Outcomes of the European Hydrogen Sustainability and Circularity Panel work

European Hydrogen Sustainability and Circularity Panel

Clean Hydrogen Partnership

Co-funded by the European Union

Introduction to S&C: Policies initiatives, scaling and impact

Julie Cren
Deputy Head of District Energy System Lab, CEA Liten

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An overview of the policy and market context

International policies

Key Policy Frameworks
- European Green Deal
- REPowerEU
- Fit-for-55

Energy policies and strategies with a focus on hydrogen
- Hydrogen Accelerator
- EU Hydrogen Strategy
- Renewable Energy Directive (RED II)
- Delegated Acts
- Renewable Energy Directive (RED III)

Additional/missing aspects

- Understanding the impacts of hydrogen scale up
- Manage critical raw and strategic materials
- Impacts of hydrogen on power production, storage and transport
- Land use
- Education / Re skilling
- Acceptance and “Not In My Backyard”
- Cooperation and stakeholders initiatives

Besides KPIs implemented, more specific measures are necessary to foster hydrogen market

EU policies driving S&C into the hydrogen market

EU policies

Carbon Pricing Mechanism

The EU Emissions Trading System (ETS) and the proposed Carbon Border Adjustment Mechanism (CBAM) are pivotal carbon pricing methods.

Aim: To incentivise industries to reduce carbon emissions by internalizing carbon costs, which in turn drives investments in low-carbon alternatives like renewable hydrogen.

Green Claims Directive

The Directive requires companies to substantiate the voluntary environmental claims in relation to their products and services with independent, peer-reviewed, widely recognized, robust and verifiable scientific evidence.

Aim: To provide more transparency for consumers and reduce greenwashing practices.

Ecodesign Directive

Aim: Eco-design as a powerful tool to support the European Commission's ambition of becoming the first CO2-neutral and circular economy in the world.

The Directive will be repealed in 2024 and replaced by the Eco-design for Sustainable Products Regulation.

Circular Economy Action Plan

Aim: To promote resource efficiency, waste reduction, and circularity across various sectors, emphasizing the use of renewable energy sources.

EU policies driving S&C into the hydrogen market

EU policies

Carbon Pricing Mechanism

Current: EU ETS drives carbon cost internalization, reducing emissions and promoting low-carbon investments (e.g., InnovFund).

Future: CBAM extends carbon pricing globally, fostering competitiveness of low-carbon technologies like renewable hydrogen.

Green Claims Directive

Current: Enhances consumer trust by demanding substantiated, verifiable environmental claims, reducing greenwashing practices.

Future: Drives market transparency, incentivizing businesses to adopt credible, science-based sustainability strategies.

Ecodesign Directive

Current: Enhances product sustainability, energy efficiency, and circularity, reducing environmental impact.

Future: Expansion of Sustainable Products Regulation (2024) further drive innovation and aligning products with CO2-neutral and circular economy goals.

Circular Economy Action Plan

Current: Promotes resource efficiency, reduces waste, and boosts circularity across industries, advancing the transition to a sustainable economy.

Future: Accelerates innovation in renewable energy and circular business models, further integrating sustainability into EU market practices.

The impacts of scaling up hydrogen deployment

Hydrogen can enhance energy security, integrate renewable energy sources, and contribute to decarbonisation, but its expansion concerns resource use, environmental impacts, and infrastructure needs.

Energy system integration

- Renewable energy storage (power to gas)
- High electricity demand for electrolysis, and direct competition with electrification

Water use

- 15-100 liters of water per Kg H_2
- Risk of local water stress

Critical Raw Materials

- Platinum, iridium, rare earth dependency → supply risks by 2030s–2040s
- Circular economy → recycling & substitution (CRM Act)

Governance & collaboration

- Cross-border regulatory alignment and certification is key
- PP cooperation to address R&I gaps and infrastructure bottlenecks

Land use

- Significant land needs for solar, wind → risk of competition with agriculture, conservation.
- Strategic siting and co-location with industrial hubs recommended.

Storage & transport

- Low energy density → need for pipelines, cryogenic storage, or chemical carriers.
- Infrastructure adaptation (e.g., repurposing gas pipelines) but embrittlement risks remain.

Public acceptance

- NIMBY concerns on safety, land use, disruption.
- Transparent communication, community participation.

Integration of S&C in R&I projects and the JU programme

Sofía De León Almaraz
Associate Professor
Department of Supply Chain Management
Corvinus University of Budapest

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Integration of S&C in **CH-JU funded** Projects

Screening of all FCH JU & Clean Hydrogen JU funded projects

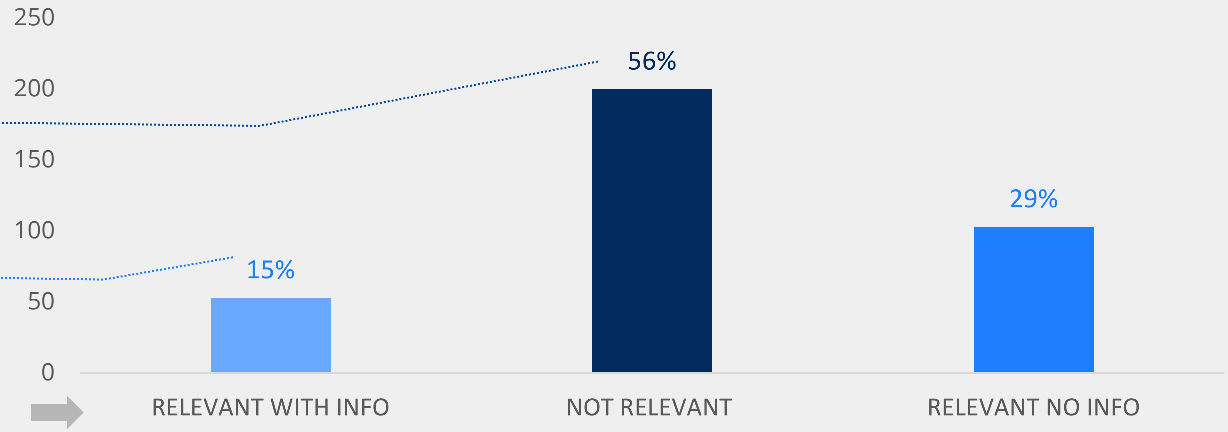
Initial project Screening for the different programmes: FP7 (2008-2013) → Horizon 2020 (2014-2022) → Horizon Europe (2022-2024)

356 projects were assessed for their integration of S&C indicators

More than half of the projects either addressed solely an economic indicator (i.e., CAPEX, OPEX) or no S&C indicator at all

Only 15% of all projects were deemed relevant and the Panel was able to find publicly available work to substantiate it

Project categorisation based on availability of S&C Indicators and publicly available information

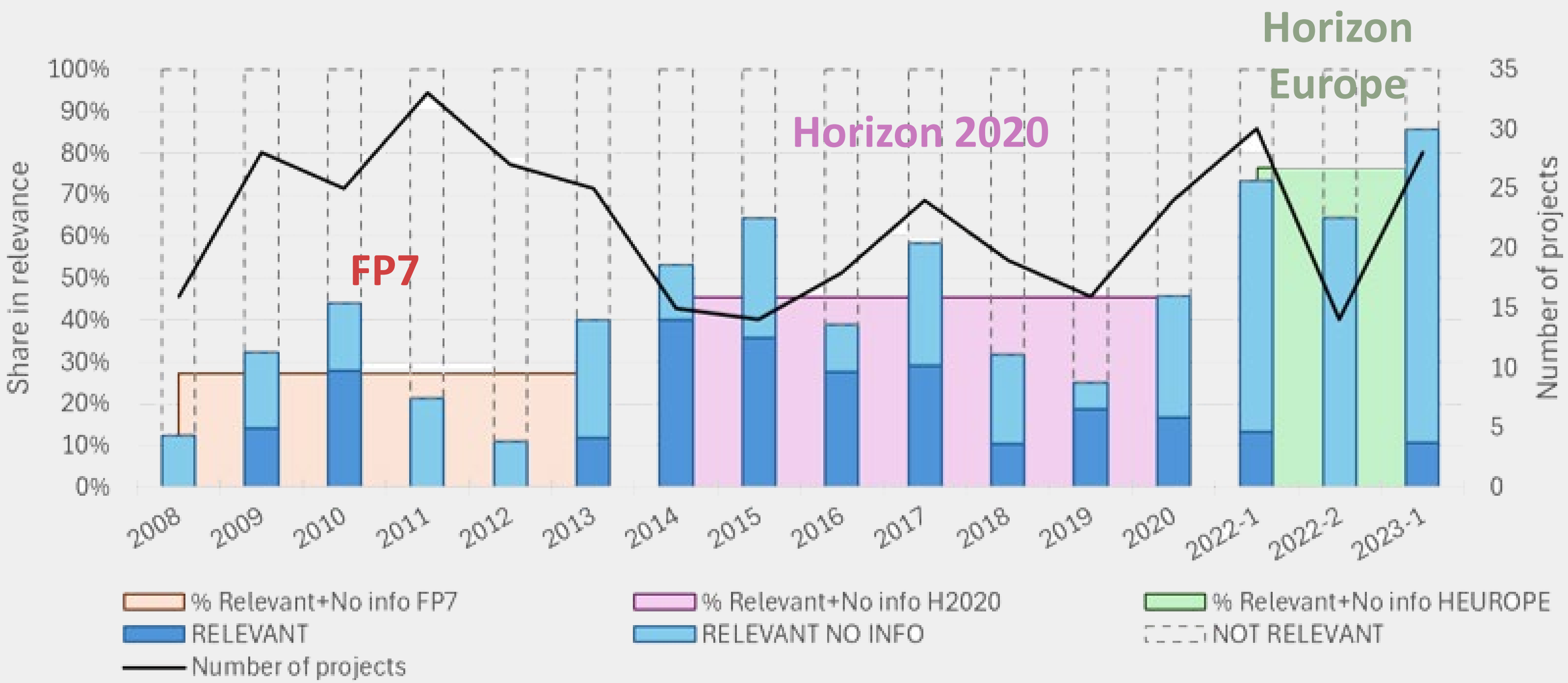


Project categorisation

*All 16 H2 Valleys projects have been assessed by all TFs and the conclusions are presented separately

Relevant projects within JU Programme

How the programs developed over time:
Projects that are found to be relevant over the years and programs



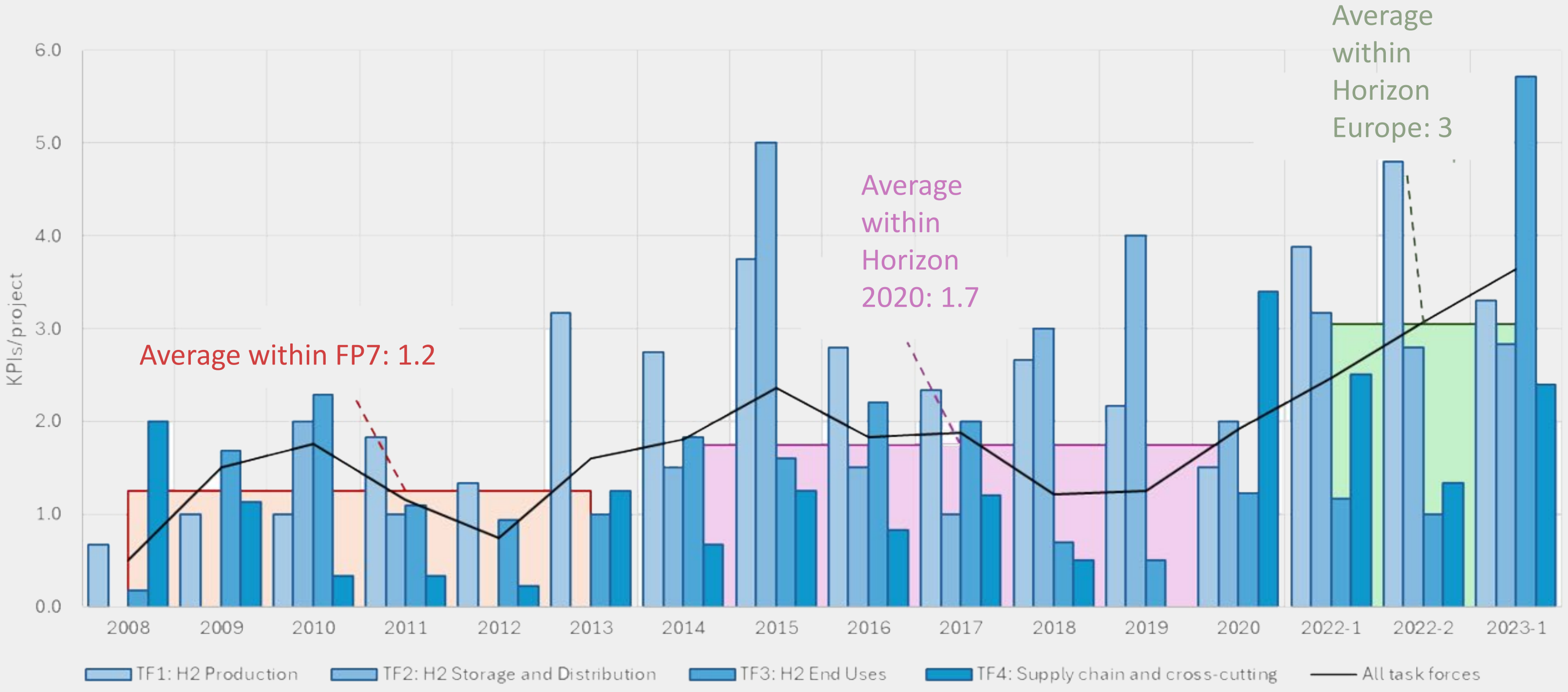
The number of awarded projects per year on H2 was higher within the FP7 program (26 project/year on average), but with a low proportion of relevant projects addressing S&C aspects (27%).

The number of relevant projects addressing S&C aspects has increased significantly since FP7. The percentage of relevant projects for FP7, H2020, and Horizon Europe is 27%, 45%, and 76%, respectively, with average annual awarded projects of 26, 18, and 24 per year, respectively.

Relevant	At least one sustainability and circularity indicator is addressed, other than the Economic (CAPEX/OPEX) indicator.
Relevant no info	Relevant projects w/o publicly available info (e.g., confidentiality reasons, websites are down or outdated, new projects, etc.)
Not relevant	These projects either address solely the Economic (CAPEX/OPEX) indicators or no sustainability and circularity Indicator at all.

S&C areas in projects and Programme

How the programs developed over time:
Extent to which S&C areas are assessed in the programs

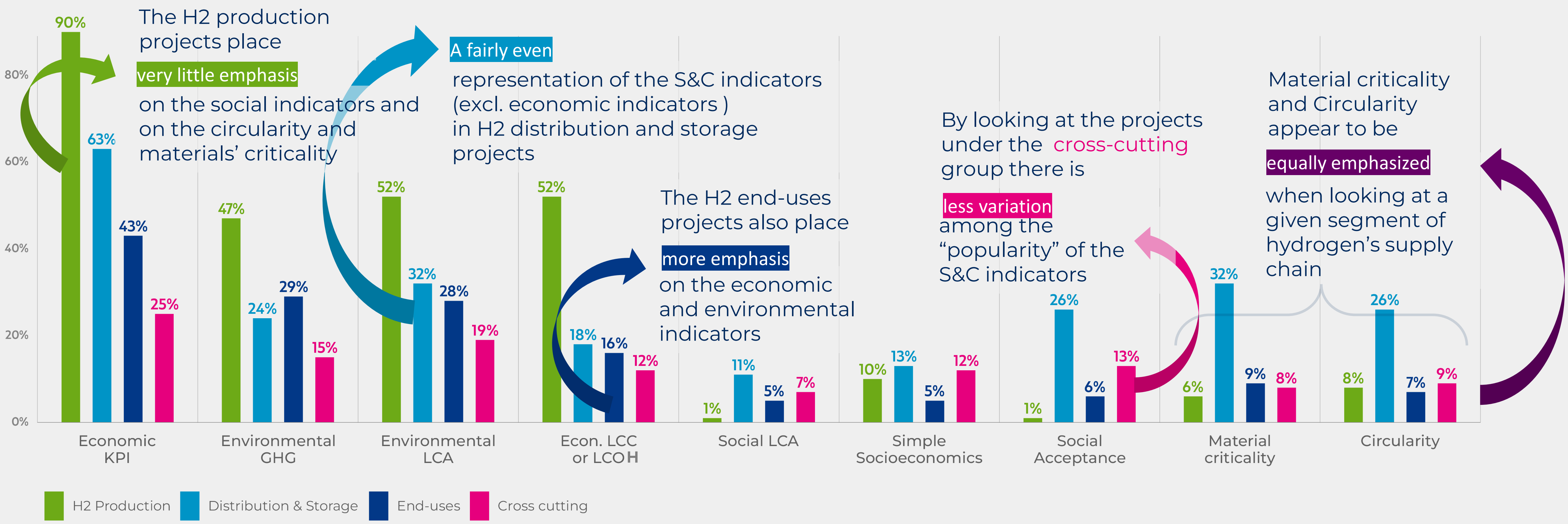


The average number of S&C areas addressed in awarded H2 projects has been increasing over the years but is still not sufficient to capture the full picture of S&C in H2.

Integration of S&C in **CH-JU funded** Projects

More granular assessment of relevant projects

S&C Indicator occurrence among all projects assessed by each TF excluding the 16 H2 Valleys projects*



Integration of S&C in CH-JU funded Projects

important findings

Only 15% of all projects were deemed relevant where the Panel was able to find publicly available work to substantiate it

- Economic indicators are the most frequently addressed → More than half of the projects focus on CAPEX and OPEX
- Environmental indicators (LCA and GHG) are the 2nd most popular indicators
- Social indicators and the criticality of materials appear to be the least addressed

H_2 storage and distribution

Percentage wise, these projects seem to address more S&C indicators based on publicly available info – even distribution of all indicators

H_2 production

Percentage wise, these projects seem to suffer more from unavailable information compared to the other parts of the supply chain. Very little emphasis is set on social indicators and circularity and materials' criticality

Cross-cutting group

Under the cross-cutting group, there is less difference within the S&C indicators

H_2 end-uses

Projects in this group of set more emphasis on the economic and environmental indicators

Integration of S&C principles into JU Programme

From Principles → to objectives → to deliverables

Principles	Objectives	Deliverables	State
Lifecycle approach	Develop frameworks and indicators to ensure sustainability and circularity are embedded into hydrogen initiatives	Lifecycle GHG savings indicators, sustainability KPIs	LCA: Well-established, focus on Carbon Footprint and GHG mainly LCC: OPEX mainly, OPEX and LCOH need clarity SLCA: Indicators are being developed. Very little emphasis so far.
Materials criticality	Optimise the use of CRMs and minimise waste in hydrogen technology deployment	Frameworks for CRM use, end-of-life strategies, and recyclability metrics	Few circularity indicators are available and quite undefined. Very little emphasis has been put so far on these indicators. Adoption of definition proposed by the EC and relevant projects (e.g., SH2E) on critical and strategic materials is required.
Circularity	Promote reuse, recycling, and renewable resource use in hydrogen value chains	Policy recommendations for circularity, including reuse and recycling guidelines	
Collaboration	Facilitate collaboration across industry, academia, and policy-making to create actionable outcomes	Stakeholder roadmaps and actionable collaboration strategies	Key challenge is the coordination of across different countries stakeholders (e.g., Universities, organisations, industry, policy-makers).
Impact awareness	Address socio-economic, environmental, and resource-related impacts comprehensively	Education and awareness campaigns, multi-objective optimisation models	Public acceptance influenced by factors such as attitudes, perceptions, and preferences (NIMBY). The transparent reporting of H2 impacts is under debate, and the DPP may play a role.

S&C KPIs for H2 Programme

Refine and expand S&C Key Performance Indicators: proposed indicators

Dimension	Indicator
Environmental	Proposed by the Environmental Footprint methodology (16 impact categories, including kg CO2 eq., human toxicity, acidification, eutrophication, land use, water use, mineral use)
Criticality	Content of critical materials (%, g/kg H2),
	Content of strategic materials (%, g/kg H2).
Economic	CAPEX
	OPEX*
	Levelized cost of hydrogen*
Social*	Forced labour
	Child labour
	Women in the sectoral labour force
	Gender wage gap
	Health expenditure
Circularity*	Recyclable materials content (%).
	Recycled materials content (%).
	Renewable materials content (%)
	Byproduct utilization - % of byproducts or co-products generated during hydrogen production that are reused, recycled, or valorised

*Further definition is required

Recommendations and look forward

Antonio Valente
Project Manager, ecoinvent

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Policy framework reflections and recommendations for scaling and impact

Key Policy Frameworks

- European Green Deal
- REPowerEU
- Fit-for-55

The panel considers that it is critically important to

- Prioritise the development of S&C approaches through more robust regulatory frameworks
- Establish clear methodologies to accurately measure GHG emissions and environmental impacts of hydrogen throughout its entire lifecycle (cradle-to-grave approach).

Recommendations for future

- Guidelines explaining which indicators should be addressed by which types of projects
- Improved methodologies and more functionable templates/data collection activities, including monitoring of S&C at JU level
- Increased public awareness and acceptance while ensuring that only absolutely confidential information/deliverables are labeled as such

Forward-looking recommendations Projects

Encourage public deliverables, balancing transparency and confidentiality

- S&C deliverables structured for public dissemination.
- Guiding in preparing dual versions (public and confidential).
- Ensure meaningful public dissemination of S&C.
- Anonymizing and aggregating sensitive data for broader dissemination.

Develop benchmarking case studies

- Develop case studies based on CHPJU-funded projects as benchmarks for project comparisons.
- Define consistent parameters to be used in assessments.
- Develop a centralised repository for case studies.

Build capacities and capabilities of project owners

- Offer online workshops or training sessions for project owners on how to implement provided S&C methodologies
- Provide best practice examples from ongoing or past projects

Review and recognition of achievements of projects

- Identify individual projects with high relevance to S&C integration
- Review projects to draw lessons for other projects and a short report for dissemination across the CHPJU
- Consider integration of these good practice reports into other activities

Forward-looking recommendations Programmes

To ensure S&C are embedded at the Clean Hydrogen JU programme level, the next panel must focus on actions that enhance strategic alignment, facilitate collaboration, and improve overall programme coherence.

1. Strengthen S&C integration across the programme

➔ Promote standardisation and knowledge sharing

➔ Monitor programme-wide S&C performance using SRIA KPIs.

➔ Identify and prioritise S&C actions in knowledge management and funding.

2. Increase collaboration with key stakeholders

➔ JU and Contractor to facilitate the exchanges and dictate an agenda

➔ JU to facilitate the outreach and mandate members to incorporate/contribute

➔ Coordinating contractor to organize the activities with minimal input from the panel

3. Capacity building and strategic guidance

➔ Address time constraints

➔ Facilitation of trainings

4. Foster long-term programme innovation

➔ Incentives for projects that exceed sustainability benchmarks.

➔ Recommendations based on the identified incentive mechanisms.

Thank you

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