Programme Office. The SRG has currently 75 members, of which 64 representatives (main and alternate) from the 27 Member States and 11 representatives from 5 Associated Countries (4 Associated Countries have not nominated a representative person).

On 19 January, during the first SRG meeting, Mr. Ioan Iordache (Romania) was elected as Chair of the States Representative Group while Ms. Lut Bollen (Belgium) and Mr. Xavier Montagne (France) were elected as Vice-Chairs.

In 2022, the States Representatives Group (SRG) met on 19 January, 2 June, and 27 September. Among other things, its activities focused on monitoring JU's work and results, including the following:

- At the January meeting, the main topics included items for decision, such as the Rules of procedures of the SRG and the Election of the Chair and Vice-Chairs of the Clean Hydrogen JU SRG; for information and discussion the main topics were the presentation on the status of SRIA and AWP 2022.
- 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 2022 and on the process on topics of 2023 call. The Chair presented the Report on opinions on AAR 2021 and discussion on process for 2022 and the Report on national and regional policies related to Hydrogen. Mr. Cristian Busoi, MEP, Chair of Committee on Industry, Research and Energy, gave a speech to support the Clean Hydrogen JU's work and encourage more Member States to engage in hydrogen development projects.
- At the September meeting, the PO presented the status of the call for proposals in 2022, sharing the first call deadline results, and updated the SRG members on the AWP 2023, the Hydrogen Week, and 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)).

According to the procedure adopted by the Governing Board (in line with the legal provisions of the Council Regulation/Single Basic Act of the JUs), the SRG members were also invited to propose potential

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candidates for the Clean Hydrogen JU Stakeholders Group.

The SRG members were mainly involved in providing an informal opinion and general comments on the draft topics proposed for the call 2023, including suggestions for potential synergies with national initiatives.

The PO shared with the SRG Members the information on the call for proposals 2022-1 and related proposals received as well as on the proposals evaluation process (and its results), according to the Recital 32 and in particular Article 20 (7a and 12) of the Single Basic Act.

The members of the SRG provided input to the "Report describing the national or regional policies and identifying specific ways of cooperation" between November and December, which the Chair consolidated. The report was submitted to the Governing Board through the Programme Office on 28 December 2022. This report includes the contribution of 21 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 JU

3.5 Scientific Committee: Not applicable for Clean Hydrogen

In accordance with the founding regulation, this section is not applicable for the Clean Hydrogen JU.

3.6 Stakeholders Group

The Stakeholders Group is an advisory body to the GB, to be consulted on various horizontal issues or specific questions in areas relevant to the work of the Clean Hydrogen JU. On 17 December 2021, the Clean Hydrogen JU launched a Call for Expression of Interest open to all candidate groups or sector representatives to join the JU's Stakeholders Group. The call closed on 16 January 2022, with 62 expressions of interest.

On 2 February 2022, after concluding the selection process following the criteria established by the Governing Board of the Clean Hydrogen JU, the members of the Stakeholders Group were appointed for a four-year term[182].

[182] Considering the need to ensure full sector coverage, as well as geographical and gender balance, the composition of the Stakeholders Group will be reassessed in 2023.

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Its 13 members[183] include representatives from various European associations, partnerships under the Horizon Europe Programme, European research organisations and one national association.

In 2022, the SG met three times (February, June and October). In 2022, the Rules of procedure of the SG were drafted and adopted. In addition, the Chair of the SG was appointed during the second meeting in June. During the meetings of the Stakeholders Group, the Programme Office presented the status of the Annual Work Programme/call 2022 as well as other JU's activities, in particular synergies with other programmes and initiatives. Moreover, the SG members provided input on the Call 2023 including synergies. In relation to this, the SG members were invited to propose new synergies within the JU's annual work programme 2023 and to report on relevant ongoing activities in their corresponding sectors where synergies may be expected.

[183] https://www.clean-hydrogen.europa.eu/about-us/organisation/stakeholders-group_en

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4 FINANCIAL MANAGEMENT AND INTERNAL CONTROL

4.1 Control results

This section assesses and reports the control results and other relevant information that supports management's assurance on the achievement of the financial management and internal control objectives[184]. It includes the information necessary to establish that the available evidence is reliable, complete and comprehensive. It reports on the performance of internal control and management systems covering all activities, programmes and management modes relevant to Clean Hydrogen JU. It presents the internal control systems in place and an assessment of their effectiveness: compliance, efficiency, effectiveness, and risk management.

The Clean Hydrogen JU's assurance building and materiality criteria are outlined in the Annex 5.11 of this document. The AAR outlines the main risks together with the control processes to mitigate them and the indicators used to measure the performance of the relevant control systems.

Cost-effective controls are those, which are effective to fulfil the intended control objectives in an efficient manner and at a reasonable cost. In order to conclude on the cost-effectiveness of the controls, it is therefore necessary to assess their effectiveness, efficiency and economy.

Effectiveness of the controls is demonstrated by the control results regarding the legality and regularity of the operations, fraud prevention, and other control objectives – in particular the safeguarding of information. The most pertinent results are the error rates detected by ex-post audits covering the main expenditure items (grants).

The efficiency of Clean Hydrogen JU's operations is to be analysed in the light of the volume of activities performed and their quality and timeliness. Indicators such as Time to Grant and Time to Pay are also among Clean Hydrogen JU's Key Performance Indicators, and the financial scoreboard in Annex 5 includes others.

The chapter dedicated to the economy of the controls gives account of the investment needed to achieve the results reported above.

Finally, a conclusion regarding the cost-effectiveness of Clean Hydrogen JU's operations is drawn, based on the previous elements.

The overview of the kinds of expenditure (administrative and operational) in terms of amounts and percentage is given as followed.

In 2022, Clean Hydrogen JU processed:

[184] 1) Effectiveness, efficiency and economy of operations; 2) reliability of reporting; 3) safeguarding of assets and information; 4) prevention, detection, correction and follow-up of fraud and irregularities; and 5) adequate management of the risks relating to the legality and regularity of the underlying transactions, taking into account the multiannual character of programmes as well as the nature of the payments (FR Art 36.2). The 2nd and/or 3rd Internal Control Objective(s) (ICO) only when applicable, given the DG's activities

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Total payments execution in 2022		
Operational budget	83 payments	71,505,991
Administrative expenditure	727 payments	5,932,322
Total		77,438,313

TABLE 22. TOTAL PAYMENTS EXECUTION IN 2022[185]

Payments made	Amounts	%
Operational expenditure:		
H2020	23,329,173	30.13
Horizon Europe	46,960,288	60.64
Procurement	1,216,530	1.57
Administrative expenditure:	5,932,322	7.66
Overall total (EUR):	**77,438,313**	**100%**

TABLE 23. OPERATIONAL AND ADMINISTRATIVE EXPENDITURES

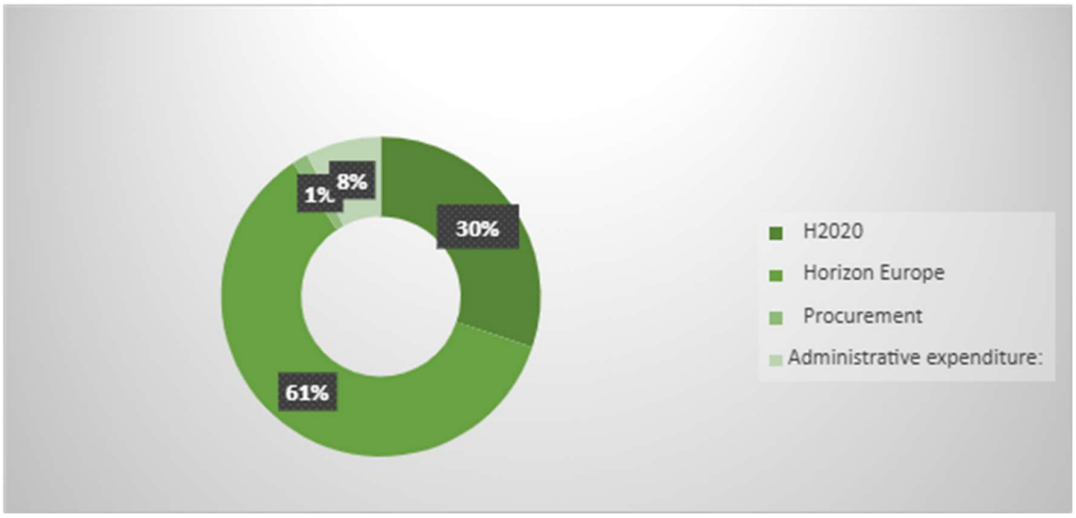

FIGURE 36. PROPORTION OF OPERATIONAL AND ADMINISTRATIVE EXPENDITURES

As for the share of expenditures, grant management represents more than 90% of the total 'payments made' while procurements accounts for 1.57% and expenditure payments for 7.66%.

Since the majority of the budget is implemented via grants in H2020 (existing running grants in 2022) and newly signed grants for Horizon Europe in 2022 (pre-financing paid), the main control activities were

[185] The amount of administrative expenditure of EUR 5,932,322 includes the C4 funds amounting to EUR 1,633

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focused on ex-ante and ex-post controls in this area.

In line with the 2018 Financial Regulation, Clean Hydrogen JU's assessment for specific reporting requirements is as follows:

Clean Hydrogen JU has no cases of "**confirmation of instructions**" in 2021 (new FR art 92.3);

- In Horizon 2020 and Horizon Europe, there are no cases of financing not linked to costs (new FR art 125.3);
- With respect to cases of flat rates for indirect costs >7% (new FR art 181.6), according to the Horizon 2020 and Horizon Europe Rules for Participation, eligible indirect costs of Horizon 2020 and Horizon Europe grants are determined by applying a flat rate of 25% of the total eligible direct costs. It is the basic act that derogates from the Financial Regulation. This applies to all Horizon 2020 and Horizon Europe grants.
- There are no cases of "Derogations from the principle of non-retroactivity pursuant to Article 193 FR" (new FR art 193.2).
- There are no "Financial Framework Partnerships >4 years" (new FR art 130.4).

4.1.1 Effectiveness of controls (ex-ante and ex-post controls, if relevant)

Control results regarding the legality and regularity of the operations, the fraud prevention and other control objectives, in particular the safeguarding of assets are detailed here. The benefits of the controls are summarised for the direct grant management.

4.1.1.1 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 5.11.

The Clean Hydrogen JU uses internal control processes to ensure the adequate management of the risks relating to the **legality and regularity** of the underlying transactions it is responsible for, taking into account the multiannual character of programmes and the nature of the payments concerned.

Ex ante and ex post controls

In order to support the conclusions on legality and regularity of the financial transactions, we have taken into account:

- **Preventive measures**: corrections made before signature of new grants and before payment of existing grants during the reporting year, as a result of ex-ante controls
- **Corrective measures**: corrections implemented after payment during the reporting year following ex-post controls

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The main elements of Clean Hydrogen JU control strategy are a combination of these preventive and corrective measures. The table below clarifies the main features of these 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
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'

TABLE 24. EX-ANTE CONTROLS VERSUS EX-POST CONTROLS

The main risks together with the control processes aimed to mitigate them and the indicators used to measure the performance of the control systems, are outlined in Annex 5.5.

Control results on the operational budget implementation

The major share of the Clean Hydrogen JU's expenditure concerns grants. Therefore, a quick overview of the control system on the overall management cycle of procurement transactions is described, which is followed by a longer one of grant transactions:

Procurement in indirect management mode

Financial management and control of 'Procurement in indirect management mode' is grouped around three main stages:

1) procurement (from the assessment of needs to the selection of the suppliers - award decision),
2) financial transactions (from establishing the financial commitment to payment and contract monitoring) and

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3) supervisory measures (management checks).

Grants in indirect management mode

The control system for grant under indirect management is deployed in four stages: 1) programming, evaluation and selection of proposals, 2) contracting, 3) monitoring and execution and 4) ex-post controls. Key indicators have been defined for each stage covering control effectiveness and control efficiency.

In addition to the controls performed during the financial circuits, the Clean Hydrogen JU has used five main supervisory measures (including associated indicators) to assess the legality and regularity of its work, namely exception reporting, the Procurement Team and legal advisory role (the procurement and legal team is further strengthened with the arrival of a new staff member in 2022), accounting controls, ex-post controls and the assurance statements from the Clean Hydrogen JU's executive Director.

Ex ante controls on operational expenditure

Ex-ante controls are essential to prevent errors and reduce the need for *ex post* corrective action. In 2022, the JU continued to apply the provisions of Article 74 of the financial regulation and Article 21 of the JU financial rules: 'each operation shall be subject at least to an *ex-ante* control relating to the operational and financial aspects of the operation, on the basis of a multiannual control strategy which takes risk into account'.

Therefore, the main objective of *ex-ante* controls is to ascertain that the principles of sound financial management have been applied.

The JU has developed and continues to apply well developed 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 H2020 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.

Ex-ante control activities in 2022 included:

- assessment of 57 periodic reports based on the "Guidance H2020 ex-ante controls on interim & final payments" issued by the Commission;
- targeted webinars focused on the specificities of each project;
- drawing up a list of selected beneficiaries (mostly SMEs and newcomers), based on a detailed analysis of the most common audit findings and financial claims, and sending a financial questionnaire to them with the purpose of evaluating beneficiaries' knowledge of H2020 rules and assessing level of risks related to most common errors detected via of the H2020 ex-post audits;
- as a follow-up on the answers to the questionnaires (following H2020 guidance on risk), targeted bilateral financial webinars were organized, with the purpose of enhancing knowledge of JU's beneficiaries, strengthening their sound financial management and understanding of the H2020

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rules;

- reinforced monitoring and targeted checks during *ex ante* controls for interim and final payments, in accordance with the H2020 *ex ante* control strategy, as published by the Common Support Centre Steering Board on 18 December 2020.

In addition, the JU actively contributed to the development of the Horizon Europe control strategy (ex-ante, audit and fraud prevention) by participating in the dedicated WGs set up by the CIC and providing input. The internal guidance for grant agreement preparation has been updated according to the Horizon Europe rules allowing the first grants signed under Horizon Europe to be compliant with these new rules.

Due to persistent systemic errors in declared personnel costs, particularly those of SMEs and new beneficiaries (which are more error-prone than other beneficiaries), the JU had been strengthening its internal controls since 2020 to address the increased risk regarding SMEs and new beneficiaries.

In 2020, a pilot project was launched to reinforce risk-based ex ante controls among top JU beneficiaries. It was specifically dedicated to newcomers and SMEs. The first results were available in 2021 and comforted by the continuously reduced error rates in 2022.

In 2022, the Clean Hydrogen JU has reviewed the entire population of its beneficiaries in H2020 grants, starting with the beneficiary with the highest EC contribution, until the beneficiaries with zero EC contribution.

The list was scrutinized for several risk-based criteria. The top beneficiaries, never audited before, with a risk profile of a newcomer or an SME, in particular, were flagged for the risk-based audits.

The remaining top "risky" beneficiaries (amount of EC contribution in all signed Clean Hydrogen JU grants > 1 mil. EUR) were invited to fill in a brief self-assessment questionnaire for the most common errors in the H2020 reporting (based on the results of ex-post audits).

Based on their replies, Clean Hydrogen JU has organized bilateral financial webinars, with focus and concentration on the legality and regularity aspects of the most important costs elements in their budget.

The outcome of the webinars and additional information have been used for all the upcoming REPAs and a follow-up questions, where necessary, were incorporated into requests for clarifications.

Error rate reduction, clearly observed for the 2022, can further confirm effectiveness and efficiency of this exercise. The impact of the reinforced ex-ante controls for the newcomers and SMEs showed reduced error rates (see Table 28).

Error rates of representative audits			
Period	Years in which ex-post audits were launched	SMEs	Newcomers
Before Ex-ante webinars	2017 - 2019	-2.53%	-1.03%
After introduction of ex-ante webinars	2020 - 2022	-0.58%	-0.60%
Total	**2017 - 2022**	**-1.64%**	**-0.78%**

TABLE 25. REDUCED ERROR RATES THANKS TO REINFORCED EX-ANTE CONTROLS FOR NEWCOMERS AND SMES

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The additional benefits of the reinforced ex-ante controls included the following, among others:

- quantitative benefits:
  - reduced error rates and reduced amount of ineligible costs,
  - timely corrections of the potential errors at ex ante level; for example, average duration of the entire exercise from the moment of identification of the risky beneficiary until the closure of a follow-up action was 6 months, in comparison with 24–36 months for a risk-based audit (from the moment of identification until the letter of conclusion);
- qualitative benefits:
  - preventive measure with a long-term effect,
  - learning for both grant officers and beneficiaries and establishing connection with both parties to build smooth working relationship,
  - reinforced teamwork and cooperation among officers with technical and financial knowledge.

Period	Years in which ex-post audits were launched	Error rates of closed audits by 31 December 2022 (%)
Without ex-ante webinars	2020 - 2022	-6.17%
With ex-ante webinars	2020 - 2022	-1.14%
Total	**2020 - 2022**	**-4.96%**

TABLE 26. REDUCED ERROR RATES THANKS TO REINFORCED EX-ANTE CONTROLS FOR EX-ANTE WEBINARS PROJECT BETWEEN 2020 AND 2022

This low ex-post error rate is a good indication of the outcome of the ex-ante controls in place via the implementation of the financial webinars.

For the period from 2020 to 2022, the error rate stemming from audits of beneficiaries without ex-ante webinars was -6.17% compared to a much lower error rate of -1.14% stemming from audits of beneficiaries participating in ex-ante webinars.

Thanks to positive results in terms of reduced error rates, and encouraging feedback received from the beneficiaries on this initiative, the JU will continue with the reinforced risk-based controls in 2023, with aid of the reinforced monitoring tool available in the corporate COMPASS/SyGMa system for H2020 grants management.

Ex post control of operational expenditure and error rates identified

Ex-post controls are the final stage of Clean Hydrogen's control strategy in the project lifecycle. This stage includes the ex-post audits as well as correction and recovery of any unduly paid amounts, if necessary.

Seventh framework programme

The JU ex post controls of FP7 grants included financial audits carried out by external audit firms. In 2021 and 2022 there were no new audits launched on FP7 projects. The last batch of FP7 audits launched in November 2019 was completed in 2020, and fully implemented in 2021. As there were no FP7 payments validated in 2022, and thanks to favourable overall results, the Clean Hydrogen JU has discontinued FP7 ex-post audit campaign.

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For information of the readers, the final FP7 ex-post controls representative error rates are the following:

- representative error rate on the EU contribution – 1.97 %
- residual error rate on the EC contribution – 1.11 %.

Horizon 2020 ex post controls, audit strategy and cooperation with the Common Implementation Centre

Ex -post controls of operational expenditure for H2020 are designed and implemented in line with the H2020 ex post audit strategy. For H2020, the CIC developed this audit strategy in cooperation with all of its clients (i.e. the entities that implement the H2020 budget: European Commission services, executive agencies and JUs).

Unit RTD.H.2 of the CIC, the Common Audit Service (CAS), ensures harmonised implementation of the H2020 ex post audit strategy for the EU's R&I expenditure, serving all H2020 stakeholders.

The CAS uses the IT tool AUDEX for audit process management. Its mission is to deliver a corporate approach to the audit cycle: audit selection, planning, application of rules, relations with beneficiaries and management information on the audit process.

The main objective of the audit strategy is to provide the individual authorising officers with the necessary elements of assurance in a timely manner, thereby allowing them to report on the budget expenditure for which they are responsible. Ex post controls on operational expenditure have three main objectives:

- to assess the legality and regularity of expenditure on a multiannual basis;
- to provide an indication of the effectiveness of the related ex ante controls;
- to provide the basis for corrective and recovery mechanisms, if necessary.

The JU is effectively integrated in this control chain: it participates in defining the audit process and in monitoring its implementation in close cooperation with the CAS and its clients. The main objectives of this cooperation are to align operations and exploit synergies in the common audit effort. The efficiency gains should further reduce audit costs and the administrative burden on auditees, always in line with the specific objectives explained above for ex post controls.

The implementation of all ex-post audit results remains the responsibility of the JU.

The JU also ensures the implementation of the research community's common anti-fraud strategy.

The main actions derived from the strategy include the organisation of awareness-raising sessions within the JU and cooperation with OLAF (in the case of risk-based audits conducted by the CAS or outsourced contractors). Implementation of the action plan derived from the strategy is monitored by the Fraud and Irregularity Committee (see also Section 4.1.1.2).

In 2022, the following main achievements were attained:

- The JU and CAS cooperated on selecting **15 new corrective and representative H2020 ex post** audits for execution in 2023 with results expected by 31 December 2023, focusing primarily on the

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top 100 beneficiaries[186];

- By continuous application of the JUs' sampling methodology (endorsed by the CIC Executive Committee on 19 July 2019), the JU reached **a significant cumulative audit coverage** (see Figure 40) of the overall H2020 expenditures, forming a strong basis for the declaration of assurance in 2022;
- It closed the 626 representative and risk-based audits (reaching a cumulative number of 82 closed audits for H2020, covering close to EUR 65 million of the EC contribution and close to EUR 86 million of the reported costs).
- The JU participated in the extension of the audit findings exercise, common to all H2020 stakeholders, enabling further cleaning of the representative error rate **down to – 0.88 % of the residual error rate.**

Horizon 2020 ex post audit methodology and error rates: corporate approach

The common representative sample (CRaS) provides an estimate, through a representative sample of cost claims across the R&I family, of the overall level of error in the research framework programmes, across all services involved in its management. All of these grants follow the same homogeneous overall control system set out in this report.

The H2020 ex post audit strategy builds upon different layers of audits:

- a corporate layer consisting of a CRaS complemented by risk-based samples,
- an additional sample for entities with specific GAs or a separate discharge procedure and Article 10 audits at the demand of the JUs.

In H2020, all implementing entities were expected to follow the same homogeneous overall ex ante control system.

The H2020 audit campaign started in 2016. Despite objective challenges due to carry over from the COVID-19 pandemic, the foreseen audit target was achieved. The CAS managed to finalise audits on 633 participations corresponding to 103.6% of the planned most probable scenario for the 2022 target.

The **targets** set for this control system are:

- for Horizon 2020, to obtain a cumulative residual error rate within a range of 2-5 % aiming to be as close as possible to 2%. Progress against Horizon 2020 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 and along with cost-benefit considerations regarding the effort and resources needed to detect and correct the errors.
- for Horizon Europe, to ensure that the cumulative residual error rate does not exceed 2%.

The error rates by 31 December 2022 were:

- representative detected error rate **2.71**%;

[186] Top 100 beneficiaries of the Clean Hydrogen JU are those beneficiaries who in the ranking order have the highest cumulative amount of budgeted EC contributions in EUR (for all their signed grants in the H2020 programme with the Clean Hydrogen JU)

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- cumulative residual error rate for the R&I family DGs **1.67** % (**1.71** % for DG Research and Innovation). In 2022, the DG R&I family's cumulative residual error rate for Horizon 2020, calculated at 1.67%, more than fulfils this condition and is below the materiality threshold.

It should be noted, however, that due to its multi-annual nature, the effectiveness of the control strategy 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 control strategy has been fully implemented, and errors, including those of a systematic nature, have been detected and corrected.

Horizon 2020 ex post audit methodology and error rates: joint undertaking's approach

For classification, reporting and error rate calculation purposes, the JU distinguishes between representative and corrective audits (Figure 38).

Corrective audits are defined as all audits that were not selected by statistically representative sampling.

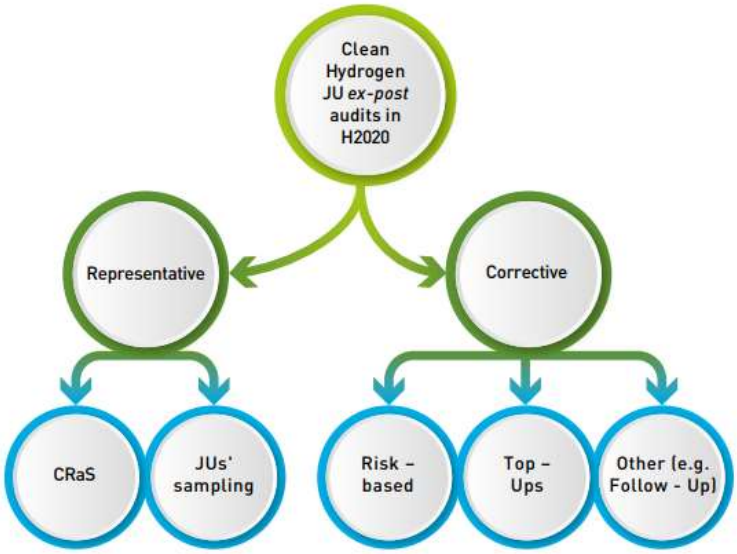

FIGURE 37. DISTINCTION BETWEEN REPRESENTATIVE AND CORRECTIVE AUDITS

Overall targets of the Horizon 2020 ex post audits

For the Clean Hydrogen JU, an initial target of 295 participations was defined([187]), following an anticipated payment profile of H2020 interim and final payments.

By 31 December 2022, the JU had selected 171 participations for ex post audits. Thanks to positive audit results (residual error rate on EC contribution of –0,88% as of 31 December 2022 attributed mainly to reinforced ex-ante controls) and thanks to significant ex-post audit coverage achieved, the JU is in the

[187] Participation is defined as a combination of a beneficiary and a grant, example: audits are launched at beneficiary level, and can include up to 3 different grants. For achievement of the CAS targets, an audit with one grant agreement is counted as 1 participation, where as an audit with 3 grant agreements is counted as 3 participations. For the Clean Hydrogen JU initial targets set up, an average of 2 participations were envisaged to be included in one ex-post audit (based on the FP7 statistics)

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position to reduce 295 participations to a revised number of 250 participations.

The remaining 79 participations (250-171: approximately 40 audits) are assessed to be fully sufficient to cover ex-post control needs for the H2020 programme in the upcoming 2-4 years.

The reduction of the ex-post audit targets should also contribute to further reduction of the audit burden of the beneficiaries and should contribute to efficient use of resources which can be allocated to preventive ex-ante controls.

Starting from 2024, when the first Horizon Europe interim payments are expected, the JU will gradually start phasing out the H2020 audits to be replaced by Horizon Europe audits.

As observed in the Figure 38, the JU is approximately in the middle of the H2020 ex-post audit campaign in terms of closed audits and already in two thirds of the way through in terms of selected and ongoing audits.

H2020 audits with Clean Hydrogen JU participations	Number of participations					
	Closed	Ongoing	To be selected	H2020 initial target	H2020 revised target	Completion status
Total up to 31 December 2022	130	41	79	295	250	52%

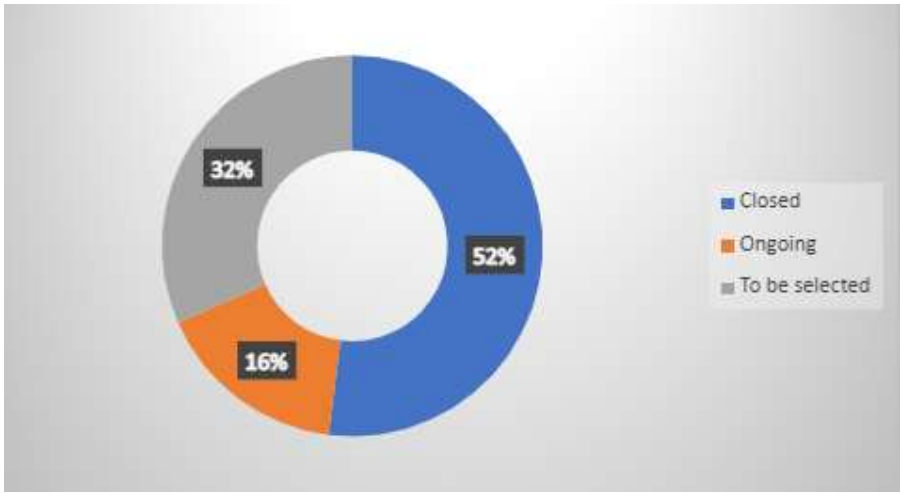

FIGURE 38. H2020 EX-POST AUDITS IN PROGRESS UP TO 31 DECEMBER 2022 – COMPLETENESS STATUS

Horizon 2020 overall direct audit coverage on the validated EC contribution

In 2022 the JU validated EUR 59.12 million of the EC contribution (EUR 88.62 million in 2021).

Throughout the year the JU selected corrective and representative audits to target overall audit coverage of around 20 % of H2020 expenditure (to be reached by the end of the framework programme), in order to ensure sufficient and timely audit results to support the annual declaration of assurance.

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YEAR	EC contribution in mil. EUR				
	Accepted by the Clean Hydrogen JU	Selected for ex-post audits	Cumulative coverage	Audits closed	Cumulative coverage
2017	37.09	8.14	21.95%	8.14	21.95%
2018	58.65	10.8	19.78%	10.8	19.78%
2019	98.53	27.27	23.79%	27.27	23.79%
2020	70.03	48.48	35.83%	23.39	26.33%
2021	88.62	17.42	31.77%	11.72	23.04%
2022	59.12	16.09	31.11%	26.02	26.05%
Total up to 31 December 2022	**412.04**	**128.2**	**31%**	**107.34**	**26.05%**

TABLE 27. EX-POST AUDITS: DIRECT AUDIT COVERAGE ON 31 DECEMBER 2022 (H2020 EUROPEAN COMMISSION CONTRIBUTION)

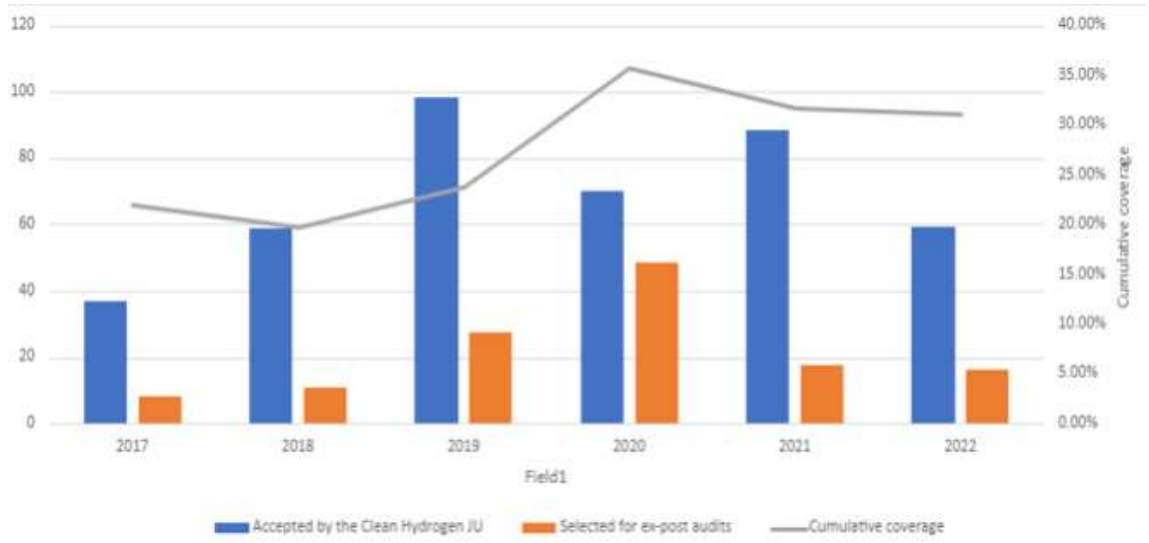

Figure 39. Direct audit coverage on the selected audits of the EC contribution in comparison with the validated EC contribution in the interim and final payments of the H2020 grants. Thanks to achievement of the targeted audit coverage set in the beginning of the H2020 ex-post audit strategy and thanks to timely selection and closure of fresh audits on annual basis, we can conclude, that by end of the year 2022, overall audit targets have been (over)achieved and provide sufficient and timely basis for the assurance.

This allows the JU, in the following 2 years of 2023 and 2024, to decrease the intensity of ex-post audits for H2020 programme, and shifting its focus on preventive measures (capitalising on the lessons learnt from the ex-post audits) for the ongoing H2020 grants and starting focusing on Horizon Europe ex-post audit campaign.

Horizon 2020 representative audits

Representative audits in 2022 were selected following the JUs' common sampling methodology. This methodology was built on the principles of stratified random sampling (which is similar to the method used by the FCH JU in FP7 and a similar to a monetary unit sampling method) with the following objectives:

- efficient use of resources

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- focusing on large-value cost claims
- providing an overview of the full range of projects and beneficiaries in the JU programme
- ensuring representativeness of the results, as per the International Standards on Auditing.

Horizon 2020 risk-based audits

Risk-based audits in 2022 were selected by applying an analytical approach of reviewing the inherent risk and exposure profiles of JU beneficiaries (first step). In the second step, the selected beneficiaries were assessed internally by the project and financial officers and approved by management to validate a rationale and specific risks involved in projects signed with those beneficiaries.

As a result of this approach five beneficiaries were selected for the risk-based audits, following a discussion with the operational services.

For efficiency purposes, all available cost claims validated by the JU until the audit was launched, if available, were added to the selection.

Distribution of the coverage of the two main audit streams is captured in Table 28 and the Figure 40.

	Clean Hydrogen JU contribution in mil. EUR		
YEAR	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	18.73	29.75	48.48
2021	10.32	7.10	17.42
2022	5.8	10.29	16.09
Total up to 31 December 2022	**57.08**	**71.13**	**128.20**

Table 28. Classification of participations selected for ex post audits as of 31 December 2022

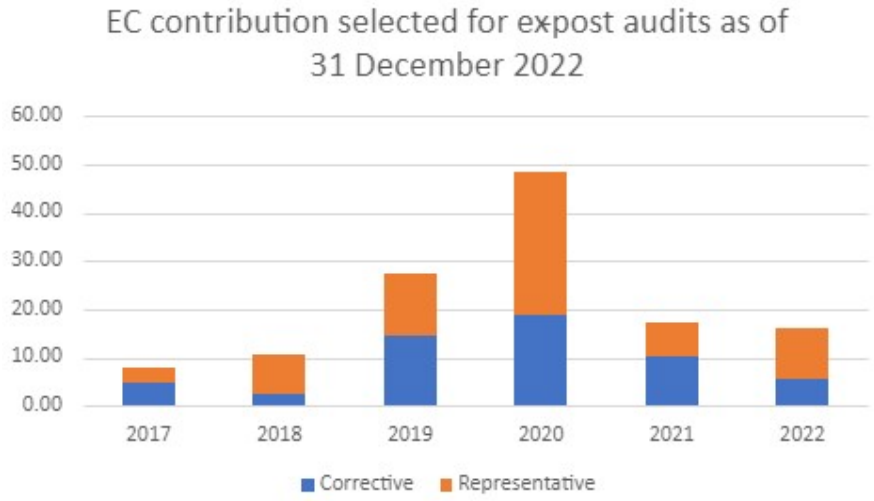

FIGURE 40. EC CONTRIBUTIONS SELECTED FOR EX POST AUDITS AS OF 31 DECEMBER 2022. RESULTS OF THE JU-SPECIFIC ERROR RATES FOR H2020

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As part of its control strategy, to determine whether there had been material losses (e.g. due to errors) and whether financial rules and procedures were respected, the Clean Hydrogen JU periodically carries out checks on the accuracy and regularity of its *ex ante* controls, via *ex post* controls on a sample of financial transactions.

As the majority of relevant expenditure for 2022 (excluding Horizon Europe pre-financing) is still related to the H2020 programme, this is the focus of the reporting in this AAR. Error rates for the Horizon Europe programme should become progressively available from AAR 2025 onwards.

Results of 63 representative items were used to calculate an indicative cumulative **representative error rate on H2020 expenditure specific to the JU, as of 31 December 2022:**

- representative detected error rate: -**2.97%**
- residual error rate for Clean Hydrogen JU contribution of -**0.88**%.
- (residual error rate for the Research and Innovation Family overall: -1.67%).

Please find below the annual evolution of the H2020 JU-specific residual error rate:

Year	JU specific residual error rate - cumulative
2018	-0.46%
2019	-0.70%
2020	-1.34%
2021	-1.73%
2022	-0.88%

TABLE 29. EVOLUTION OF THE H2020 JU-SPECIFIC RESIDUAL ERROR RATE ON THE EUROPEAN COMMISSION CONTRIBUTION

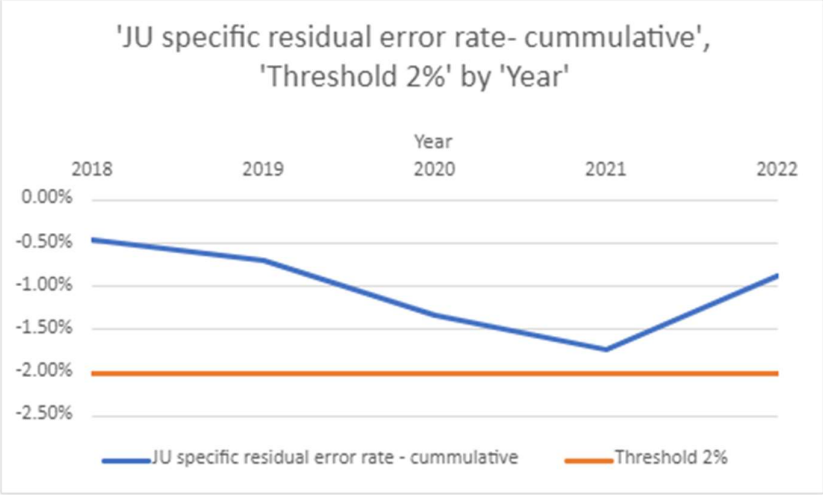

FIGURE 41. JU-SPECIFIC CUMULATIVE RESIDUAL ERROR RATE VERSUS THE 2 % THRESHOLD.

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In line with the Financial Statement accompanying the Commission's proposal for the Horizon 2020 regulation, a reservation is not necessary for the related expenditure if the cumulative residual error rate for the programme falls within the target range of 2-5%. In 2022, and despite the above-mentioned caveats, the Clean Hydrogen JU cumulative residual error rate for Horizon 2020, calculated at 0.88%, more than fulfils this condition and is below the materiality threshold. The outstanding result of this 0.88% low error rate is achieved by the senior financial officers' expertise in explaining the financial rules, detecting errors and asking beneficiaries to correct them at reporting stage before the audits were conducted; this exceptional goal is obtained thanks to the joint effort of the Clean Hydrogen JU' project and financial offers. Despite the absence of reservation, the root causes of errors have been identified and targeted actions taken to address any identified weaknesses in order to remain below the materiality threshold of 2% of the total expense recognised until the end of the programme.

Since Horizon 2020 is a multi-annual programme, the error rates, and the residual error rate in particular, should be considered within a time perspective.

European Court of Auditors audits

Since 2020, the European Court of Auditors (ECA) started to perform additional systems testing at each JU. This additional testing, based on a monetary unit sample of 30 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 JUs, 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 taking into account the following elements:

- the 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; and
- the correctness of the calculation of the residual error rate reported by the JUs, based on the ex post audit results for their grant payments.

For the year 2022, the ECA selected and reviewed 4 transactions (out of 30) from JU participations validated in 2022.

Horizon Europe framework programme The year 2022 was the second year of implementation of the Horizon Europe framework programme (2021-2027) and the first Clean Hydrogen JU grants were signed in December 2022. No representative error rate calculation for Horizon Europe is available in 2022 as the Clean Hydrogen JU's ex-post audit campaign for the Horizon Europe Programme is planned to be launched in 2024 at the earliest, once of the first interim payments are validated.

H2020 programme - Implementation of audit results

The JU has implemented the necessary controls and monitoring mechanisms to ensure that all errors detected in favour of the JU are corrected in due course (either through a recovery order or by offsetting a future payment).

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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. The timely implementation of extension of audit findings relies on beneficiaries preparing and submitting revised cost claims from which the effect of any systematic errors detected in audits has been eradicated.

All audit adjustments (positive, nil or negative), including extensions, are implemented via H2020 corporate tools in Sygma/Compass via an AURI188 workflow.

The table below summarises the status of the implementation of audit results for the finalised audits on a cumulative basis, as of the cut-off reporting date of 31 December 2022:

Type	Number of audit results processed	Proportion of audit results processed (%)	Number of audit results pending	Proportion of audit results pending (%)	Total number of audit results
Audits	135	96.43%	5	3.57	140
Extensions	48	100.00%	0	0.00	48
Total	183	97.34%	5	2.66	188

TABLE 30. CUMULATIVE IMPLEMENTED AUDIT RESULTS (FROM THE START OF THE MULTIANNUAL FINANCIAL FRAMEWORK) – STATUS AS OF 31 DECEMBER 2022

	0–6 months		Over 6 months		Total number of
	Number of audit results	Proportion of audit results (%)	Number of audit results	Proportion of audit results (%)	audit results
Closed projects. Negative adjustments with recovery	2	50.00	2	50.00	4
Closed projects. Positive or zero adjustments	15	100.00	0	0.00	15
Ongoing projects. Negative adjustments	2	100.00	0	0.00	2
Ongoing projects. Positive or zero adjustments	11	100.00	0	0.00	11

[188] AURI = AUdit Results Implementation

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Total	30	93.75	2	6.25	32

TABLE 31. TIME TO IMPLEMENT CLOSED AUDIT RESULTS IN THE FINANCIAL YEAR 2022

Exception reporting for procurement and grants

In total 8 exceptions and non-compliance events were recorded in the central register in 2022, 8 of which were classified as exceptions. The exceptions were linked to deviations from standard financial and procurement procedures which cannot be directly associated with a material loss. To put the exception reporting into context, the Clean Hydrogen JU dealt in 2022 with 810 payments. The exceptions and non-compliance events amount to 1.01% of the total number of payments.

Accounts

The main aim of accounting controls is to assure the quality and reliability of the accounts and underlying transactions through methodical checks on the accounting records (data) and timely communication and correction of the errors. The controls carried out in 2022 have followed the Annual Accounting Quality Plan. The controls performed are additional to the ex-ante controls performed by Financial Verifier and Authorising Officer on each transaction, in compliance with the Financial Regulation.

First, the controls on the General Ledger (GL) account of invoices were performed periodically according to the Accounting Quality plan. A vast majority of invoices is subject to one of the following controls: operational/administrative coherence, Legal Entity default GL, greatest amounts checked, asset risk-based analysis, random sample. The errors detected are either corrected in ABAC or by means of an accounting adjustment at the year end.

Secondly, Ernest & Young audited the Final annual accounts of the Clean Hydrogen JU and stated in June 2022 that the Annual Accounts present a true and fair view of the financial position of the Joint Undertaking in all material respects for the year ended December 31, 2021.

Opinion on the reliability of the accounts

In the ECA's opinion, the accounts of the JU for the year ending on 31 December 2021 present fairly, in all material respects, the financial position of the JU, the results of its operations, its cash flows, and the changes in net assets for the year then ended, in accordance with its Financial Regulation and with accounting rules adopted by the Commission's accounting officer. These are based on internationally accepted accounting standards for the public sector. For the year ended 31 December 2021 the ECA issued a clean opinion on the reliability of the accounts189.Opinion on the legality and the regularity of the transactions underlying the accounts

In the Court's opinion, the transactions underlying the annual accounts for the year are legal and regular in all material respects.

Conclusion on the assessment as regards legality and regularity

Residual error rate as a prime indicator on the legality and regularity aspects of the underlying transactions, with its stable and positive results, far below 2% threshold, both for FP7 and H2020 programmes, confirm that both ex-ante and ex-post controls of the JU are present and functioning effectively.

[189] Annual report on EU Joint Undertakings for the financial year 2021

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Over 2022, the COVID-19, Brexit crisis and Ukrainian war continued to overshadow all other contributing factors towards meeting the targets. However, most of the negative effects continue to be mitigated by the flexible working techniques, increasing digitalisation of finance and procurement processes, helping UK beneficiaries having funding through the UKRI agency and finding alternatives to the soaring price of electricity impacting the ongoing projects.

In conclusion, based on the analysis of the results of the above-mentioned control sources, no significant weakness has been unveiled which could have a material impact as regards the legality and regularity of the procurement and revenue operations. Therefore, it is possible to conclude that the internal controls systems implemented by the Clean Hydrogen JU provide sufficient assurance to adequately manage the risks relating to the legality and regularity of the underlying transactions.

4.1.1.2 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 JU participates. Furthermore, for areas of expenditure other than grants, the JU applies mutatis mutandis, by analogy, the anti-fraud strategy of DG Research and Innovation. This is relevant in particular to expert management, procurement and internal fraud, and the risk analysis leads to the conclusion that the residual risks (after mitigating actions) are low.

Awareness raising remains the main preventive measure. In this regard, the OLAF anti-fraud training courses for the JUs exclusively took place on 6 December 2022 (for the whole JU staff) and it also held a workshop for DG RTD on 16 November 2022 on ex-ante checks to detect potential fraud for Horizon Europe programme. They delivered an updated version of the common antifraud training material for the R&I family and these training courses are addressed to all staff dealing with research grants in cooperation with OLAF, the Fraud and Irregularity Committee and a Common Audit Service (CAS) of the DG R&I.

4.1.1.3 Assets and information, reliability of reporting

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"[190]. In the Clean Hydrogen Joint Undertaking this is ensure since 2011 by following the inventory procedure which is covering not only the assets over 420€ but also any items below kept in the inventory. We keep the control effective by using our own inventory tags and performs annual physical inventory counts in relation to the assets report, which is provided to the accountant for the preparation of the annual accounts. Out phasing and impairment are also kept timely way in the database to support the disposal exercises done on ad hoc basis.

In the event of a disaster, the Joint Undertaking ensures the complete restoration of the system. In the common IT Security for the Joint Undertakings, the following principles have been defined:

Personal computer users are responsible for backing up the information stored on their local machines.

We use industry-standard media, techniques, and timelines when executing all backups. For servers, whenever systems software permits, backups must be performed without end-user involvement, over an

[190] Source: The Committee of Sponsoring Organizations (COSO) of the Treadway Commission's Addendum, Reporting to External Parties

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internal network and during the off hours. Media are stored in fireproof safes, at a separate location at least several city blocks away from the system being backed up. All Confidential information stored on backup media are encrypted using approved encrypting methods. Back up communication and streaming should be encrypted.

With the increased use of cloud storage for the information management system, the Joint Undertaking is relying on the security measures and backup provided by the Microsoft 365 solution. Nevertheless, we will also deploy in 2023 a cloud-backup solution as a safeguard to the retention policy for documents deployed.

Other general controls like antivirus, firewalls, and change management processes are ensured by our ICT managed service providers. Regarding cybersecurity vigilance we 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. Phishing campaigns and redteaming exercises are performed on an annual basis with the support of ENISA and CERT-EU.

4.1.2 Efficiency of controls ("Time to")

4.1.2.1 TIME-TO-PAY[191]

Operational payments

FP7

In 2022, 1 interim FP7 report was assessed (3 in 2021). The overall time to pay (TTP) slightly decreased to 61 days (compared to 64 in 2021).

The gross TTP (including any suspensions due to requests for clarifications and amendments) reached 63 days.

H2020

In 2022, 57 (44 interim and 13 final) H2020 reports were assessed (65 in 2021). The overall time to pay (TTP) remained stable and in line with prior years (66 days in 2022 compared to 65 in 2021).

The gross TTP (including any suspensions due to requests for clarifications and amendments) reached 104 days.

Horizon Europe

8 pre-financing payments were processed in December 2022, with grants starting to incur costs in 2023. First interim reports are due and will be assessed in 2024.

Administrative payments[192]

The average TTP for administrative payments (invoices from suppliers of goods, service providers and cost

[191] 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

[192] Art 116.1 FR: 30 calendar days for all other contribution agreements, contracts and grant agreements

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claims from experts/staff) was 18 days (15.1 in 2021).

Framework programme - interim and final payments	Year 2021 - average days to pay	Year 2022 - average days to pay	Benchmark - Financial Regulation requirement
FP7	64	61	90
H2020	65	66	90
Horizon Europe	N/A	N/A	90

TABLE 32. TIME TO PAY OVERALL EFFICIENCY: OPERATIONAL EXPENDITURE

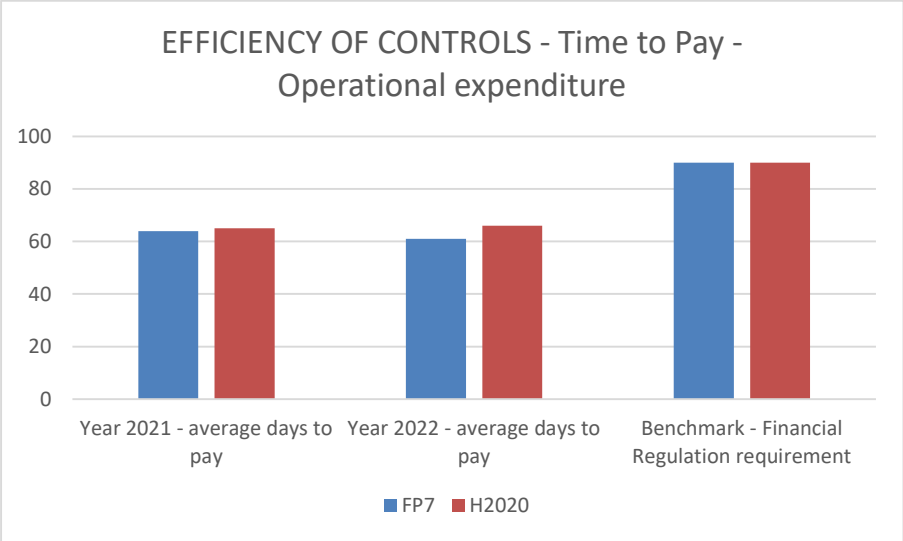

FIGURE 42. TIME TO PAY OVERALL EFFICIENCY: OPERATIONAL EXPENDITURE

As showed via comparative analysis of an average time-to-pay indicator over the past two years against required benchmarks, Clean Hydrogen JU has performed well below each of the required indicators:

Administrative payments	2021	2022	Benchmark - Financial Regulation requirement
Average number of days	15	18	30

TABLE 33. TIME TO PAY OVERALL EFFICIENCY: ADMINISTRATIVE EXPENDITURE

This was achieved via an effective monitoring and prioritising system in place which assesses various aspects, such as timeliness of responses, priorities, complexity of transactions, etc. 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 CFS certificates, etc.)

Thanks all these preventive and monitoring measures, average time-to-pay for both, operational and administrative expenditures in 2021 and 2022 demonstrate high level of efficiency.

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4.1.3 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." [193]

The analysis the economy of controls can be estimated by their costs. Hence, we have reported on the cost of the controls put in place in Clean Hydrogen JU. Based on the calculation and assessment of the amount and % of the budget managed, we have assessed the economy aspect of our controls.

	All running grants (FP7, H2020) and newly signed grants (Horizon Europe)	**Resources used on *ex ante* and *ex post* controls – estimated**
Operational expenditure for 2022 (EUR)	156,006,506	1,491,500
Proportion of expenditure		0.96 %
Number of grants	81	9.5
Proportion of number of grants		8.53 %

TABLE 34. COST OF CONTROLS AS OF 31 DECEMBER 2022

As regards grant management, Clean Hydrogen JU's total cost of controls, measured by the ratio of costs/payments, is of 0.96%% (1.06% in 2021. It means **that the cost of controls represents 0.96% % of the JU operational expenditure in 2022** and can be quantified as EUR **18,414** per running grant agreement.

In 2022, as compared to year 2021, the costs of controls have increased as based on results of the first Horizon Europe 2022 call, 20 new grants have been assessed before their signature in December 2022, during the grant agreement preparation phase.

As an additional measure of effectiveness, we consider that the residual error rate shows a stable trend over the years, well below 2 %. In 2022, in particular, we demonstrated a significant decrease in the error rate for SMEs and newcomers, mainly thanks to targeted risk-based ex ante webinars, first introduced in 2020.

Cost-effective controls are those, which are effective to fulfil the intended control objectives in an efficient manner and at a reasonable cost. In order to conclude on the cost-effectiveness of the controls in place, it is therefore necessary to assess their benefits, their level of efficiency and their costs.

In the cost–benefit analysis, the JU considered the cost of controls employed ex ante and ex post in comparison with the amount of recoveries and ineligible costs detected either ex ante or ex post.

The ratio of the average cost to the average benefit for one running project in 2022 is 1:1.7 (calculated as 18,414 : 31,786) and can be interpreted that for every 1 EUR spent on the ex-ante and ex-post controls,

[193] Source: Financial regulation applicable to the general budget of Union, article 33 on Article 33 Performance and principles of economy, efficiency and effectiveness

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there is an overall benefit of EUR 1.7 EUR in ex-post recoveries or in protecting EU budget from ineligible costs prior to payments to beneficiaries.

BENEFITS (+) and COSTS (-) of controls as of 31 December 2022	Cost (-) or benefit (+) in EUR	Average cost or benefit of control per a running grant (81 in total, including 20 newly signed grants)
Costs of ex-ante and ex-post controls - estimated	(1,491,500)	(18,414)
Ex-ante rejections	2,149,659	26,539
Recoveries and ex-post audit adjustments in 2022	425,014	5,247
Overall costs (-) / benefits (+)	4,066,173	50,200

TABLE 35. COSTS AND BENEFITS OF CONTROLS AS OF 31 DECEMBER 2022

The two tables above demonstrate measurable benefits of the efficient and effective use of resources in the JU to reduce error rates ensure that principles of sound financial management are well understood and followed by the JU beneficiaries. In the long-term perspective, we believe that other benefits of a preventive nature that are not directly measurable will materialise in future.

4.1.4 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, as compared to 2021, with introduction of the new Horizon Europe programme, accompanied by significant increase in budget and number of grants to be assessed, the pressure on JU team has increased dramatically and is expected to increase further in the upcoming years.

In order to ensure adequate level of ex-ante controls, especially for interim and final payments, also staffing issue shall be addressed adequately194.

4.2 Audit observations and recommendations

4.2.1 Internal Audit

Internal audits are carried out by the Internal Audit Service of the European Commission (IAS) in liaison with Internal Control and Audit Manager.

[194] We refer to the top identified staff issue risk in the Risk Assessment, Section 1 of the AAR

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In 2022 a focus was put on providing input and assistance to IAS in conducting their reviews and audits as per the Annual Audit Plan 2022 of the IAS for the Clean Hydrogen JU.

In line with the predefined annual audit plan, there were two assignments undertaken by the IAS of in 2022 for the Clean Hydrogen JU:

1. Follow-up audit on the actions set up in response to the audit Horizon 2020 grant implementation performed in the former Fuel Cells and Hydrogen 2 Joint Undertaking;
2. Strategic Risk Assessment (SIAP 2023-2025).

As the Clean Hydrogen Joint Undertaking has been established recently, the IAS performed a full risk assessment covering all processes (administrative, financial, operational and IT) to serve as a basis for their Strategic Internal Audit Plan (SIAP) covering the period of 2023-2025 which would include the key risks identified by the IAS and a list of proposed audit topics for future IAS engagements.

Outcome of the IAS audit assignments in 2022 was as follows:

1. Based on the results of the follow-up audit, the IAS concluded that all recommendations have been adequately and effectively implemented.
2. The final 2023– 2025 Internal Audit Service (IAS) strategic internal audit plan for the Clean Hydrogen Joint Undertaking was communicated by the IAS on 30 January 2023. The plan was based on the results of the IAS risk assessment conducted between May and September 2022, which consisted of onsite visits and remote fieldwork, including meetings and interviews with the Clean Hydrogen JU staff, and a subsequent desk review of information available and documents provided by the Clean Hydrogen JU.

The IAS will be reviewing their strategic internal audit plan on an annual basis.

4.2.2 Audit of the European Court of Auditors

As regards European Court of Auditors (ECA) audits, in 2022 the Clean Hydrogen JU:

- Liaised with the independent auditor (contracted in 2020 and in 2022 based on the results of the reopening of competition under EC (DG BUDG) FWC) to audit Clean Hydrogen JU accounts for 2021 and 2022 as required by the Financial Rules of the Clean Hydrogen JU;
- Followed up and implemented recommendations made in the previous ECA reports on the 2020 and 2021 annual accounts;
- Provided the necessary information and support for ECA audit on 2021 and 2022 accounts;
- Assisted and supported ECA in their horizontal audit on HR and staffing of the JUs announced in December 2021 as well as in their new horizontal audit on risk–based ex-ante controls in H2020 in the JUs;
- Supported the ECA team in their field or remote missions for Clean Hydrogen projects selected (on a sample basis) for an ex-post financial review, including follow up with Clean Hydrogen JU beneficiaries and with CAS;

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- Assisted ECA in their preliminary review of the accounts and legality and regularity checks conducted in connection with the 2022 annual accounts – in connection to which the Clean Hydrogen JU obtained a statement from ECA that " *the audit team assigned to your JU did not identify any significant weaknesses during their first audit visit* ".

In 2022, the Clean Hydrogen JU received, in the scope of their Annual report on EU Joint Undertakings for the financial year 2021, an unqualified (clean) opinion from the Court of Auditors on:

- Reliability of the accounts
- Legality and regularity of the transactions underlying the accounts.

ECA, in their report equally confirmed status of all previous applicable recommendations as fully completed by the Clean Hydrogen JU in 2022.

4.2.3 Overall Conclusions

The Clean Hydrogen JU in 2022 received positive feedback from both, Internal Audit Service of the European Commission (IAS) and from the European Court of Auditors (ECA) on its performance and legality and regularity of the operations. These results, jointly with the other key performance indicators, confirmed a continuous improvement and maturity of the internal control environment, and efficiency and effectiveness of preventive controls and follow-up actions on all previous audit recommendation that were put in place by the JU.

All previous recommendations from IAS and ECA have been adequately and effectively implemented.

4.3 Assessment of the effectiveness of internal control systems

The JU internal control framework (ICF) is designed to provide reasonable assurance regarding the achievement of the following five 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,
- adequate management of the risks relating to the legality and regularity of the underlying transactions.

In line with the Commission's internal control framework and in line with the objectives and priorities described in the 2022 AWP, 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-

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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.

4.3.1 Continuous monitoring

The robustness of the internal control system was monitored throughout the year.

Internal control, ex ante and ex post controls, segregation of duties, documented processes and procedures, and sound financial management, were discussed at least on a weekly basis during unit meetings and on an ad hoc basis when preparing new processes or revising existing operating processes.

Risks identified through the annual risk assessment exercise, which might pose a threat to achieving the JU's mission and objectives, were also systematically assessed and managed through appropriate controlling and mitigating actions. Throughout the year, particular efforts were made to monitor the KPIs, which led to further improvement in financial management as indicated by the TTP.

Assurance is provided on the basis of an objective examination of evidence of the effectiveness of risk management, control and governance processes. This examination is carried out by management, who monitor the functioning of the internal control systems on a continuous basis, and by internal and external auditors.

The following reports have been considered:

- the periodic reports from the Operational and Financial Units on implementation progress in their respective areas of responsibilities, including on achievements and internal control in their Unit;
- the contribution of the Risk Management and Internal Control (RMIC) manager, including the results of internal control monitoring and risk assessment at JU level;
- the register of exceptions and non-compliance events and its corresponding analysis;
- the summary reports on the ex-post audit results;
- the DG BUDG report on the validation of the local systems;
- the conclusion of the Internal Auditor on the state of internal control, the observations and follow-up carried out by the Internal Audit Service (IAS);
- the observations and the recommendations reported by the European Court of Auditors (ECA).

These reports result from a systematic analysis of the available evidence. The results are explicitly documented and reported to the Executive Director.

This approach provides sufficient guarantees as to the completeness and reliability of the information reported and results in a complete coverage of the budget delegated to the Executive Director of Clean Hydrogen JU.

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4.3.2 Risk assessment and management

Risk management is a crucial part of the strategic decision-making process. Robust risk management frameworks help to ensure that the EU budget is used effectively and efficiently, that potential barriers to achieving objectives are identified in a timely fashion and that appropriate mitigation action is taken. All members of staff share responsibility for risk management. The Executive Director is accountable to the Governing Board and is ultimately responsible for the management of the JU's activities and the achievement of its objectives and must ensure that the JU's critical risks are known and appropriately managed ([195]).

For details on the risk assessment and its conclusions, we refer to section 1.1.

4.3.3 In view of the risks identified and actions implemented, the level of risks incurred by the Joint undertaking is considered acceptable. Prevention of Conflict of Interest

The Programme Office has developed a comprehensive set of rules and procedures that are effectively implemented across its entire governance structure, as follows:

- when joining the Programme Office team, each staff member agrees to the application of the staff regulation and signs a declaration of honour on the management of conflicts of interest;
- with the Executive Director's decision of 27 September 2019, the JU applies by analogy, mutatis mutandis, the 'Code of good administrative behaviour for staff of the European Commission in their relations with the public;
- conflict of interest procedures was in place for the members of both the FCH 2 JU GB and the advisory bodies, and were renewed in December 2021 in the scope of newly adopted rules of procedures of the GB for the Clean Hydrogen JU;
- specific measures have been implemented for the prevention and management of conflicts of interest of experts in charge of the evaluation of grant applications and of the review of projects and tenders.
- for each recruitment procedure to select the best candidate, both Selection Committee members and candidates are required to declare any possible conflicts of interest by signing a declaration so that conflict of interests can be considered and potential adjustments made accordingly.

In addition, the 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 JU participates.

Furthermore, for areas of expenditure other than grants, the JU applies mutatis mutandis, by analogy, the anti-fraud strategy of DG Research and Innovation. This is relevant in particular to expert management, procurement and internal fraud, and the risk analysis leads to the conclusion that the residual risks (after mitigating actions) are low.

The Clean Hydrogen JU has ensured the enforcement of Article 61 of the Financial Regulation (conflict of

([195]) Article 19(4)(t) of the SBA.

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interests) and raise awareness both within its organisation and towards external stakeholders.

The conflicts of interest and lack of objectivity have been identified as risks with a low probability. This is due to the ethical awareness and the stance of the Clean Hydrogen JU staff. As such, Clean Hydrogen JU has reasonable assurance that the measures in place to prevent conflicts of interest are effective.

4.4 Conclusion on the assurance

The purpose of this section is to provide an overall conclusion on the declaration of assurance as a whole. 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 5.11.).

Based on the information provided in the sections above, the following conclusions can be drawn.

- Concerning the 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 is also the case for JU's payments relating to administrative expenditure and procurement, as well as 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.
- In the moment of establishing the annual activity report, the certification process for the IKAA 2022 was still ongoing. The results of certified IKAA of EUR 121.07196 million (out of EUR 520.77 IKAA Plan) as presented in the IKAA 2022 Final Report as of 31 May 2023 would increase further and will be reported to the Clean Hydrogen JU Governing Board later in the year 2023. Therefore, no reservation in this area is necessary either.
- In conclusion, the 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 ad interim, 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 CAAR for 2022 give a fair assessment of operational and financial management needed for achieving the objectives. Based on the

[196] Certified figures as of 31 May 2023, as per the IKAA 2022 Final Report for the year 2022

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information provided, the JU key objectives set up for 2022 have been met 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, risks are being properly monitored and mitigated. Therefore, the Executive Director ad interim, in her capacity as Authorising Officer, has signed the Declaration of assurance without any reservation. The Governing Board thanks Mr. Bart Biebuyck, Executive Director of the JU until May 2023, for his continuous effort to deliver the JU's work programmes over years since 2016, and for his achievements and major contribution to developing Hydrogen in the European Union.

4.5.2 Declaration of assurance

I, the undersigned, Mirela Atanasiu

Executive Director ad interim of Clean Hydrogen JU,

In my capacity as authorising officer,

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 -control and audit manager 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.

Done in Brussels, on 29 June 2023

Mirela Atanasiu, Executive Director ad interim

Mirela Atanasiu

Digitally signed by Mirela Atanasiu
Date: 2023.06.30 12:51:57 +02'00'

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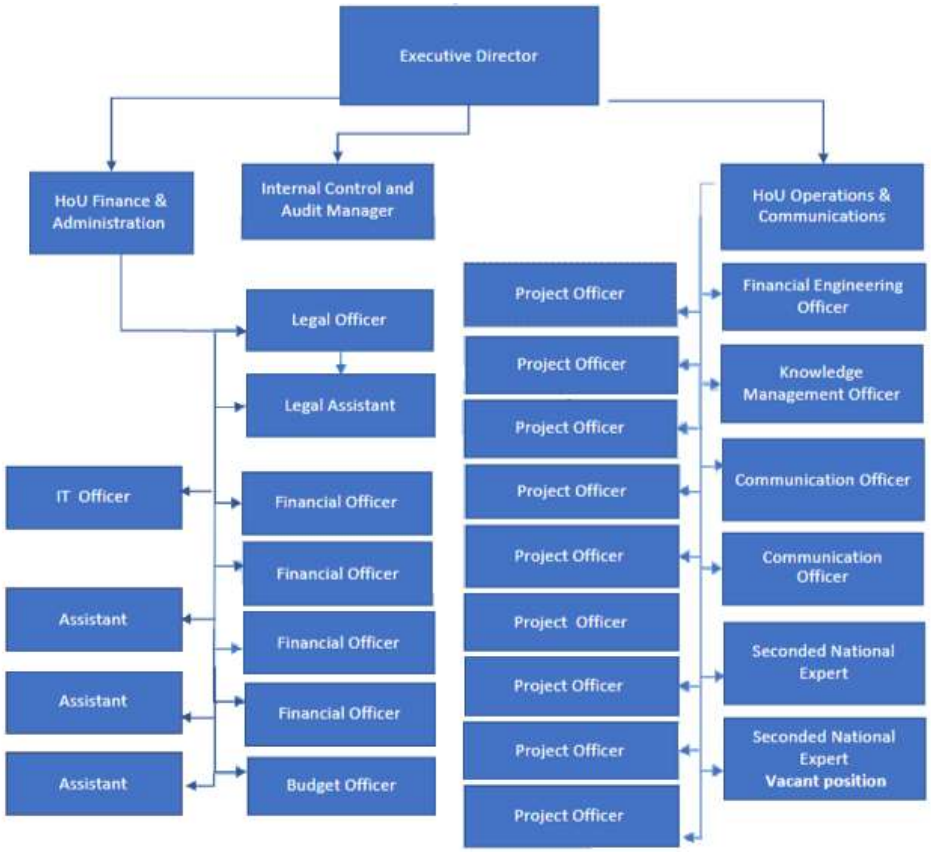
5 ANNEXES

5.1 Organisational chart



NB: HoU, head of unit.

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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 2022 Staff Establishment Plan is shown below:

Grade	2020 budget	2020 filled	2021 budget	2022 Budget
AD 14	1	1	1	1
AD 13	-	-	-	
AD 12	-	-	2	2
AD 11	2	2	-	
AD 10	-	-	-	
AD 9	4	4	5	5
AD 8	4	4	3	4
AD 7	1	1	2	2
AD 6	3	3	2	3
AD 5	-	-	-	-
Total AD	15	15	15	17
AST 9	1	1	1	1
AST 8	1	1	1	1
AST 7	1	1	1	1
AST 6	1	1	1	1
AST 5	1	1	2	2
AST 4	4	4	3	3
AST 3				1
Total *AST*	9	9	9	10
Function Group IV	1	1	1	1
Function Group III	1	1	1	1
Function Group II	1	1	1	0
Total Contract Agents	3	3	3	2
Total Seconded National Experts	2	2	2	2

NB: AD, Administrators. AST, Assistants

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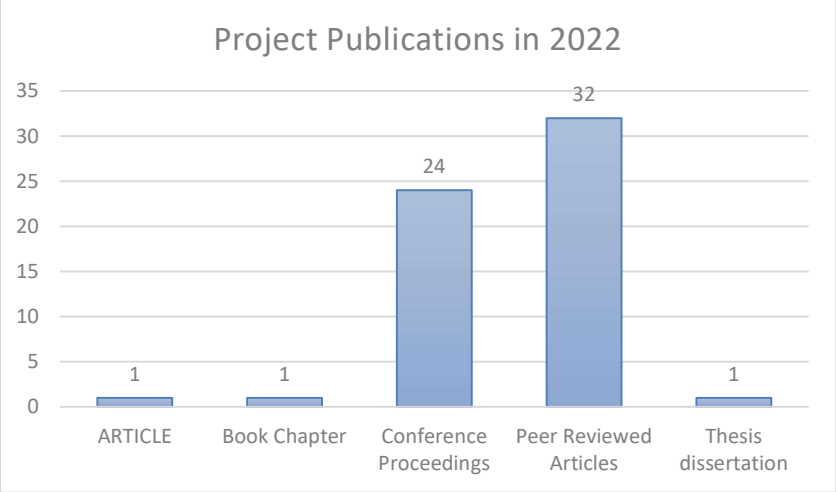
5.3 Publications from projects

Publications in 2022 related to H2020 projects, based on the information extracted from CORDA. As regards publications of H2020 projects of previous years, please refer to our past Annual Activity Report publications. There were no publications related to Horizon Europe projects in 2022.

In total there were 59 publications from the Clean Hydrogen JU projects, split per type as per the chart below:



Source: CORDA

FIGURE 43. PROJECT PUBLICATIONS IN YEAR 2022

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Project Acronym	Publication Type	Publication Title	Publication Authors	Publication DOI	Publication ISSN	Publication Is Peer Reviewed ?	Publication Journal Title	Publication Journal No	Publication Place	Publication Year	Publication Relevant Pages	Publication Is Joint Public/ Private ?	Publication In Gold O-A ?	Publication In Green O-A ?	Publication Repository URL
H2Future	ARTICLE	Decarbonization of the steel industry. A techno-economic analysis	Amaia Sasiain Conde1*, Katharina Rechberger1, Andreas Spanlang1, Hermann Wolfmeir2 and Christopher Harris	10.1051/mattech/202202	326895	No	MatÃ©riaux & Techniques	MatÃ©riaux & Techniques 109, 305	France	2022	N/A	No	No	Yes	N/A
Demo4Grid	PEER_REVIEWED_ARTICLE	Hydrogen in Grid Balancing: The European Market Potential for Pressurized Alkaline Electrolyzers	Emmanuel Stamatakis,Ewald PerwÃ¶g,Ermis Garyfallos, Mercedes Sanz MillÃ¡n, Emmanuel Zoulias and Nikolaos Chalkiadakis	10.3390/en15020637	1996-1073	Yes	Energies	Energies 2022, 15(2), 637	Switzerland	2022	N/A	Yes	Yes	No	N/A
GRASSHOPPER	PEER_REVIEWED_ARTICLE	Dynamic Modeling of a PEM Fuel Cell Power Plant for Flexibility Optimization and Grid Support	Crespi E, Guandalini G, Nieto Cantero G, Campanari S	10.3390/en15134801	1996-1073	Yes	Energies	15 (13)	Switzerland	2022	4801	Yes	Yes	No	http://hdl.handle.net/11311/1218407

GRASSHOPPER	CONFERENCE_PROCEEDING	Grasshopper: A Modular and Flexible Hydrogen PEM Power Plant for Grid Balancing Services	M. Tejada, G. Nieto and B. Sarmiento	N/A	N/A	Yes	European Hydrogen Energy Conference	N/A	Madrid	2022	N/A	No	No	No	https://www.ehec.info/index.php/conference-material/proceeding-book
Haeolus	PEER_REVIEWED_ARTICLE	Degradation identification and prognostics of proton exchange membrane fuel cell under dynamic load	Yue, Meiling; Li, Zhongliang; Roche, Robin; JemeÃ¯, Samir; Zerhouni, Noureddine	10.1016/j.conengprac.2021.104959	0967-0661	Yes	Control Engineering Practice	118	United Kingdom	2022	104959	No	Yes	No	N/A
Haeolus	CONFERENCE_PROCEEDING	Producing and Exporting Hydrogen from Stranded Resources	Zenith, Federico	10.5281/zenodo.6468199	N/A	No	N/A	N/A	Workshop "Hydrogen in the Hy North "	2022	N/A	No	Yes	No	https://doi.org/10.5281/zenodo.6468199
Haeolus	CONFERENCE_PROCEEDING	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	N/A	N/A	No	World Hydrogen Energy Conference	N/A	Istanbul, Turkey	2022	N/A	No	Yes	No	N/A
GAMER	PEER_REVIEWED_ARTICLE	Thermo-fluid dynamics modelling of steam electrolysis in fully-assembled tubular high-temperature	CatalÃ¡n-MartÃnez, D.; Navarrete, L.; Tarach, M.; Santos-Blasco, J.; VÃ¸llestad, Einar; Norby, Truls; Budd,	10.1016/j.ijhydene.2022.06.112	0360-3199	Yes	International Journal of Hydrogen Energy	volume 47 issue 65	United Kingdom	2022	27787 - 27799	Yes	Yes	No	https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/3033769/Catalan-

		proton-conducting cells	M.I.; Veenstra, P.; Serra, J.M.												Mart%25C4%25B1nez_etal_2022.pdf?sequence=1&isAllowed=y
NEPTUNE	PEER_REVIEWED_ARTICLE	Reinforced short-side-chain AquivionÂ® membrane for proton exchange membrane water electrolysis	S. Siracusano, F. PantÃ², S. Tonella, C. Oldani, A. S.AricÃ²	10.1016/j.ijhydene.2022.03.061	0360-3199	Yes	International Journal of Hydrogen Energy	Volume 47, Issue 35	United Kingdom	2022	15557 - 15570	No	No	Yes	http://eprints.bice.rm.cnr.it/id/eprint/21834
REMOTE	PEER_REVIEWED_ARTICLE	The role of hydrogen in the optimal design of off-grid hybrid renewable energy systems	Paolo Marocco, Domenico Ferrero, Andrea Lanzini, Massimo Santarelli	10.1016/j.est.2021.103893	2352-152X	Yes	Journal of Energy Storage	Volume 46, February 2022, 103893	Netherlands	2022		No	Yes	No	N/A
FLHYSAFE	PEER_REVIEWED_ARTICLE	Design and Demonstration of a 540 V/28 V SiC-Based Resonant DCâ€“DC Converter for Auxiliary Power Supply in More Electric Aircraft	Bhattacharya, S.; Willich, C.; Kallo, J.	10.3390/electronics11091382	2079-9292	Yes	Electronics	11(9)	Switzerland	2022	1382	Yes	Yes	No	https://www.mdpi.com/2079-9292/11/9/1382
MAMA-MEA	PEER_REVIEWED_ARTICLE	Multilayer additive manufacturing of catalyst-coated membranes for polymer	Andreas Willert, Farzin Z. Tabary, Tatiana Zubkova, Paolo E. Santangelo, Marcello Romagnoli,	10.1016/j.ijhydene.2022.04.197	0360-3199	Yes	International Journal of Hydrogen Energy	47	United Kingdom	2022	20973 - 20986	No	Yes	No	N/A

		electrolyte membrane fuel cells by inkjet printing	Reinhard R. Baumann												
TeacHy	CONFERENCE_PROCEEDING	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	N/A	N/A	No	Proceedings WHEC 2022, Istanbul, June 2022	23rd / 26-30 June 2022	Istanbul	2022	N/A	No	No	Yes	N/A
TeacHy	CONFERENCE_PROCEEDING	Training Staff in Fuel Cell and Hydrogen Technologies â€“ Continuous Professional Development and Blended Learning	Robert Steinberger-Wilckens, Naser Al-Mufachi, Ahmad El-kharouf, Yousif Al-Sagheer, Kun Zhang, Artur Majewski, John Hooper	N/A	N/A	No	Proceedings of the EFCF-2022 - SOFC-SOE Forum, Lucerne July 2022	15th / 05 - 08 July 2022 / bi-annually	Lucerne	2022	N/A	No	No	Yes	www.efcf.com

AD ASTRA	PEER_REVIEWED_ARTICLE	Prediction of crack nucleation and propagation in porous ceramics using the phase-field approach	A. Abaza, J. Laurencin, A. Nakajo, S. Meille, J. Debayle, D. Leguillon	10.1016/j.tafmec.2022.103349	1678442	Yes	Theoretical and applied fracture mechanics	119	Netherlands	2022	103349	No	No	Yes	https://hal.archives-ouvertes.fr/hal-03681038
AD ASTRA	PEER_REVIEWED_ARTICLE	Test and Modelling of Solid Oxide Fuel Cell Durability: A Focus on Interconnect Role on Global Degradation	R. Spotorno, F.R. Bianchi, D. Paravidino, B. Bosio, P. Piccardo	10.3390/en15082762	1996-1073	Yes	Energies	15(8)	Switzerland	2022	2762	No	No	Yes	https://www.mdpi.com/1996-1073/15/8/2762
AD ASTRA	PEER_REVIEWED_ARTICLE	Investigation of a Metallic Interconnect Extracted from an SOFC Stack after 40,000 h of Operation	P. Piccardo, R. Spotorno, C. Geipel	10.3390/en15103548	1996-1073	Yes	Energies	15(10)	Switzerland	2022	3548	Yes	No	Yes	https://www.mdpi.com/1996-1073/15/10/3548
AD ASTRA	PEER_REVIEWED_ARTICLE	Fracture properties of porous yttria-stabilized zirconia under micro-compression testing	A. Abaza , J. Laurencin, A. Nakajo, M. Hubert, T. David, F. Monaco, C. Lenser, S. Meille	10.1016/j.jeurceramsoc.2021.11.051	0955-2219	Yes	Journal of the European Ceramic Society	42/4	Netherlands	2022	1656-1669	No	No	Yes	https://hal.inria.fr
AD ASTRA	CONFERENCE_PROCEEDING	Redox Cycling for SOFC Accelerated Degradation	D. Vladikova, B. Burdin, A. Sheikh, P. Piccardo, M. Krapchanska, D. Montinaro	10.1051/e3sconf/202233404015	2267-1242	Yes	E3S Web of Conferences	334	France	2022		Yes	No	Yes	https://www.e3s-conferences.org

AD ASTRA	CONFERENCE_PROCEEDING	Degradation of Ni-YSZ and Ni-GDC fuel cells after 1000 h operation: Analysis of different overpotential contributions according to electrochemical and microstructural characterization	A. K. Padinjarethil, F. R. Bianchi, B. Bosio, A. Hagen	10.1051/e3sconf/202233404011	2267-1242	Yes	E3S Web of Conferences	334	France	2022		No	No	Yes	https://www.e3s-conferences.org
AD ASTRA	PEER_REVIEWED_ARTICLE	Accelerated Stress Tests for Solid Oxide Cells via Artificial Aging of the Fuel Electrode	D. Vladikova, B. Burdin, A. Sheikh, P. Piccardo, M. Krapchanska, D. Montinaro, R. Spotorno	10.3390/en15093287	19961073	Yes	Energies	15(9)	Switzerland	2022	3287	Yes	No	Yes	https://www.mdpi.com/1996-1073/15/9/3287
GAIA	PEER_REVIEWED_ARTICLE	Influence of the Carbon Support on the Properties of Platinumâ€“Yttrium Nanoalloys for the Oxygen Reduction Reaction	C. A. Campos-RoldÃ¡n, A. ParniÃ¨re, N. Donzel, F. Pailloux, P.-Y. Blanchard, D. J. Jones, J. RoziÃ¨re, and S. Cavaliere	10.1021/acsaem.1c03922	2574-0962	Yes	ACS Applied Energy Materials	5, 3	USA	2022	3319â€“3328	No	No	Yes	https://figshare.com/articles/journal_contribution/Influence_of_the_Carbon_Support_on_the_Properties_of_Platinum_Yttrium_Nanoalloys_for_the_Oxygen_Reduction_Reaction/19375898

GAIA	PEER_REVIEWED_ARTICLE	Nitrogen Plasma Modified Carbons for PEMFC with Increased Interaction with Catalyst and Ionomer	Alice ParniÃ¨re, BÃ©nÃ©dicte Prelot, Pierre-Yves Blanchard, Sara Cavaliere, Jacques RoziÃ¨re, and Deborah J. Jones	10.1149/1945-7111/ac609e	1945-7111	Yes	Journal of The Electrochemical Society	169, 4	United Kingdom	2022		No	Yes	No	N/A
HyTunnel-CS	PEER_REVIEWED_ARTICLE	Quantitative risk assessment methodology for hydrogen tank rupture in a tunnel fire	Kashkarov, S., Dadashzadeh, M., Sivaraman, S., Molkov V.	10.3390/hydrogen3040033	2673-4141	Yes	Hydrogen	3	Basel, Switzerland	2022	512-530	No	Yes	No	N/A
HyTunnel-CS	CONFERENCE_PROCEEDING	QRA methodology of hydrogen tank rupture in a fire in a tunnel	Kashkarov S., Sivaraman S., Molkov V.	N/A	N/A	Yes	10th Int. Seminar on Fire and Explosion Hazards, Oslo, Norway	10	Norway	2022	N/A	No	No	Yes	N/A
HyTunnel-CS	PEER_REVIEWED_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.	10.3390/en15010271	1996-1073	Yes	Energies	15	Switzerland	2022	111844	No	Yes	No	N/A

HyTunnel-CS	PEER_REVIEWED_ARTICLE	Blast wave generated by delayed ignition of under-expanded hydrogen free jet at Aambient and cryogenic temperatures	Cirrone D., Makarov D., Friedrich A., Grune J., Takeno K., Molkov V.	10.3390/hydrogen3040027	2673-4141	Yes	Hydrogen	3	Basel, Switzerland	2022	433â€“449	No	Yes	No	10.3390/hydrogen3040027
HyTunnel-CS	CONFERENCE_PROCEEDING	Risk associated to H2 vehicles in tunnels and other confined spaces	Russo, P., Cortellini, M.C., Markert, F.	N/A	978-91-89711-12-9	Yes	Nordic Fire and Safety Days 2022 â€“ Book of Abstracts	Yearly	Sweden	2022	13-14	No	Yes	No	http://ri.diva-portal.org/smash/get/diva2:1657152/FULLTEXT01.pdf
HyTunnel-CS	PEER_REVIEWED_ARTICLE	Full-scale tunnel experiments: Blast wave and fireball evolution following hydrogen tank rupture	Kudriakov, S., Studer, E., Bernard-Michel, G., Bouix, D., Domergue, L., Forero, D., Gueguen, H., Ledier, C., Manicardi, P., Martin, M., Sauzedde, F.	10.1016/j.ijhydene.2022.04.037	1879-3487	Yes	International Journal of Hydrogen Safety	47(43)	Denmark	2022	18911-18933	No	No	Yes	doi.org/10.1016/j.ijhydene.2022.04.037
HyTunnel-CS	PEER_REVIEWED_ARTICLE	Effect of heat transfer through the release pipe on simulations of cryogenic hydrogen jet fires and hazard distances	Cirrone D., Makarov D., Kuznetsov M., Friedrich A., Molkov V.	10.1016/j.ijhydene.2022.04.276	0360-3199	Yes	International Journal of Hydrogen Energy	47(50)	United Kingdom	2022	21596-21611	No	No	Yes	N/A
HyTunnel-CS	CONFERENCE_PROC	Water Mist Characteristics	Lundberg J., Sikka R.,	N/A	N/A	Yes	10th Int. Seminar on Fire	10	Norway	2022	N/A	No	No	Yes	N/A

	EEDING	for Explosion Mitigation	Vaagsaether K. Bjerketvedt D.				and Explosion Hazards								
HyTunnel-CS	CONFERENCE_PROCEEDING	Thermal effects from downwards hydrogen impinging jet flame â€“ experimental results from high-pressure releases in a carpark	Lach A.W., Gaathaug A.V. and Vaagsaether K.	N/A	N/A	Yes	10th Int. Seminar on Fire and Explosion Hazards	10	Oslo, Norway, 22-27 May 2022	2022	N/A	No	No	Yes	N/A
WASTE2WATTS	PEER_REVIEWED_ARTICLE	Comparison and optimization of different fuel processing options for biogas-fed solid-oxide fuel cell plants	ShuaiMa, GabrieleLoreti, LigangWange,FranÃ§oisMarÃ©chal, JanVanherle, ChangqingDong	10.1016/j.ijhydene.2021.10.025	0360-3199	Yes	International Journal of Hydrogen Energy	Volume 47, Issue 1, 1 January 2022,	United Kingdom	2022	551-564	Yes	No	Yes	N/A
WASTE2WATTS	PEER_REVIEWED_ARTICLE	Reversible solid-oxide cell stack based power-to-x-to-power systems: Comparison of thermodynamic performance	LigangWang, YumengZhang, MarPÃ©rez-Fortes, PhilippeAubin, Tzu-nLin, YongpingYang, FranÃ§oisMarÃ©ch, JanVanherle	10.1016/j.apenergy.2020.115330	0306-2619	Yes	Applied Energy	Volume 275, 1 October 2020, 115330	United Kingdom	2022	N/A	Yes	No	Yes	N/A
WASTE2WATTS	THESIS_DISSERTATION	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,	N/A	N/A	Yes	N/A	N/A	. N/A	2022	N/A	Yes	No	No	. N/A

			Serge M.A. Biollaz, Tilman J. Schildhauer												
LOWCOST-IC	PEER_REVIEWED_ARTICLE	Fracture toughness of reactive bonded Coâ€“Mn and Cuâ€“Mn contact layers after long-term aging	Yousef Alizad Farzin; Ilaria Ritucci; Belma Talic; Ragnar Kiebach; Henrik Lund Frandsen	10.1016/j.ceramint.2022.04.050	0272-8842	Yes	Ceramic International	Volume 48, Issue 14	United Kingdom	2022	20699 - 20711	No	Yes	No	https://orbit.dtu.dk/en/publications/65229440-f46f-45a3-8fbe-5513e9e2a930
GrInHy2.0	CONFERENCE_PROCEEDING	Experimental Report on Galvanostatic Operation of Electrolyte-Supported Stacks for High Temperature Electrolysis	J. Aicart, L. Tallobre, A. Surrey, D. Reynaud, and J. Mougin	N/A	N/A	No	15th European SOFC & SOE Forum	once every two years	Lucerne, Switzerland	2022	N/A	No	No	No	N/A
HYDROSOL-beyond	PEER_REVIEWED_ARTICLE	Experimental Investigation of the Applicability of a 250 kW Ceria Receiver/Reactor for Solar Thermochemical Hydrogen Generation	Vamshi K. Thanda, Thomas Fend, Dmitrij Laaber, Alon Lidor, Henrik von Storch, Jan P. SÃ¤ck, Johannes Hertel, JÃ¶rg Lampe, Steffen Menz, Gregor Piesche, Stefan Berger, Souzana Lorentzou, Maria Syrigou, Thorsten Denk, Aurelio	10.1016/j.renene.2022.08.010	0960-1481	Yes	Renewable Energy	N/A	United Kingdom	2022	N/A	No	No	No	https://www.sciencedirect.com/science/article/pii/S0960148122011764

			Gonzales-Pardo, Alfonso Vidal, Martin Roeb, Christian Sattler												
PRHYDE	CONFERENCE_PROCEEDING	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	N/A	N/A	No	BOOK OF ABSTRACTS of World Hydrogen Energy Conference (WHEC) 2022	23rd World Hydrogen Energy Conference	Istanbul	2022	215	Yes	No	Yes	https://lbst.de/wp-content/uploads/2022/09/2022-01-14-WHEC2022_AbstractFormatted-Modeling-for-the-development-of-HD-refueling-protocols.pdf
PRHYDE	CONFERENCE_PROCEEDING	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	N/A	N/A	No	BOOK OF ABSTRACTS of World Hydrogen Energy Conference (WHEC) 2022	23rd World Hydrogen Energy Conference	Istanbul	2022	215	Yes	No	Yes	https://lbst.de/wp-content/uploads/2022/09/WHEC2022Abstract_influence_of_turbulence_modelin_cfd_of_filling_hydrogen_tank-1.pdf

ANIONE	PEER_REVIEWED_ARTICLE	Performance and stability of a critical raw materials-free anion exchange membrane electrolysis cell	S. C. Zignani, M. L. Faro, A. Carbone, C. Italiano, S. Trocino, G. Monforte, A.S. AricÃ²	10.1016/j.electacta.2022.140078	0013-4686	Yes	Electrochim. Acta 413 (2022) 140078.	N/A	United Kingdom	2022	N/A	No	Yes	No	Elsevier Open Access Science Direct
ANIONE	PEER_REVIEWED_ARTICLE	Aquivion-based Anion Exchange Membranes: Synthesis Optimization and Physio-Chemical Investigation	A. Carbone, I. Gatto, R. Pedicini, S. C. Zignani, C. Oldani, A. Cattaneo, A. S. AricÃ²	10.1016/j.cej.2022.140765	1385-8947	Yes	Chemical Engineering Journal (2022) 140765.	N/A	Netherlands	2022	N/A	Yes	Yes	No	Elsevier Science Direct
RUBY	BOOK_CHAPTER	Online Diagnosis of PEM Fuel Cell by Fuzzy C-Means Clustering	Damien Chanal; NadiaYousfi Steiner; Raffaele Petrone; Didier Chamagne; Marie-CÃ©cile PÃ©ra	10.1016/b978-0-12-819723-3.00099-8	9.78013E+12	Yes	Encyclopedia of Energy Storage		Netherland	2022	N/A	No	No	No	N/A
SWITCH	CONFERENCE_PROCEEDING	Experimental validation of a dynamic modelling of a Reversible Solid Oxide Cells	Michele Bolognese, Matteo Testi, Lorenzo De Bortoli, Ruben Bartali and Luigi Crema	10.1051/e3sconf/202233401003	N/A	No	E3S Web Conference	334	Online	2022	N/A	No	Yes	No	N/A
StasHH	CONFERENCE_PROCEEDING	Developing high power fuel cell systems for automotive applications	Greg Harris	N/A	N/A	No	Proceedings of the International Hydrogen Energy Exhibition and Forum	N/A	Ulsan, Korea	2022	N/A	No	Yes	No	N/A

IMMORTAL	PEER_REVIEWED_ARTICLE	Platinum-Rare Earth Alloy Electrocatalysts for the Oxygen Reduction Reaction: A Brief Overview	Carlos A. Campos-RoldÃ¡n, Deborah J. Jones, Jacques RoziÃ¨re, Sara Cavaliere	10.1002/cctc.202200334	1867-3899	Yes	ChemCatChem	N/A	Weinheim	2022	N/A	No	Yes	No	N/A
SO-FREE	CONFERENCE_PROCEEDING	Progress of SOC Development at Elcogen	Matti Noponen, Pauli Torri, Jukka GÃ¶Ã¶s, Jouni Puranen, Timo Lehtinen, Sergii Pylypko, and Enn Ã•unpuu	N/A	N/A	No	ECS Meeting Abstracts	ECS Meeting Abstracts, MA2021-03Â 189	17th International Symposium on Solid Oxide Fuel Cells (SOFC-XVII),Â July 18-23, 2021,Â Digital Meeting	2022	N/A	No	No	Yes	https://iopscience.iop.org/article/10.1149/MA2021-031189mtgabs
HYPSTER	CONFERENCE_PROCEEDING	Creep tests on salt samples performed at very small stresses	Armines / Polytechnique, Brouard Consulting	N/A	N/A	No	N/A	N/A	SMRI Spring Meeting, Rapid City, South Dakota.	2022	N/A	No	No	No	N/A
HYPSTER	CONFERENCE_PROCEEDING	Calibration of rock salt thermal and mechanical parameters	Armines / Polytechnique & Brouard Consulting	N/A	N/A	No	N/A	N/A	SMRI Spring Meeting, Rapid	2022	N/A	No	No	No	N/A

		based on available field data							City, South Dakota						
WINNER	PEER_REVIEWED_ARTICLE	Redox-stable composite electrodes for CH4 conversion reactors based on proton ceramic electrochemical cells	L. Almar, N. BausÃ¡, M. Fabuel, S. EscolÃ¡stico, J. M. Serra	N/A	0378-7753	Yes	Journal of Power Sources	N/A	Netherlands	2022	N/A	No	Yes	No	N/A
eGHOST	CONFERENCE_PROCEEDING	Social Life Cycle Assessment of a Proton Exchange Membrane Fuel Cell stack	Eleonora Bargiacchi, Felipe Campos-Carriedo, Diego Iribarren and Javier Dufour	10.1051/e3sconf/202233409001		Yes	EFC21 - European Fuel Cells and Hydrogen Piero Lunghi Conference	Volume 334	E3S Web of Conferences 334, 09001 (2022)	2022	N/A	No	No	Yes	https://www.e3s-conferences.org/articles/e3sconf/abs/2022/01/e3sconf_efc2022_09001/e3sconf_efc2022_09001.html
BEST4Hy	PEER_REVIEWED_ARTICLE	Analysis of Lanthanum and Cobalt Leaching Aimed at Effective Recycling Strategies of Solid Oxide Cells	Alice Benedetto Mas, Silvia Fiore, Sonia Fiorilli, Federico Smeacetto, Massimo Santarelli, Ilaria Schiavi	10.3390/su14063335	2071-1050	Yes	Sustainability, MDPI	Sustainability 2022, 14(6), 3335	Switzerland	2022	N/A	Yes	No	Yes	https://www.mdpi.com/2071-1050/14/6/3335
SHERLOHCK	PEER_REVIEWED_ARTICLE	Low-Pt-Based Sn Alloy for the Dehydrogenation of Methylcyclohexane to Toluene: A Density Functional Theory Study	Kingsley Onyebuchi Obodo, Cecil Moro Naphtaly Ouma, Dmitri Bessarabov	10.3390/catal12101221	2073-4344	Yes	Catalyst	12/10/2022	Switzerland	2022	N/A	No	No	Yes	N/A

SHERLOHCK	PEER_REVIEWED_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, Cecil Naphtaly Moro Ouma, DmitriBessarabov	N/A	0169-4332	Yes	Applied Surface Science	N/A	Netherlands	2022	N/A	Yes	Yes	No	N/A
e-SHyIPS	CONFERENCE_PROCEEDING	Development of a Learning Ecosystem for Effective Learning in Socio-Technical Complex Systems	M. Callupe, M. Rossi, B.P. Sullivan, S. Terzi	N/A	N/A	Yes	Proceedings of IFIP 2022 - â€ 19th International Conference on Product Lifecycle Managementâ€	N/A	online	2022	N/A	No	No	Yes	https://e-shyips.com/wp-content/uploads/2022/11/Development-of-a-Learning-Ecosystem-for-Effective-Learning-in-Socio-Technical-Complex-Systems.pdf
e-SHyIPS	CONFERENCE_PROCEEDING	EcoDesign strategies for zero-emission hydrogen fuel vessels scenarios	Giuditta Margherita Maria Ansaloni; Arianna Bionda; Monica Rossi	10.23919/splitech55088.2022.9854279	978-1-6654-8828-0	Yes	2022 7th International Conference on Smart and Sustainable Technologies (SpliTech)		Piscataway, New Jersey	2022	N/A	No	Yes	No	N/A

e-SHyIPS	PEER_REVIEWED_ARTICLE	A Life Cycle Perspective to Sustainable Hydrogen Powered Maritime Systems - Functional and Technical Requirements	Brendan Sullivan, Giuditta Ansaloni, Arianna Bionda, Monica Rossi	10.1504/ijplm.2022.125822	1743-5110	Yes	International Journal of Product Lifecycle Management	N/A	United Kingdom	2022	N/A	No	Yes	No	https://www.inderscience.com/admin/ospeers/getSource.php?id=344725&fid=1698156&fromonsusy=yes
e-SHyIPS	CONFERENCE_PROCEEDING	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	10.1051/e3sconf/202131207009	N/A	Yes	E3S Web of Conferences	N/A	France	2022	N/A	No	Yes	No	N/A
e-SHyIPS	CONFERENCE_PROCEEDING	Hydrogen-based technologies in maritime sector: technical analysis and prospective	Mariagiovanna Minutillo, Viviana Cigolotti, Giovanni Di Ilio, Arianna Bionda, Erik-Jan Boonen, Thomas Wannemacher	10.1051/e3sconf/202233406011	N/A	Yes	E3S Web of Conferences	N/A	France	2022	N/A	No	Yes	No	N/A

5.4 Patent from projects

The patents reported below concern H2020 projects for the whole duration of the Programme, not just for year 2022. The reason is the long time required for their processing and approval, which can take more than 5 years. Concerning the source of information, they have been mainly drawn from CORDA and SYGMA, complemented by the Clean Hydrogen JUs annual data collection. As expected, there are no patents related to Horizon Europe projects in 2022.

Compared to the Annual Activity Report 2021, the only additional reported patent this year is the one of SH2APED.

5.4.1 Information extracted from CORDA for H2020

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	NO	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)
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+Electro

							chemical+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 Energies France SAS	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(Composite+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	14/1/2021	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)

5.4.2 Additional information on patents, complementing the partial information on CORDA and SyGMA for H2020

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 additive manufacturing by pasty process with an improved supply of paste and manufacturing machine for implementing the method	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(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)

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	NO	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/EP4072715A1
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
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	KIST, Technion	27/01/2021	NO	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+cationic+groups+as+side+chain%2c+preparation+method+thereof%2c+and+anion+exchange++membrane+made+of+the+

		the same					same)
826204	DOLPHIN	Procédé de fabrication d'un guide d'écoulement pour réacteur électrochimique	CEA	20/12/2021	YES	EP4016677A1	https://patentimages.storage.googleapis.com/04/31/13/bb1f9368ef6a02/EP4016677A1.pdf
735918	INSIGHT	Stack monitoring by means of stack segments			NO		
735918	INSIGHT	Monitoring by periodic non-sinusoidal excitation, multi frequency based metric approach			NO		

5.5 Scoreboard of H2020 legacy KPIs specific to JU

In the three 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 the reported value is the same as the one reported in AAR21 and is not expected to change in the future.

5.5.1 Scoreboard of common KPIs[197]

	H2020 KPI number	KPI	Type of data required	Results H2020 up to 31 December 2022 (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	101
	13	SME - Growth and job creation in participating SMEs	Turnover of company, number of employees	Turnover of SMEs at most recent reporting: EUR 1,651.8 Mil No of employees at SMEs at most recent reporting: 15,781 employees
SOCIETAL CHALLENGES	14	Publications in peer-reviewed high-impact journals	Publications from relevant funded projects (DOI: digital object identifiers); journal impact benchmark (ranking) data to be collected by commercially available bibliometric databases	490 publications in peer-reviewed high-impact journals
	15	Patent applications and patents awarded in the area of the JTI	Patent application number	15 patents awarded and 6 patent pending applications (aligned with Section 5.4)
	16	Number of prototypes testing activities and clinical trials	Reports on prototypes, and testing activities, clinical trials	Nr of prototypes: 512198 Nr of testing activities: 733 Nr of clinical trials: 1

[197] Based on Annex II to Council Decision 2013/743/EU. Source: CORDA, unless otherwise noted.

[198] MAMA-MEA is responsible for 275 prototypes, while MAMA-MEA and THYGA together for 376 testing activities.

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	H2020 KPI number	KPI	Type of data required	Results H2020 up to 31 December 2022 (Calls 2014-2020)
	17	Number of joint public-private publications in projects	Properly flagged publications data (DOI) from relevant funded projects	131 Joint Public/Private
	18199	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: 73 New processes: 40 New methods: 29
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)	135 information letters with an average of 107 days (100% within target)
	NA	Redress after evaluations	Number of redresses requested	2 redress (both unfounded: no re-evaluation, no change to the ranked list)
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	Average TTG: 202 days Maximum TTG: 262 days (after approval of a request for GAP extension by the consortium)
GRANTS	NA	Time to grant (TTG) measured (average) from call deadline to signature of grants	Number and % of grants signed within target	27 GA signed, out of which 26 GA (96%) within target

[199] 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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5.5.2 Indicators for monitoring cross-cutting issues [200]

<table>
<tr><th>Number</th><th>Definition/Responding to question</th><th>Type of data required</th><th>AAR 2022 (CALLS 2014-2020)201</th></tr>
<tr><td>2.1</td><td>Total number of participations by EU-27 Member States + the UK</td><td>Nationality of H2020 applicants and beneficiaries (number)</td><td>EU-27 + UK
Application Participations
3197
Grant Participations
1393
Application Participants
1329
Grant Participants
710</td></tr>
<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 583.87 million):
AT 24.73 | BE 22.37 | BG 0.39 | CY 0.17 | CZ 1.46 | DE 152.16 | DK 25.18 | EE 0.61 | EL 6.15
ES 39.11 | FI 18.81 | FR 85.96 | HR 0.73 | HU 0.02 | IE 0.28 | IT 55.14 | LT 0.13 | LU 1.64
LV 0.66 | MT 0.03 | NL 53.79 | PL 1.06 | PT 0.76 | RO 0.26 | SE 9.60 | SI 4.30 | UK 78.35</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
Application Participations
353
Grant Participations
155
Application Participants
150
Grant Participants
81</td></tr>
</table>

[200] Based on Annex III to Council Decision 2013/743/EU; source: CORDA, unless specified otherwise.
[201] The figures concern 133 projects, not including ELECTROOU which was terminated early.

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<table>
<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 48.74 million):
<table><tr><td>CH</td><td>14.50</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>32.03</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 rowspan="2">3.1</td><td rowspan="2">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</td><td rowspan="2"><table><tr><td colspan="3">SME beneficiaries</td></tr><tr><td>Grants participations</td><td>Grant participants</td><td>Funding</td></tr><tr><td>354 (23 %)</td><td>166 (21 %)</td><td>EUR 176.4 mil. (28 %)</td></tr></table></td></tr>
<tr><td>% of EU contribution going to beneficiaries flagged as SMEs</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>According to continuous reporting:
25.89 % (12.539 women)</td></tr>
<tr><td>6.2</td><td>Percentage of women project coordinators in H2020</td><td>Gender of MSC[202] fellows, ERC principal investigators and scientific coordinators in other H2020 activities</td><td>30/107 (28.0 %)</td></tr>
<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>15</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>
</table>

[202] Marie Skłodowska-Curie

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9.1	Share of projects and EU financial contribution allocated to IAs	Number of IA proposals and projects properly flagged in the WP; follow-up at grant level	Number: 36/133 (28.2%) Funding: EUR 366 732 793.62/ EUR 632 885 191.2 (57.95 %)
9.2	Within the IAs, share of EU financial contribution focused on demonstration and first-of-a-kind activities	Topics properly flagged in the WP; follow-up at grant level	EUR 366 732 793.62/ EUR 901 903 296.04 (40.7%)
N/A	Scale of impact of projects (high technology readiness level - TRL)	Number of projects addressing TRL between (2-3, 4-6, 5-7)	Based on TRL specified in the topic (project start) TRL: # projects 2: 14 3: 30 4: 28 5: 15 6: 11 7: 10 8: 1 unspecified: 24
11.1	Percentage of H2020 beneficiaries from the private-for-profit sector	Number of and % of the total H2020 beneficiaries classified by type of activity and legal status	Participations: 939 / 1562 (60.1 %) Participants: 536/ 804 (66.7 %)
11.2	Share of EU financial contribution going to private-for-profit entities (Enabling and industrial tech and Part III of Horizon 2020)	H2020 beneficiaries classified by type of activity; corresponding EU contribution	EUR 442.03 mil (69.8 %)
12.1	EU financial contribution for public-private partnerships (PPP) (Art. 187)	EU contribution to PPP (Art. 187)	2021-2027: EUR 1,000,000,000, including up to EUR 30,193,000 for administrative costs (SBA Article 76)
12.2	PPPs leverage: total amount of funds leveraged through Art. 187 initiatives, including additional activities, divided by the EU contribution	Total funding made by private actors involved in PPPs - in-kind contribution already committed by private members in projects selected for funding	See section 1.2. 2.6)

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<table>
<tr><td></td><td></td><td>- additional activities (i.e. research expenditure/investment of industry in the sector, compared to previous year)</td><td></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 2022 and 2023 for the reporting years 2021 and 2022 respectively:

<table><tr><th>Dissemination activities (excl. Scientific Publications)</th><th>2021 (73 projects)</th></tr><tr><td>Total Activities</td><td>226</td></tr><tr><td>Conferences/Events (Presentations)</td><td>136</td></tr><tr><td>Meetings (with policy stakeholders/working groups, etc)</td><td>33</td></tr><tr><td>Education & Training Activities</td><td>37</td></tr><tr><td>Collaboration with EU projects</td><td>9</td></tr><tr><td>Press Releases, Newsletters, Videos, Interviews</td><td>-</td></tr><tr><td>Clustering Activities</td><td>-</td></tr><tr><td>Workshops, webinars</td><td>3</td></tr><tr><td>Other</td><td>8</td></tr></table>
<table><tr><th>EU Research Days</th><th>2022 (96 projects)</th></tr><tr><td>Websites</td><td>96</td></tr><tr><td>Twitter accounts</td><td>40</td></tr><tr><td>LinkedIn accounts</td><td>45</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>
<tr><td>14.3</td><td>Proposal evaluators by organisations' type of activity</td><td>Type of activity of evaluators' organisations</td><td>N/A
(no more H2020 evaluations)</td></tr>
<tr><td rowspan="2">N/A</td><td rowspan="2">Participation of RTO[3]s and universities in PPPs (Art. 187 initiatives)</td><td>Number of RTOs participations in funded projects and % of the total</td><td>304 / 1562 (19.5 %)</td></tr>
<tr><td>Number of universities participations in funded projects and % of the total</td><td>207 / 1562 (13.3 %)</td></tr>
</table>

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		% of budget allocated to RTOs and to universities	RTO: EUR 99.2 million (15.7 %) HES: EUR 49.2 million (7.8 %)
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: -2.97% Residual: -0.88%
N/A	Implementation of *ex-post* audit results	Number of cases implemented; of cases implemented/total cases	H2020: # closed participations : 158 Percentage of implementation: 69%

5.5.3 Scoreboard of KPIs specific to FCH 2 JU[203]

No.	KPI	Results
1	Share of the funding allocated to the following research activities: · renewable energy · end-user energy efficiency · smart grids · storage	Renewable energy: EUR 96.2 million (15 %)[204] End-user energy efficiency: EUR 121.4 million (19 %) Smart grids: EUR 38 million (6 %) Storage: EUR 72 million (11 %)

[203] As in 2021 both FCH 2 JU and Clean Hydrogen JU were operational, it was decided that the KPIs for both JUs should be presented here. Nevertheless, for the Clean Hydrogen JU only the baseline and targets can be reported.

[204] Projects addressing topics related to renewable energy integration (KPI 1.1) and storage (KPI 1.4) are interrelated, in many cases covering both aspects. Complementarily, a common KPI of 26 % can be reported for KPIs 1.1 and 1.4.

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No.	KPI	Results
2	Demonstrator projects hosted in Member States and regions benefiting from EU Structural and Investment Funds	The FCH 2 JU has collaborated with national programmes for the blending of funds. For instance, the FHC 2 JU project HySHIP on a 3MW FC-powered ferry is benefiting from circa EUR 20 million in funding from ENOVA (Norwegian Innovation Fund) in addition to the EUR 8 million support from the FCH 2 JU.

5.6 Scoreboard of Horizon Europe common Key Impact Pathway Indicators (KIPs)[205]

The nine Key Impact Pathways, presented in the table below, will be calculated and reported via the Horizon Europe Dashboard, based on the continuous reporting of the projects.

For the year 2022 there are no results to report yet, as the first grants from Call 2022-1 were only signed in December 2022. Therefore, all relative indicators are reported as not available (N/A).

Key Impact Pathway[206]	Short-term	Medium-term	Longer-term	Detail per action or globally for 2022
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	N/A
2-Strengthening human capital in R&I	Skills -Number of researchers involved in upskilling (training, mentoring/coaching, mobility and access to R&I infrastructures) activities in projects funded by the Programme	Careers -Number and share of upskilled researchers involved in the Programme with increased individual impact in their R&I field	Working conditions -Number and share of upskilled researchers involved in the Programme with improved working conditions, including researchers' salaries	N/A
3-Fostering diffusion of knowledge	Shared knowledge Share of research outputs (open	Knowledge diffusion -Share of open access	New collaborations -Share of Programme beneficiaries which have developed new	N/A

[205] (based on Annex V to Regulation 2021/695/EU)

[206] NB: For some of those KIPs the data will not be available in the short or even medium term.

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and open science	data/publication/software etc.) resulting from the Programme shared through open knowledge infrastructures	research outputs resulting from the Programme actively used/cited	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)	N/A
-				
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	N/A
Towards technological / economic impact				
7-Generating innovation-based growth	Innovative results -Number of innovative products, processes or	Innovations -Number of innovations	Economic growth -Creation, growth & market shares of	N/A

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	methods resulting from the Programme (by type of innovation) & Intellectual Property Rights (IPR) applications	resulting from the projects funded 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)	N/A
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	N/A

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5.7 Horizon Europe Partnership common indicators[207]

For some of the indicators, there are no results to report yet, as the first grants from Call 2022-1 were only signed in December 2022. DG R&I provided clarifications on the common indicators below, including their definitions and what is expected from the JUs to report. The reporting was therefore aligned to the instructions given. Note also that the JU has not targets on most of these KPIs, thus they were reported as N/A.

N°	Criterion addressed	Proposed common indicators	Baseline	Results for 2022	Target 2027
1	Additionality	Progress towards (financial and in-kind) contributions from partners other than the Union – i.e. committed vs. actual	€ 1.7 B[208]	Eur 100 million[209]	€ 1.0 B[210]
2	Additionality/ Synergies	Additional investments triggered by the EU contribution, including qualitative impacts related to additional activities[211]	N/A[212]	3	N/A
3	Directionality	Overall (public and private, in-kind and cash) investments mobilised towards EU priorities[213]	100% towards Grean Deal	100% towards Grean Deal 300.5 million + IKOP + IKAA for	100% towards Grean Deal

[207] (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)

[208] Amount of 1.7 billion is expected to be reached by the end of the H2020 programme. However, it is to be noted that the applicable legal basis for Horizon Europe states a new target of EUR 1 billion and the partners other than the Union need to start collecting and certifying their contributions back from zero.

[209] Amount of certified IKAA as per legal reporting deadline of 31 May 2023 set by the Horizon Europe legal basis

[210] The Commission topped up the overall budget of the Clean Hydrogen JU with an additional funding of EUR 200 million, so as to double the number of Hydrogen Valleys in the EU by 2025. The SBA has not been amended yet to reflect this, however it is expected to be matched by the same amount by the private members.

[211] Reporting JU activities that may trigger additional investments than the ones of the Programme and excluding the ones reported under KPI 8 and KPI 9. This table reports an approximate figure, which will be explained in Section 1.7.2.

[212] It is not possible to provide a baseline as these actions were not monitored in the past.

[213] Please note that there can be an overlap among the different priorities, as certain activities may contribute to more than one of them. Nevertheless, as the Green Deal is the primary specific general objective of the Clean Hydrogen JU and in essence all it's budget is directed towards to associated activities, we consider that 100% of the budget goes into that direction.

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			€ 2.56 B[214]	2022 (single value)	€ 2.0 B
4	International visibility and positioning	International actors involved[215]	276	167	N/A
5	Transparency and openness	Share & type of stakeholders and countries invited/engaged[216]	Please see Table 36 below	Please see Table 37 below	N/A
6	Transparency and openness	No and types of newcomer members in partnerships and their countries of origin (geographical coverage)	N/A	N/A	N/A[217]
7	Transparency and openness	No and types of newcomer beneficiaries in funded projects (in terms of types and countries of origin)	Please see Table 38 below	Please see Table 39 below	N/A
8	Coherence and synergies	Number and type of coordinated and joint activities with other European Partnerships	N/A[212]	Coordinated call for proposals 0 Systematic Collaboration 3 Ad hoc Collaboration 3	N/A
9	Coherence	Number and type of	Coordinated call 1[218]	Coordinated call 0	N/A

[214] Total committed EU + Private contributions, as reported in the last Clean Hydrogen JU Annual Activity Report for 2021 for its predecessor FCH 2 JU.

[215] An effort has been made to report on this indicator despite certain unclarity on its exact definition, even after the four workshops organised by the DG R&I on the KPIs in February and March 2023. We expect its reporting will be improved in AAR23, after the JUs have received better guidance, leading to possible changes in the reporting methodology. For AAR22, the JU reports on the international (non-EU, non-Associated countries) applicants in JU Calls: for the baseline during the whole period of H2020, while for 2022 only for the two Calls 2022. This selection allows for comparability and the possibility to provide a baseline.

[216] An effort has been made to report on this indicator despite certain unclarity on its exact definition, even after the four workshops organised by the DG R&I on the KPIs in February and March 2023. We expect its reporting will be improved in AAR23 after the JUs have received better guidance, leading to possible changes in the reporting methodology. For AAR22, the JU reports on the project beneficiaries in JU Calls: for the baseline during the whole period of H2020, while for 2022 only for the Call 2022-1. This selection allows for comparability and the possibility to provide a baseline.

[217] See explanation in section 1.7.2.4 on KPI-6

[218] Project JIVE, supported also by CEF and different regions.

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	and synergies	coordinated and joint activities with other R&I Initiatives at EU /national/regional/sectorial level	for proposals Hydrogen Valleys 3 Co-funding 9[219]	for proposals Hydrogen Valleys 0 Co-funding 0 Formal Collaboration 1 Ad-hoc Collaboration 4 Various Activities 3	
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)	6.88%[220]	0[221]	N/A
11	International visibility and positioning	Visibility of the partnership in national, European, international policy/industry cycles[222]	N/A[212]	National Events 3 International Events/Exhibitions 11 International Webinars and Workshops 7 Publications 4	N/A

[219] Projects CHIC, HyFIVE (suppoted by local ERDF), PACE, ene.field, HyBalance (receiving regional co-funding), ELCOGEN (private company, receiving funding for its 4 JU supported projects from EIB, Financial Instruments and SME instrument).

[220] Complementary and cumulative funding from other Union or national funds as a percentage of the total FCH 2 JU budget. The reported percentage can be disaggregated to National/Regional Funding (6.19%) and CEF funding (0.69%).

[221] Although there are parallel actions of the projects to secure complementary funding, these were not finalised by end of 2022. Quantitative data will hopefully become available as of 2023 or later. This table will report an approximate figure, which will be explained in Section 1.7.2.

[222] For a detailed list of activities please see Table 40 below.

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				Platforms 3 Social Media Twitter: 8,242 LinkedIn: 31,452	

Countries	HES	PRC	PUB	REC	OTH	Grand Total
AE	1					1
AT	4	3	36	2	6	51
BE	3	14	35	4	7	63
BG	1	1	5	2	2	11
CA	1		1			2
CH	5	1	31		8	45
CL		1	1			2
CN	3					3
CR			1			1
CY		1	4	2		7
CZ	3		13	1	3	20
DE	20	8	216	4	21	269
DK	1	2	34	6	3	46
EE	2		5		1	8
EL	7	1	24	1	6	39
ES	11	4	80	6	18	119
FI	4		16		3	23
FR	6	2	110	10	11	139
HR	2		4		2	8
HU	1		1			2
IE	3		7			10
IL	2		3			5
IS		1	6	2		9

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IT	21	8	98	4	13	144
JP	1				1	2
KR					2	2
LT	2		2		2	6
LU			1			1
LV	2	1	5			8
MA		1				1
MH			1			1
MK			1	1		2
MT	1	1	1	1		4
NL	8	4	78	10	6	106
NO	5	5	44	3	7	64
PA			1			1
PL	8		11	2	4	25
PT	4	1	15	1	3	24
RO	4		7		2	13
RS					1	1
SE	4	1	24		3	32
SI	2		11	1	4	18
SK	2		3			5
TN	1		2			3
TR	4		10		1	15
TW					1	1
UA			3		3	6
UK	21	6	91	6	5	129
US	1	1	5			7
ZA	10		1			11
Grand Total	181	68	1048	69	149	1515

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TABLE 36 SHARE & TYPE OF STAKEHOLDERS (=APPLICANTS) AND THEIR COUNTRIES OF H2020 (BASELINE)[223]

Row Labels	HES	PRC	PUB	REC	OTH	Grand Total
AE			1		1	2
AT	1		9	1	2	13
AU	1				1	2
BA	1					1
BE	2	5	36	1	5	49
BG	4	5	23	3	3	38
CA			1			1
CH	5	1	11	1		18
CI			1			1
CV				1		1
CY		1	5			6
CZ	2	2	4		2	10
DE	16	4	79	1	15	115
DK	3	2	14			19
DZ				1		1
EE	1	3	9	1	1	15
EG	1		1	1		3
EL	4	4	33	5	6	52
ES	10	2	41	1	16	70
FI	4	4	24	1	1	34
FR	11	2	107		6	126
GH	1	1				2
HR	3	1	5	3	1	13
HU		1	1			2
IE	3		7	1	3	14

[223] Types of organisations: [HES]: Higher Education Schools, [PRC]: Private Companies, [PUB]: Public Companies, [REC]:Research Centres, [OTH]: Other

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IL	2		13	2		17
IN			1			1
IS				1		1
IT	14	8	71	6	7	106
KE	1		2			3
KR			1			1
KZ				1		1
LT	2	3	4		1	10
LU	1	1	11	1	1	15
LV		3	1	1		5
LY					3	3
MA	1	1	2		2	6
ME	1					1
MK					1	1
MT			1			1
MU		1				1
MZ		1		1		2
NA			1			1
NG			2			2
NL	4	4	57	1	3	69
NO	3	2	11	1	7	24
NZ		1				1
PL	7	5	17		4	33
PT	2		16		2	20
RO	1	3	5		2	11
RS	1				2	3
RW	1		1			2
SE	5		12		2	19
SI	2		9	1	3	15
SK	1	2	3			6

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TN	2		1		1	4
TR	5	3	30	4	3	45
UA	2		1	1	3	7
UK	14	3	24	1	3	45
US			1			1
ZA	4		1			5
Grand Total	149	79	711	44	113	1096

TABLE 37 SHARE & TYPE OF STAKEHOLDERS (=APPLICANTS) AND THEIR COUNTRIES OF CLEAN HYDROGEN JU IN 2022

Row Labels	HES	PRC	PUB	REC	OTH	Grand Total
Austria	1	14	1	4	1	21
Belgium		14	2	6	5	27
Bulgaria	1					1
Canada	1					1
Chile					1	1
China (People's Republic of)	2					2
Croatia	1	1				2
Cyprus		2				2
Czechia		2	1	3		6
Denmark		9	2	1	1	13
Estonia	1					1
Finland		6		1		7
France	8	53	5	5	1	72
Germany	6	83		2	3	94
Greece		5	1		1	7
Hungary	1	1				2
Iceland		1	1			2
Ireland	1	2				3
Israel		1				1
Italy	4	42		3	2	51

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Japan				1		1
Korea (Republic of)				1		1
Latvia		3			1	4
Luxembourg		1				1
Malta			1			1
Marshall Islands		1				1
Morocco					1	1
Netherlands	2	50	13	3	3	71
Norway	1	29	1	2	2	35
Panama		1				1
Poland	1	3		2		6
Portugal	1	5		1		7
Romania	2			1		3
Slovakia		1				1
Slovenia		3	2			5
South Africa	1					1
Spain	4	33	7	3	3	50
Sweden	1	9	1			11
Switzerland	3	11			1	15
Turkiye	1	3				4
Ukraine	1					1
United Kingdom	4	21	3	1	4	33
United States		3				3
Grand Total	49	413	41	40	30	573

TABLE 38 NO AND TYPES OF NEWCOMER BENEFICIARIES IN FUNDED PROJECTS (BASELINE)

Row Labels	HES	PRC	PUB	REC	OTH	Grand Total
Australia				1		1
Austria			1	1		2
Belgium		2			1	3

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Denmark		4				4
France		17				17
Germany		14		1		15
Greece		2			1	3
Ireland		1				1
Italy	1	11		2	2	16
Kenya	1					1
Mauritius					1	1
Morocco				1		1
Netherlands		10		1	1	12
Poland		4		1		5
Romania					2	2
Slovakia		1				1
Spain		9		1		10
Sweden		2				2
Switzerland		1	1			2
United Kingdom		4				4
United States			1			1
Grand Total	2	82	3	9	8	104

TABLE 39 NO AND TYPES OF NEWCOMER BENEFICIARIES IN FUNDED PROJECTS FOR CLEAN HYDROGEN IN 2022

Type of Activity	Activities
National Events	Info Days (France, Spain) Information event on hydrogen with and for Visegrad Four countries: Searching for synergies
International Events/Exhibitions	EU European Hydrogen Week 2022 EU Research Days 2022 Hydrogen Transition Summit COP 27 3rd International Hydrogen Aviation Conference (IHAC 2022) World Hydrogen 2022 Summit & Exhibition

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	European Research& Innovation days EuRegions Week European Sustainable Energy Week Hannover Messe ConnectingEurope Days 2022 Transport Research Arena (TRA)
International Webinars and Workshops	Webinar - Computational Fluid Dynamics (CFD) for hydrogen safety analysis Webinar - Launch of the Project Development Assistance for Regions (PDA II) Webinar - Safety Planning and Management in EU hydrogen and fuel cell projects Workshop - European Hydrogen Ports Network event Workshop - IEA H-TCP Task 42 workshop on underground hydrogen storage Workshop - Joint European Hydrogen Ports Network and CEM Global Ports Hydrogen Coalition event Workshop - Clean Hydrogen JU Expert Workshop on Environmental Impacts of Hydrogen
Publications	Programme Review Report 2022 2022 Success Stories Study on impact of deployment of battery electric vehicles (BEV) and fuel cells electric vehicles (FCEV) infrastructure Updated report on Hydrogen Valleys and the Mission Innovation Hydrogen Valley Platform was published on 22 September 2022.
Supported Platforms	Mission Innovation Hydrogen Valley Platform Fuel Cell and Hydrogen Observatory European Hydrogen Refuelling Station Availability System

TABLE 40 INTERNATIONAL VISIBILITY[224]

[224] Please note that all communication actions, events and campaigns of the JU have by default an international audience, which varies according to the type of action and its desired impact. The target groups identified in the yearly communication plan include stakeholders, partners and general public in all EU countries as well as beyond (i.e. in the case of the Mission Innovation platform). More details on the communication activities can be found in Section 2.1.

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5.8 Scoreboard of KPIs specific to Clean Hydrogen JU

Please note that for KPIs 1, 2, 3, 4, 9 and 13 results in the table below come only from Call 2022-1. Concerning KPIs 7, 8 and 11, these can only be reported after the result from the projects are submitted to the JU, which for the moment is not possible since the first projects signed their grants only in December 2022.

Moreover, the exact definition and methodology (as well as baseline in some cases) for KPIs 7, 8, 14, 17 and 18 will be determined with the help of experts. In particular KPIs 7 and 8 have been foreseen as task of the procurement No Clean Hydrogen/OP/Contract 332 ("Provision of data and services in support of the European Hydrogen Observatory and monitoring of the hydrogen sector"). KPIs 14, 17 and 18 have been foreseen as part of the procurement No CLEANHYDROGEN / OP / CONTRACT 320 ("European Hydrogen Observatory").

Finally, KPIs 5, 6 and 14 are qualitative and the related content can be found in the main text of the Annual Activity Report, so only the related links are provided.

A more complete description of the KPIs and the methodologies can be found in Section 7 and Annex 1 of the SRIA, as well as Section 9 and Annex 1 of the Programme Review 2022225.

Key performance indicators specific to the Clean Hydrogen Joint Undertaking – Operational:

Strategy Map Objective	KPI Name	Unit of measurement	Baseline (2020)	Results 2022	Target 2027
Resources (input), processes and activities					
Supporting sustainable solutions	1. Supporting sustainable solutions (total)	% of budget	2.5	62	50
	1a. Hydrogen end-use solutions in hard to abate sectors	*% of budget*	*2.5*	*51*	*40*
	1b. Circular and sustainable solutions	*% of budget*	*<1*	*12*	*15*
R&I for hydrogen technologies	2. Early research projects	% of budget	10	40	10
	3. Demonstration projects	# of projects	43	4	60
Supporting market uptake of clean hydrogen	4. Education and training	# of projects	4	0	6
	5. Monitoring technology progress	*Qualitative indicator*	N/A	See section 1.5.1	N/A

225 https://op.europa.eu/en/publication-detail/-/publication/cd8e8e16-801a-11ed-9887-01aa75ed71a1/language-en/format-PDF/source-281227135

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applications	6. Supporting EC in H2 market uptake	*Qualitative indicator*	N/A	See Sections 1.6.4 and 1.6.7	N/A
Outcomes					
Limiting environmental impacts	7. Environmental impact and sustainability	*TBD*	*TBD*	N/A	*TBD*
Improving cost-effectiveness	*8.a Capital cost of electrolysers*	€/kW	*TBD*	N/A	*TBD*
	8.b Capital cost of heavy-duty transport applications	€/kW	*TBD*	N/A	*TBD*
Synergies with other partnerships	9. Research and Innovation Synergies	# of projects	5	1	20
Increasing Public Awareness	10. Public perception of hydrogen	*Qualitative indicator*	N/A	See Section **Error! Reference source not found.**	N/A
Reinforcing EU scientific and industrial ecosystem, including SMEs	11. Total persons trained	# of persons	4,163	N/A	6,000
	12. Patents and publications	#of patents / publications	12 / 289	15 / 113	25/ 450
	13. Promoting cross-sectoral solutions	# of projects	15	0	25
Impacts					
Reducing GHG emissions	14. Expected avoided emissions	Mt of CO2-eq	*TBD*	TBD	N/A
Energy transition with renewable hydrogen	15. Deployment of electrolysers	Gigawatt	0.074[226]	0.143	10
	16. Market uptake of	Mt of clean	0.007[227]	0.014	2

[226] The baseline figure has been updated, as the 1 GW figure mentioned in the SRIA could not be confirmed and probably referred to all types of electrolysers, not the ones associated with the EU Hydrogen Strategy targets, i.e. concerning power-to-hydrogen water electrolysis. New source: Hydrogen Europe data, provided for the Fuel Cell and Hydrogen Observatory.

[227] The baseline figure has been updated, as the 0.155 Mt figure mentioned in the SRIA could not be confirmed and included also other forms of hydrogen production like with SMR with CCS ("blue hydrogen"). Now the figure reports only renewable hydrogen, in line with the EU Hydrogen Strategy Targets. New source: Hydrogen Europe data, provided for the Fuel Cell and Hydrogen Observatory. Calculated as the EU electrolytic hydrogen production from the capacity mentioned under KPI 15 (acknowledging this is not entirely consistent with the definition of

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	clean hydrogen	hydrogen consumed			
Competitive and innovative European hydrogen value chain	17. Total cost of hydrogen at end-use	€/kg	8	TBD	4.5
	18. Size of private hydrogen sector	TBD	TBD	TBD	TBD

Key performance indicators specific to the Clean Hydrogen Joint Undertaking – Administrative:

Payments	N/A	Time to pay (% made on time) — pre-financing — interim payment — final payment	Average time to pay (calendar days)	Average time to pay: 41 days
HR	N/A	Vacancy rate (%)	Vacancy rate (%)	Vacancy rate= 0 %
JU EFFICIENCY	NA	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: 110 days Maximum TTS: 170 days (after approval of a request for GAP extension by the consortium)
	N/A	Administrative budget: Number and % of total of late payments	Number and % of total of late payments	% of late payments: 8% Number of late payments: 51

5.9 IKAA Report

According to COUNCIL REGULATION (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe, Hydrogen Europe Industry and Hydrogen Europe Research Members of the Clean Hydrogen Joint Undertaking have submitted their first Additional Activities Plan covering the period of 1 January 2022 – 31 December 2022 as an annex to the Annual Work Plan 2022. For the reporting of the annual additional activities plan annexed to the main part of the work programme, a scope of the additional activities was presented according to categories in line with the Article 78 of the COUNCIL REGULATION (EU) 2021/2085.

The Plan included Additional Activities for a total amount of EUR 520,764,523.90.

clean hydrogen, but being the best approximation to it at the moment), assuming 5,000 hours of utilisation and an average efficiency of 52 KWh/kg.

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The private members shall report by 31 May each year at the latest to their respective governing board on the value of the in-kind contributions.

According to the Horizon Europe legal basis, a certificate on the in-kind contributions to additional activities (IKAA) must be provided for contributions of private members for activities contributing to the objectives the Clean Hydrogen Joint Undertaking.

For valuing these contributions, the costs shall be determined in accordance with the usual cost accounting practices of the entities concerned, to the applicable accounting standards of the country where the entity is established, and to the applicable International Accounting Standards and International Financial Reporting Standards. The costs shall be certified by an independent audit body appointed by the entity.

The purpose of the IKAA certificate is to provide the EU granting authority with sufficient information on the value of private contributions from the members of the Clean Hydrogen Joint Undertaking other than the EU; these members must make or arrange for their constituent or affiliated entities to make a total contribution of at least EUR 1 000 000 000.

In the moment of establishing the annual accounts for the Clean Hydrogen JU, the certification process for the IKAA 2022 were launched and was still ongoing. The values of the certified contributions for the year 2022 will be reported to the Clean Hydrogen JU Governing Board later in the year 2023.

The table below reflects the situation as of 31 May 2023:

OVERVIEW AMOUNT OF IKAA FOR 2022		
Description of the AA	**Certified IKAA (€)**	**Reported IKAA with pending certification (€)**
A Pre-commercial trials and field tests	6,092,485.00	21,448,155.85
B Proof of concept	26,829,392.93	67,533,422.74
C Improvement of existing production lines for up-scaling	14,672,868.64	12,198,001.00
D Large scale case studies	16,968,881.46	93,915,371.69
E Awareness-raising activities on hydrogen technologies and safety measures	684,940.00	1,976,184.00
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	18,285,127.03	19,375,460.00
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	34,902,846.94	115,520,206.67
H Other, contributing to the JU objectives	2,631,645.68	58,303,510.00
TOTAL IKAA	**121,068,187.68**	**390,270,311.94**

TOTAL IKAA 2022
(Evolution- Value in € million)

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Planned IKAA	Reported IKAA with pending certification	Certified IKAA
520.765	**390.270**	**121.068**

The difference between submitted IKAA 2022 overall plan value of EUR 520.765 million and reported / certified IKAA of EUR 511.338 million as of 31 May 2023 (see above) is attributed to the adjusted estimates for the expected certified figures in 2023.

TOTAL IKAA 2022: BREAKDOWN PER COUNTRY	
Country	**Value (€)**
AT	2,219,027.48
BE	1,506,854.00
CZ	733,062.00
DE	64,260,504.35
DK	10,680,258.00
ES	1,044,626.49
FR	3,439,743.36
NO	24,887,881.00
PL	1,173,563.00
SE	9,345,405.00
UK	1,777,263.00
TOTAL IKAA	**121,068,187.68**

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5.10 Final annual accounts

5.10.1 Balance Sheet

		EUR '000
	31.12.2022	31.12.2021
NON-CURRENT ASSETS		
Intangible assets	*4*	*11*
Property, plant and equipment	*136*	*173*
Pre-financing	*64 905*	*86 208*
	65 045	**86 393**
CURRENT ASSETS		
Pre-financing	*46 252*	*40 689*
Exchange receivables and non-exchange recoverables	*47 054*	*9 646*
	93 306	**50 335**
TOTAL ASSETS	**158 351**	**136 728**
CURRENT LIABILITIES		
Payables and other liabilities	*110 975*	*59 014*
Accrued charges and deferred income	*49 915*	*49 664*
	160 890	**108 678**
TOTAL LIABILITIES	**160 890**	**108 678**
Contribution from Members	*1 580 943*	*1 483 783*
Accumulated deficit	*(1 455 733)*	*(1 331 981)*
Economic result of the year	*(127 749)*	*(123 753)*
NET ASSETS	**(2 539)**	**28 049**
TOTAL LIABILITIES AND NET ASSETS	**158 351**	**136 728**

5.10.2 Statement of financial performance

		EUR '000
	2022	2021
REVENUE		
Revenue from non-exchange transactions		
Recovery of expenses	*1 563*	*4 994*
	1 563	**4 994**
Revenue from exchange transactions		
Financial revenue	*0*	*0*
Other exchange revenue	*36*	*3*
	36	**3**
Total revenue	**1 599**	**4 997**
EXPENSES		
Operational costs	*(123 005)*	*(123 509)*
Staff costs	*(3 359)*	*(3 188)*
Other expenses	*(2 984)*	*(2 053)*
Total expenses	**(129 348)**	**(128 750)**
ECONOMIC RESULT OF THE YEAR	**(127 749)**	**(123 753)**

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5.10.3 Cash flow statement

EUR '000

	2022	2021
Economic result of the year	*(127 749)*	*(123 753)*
Operating activities		
Depreciation and amortization	*66*	*71*
(Increase)/decrease in pre-financing	*15 739*	*35 869*
(Increase)/decrease in exchange receivables and non-exchange recoverables	*(37 408)*	*(2 618)*
Increase/(decrease) in payables	*51 961*	*(125)*
Increase/(decrease) in accrued charges	*251*	*10 501*
Increase/(decrease) in cash contributions	*77 924*	*49 954*
Increase/(decrease) in in-kind contributions	*19 236*	*30 221*
Investing activities		
(Increase)/decrease in intangible assets and property, plant and equipment	*(21)*	*(119)*
NET CASHFLOW	-	-
Net increase/(decrease) in cash and cash equivalents	-	-
Cash and cash equivalents at the beginning of the year	-	-
Cash and cash equivalents at year-end	-	-

5.10.4 Statement of changes in net assets

EUR '000

	Contribution from Members	Accumulated Surplus/ (Deficit)	Economic result of the year	Net Assets
BALANCE AS AT 31.12.2020	**1 403 608**	**(1 238 612)**	**(93 368)**	**71 628**
Allocation 2020 economic result	-	*(93 368)*	*93 368*	-
Cash contribution	*49 954*	-	-	*49 954*
Contribution in-kind	*30 221*	-	-	*30 221*
Economic result of the year	-	-	*(123 753)*	*(123 753)*
BALANCE AS AT 31.12.2021	**1 483 783**	**(1 331 981)**	**(123 753)**	**28 049**
Allocation 2021 economic result	-	*(123 753)*	*123 753*	-
Cash contribution	*77 924*		-	*77 924*
Contribution in-kind	*19 236*	-	-	*19 236*
Economic result of the year	-	-	*(127 749)*	*(127 749)*
BALANCE AS AT 31.12.2022	**1 580 943**	**(1 455 734)**	**(127 749)**	**(2 539)**

5.11 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 his/her declaration. The same materiality criteria are applicable to the FP7 and H2020

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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 which reduce the impact of the weakness);
- The existence of effective corrective actions to correct the weaknesses (action plans and financial corrections) which 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.

Whereas the JU control strategy is of a multi-annual 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 to determine whether to qualify his 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, with a multi-annual outlook.

The **control objective** for JU is to ensure that the '**residual error rate**', i.e. the level of errors which remain undetected and uncorrected, does not exceed 2 % by the end of the JU's 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. As long as the residual error rate is not (yet) below 2 % at the end of a reporting year within the programme's life cycle, a reservation would (still) be made. Nevertheless, apart from the residual error rate, the executive director may also take into account other management information at his/her 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, an assessment needs to be made on whether the scope and results of these audits are sufficient and adequate to meet the control objectives.

EFFECTIVENESS OF CONTROLS

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The **starting point** to determine 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) = sum of all individual error rates of the sample (in %). Only those errors in favour of the JU will be taken into consideration.

r = sample size

Second step: calculation of 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:

$$RepER\% = \frac{(RepER\% * (P-A) - (RepERsys\% * E)}{P}$$

Where:

ResER% = residual error rate, expressed as a percentage.

RepER% = 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% = 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 = total amount in EUR of the auditable population.

A = total of all audited amounts, expressed in EUR.

E = total non-audited amounts of all audited beneficiaries. This will comprise the total amount, expressed in EUR, of all non-audited validated cost statements for all audited beneficiaries, excluding those beneficiaries for which an extrapolation is ongoing.

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This calculation will be performed on a point-in-time basis, i.e. all the figures will be provided as of a certain date.

5.12 Results of technical review (optional) : N/A

5.13 List of acronyms

ABAC accrual-based accounting

AEMEL anion exchange membrane electrolyser

AEMWE anion Exchange Membrane Water Electrolyzer

AEL alkaline electrolysis

AER average error rate

AHG1 Advisory Hydrogen Group 1

AIB Association of Issuing Bodies

APTAR annual programme technical assessment report

ARES Advanced Record System

AST accelerated stress test

AWP annual work plan

BEV battery electric vehicle

BoP balance of plant

CAPEX capital Expenditure

CAS Common Audit Service

CEF Connecting Europe Facility

CEM13/MI7 13th Clean Energy Ministerial and seventh Mission Innovation

CEN European Committee for Standardization

CENELEC European Committee for Electrotechnical Standardisation

CFD computational fluid dynamics

CFS certificate on financial statements

CIC Common Implementation Centre

CINEA European Climate, Infrastructure and Environment Executive Agency

COMREF COMmon REFerence

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CRaS common representative sample

D&E dissemination and exploitation

DEP Digital Europe Programme

DG Directorate-General

DGBUDG Directorate-General Budget

DOI digital object identifier

ECA European Court of Auditors

EHO European Hydrogen Observatory

EHS&C European Hydrogen Sustainability and Circularity

EHSP European Hydrogen Safety Panel

EIC European Innovation Council

EISMEA European Innovation Council and SMEs Executive Agency

EoI Expression of interest

EU European Union

EURAMET European Association of National Metrology Institutes

FC fuel cell

FCB fuel cell bus

FCEV fuel cell electric vehicle

FCH 2 JU Fuel Cells and Hydrogen 2 Joint Undertaking

FCH JU Fuel Cells and Hydrogen Joint Undertaking

FCHO Fuel Cell Hydrogen Observatory

FI Financial instruments

FP7 seventh framework programme

FTC Fuel Cell truck

GA grant agreement

GB Governing Board

GHG greenhouse gas

GKN Ltd British automotive and aerospace components business

GO guarantee of origin

H2020 Horizon 2020

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H2V Hydrogen Vehicle

HADEA European Health and Digital Executive Agency

HIAD Hydrogen Incident and Accident Database

HRS hydrogen refuelling station

IA Innovation action

IAS Internal Audit Service

ICT information and communications technology

IEA International Energy Agency

IEC International Electrotechnical Commission

IEC/TC International Electrotechnical Commission/Technical committee

IGF international code of safety for ship using gases or other low-flashpoint fuels

IKAA in-kind contributions to additional activities

IKOP in-kind contributions to operational activities

IMO International Maritime Organization

IP intellectual property

IPCEI Important Projects of Common European Interest

IPHE International Partnership for Hydrogen and Fuel Cells in the Economy

IPR intellectual property rights

ISO International Organization for Standardization

ISO/AWI International Organization for Standardization/Approved work item

IT information technology

JIVE Joint initiative for hydrogen vehicles across Europe

JRC Joint Research Centre

JU joint undertaking

KDT JU Key Digital Technologies Joint Undertaking

KIP key impact pathway

KM knowledge management

KPI key performance indicator

LCA life cycle assessment

LH2 liquid hydrogen

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LIFE Programme for Environment and Climate Action

LOHC liquid organic hydrogen carrier

LT PEMFC Low Temperature Proton Exchange Membrane fuel cells

MAWP multiannual work programme

MEA membrane electrode assembly

m-CHP micro-scale combined heat and power

MEPC Marine Environment Protection Committee

MS member states

MSC Marie Skłodowska-Curie

MW megawatt

Nedo New Energy and Industrial Technology Development Organization

NDP Numérisation des Dossiers Personnels

NG Natural gas

NOW National Organisation Hydrogen and Fuel Cell Technology

NGC non-governmental certification

NWIP New Work Implementation Proposal

OLAF European Anti-Fraud Office

OP Open procedure

OPEX operational expenditure

P4P Processes for Planet

PACE Pathway to a Competitive European Fuel Cell micro-Cogeneration Market

PCC Proton Conducting Ceramic

PCCEL Proton Conducting Ceramic Electrolysis

PCEL Proton Ceramic Electrolyser

PDA project development assistance

PEM proton exchange membrane

PEMEL proton exchange membrane electrolyser

PEMFC proton exchange membrane fuel cell

PNR pre-normative research

PO Programme office

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PPMT	public procurement management tool
QES	qualified electronic signature
R & D	research and development
R & I	research and innovation
RCS	regulations, codes and standards
RCS SC	regulations, codes and standards strategy coordination
RED	Renewable Energy Directive
REPA	Reporting and payment
RETO	REservation Tool
RFNBO	renewable fuel of non-biological origin
SBA	single basic act
SET	strategic energy technology
SG	Stakeholders Group
SMEs	small and medium-sized enterprises
SNE	seconded national expert
SoA	state of the art
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
TC	technical committee
TIM	Tools for Innovation
TTP	time to pay
TR	technical report
TRL	technology readiness level
TRUST	Technology Reporting Using Structured Templates
WG	working group

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