Repository

Section 15 - Hydrogen, Sustainability & Circularity

Topic 99 - Sustainability Criteria & Supply Chain

Dissemination Level: Public

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1. Repository Introduction

This document is part of the H2VE Repository, a structured collection of learning resources and materials developed to support Centres of Vocational Excellence (CoVEs) and training providers in delivering high-quality, up-to-date hydrogen education. The thematic clusters and sub-topics covered in this repository were jointly compiled by all H2VE project partners as part of Deliverable D5.1 - Educational Training Material Specification Document. Each document corresponds to a specific sub-topic within a broader thematic cluster and follows a standardized structure comprising a document header, learning context, core content, curated digital tools, and assessment guidance, where applicable. The aim is to provide trainers and educators with general resources as well as modular content that can be integrated into existing curricula or adapted to specific training contexts. A list of underlying resources and sources is provided at the end of each document to allow for further exploration and verification of the material presented.

2. Topic Overview

Assessing hydrogen value chains against environmental, social, and economic sustainability criteria is essential as production and deployment scale up across Europe. This topic covers the three pillars of sustainability applied to hydrogen: environmental (e.g., GHG emissions, water, land use), social (e.g., labour rights, community impacts, employment), and economic (e.g., cost, energy security). It identifies key sustainability hotspots across the value chain, from production and storage to transport and end-use. Learners are introduced to responsible sourcing frameworks, including due diligence practices, supply chain transparency, and traceability tools, as well as the EU regulatory context shaping these requirements, including the EU Green Deal, EU Hydrogen Strategy (2020), and REPowerEU (2022). This grounding equips learners to critically evaluate sustainability performance across the hydrogen value chain and to engage with the policy instruments used to define and verify compliance.

3. Learning Resource Overview

1. Learning Context	**Prerequisites**: • Basic understanding of the hydrogen value chain (production, storage, transport, use) • Familiarity with the three pillars of sustainable development (environmental, social, economic)

	• EQF 4+ recommended; EQF 3 accessible with instructor support
2. Content	• **The three pillars of sustainability in hydrogen value chains**: Assessing hydrogen sustainability requires looking beyond carbon emissions alone. The environmental pillar covers greenhouse gas emissions (which vary significantly depending on the electricity source used for production), water consumption (electrolysis requires large volumes of purified water), and land use (particularly for renewable electricity generation feeding the process). The social pillar addresses labour rights and working conditions in raw material extraction and component manufacturing, impacts on local communities near production or storage facilities, and employment effects as the sector scales. The economic pillar considers production cost competitiveness relative to fossil alternatives, energy security implications of import dependency, and the broader economic viability of hydrogen projects. A robust sustainability assessment considers trade-offs across all three pillars rather than optimizing for one at the expense of the others. • **Sustainability hotspots across the value chain**: Each stage of the hydrogen value chain carries distinct sustainability risks. In production, the choice of energy source is the dominant factor determining the carbon intensity of the resulting hydrogen, while electrolyser manufacturing depends on critical raw materials such as platinum and iridium. In storage, compression or liquefaction processes are energy-intensive and can result in boil-off losses. In transport, pipeline transport is generally more efficient at scale but requires new or retrofitted infrastructure (hydrogen can embrittle certain steels), while truck transport offers flexibility at higher per-unit cost and emissions. In end-use, fuel cell durability affects the overall lifecycle footprint of the technology, and while tailpipe emissions are zero, upstream emissions from production remain the primary sustainability concern. • **Responsible sourcing frameworks**: As demand for critical raw materials grows, responsible sourcing has become a

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	key sustainability lever. Due diligence refers to the systematic identification and mitigation of environmental, social, and governance risks in the supply chain, particularly for materials with high geopolitical or human rights risk exposure. Supply chain transparency involves the disclosure of sourcing practices and supplier relationships to stakeholders and regulators. Traceability tools, such as certification schemes and guarantees of origin, allow the sustainability characteristics of hydrogen (e.g., renewable origin, GHG intensity) to be verified and communicated along the value chain. • **EU policy and regulatory context**: Several EU policy instruments define the sustainability requirements hydrogen projects must meet. The EU Green Deal sets the overarching climate neutrality target framing all sector-specific hydrogen policy. The EU Hydrogen Strategy (2020) establishes the EU's ambition for renewable hydrogen deployment and lays the groundwork for supporting regulation. REPowerEU (2022) accelerates this ambition in response to energy security concerns following reduced reliance on Russian energy imports. Together, these frameworks underpin the Delegated Acts that define detailed sustainability criteria for renewable hydrogen — including additionality (new renewable capacity must be built to supply the electrolyser), temporal correlation (renewable electricity must be matched to hydrogen production on an hourly or monthly basis), and geographical correlation (the renewable electricity source must be reasonably close to the point of hydrogen production).
3. Digital Tools	• FCH-LCA Tool (SH2E / GreenDelta): Free, Open Source, Use the guided wizard to set system boundaries and identify value chain stages for a chosen Hydrogen pathway. Introductory exercise before full LCA. • IEA Global Hydrogen Review 2024: Data & Charts, Interactive data explorer for Hydrogen production volumes, costs, and sustainability metrics by region. Use as a data source for classroom exercises.
4. Assessment Guidance	**Assessment Methods**

	• Short essay (500 words): 'Compare the social and environmental sustainability hotspots of green hydrogen produced domestically vs. imported from a non-EU country.' • Group exercise: assign each group a different Hydrogen production pathway; each group maps hotspots across the value chain and presents a 5 - minute summary. **Sample Questions** 1. What are the three pillars of sustainability and how does each apply to hydrogen fuel cell systems? 2. Identify two environmental and two social sustainability hotspots in the PEM electrolysis supply chain. 3. 3The EU Hydrogen Strategy sets additionality, temporal correlation, and geographical correlation criteria for renewable Hydrogen. What does each criterion mean and why does it matter? **Evaluation Criteria** • Accuracy of hotspot identification across all three sustainability pillars (40%) • Ability to link value chain stages to specific sustainability criteria (40%) • Quality of policy reference and contextualisation (20%)
5. References	European Commission. (2020). A hydrogen strategy for a climate-neutral Europe. Publications Office. https://energy.ec.europa.eu/system/files/2020-07/hydrogen_strategy_0.pdfn IEA. (2024). Global hydrogen review 2024. International Energy Agency. https://www.iea.org/reports/global-hydrogen-review-2024 Osman, A. I., et al. (2024). Life cycle assessment of hydrogen production, storage, and utilization. WIREs Energy and Environment, 13(3), e526. https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wene.526 European Court of Auditors. (2024). SR-2024-11: EU industrial policy on renewable hydrogen. https://www.eca.europa.eu/ECAPublications/SR-2024-11/SR-2024-11_EN.pdf

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