CLEAN HYPRO

Open Innovation Test Bed for Electrolysis Materials for Clean Hydrogen Production

D2.4 FINAL REPORT ON SEP DEFINITION AND BUSINESS MODEL

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EXECUTIVE SUMMARY

The CLEANHYPRO project aims to establish a sustainable Open Innovation Test Bed (OITB) dedicated to the development and validation of electrolysis materials and components, with the goal of accelerating clean hydrogen production. Through a coordinated network of facilities and services, the project supports companies in testing and implementing innovative solutions for various applications.

The purpose of this deliverable is to define the Single Entry Point (SEP) and its business model, which will serve as the central gateway to the service offering of the CLEANHYPRO OITB. The structured and innovative offering is built on the implementation of an OITB that delivers advanced technical services from the design and testing of electrolyzers based on various technologies (AEL, PEM, AEM, SOEC) to system validation, simulation, and integration alongside commercial support services such as certification, regulatory assistance, and facilitation of networking and investment opportunities. This is complemented by the creation of a strategic ecosystem where the collaboration between SMEs, large companies, research centers, and investors helps bridge the gap between research and industrial application. The document also highlights the added value of the project, which, through access to industrial-scale testing infrastructures and specialized technical support, aims to accelerate the validation and scalability of electrolysis technologies. This approach addresses key barriers that currently hinder the widespread adoption of hydrogen as a clean energy source, including high development costs, long time-to-market, limited access to advanced facilities, and regulatory complexity. From an operational standpoint, the deliverable details the role of the SEP, its business model, and several viable fee structure options. Specifically, it analyzes a fixed-fee model, a success fee-based model with the right to sign contracts, a success fee model without signing rights, and a hybrid model that combines the strengths of the previous ones. Each option is evaluated in terms of benefits such as revenue stability and performance-based incentives and critical issues, including the risk of internal conflicts and challenges in defining responsibilities and contractual obligations.

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ABBREVIATIONS

OITB	Open Innovation Test Bed
SEP	Single Entry Point
GDPR	General Data Protection Regulation
PEM	Polymer Electrolyte Membrane
AEM	Anion Electrolyte Membrane
AEL	Alkaline Electrolysis
SOEC	Solid Oxide Electrolyser Cell
IP	Intellectual Property
SMEs	Small and medium-sized enterprise
PLs	Pilot Lines
TRL	Technology Readiness Level
R&D	Research and Development
ALD	Atomic Layer Deposition
FTEs	Full-Time Equivalents

1 Introduction

CLEANHYPRO is an ambitious European initiative designed to revolutionize the clean hydrogen sector by accelerating the development, validation, and commercialization of next-generation electrolysis technologies. At its core, the project responds to the pressing need for a cohesive innovation framework that bridges the gap between cutting-edge research and industrial-scale implementation that has hindered so far the widespread adoption of clean hydrogen.

The initiative is structured around a centralized access point, the Single Entry Point (SEP), which integrates an OITB and a comprehensive ecosystem of technical and business services. By providing state-of-the-art testing facilities, advanced simulation tools, and expert consultancy in areas such as materials science, system integration, and regulatory compliance, CLEANHYPRO creates an environment where SMEs, large corporations, research institutions, and investors can collaborate seamlessly. This collaborative framework is key to overcoming traditional barriers such as high R&D costs, lengthy time-to-market, and fragmented market pathways, ultimately positioning Europe as a global leader in sustainable energy solutions.

Furthermore, the service model is designed around a mix of fixed-rate services and performance based incentives, ensuring both accessibility and alignment with client success. This approach not only guarantees the technical robustness of emerging technologies but also supports their economic viability and scalability. Through this integrated and flexible framework, CLEANHYPRO OITB transforms systemic challenges into growth opportunities, contributing significantly to the energy transition toward a low-carbon future.

1.1 Scope of the Deliverable

This document presents the final SEP framework, consolidating the shared vision and strategy established in Task 2.1. It integrates partner contributions and insights gained throughout the project (M1–M18). The SEP structure outlined in these deliverable builds on Deliverable D2.3, *Preliminary Report on SEP Definition and Business Model*.

The document details a strategy to support SMEs through OITBs, fostering stakeholder collaboration and maximizing environmental and economic impact. It defines a business model based on a two-sided marketplace, where the SEP acts as an intermediary linking customer needs with OITB capabilities including services, infrastructure, and intellectual property. While customers may contract directly with service providers, the SEP retains the ability to engage independently when necessary.

The deliverable is structured into key chapters, each addressing a critical aspect of CLEANHYPRO's objectives and implementation:

- **Introduction and Overview:** Outlines CLEANHYPRO's OITB goals, scope, and strategic relevance.

- **Products & Services:** Defines CLEANHYPRO's core offering. It composed by a highly efficient OITB supporting hydrogen production, storage, and utilization through tailored technological and market-driven services.
- **OITB Services:** Details the technical and business services provided, including electrolyzer manufacturing and testing, value chain support, certification, investment facilitation, IP management, and a digital collaboration platform.
- **CLEANHYPRO Ecosystem:** Describes the strategic ecosystem connecting SMEs, corporations, research institutions, and investors to bridge the gap between research and industry, enhance market insights, and reduce innovation risks.
- **Team and Organization:** Outlines the consortium structure, roles of partners, and coordinated approach to electrolysis technology innovation and scaling.
- **Mission, Goals, and Objectives:** Defines CLEANHYPRO's mission to advance electrolysis technologies and promote industrial adoption, with a focus on infrastructure development, service integration, technology validation, and economic sustainability.
- **Members' Roles and Contributions:** Details consortium members, their expertise, and the infrastructure they contribute to the OITB.
- **Value Proposition:** Showcases the CLEANHYPRO's OITB impact on the hydrogen sector, demonstrating how the project contributes to accelerating the development, optimisation and commercialisation of electrolysis technologies for clean hydrogen production.
- **SEP Operations and Fee Structure:** Explains the SEP's role as the central access point for CLEANHYPRO services, presenting fee models such as fixed fees, success-based structures, and hybrid approaches for financial sustainability.
- **Conclusion:** Reinforces the initiative's role in driving hydrogen technology development, validation, and commercialization, emphasizing the OITB's strategic importance in fostering innovation and strengthening Europe's leadership in clean hydrogen.

2 Team and Organization

CLEANHYPRO is a European OITB that brings together leading companies, research centers, and academic institutions to drive innovation in the field of electrolysis. The project is structured to foster collaboration between technical and managerial expertise, integrating advanced infrastructures to tackle the challenges of energy transition and decarbonization. Through this synergy, CLEANHYPRO provides an optimal environment for testing, validation, and scaling up innovative materials and components for clean hydrogen production.

2.1 Mission Statement

CLEANHYPRO's mission is to promote advanced electrolysis technologies and facilitate their industrial adoption by providing access to state-of-the-art pilot plants and a comprehensive suite of services. The project aims to optimize hydrogen production processes, improving performance through advanced simulations and experimental testing while reducing operational costs and increasing efficiency.

Beyond technological advancement, the consortium seeks to establish a system that enhances technology transfer, enabling connections between technology providers and end users, with a particular focus on SMEs and startups. The creation of a SEP will simplify access to the consortium's resources, making the adoption of new industrial solutions more accessible. At the same time, the project includes the continuous upgrading of pilot lines and the integration of quality management practices to ensure reliability, repeatability, and compliance with environmental and safety standards.

2.2 Goals and Objectives

CLEANHYPRO aims to strengthen its industrial ecosystem through a series of strategic actions designed to ensure the long-term sustainability of the innovations developed. A key element of the project is the enhancement of infrastructures, with the upgrade of nine pilot lines to improve the reproducibility of industrial prototypes. This goal will be achieved through the implementation of advanced control systems, process capability tests, and real-time traceability tools capable of monitoring the performance of materials and components. Beyond the technical aspects, the project will develop a comprehensive service offering covering the entire innovation cycle, from the initial concept to industrial scale-up and market entry. Companies will benefit from technical support in process design, multiphysics simulation, and advanced material characterization, as well as strategic assistance on regulatory aspects, market analysis, and access to financing.

To facilitate technology transfer and reduce the costs and risks associated with innovation adoption, CLEANHYPRO will establish a SEP as a centralized access point for the consortium's

facilities and services. This platform will provide a streamlined interface for businesses, particularly SMEs and startups, enabling direct access to the expertise and resources needed to develop new technologies.
Finally, the project will focus on validating technologies in real-world applications through large-scale demonstrations and case studies in collaboration with industrial partners. These activities will not only provide concrete data on performance, durability, and efficiency but also help build industry confidence in adopting new solutions. To ensure a lasting impact beyond the project's duration, CLEANHYPRO will develop a self-sustaining business model for the SEP, based on intermediation and brokerage activities, ensuring continuous support for the hydrogen industry ecosystem.

2.3 Members Roles

The OITB consists of multiple members, each providing distinct services and fulfilling various roles based on their resources, as outlined in the following table.

TABLE 1 – MEMBERS ROLES

Partner	Role and related infrastructure
ISE	Automated PEM test stands for test cells and short stacks to efficiently test CCM materials at cell and stack level under diverse testing conditions (temperature, pressure, flow rates, etc.). Extensive knowledge in designing and operating SoA-PEM EL test benches. PEM water electrolysis stack testbench up to 2000 A.
UMICORE	Umicore specializes in catalyst and electrocatalyst development, upscaling, and production for green energy applications. With dedicated R&D and production facilities, it provides high-performance catalyst materials tailored to partner specifications, targeting electrode manufacturers, MEA producers, OEMs, and system builders.
UMI	Catalyst precursor development, upscaling and production. Development and production facilities for ALD precursor materials.
VTT	SOC fuel cells and electrolysers electrochemical testing, material, BOP component, and system testing. Lab: Multiple SOC fuel cell and electrolyser test benches for single cells to tens of kW stacks, possibility for long-term tests (~ year). Furnaces for (SOFC) material testing. Electrochemical testing and post-mortem analysis.
MCP	Electrolyzers and refuelling stations developers with internal R&D and engineering teams. Alkaline pressurized electrolyzer technology and refuelling stations technology. Technical infrastructure in McPhy Italy for testing and validating internal components of the stack up to a TRL 7. Lab infrastructure in McPhy Germany for testing electrodes and diaphragms up to a TRL 2-3 (under construction).
JRC	Testing services for fuel cells and electrolyser. Test facilities for low- and high-temperature fuel cells (PEMFC, SOFC) and stacks as well as electrolysis cells (PEM, SOC).
IREC	IREC contributes to SOEC innovation through advanced electrode materials and

	validation of 3D-printed cells. Its key infrastructure includes high-temperature electrochemical testing, pilot-scale manufacturing, and advanced characterization labs.
SparkNano	Spark Nano specializes in Spatial Atomic Layer Deposition (ALD) for low PGM catalyst layers, offering cutting-edge deposition technology. Its critical infrastructure includes advanced Spatial ALD equipment for precise and scalable thin-film manufacturing.
3DCS	3D Ceram specializes in 3D printing of technical ceramics, with expertise in SLA-based fabrication of YSZ solid oxide cells. Its critical infrastructure includes advanced SLA 3D printers, ceramic formulation know-how, and full-process capabilities from CAD design to sintering.
VSP	VS Particle specializes in spark ablation technology for liquid-free catalyst layer deposition. Its critical infrastructure includes advanced nanoparticle synthesis and deposition equipment, supporting materials and applications development for electrolyzers and beyond.
CPT	Ceramic Powder Technology specializes in high-quality ceramic oxide powders produced via spray pyrolysis. Its key strength lies in proprietary know-how and patented processes, supplying advanced materials for SOC manufacturing.
EGHAC	EGHAC specializes in innovation commercialization, offering equity investment, market access, and a vast network across public and private sectors. Its critical role includes startup validation, due diligence, and business development support for hydrogen and clean energy solutions.
MASS	Mondragon Assembly specializes in designing and manufacturing flexible automatic assembly systems. Its critical infrastructure includes six global production plants, proprietary robotics and automation technology, and extensive expertise in custom assembly solutions for industrial applications.
BV	Bureau Veritas specializes in certification, quality labeling, and safety verification for electrolysers. Its key role is to define testing standards and develop a quality label to classify OEMs, providing strategic value for manufacturers and technology buyers
BTU	Brandenburgische Technische Universität specializes in R&D for pressurized alkaline electrolysis. Its critical infrastructure includes an alkaline pressure electrolysis system and specialized test rigs for component evaluation, dynamic operation studies, and in-operando analysis at the single-cell level.
ENAPTER GMBH	Enapter GmbH is a leader in AEM technology, specializing in cell and stack testing, degradation analysis, and material characterization. Its advanced lab infrastructure supports ex-situ and post-mortem analysis, including SEM, EDX, and IR spectroscopy.
F6S	F6S specializes in Dissemination, Clustering, and Exploitation, leading WP6 in CleanHyPro. It manages communication, stakeholder engagement, and open calls, leveraging its open innovation platform to connect start-ups, SMEs, research centers, and industry partners. The company provides expertise in project management, communication, scouting, and networking to maximize CleanHyPro's visibility and impact

STAM	STAM bridges technology providers and end-users, supporting hydrogen integration through project management and business model development. It facilitates pilot line upgrades and connects innovations with market needs.
PNO	PNO supports innovation by identifying and engaging SMEs in CleanHyPro, ensuring informed participation in open calls. It maps relevant services and gathers data to expand client networks in green hydrogen production.
TECNALIA	Project Coordinator. Tecnalia develops solutions in the fields of hydrogen generation, distribution, transport, storage and use that meet the decarbonisation challenges of the energy system, industry and mobility. Our technologies integrate renewable energy into the energy system and drive the decarbonisation of hard-to-electrify sectors.

3 Product & Services

CLEANHYPRO's main offering is based on a high level of efficiency aimed at supporting the research and development activities of companies involved in the hydrogen sector. This will be achieved through a bundle of services that offer a comprehensive package, enabling technology developers to innovate and advance novel hydrogen production, storage, and utilization solutions based on two key axes of operation:

1. The Open Innovation Test Bed services,
2. The ecosystem of CLEANHYPRO that will be developed around the services of the OITB.

3.1 Open Innovation Test Bed Services

CLEANHYPRO will establish an OITB that enables hydrogen technology developers to integrate their solutions into European Key Value Chains.
Some of the services included in the OITB will be:

- Technical Services
- Business Services

TABLE 2 – OITB SERVICES

Category	Service
Technical Services	Manufacturing & Testing of electrolyzers (AEL, PEM, AEM, SOEC)
	Technology upscaling and assessment (TRL 4-7)
	Feasibility studies, LCA, and LCC analysis
	Access to pilot facilities for electrolysis
	Testing & certification of H2 systems
	Integration into energy systems
	Advanced simulations & digital twins
Business Services	Electrolyzer certification & compliance
	Communication & dissemination
	Networking, scouting & investor access
	Innovation & commercialization support
	Public-private financing advisory
Additional Offerings	Standardized IP & licensing via SEP
	Digital platform for collaboration & funding

These services will be detailed in the following section.

3.1.1 Technical Services

- **Manufacturing and Testing of Electrolyzers and Components**:
  - Advanced Alkaline Electrolyzers (AEL)
  - Advanced Proton Exchange Membrane Electrolyzers (PEM)

    - Advanced Anion Exchange Membrane Electrolyzers (AEM)
    - Advanced Solid Oxide Electrolyzers (SOEC)
- **Comprehensive Technology Upscaling and Assessment**: Covering TRL 4 to 7 for hydrogen production, storage, and utilization technologies, enabling validation, optimization, and upscaling.
- **End-to-End Hydrogen Value Chain Support**: Providing technical and economic feasibility studies, lifecycle assessments (LCA), and cost analysis (LCC) for hydrogen technologies.
- **Pilot Facilities for Electrolysis Technologies**: Access to research and technology infrastructures for PEM, AEM, AEL, and SOEC electrolysis systems, ensuring efficient and scalable hydrogen production.
- **Testing and Certification Facilities**: Offering testing infrastructure for hydrogen storage systems, fuel cells, and innovative materials, ensuring compliance with industry standards and regulatory frameworks.
- **Integration and System Validation**: Enabling the validation of hydrogen technologies within existing energy systems, including power-to-gas, hydrogen refueling stations, and industrial applications.
- **Advanced Simulation and Digital Twins**: Utilizing AI-driven simulations and digital twin technology for optimizing hydrogen system design and performance.

3.1.2 Business Services

- **Labelling and Certification of New Electrolyzers**: Ensuring compliance with industry regulations and quality standards.
- **Dissemination and Communication**: Promoting project results, knowledge-sharing, and stakeholder engagement.
- **Scouting, Networking, and Access to Investors**: Facilitating connections with key industry players, financial institutions, and funding opportunities.
- **Innovation Services**: Supporting the development of new business models, IP protection strategies, and technology commercialization pathways.
- **Public-Private Financing Support**: Providing guidance on funding mechanisms, investment opportunities, and financial due diligence for market entry and commercialization.

Furthermore, CLEANHYPRO will be the first OITB providing:

- **Standardized IP and Licensing Frameworks**: Procedures and contract models for the licensing and commercialization of joint intellectual property through the Single-Entry Point (SEP).
- **A Digital Collaboration Platform**: A multilingual online portal integrating the service portfolio of all OITBs, offering access to funding opportunities, regulatory guidelines, EU strategies, company news, and public research project deliverables. The platform

will facilitate collaboration among key stakeholders and enable digital project and knowledge management.

- **Innovative Financing Models for SMEs**: Combining trust-based due diligence structures with project-based investment models and crowdfunding opportunities to accelerate market entry and commercialization.

3.2 CLEANHYPRO Ecosystem

The CLEANHYPRO ecosystem will be a dynamic network designed to drive innovation and accelerate the development of hydrogen technologies through collaboration among diverse stakeholders. This ecosystem will integrate SMEs, large corporations, research institutions, technology providers, and end users to create a robust support structure that addresses the specific needs of hydrogen industry players.

By conducting continuous market research, CLEANHYPRO will provide its clients and stakeholders with a deep understanding of hydrogen market dynamics, emerging trends, and regulatory developments. This ecosystem will offer a strategic vision for the future of hydrogen technologies, guiding innovation efforts toward the most impactful and commercially viable solutions.

Through this structured ecosystem, CLEANHYPRO will reduce the uncertainty and risk associated with innovation projects, foster SME participation in the European hydrogen market, and remove barriers that currently limit their engagement. By doing so, CLEANHYPRO will play a crucial role in strengthening the European hydrogen economy and supporting the transition toward a sustainable, decarbonized energy future.

4 Value Proposition

CLEANHYPRO provides a unique value proposition by accelerating the development, optimization, and commercialization of electrolysis technologies for clean hydrogen production. This value is delivered through two fundamental pillars:

Technical Advancements in Electrolysis Technologies

- CLEANHYPRO enhances the efficiency, durability, and cost-effectiveness of key electrolysis systems, including PEM, AEM, AEL, and SOEC electrolyzers, ensuring their scalability for large-scale industrial use.
- The project focuses on advanced material development and testing, process innovation and optimization, and real-world validation, helping to overcome the technical obstacles that hinder hydrogen production and making these technologies ready for mass deployment.
- By integrating renewable energy sources into electrolysis processes, CLEANHYPRO supports the transition toward zero-emission hydrogen and strengthens Europe's position as a global leader in sustainable energy solutions.

Access to R&D and Innovation Ecosystem

- As an OITB, CLEANHYPRO provides SMEs, startups, and established industry players with access to state-of-the-art testing facilities, expert guidance, and collaboration opportunities.
- The project acts as a bridge between cutting-edge research and practical market adoption, offering tailored support to electrolyzer manufacturers to help them validate, refine, and scale their technologies.
- By fostering a network of businesses, investors, and stakeholders, CLEANHYPRO stimulates market opportunities and strengthens the European hydrogen value chain, creating an interconnected ecosystem that accelerates the growth of the clean hydrogen sector.

4.1 Problem Definition

Despite the growing demand for hydrogen as a sustainable energy source, its widespread adoption is hindered by significant technical and structural challenges that slow the development, validation, and commercialization of electrolysis technologies. The large-scale deployment of clean hydrogen is crucial for the energy transition towards decarbonization, yet the sector faces barriers that prevent rapid and efficient scaling, particularly for SMEs and emerging technology developers, which are at the heart of innovation in this field.

One of the major obstacles is the lack of a clear and integrated pathway that connects academic research and industrial development with the real market. Electrolysis technologies such as PEM, AEM, AEL, and SOEC are essential for hydrogen production, but their development is often fragmented. This results in situations where collaborations between research institutions, technology developers, and industry players are limited, creating a gap that leads to:

- Long and costly development cycles, where companies struggle to move past prototype stages due to the lack of advanced testing infrastructure and technical validation.
- Challenges in scaling innovations to industrial levels, as new electrolysis solutions require real-world demonstrations to prove their efficiency, durability, and cost-effectiveness at large-scale production levels.
- Regulatory and standardization complexities, which prevent emerging technologies from meeting compliance requirements and becoming market-ready on a global scale.

While large corporations can invest significant resources into in-house R&D, SMEs and startups are often disadvantaged. These companies face difficulties competing on equal footing due to the following challenges:

- Limited access to advanced testing infrastructure: Large companies can afford in-house laboratories, but SMEs are forced to rely on external facilities, which are often expensive, hardly accessible, or not sufficiently specialized to test emerging technologies.
- Difficulties in obtaining technical expertise: Refining electrolysis technologies requires specific expertise in areas such as material chemistry and system engineering, which is often unavailable to SMEs that lack the resources to hire or train experts in these fields.
- Limited financial resources: Developing new technologies requires significant investment, both for research and for large-scale demonstration. SMEs and startups often struggle to access the necessary funding to support these processes, preventing many innovations from progressing past the laboratory stage and achieving commercialization.

As a result, many promising electrolysis technologies are stuck in the development phase, unable to transition from research to industrial application. This creates an innovation bottleneck, slowing down the widespread adoption of clean hydrogen and its potential contribution to the global energy transition.

CLEANHYPRO aims to address these issues by providing an OITB that bridges the gap between advanced research and industrial adoption. By offering advanced testing infrastructure, access to specialized expertise, and financial support, CLEANHYPRO enables SMEs and startups to validate and scale their electrolysis technologies, accelerating the transition towards a more sustainable and competitive clean hydrogen production system at a global scale. The detailed explanation of the problems and barriers facing the market are explained in detail in deliverable 1.2 of CleanHypro project.

4.2 Value Creation

CLEANHYPRO creates significant value by addressing key barriers in the development, optimization, and commercialization of electrolysis technologies for clean hydrogen production. Through a comprehensive approach, it accelerates the pathway to market for new electrolysis solutions, ensuring that clean hydrogen can emerge as a viable and scalable energy solution for decarbonization. The OITB provides value across several fronts, including technical advancements, access to state-of-the-art testing infrastructure, and fostering a dynamic innovation ecosystem.

TECHNICAL ADVANCEMENTS IN ELECTROLYSIS TECHNOLOGIES

CLEANHYPRO plays a pivotal role in advancing the technical capabilities of electrolysis technologies. It focuses on enhancing the efficiency, durability, and cost-effectiveness of a range of electrolysis technologies, including PEM, AEM, AEL and SOEC. These technologies are at the heart of the hydrogen production process, and their ability to be scaled up to industrial levels is crucial for achieving the clean hydrogen targets set for the energy transition.

By providing advanced material testing, process optimization, and real-world validation, CLEANHYPRO helps overcome critical technical challenges that limit the performance of electrolysis technologies. For example, it aids in improving the longevity and efficiency of electrolyzers, which are essential for reducing costs and increasing the competitiveness of clean hydrogen. Additionally, the project ensures that these electrolysis solutions can handle industrial-scale operations, making them ready for large-scale deployment across various sectors.

One of the project's most valuable contributions is its support in integrating renewable energy sources into the electrolysis process. As the global push for zero-emission hydrogen intensifies, CLEANHYPRO's focus on enhancing electrolysis technologies ensures that the clean hydrogen produced is fully aligned with the goals of sustainable energy. By reducing reliance on fossil fuels, CLEANHYPRO helps strengthen Europe's leadership in clean energy technologies, accelerating the energy transition toward a low-carbon future.

ACCESS TO CUTTING-EDGE R&D AND TESTING INFRASTRUCTURE

One of the core value propositions of CLEANHYPRO is its role as an OITB, offering SMEs, startups, and industry players access to state-of-the-art testing facilities and cutting-edge R&D capabilities. This access is especially critical for smaller companies, which often lack the resources to develop and test electrolysis technologies on their own. By providing testing facilities that are otherwise out of reach, CLEANHYPRO levels the playing field, enabling these companies to validate their technologies and fast-track their innovations to market.

The project provides specialized infrastructure for the testing of electrolysis technologies, ensuring that both small-scale prototypes and larger pilot-scale systems can undergo the rigorous testing needed for optimization. This infrastructure includes test rigs and laboratories that can accommodate high-pressure testing, long-term durability studies, and real-world performance validation under varying operating conditions. This is a crucial step in taking promising electrolysis technologies beyond the lab-scale stage, where many innovations stagnate due to the lack of proper validation and demonstration.

In addition to testing capabilities, CLEANHYPRO connects participants with a network of experts in material science, electrochemistry, system engineering, and manufacturing. By providing access to highly specialized technical expertise, the project ensures that companies can troubleshoot design challenges, optimize system performance, and refine their solutions. This access to a wide array of technical knowledge significantly shortens the development cycle, enabling faster time-to-market for cutting-edge technologies.

BRIDGING THE GAP BETWEEN RESEARCH AND MARKET ADOPTION

CLEANHYPRO creates value by serving as a bridge between research and market adoption. While many electrolysis technologies have demonstrated significant promise in laboratory settings, the leap from research to commercialization remains a critical barrier. CLEANHYPRO addresses this gap by providing tailored support to electrolysis manufacturers, guiding them through the process of scaling up and ensuring their solutions meet the commercial demands of the clean energy market.

The project works closely with technology developers to identify opportunities for real-world demonstration of new electrolysis systems. By helping companies conduct trials and pilot projects, CLEANHYPRO provides essential data that validates the performance of electrolysis technologies and builds the confidence of investors and stakeholders in the technologies' market potential. This practical, hands-on approach to scaling up makes it easier for innovators to showcase the benefits of their technologies and gain early-stage market traction.

FOSTERING A COLLABORATIVE INNOVATION ECOSYSTEM

CLEANHYPRO creates value not only through technical advancements and access to infrastructure but also by building and nurturing a dynamic innovation ecosystem. As an OITB, the project facilitates collaboration between a diverse range of stakeholders, including SMEs, startups, large corporations, research institutions, investors, and policy makers. This ecosystem fosters a vibrant exchange of ideas, resources, and expertise, enabling breakthroughs in electrolysis technology to reach commercial deployment more efficiently. Through its comprehensive support, CLEANHYPRO helps to expand the European hydrogen value chain, creating synergies between technology developers, end-users, and suppliers. By facilitating partnerships and collaborations, the project accelerates the commercialization of electrolysis technologies, driving the growth of the clean hydrogen sector. Furthermore, by aligning the interests of businesses, investors, and research institutions, CLEANHYPRO helps attract investment into the hydrogen economy, fuelling further innovations and market growth.

FIGURE 1 – VALUE CREATION

4.3 Value Capture

CLEANHYPRO not only creates value through the acceleration of electrolysis technologies but also effectively captures that value by facilitating the successful commercialization and widespread deployment of these technologies across various markets. The project ensures that its stakeholders ranging from technology developers to industry players, SMEs, and

investors can realize significant financial returns, growth opportunities, and a strong competitive advantage within the emerging clean hydrogen market.

MONETIZATION THROUGH TECHNOLOGY COMMERCIALIZATION

The primary mechanism through which CLEANHYPRO captures value is by facilitating the commercialization of electrolysis technologies. By addressing the critical barriers that impede the scalability and market readiness of these technologies, the project enables innovators to bring their products to market faster and with greater confidence. As electrolysis technologies move from the lab to industrial-scale applications, they become more attractive to commercial stakeholders, investors, and end-users.

For technology developers, the validation and demonstration of electrolysis systems through CLEANHYPRO's testing and piloting support directly translate into a stronger market position and the potential for revenue generation. These companies can monetize their innovations through sales contracts, partnerships, and licensing agreements with large corporations, system integrators, and other key players in the hydrogen sector. The project also helps developers identify new market opportunities and tailor their technologies to meet the specific needs of different sectors, further improving their chances of financial success.

By opening up access to advanced testing and infrastructure, CLEANHYPRO provides developers with the means to improve their technologies' performance, durability, and efficiency, making them more competitive and better suited for mass-market applications. As a result, technology developers can capture value through higher-value contracts, market differentiation, and premium pricing for their enhanced electrolysis systems.

INVESTMENT ATTRACTION AND RISK MITIGATION

Another critical aspect of value capture in CLEANHYPRO is its ability to attract investment. By facilitating real-world validation, pilot testing, and demonstration of electrolysis technologies, the project provides the proof of concept necessary to attract both public and private investments. These investments are essential for scaling up production, conducting further R&D, and commercializing the technologies on a larger scale.

For investors, CLEANHYPRO serves as a de-risking mechanism by offering access to tested technologies with a clear path to market. The validation and testing provided by the project significantly reduce the technical and commercial risks associated with new electrolysis solutions, making them more attractive investment opportunities. Additionally, the project helps investors identify high-potential companies with innovative technologies that are poised for growth in the burgeoning clean hydrogen sector.

Through the network of businesses, research institutions, and industry players that CLEANHYPRO fosters, investors gain strategic insights into the rapidly developing clean hydrogen market, enabling them to make informed investment decisions. The project's

comprehensive approach ensures that investors can capture value through returns on investment in early-stage technologies and long-term partnerships with successful technology developers.

SUSTAINABLE BUSINESS MODELS AND LONG-TERM GROWTH

Finally, value capture in CLEANHYPRO also extends to ensuring that technologies developed under the project are built to be financially sustainable. By focusing on cost-effective production, scalable systems, and long-term operational efficiency, the project ensures that its technologies are not only market-ready but also offer attractive business models for continued growth. This includes exploring performance-based contracts, licensing agreements, and partnership opportunities that provide stakeholders with long-term revenue streams and financial returns.

The project's focus on sustainability ensures that the hydrogen economy remains financially viable and robust in the face of fluctuating market conditions, providing a solid foundation for businesses to capture value both in the short and long term.

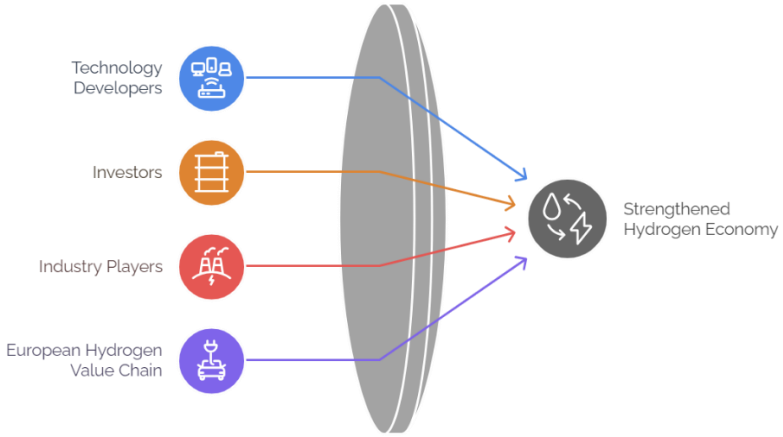

FIGURE 2 - VALUE CAPTURE

4.4 Value Proposition Canvas

4.4.1 The Canvas

CLEANHYPRO's Value Proposition Canvas illustrates how the ecosystem provided by the project meets the needs and expectations of its target customers. It addresses the key challenges (pains) in developing and scaling up electrolysis technologies and creates tangible benefits (gains) for companies and stakeholders within the green hydrogen production chain.

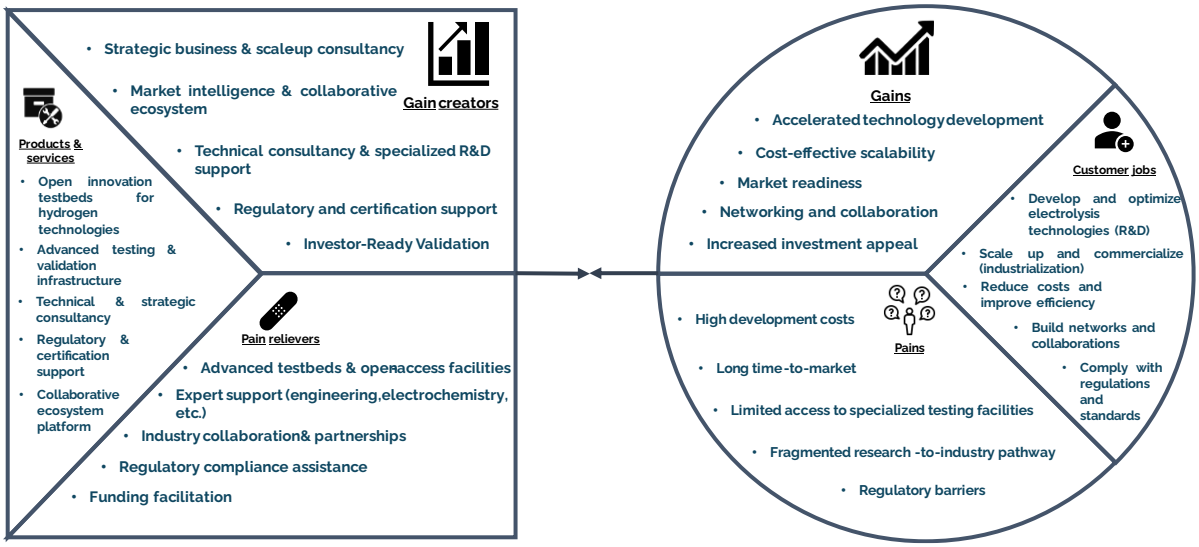

FIGURE 3 - VALUE PROPOSITION CANVAS

PAINS

- **High Development Costs**

Research, development, and testing of electrolysis technologies are expensive, compounded by limited access to funding and advanced testing infrastructure.

- **Long Time-to-Market**

Transitioning from prototype to an industrial-scale solution is lengthy and hindered by technical and regulatory obstacles.

- **Limited Access to Specialized Testing Facilities**

Many SMEs and startups struggle to access industrial-scale testbeds needed for validating and optimizing their innovations.

- **Fragmented Research-to-Industry Pathway**

A disconnect between advanced research and practical industrial application slows down the commercialization process.

- **Regulatory Barriers**

Continuously evolving regulations and standards can delay market entry and increase compliance costs.

PAIN RELIEVERS

- **Advanced Testbeds and Facilities**

By providing open-access, industrial-level testbeds and laboratories, CLEANHYPRO enables realistic validation and optimization of electrolysis technologies, reducing uncertainty and risks.

- **Expert Technical Support**

Through specialized consultancy in engineering, materials science, and electrochemistry, CLEANHYPRO guides companies in identifying critical areas and overcoming technical challenges, accelerating development.

- **Regulatory Compliance Assistance**

Support in navigating complex regulatory landscapes helps companies achieve necessary certifications and access global markets more rapidly.

- **Ecosystem Partnerships**

Building an integrated network that connects SMEs, startups, large enterprises, and research institutions, CLEANHYPRO fosters knowledge transfer, collaborative innovation, and strategic partnerships.

- **Facilitation of Funding Access**

By enhancing the technical and commercial validation of projects, CLEANHYPRO makes innovations more attractive to investors and funding bodies, helping to bridge resource gaps.

GAINS

- **Accelerated Technological Development**

Reduced R&D cycles through access to state-of-the-art testing facilities that enable rapid technology optimization.

- **Cost-Effective Scalability**

Industrial-grade infrastructures facilitate the transition from laboratory prototypes to large-scale production while minimizing overall development costs.

- **Market Readiness**

Assistance in regulatory compliance ensures that technologies meet required standards, preparing them for swift market entry.

- **Networking and Collaboration Opportunities**

The collaborative ecosystem promotes strategic partnerships and knowledge sharing, opening new business opportunities.

- **Increased Investment Appeal**

Technical validation and strategic support enhance project credibility, making them more attractive to investors and financial backers.

GAIN CREATORS

- **Strategic Business and Modelling Consultancy**

Support in developing business models and scale-up strategies to maximize commercial potential.

- **Market Intelligence and Collaborative Ecosystem**

Provision of updated market insights and access to an integrated network that stimulates collaboration among industry stakeholders.

- **Regulatory and Certification Assistance**

Specialized guidance to help companies navigate the regulatory landscape and secure necessary certifications.

- **Continuous Technical Support**

Ongoing involvement of expert partners ensures effective knowledge transfer and optimal management of the innovation process.

- **Funding Facilitation**

Establishing pathways to investment and financial support by demonstrating the technical and commercial viability of projects.

PRODUCTS & SERVICES

- **Advanced Testbeds and Open-Access Facilities**

CLEANHYPRO provides industrial-grade testing platforms where companies can validate, upscale and optimize electrolysis technologies under real-world conditions. This shared infrastructure helps reduce R&D costs and time-to-market by allowing participants to test performance at scale without needing to build their own facilities.

- **Technical & Strategic Consultancy**

Experts in engineering, materials science, electrochemistry, and business strategy support participants throughout the innovation process. This includes guidance on process

optimization, system design, and commercial positioning, ensuring that new solutions align with both technical requirements and market demands.

- **Regulatory & Certification Support**

CLEANHYPRO helps companies navigate evolving international standards and safety requirements, streamlining the path to certification. By integrating compliance considerations early in the development process, participants can accelerate market entry and avoid costly regulatory setbacks.

- **Market Intelligence & Networking**

Access to up-to-date market data, policy insights, and competitor analyses enables companies to make informed strategic decisions. Additionally, CLEANHYPRO fosters connections among SMEs, startups, large industrial players, research institutions, and investors, creating a collaborative environment where knowledge is shared, and partnerships can flourish.

- **Collaboration Platform**

A dedicated platform, both digital and physical, brings together all stakeholders to facilitate co-development, resource sharing, and the formation of strategic alliances. This collaborative approach helps accelerate innovation and encourages the adoption of green hydrogen solutions at scale.

CUSTOMER JOBS

- **Develop & Optimize Electrolysis Technologies**

Customers focus on refining processes, materials, and system designs to enhance efficiency, reliability, and overall performance in producing green hydrogen.

- **Scale Up & Commercialize**

Moving from laboratory prototypes to fully operational industrial systems is a core priority. Companies seek to mitigate technical risks, control costs, and ensure consistent product quality during this transition.

- **Reduce Costs & Improve Efficiency**

Lowering the capital and operational expenses associated with electrolysis is essential for making green hydrogen economically viable compared to conventional fossil fuels.

- **Ensure Regulatory Compliance**

Meeting international standards and safety regulations is crucial for market acceptance and securing the trust of investors, partners, and end users.

- **Engage in Strategic Networking**

Building relationships with industry peers, research bodies, and potential investors is key to unlocking new funding opportunities, sharing technical expertise, and entering new markets.

5 Operational Decisions and Fee Structure of the SEP

5.1 SEP Role and Fee Structure

SEP is the central access channel for CLEANHYPRO OITB, with STAM confirmed as the partner responsible for this role during the execution of CLEANHYPRO, while being a firm candidate for the SEP that will be created after the project has concluded. Importantly, SEP will not be established as a separate legal entity; instead, it will be created through a contractual agreement among the OITB members.

Following a series of validated meetings, the initial discussion points have been finalized and the first decisions regarding the SEP role and fee structure have been taken. A draft of the contractual agreement has already been prepared based on these decisions. This draft will undergo further review to ensure that it aligns with the internal policies of every signing partner and is free of any legal issues.

This validated approach lays a solid foundation for the SEP, ensuring operational clarity and a flexible framework for CLEANHYPRO OITB as it moves forward.

5.2 Fee Models and Role Options (Comparative Analysis)

The objective is that CLEANHYPRO OITB members who intend to be a part of the OITB after the project ends to evaluate the different alternatives and choose the alternatives to be voted in the Steering Committee.
The discussions in multiple meetings among the partners regarding the SEP fee structure and the SEP right to sign contracts with clients led to three different alternatives:

1. Option 1: Fixed flat fee
2. Option 2: Success fee with the right to sign
3. Option 3: Success fee without the right to sign

5.2.1 Fixed Flat Fee

In the Fixed Flat Fee model, the SEP would commit to making available a specific number of Full-Time Equivalents (FTEs) that have been negotiated with the OITB members. The level of effort provided by the SEP is designed to match the ambitions and requirements of the service.

FIXED FLAT FREE ADVANTAGES

1- Stable Income: This model guarantees the SEP a predictable and stable income, particularly vital during the early years when the OITB is still developing its full potential.

2- Focused Commercialization**:** With a flat fee structure, the SEP can concentrate exclusively on lead generation and commercialization activities without being burdened by the complexities of project management.

3- Enhanced Partner Engagement: By committing to a fixed fee, all partners are encouraged to actively participate in the OITB's activities, knowing that the SEP's operations are not solely contingent upon project-based success fees.

FIXED FLAT FREE CHALLENGES

1- Financial Commitment: One of the key drawbacks is that every partner is required to contribute a fixed amount annually, irrespective of the immediate returns. This could lead to reluctance among some partners if the expected benefits do not materialize.

2- Risk of Opt-Out**:** There is a possibility that some partners might choose to withdraw from the OITB once the project concludes if they perceive the fixed fee as too burdensome relative to the actual value delivered.

5.2.2 Success Fee With the Right to Sign

Under this alternative, the SEP would be endowed with the authority to negotiate and sign contracts with clients, effectively taking on the role of the main contractor. In this model, the SEP not only secures the best possible value based on the client's willingness to pay but also manages the execution of the projects by subcontracting the work to the OITB members. To support the ramp-up of activities during the initial phase, the SEP would receive a one-time flat fee (albeit lower than that of the fixed fee model) prior to the activation of the performance-based success fees.

SUCCESS FEE WITH THE RIGHT TO SIGN ADVANTAGES

1- Performance Incentives**:** Since the SEP's revenue is directly linked to the number and value of projects it secures, there is a strong incentive to maximize commercialization efforts.

2- Flexibility in Resource Management**:** This model allows the SEP to adjust its resource allocation dynamically, in line with market demands and project opportunities.

3- Risk Mitigation for Partners**:** The fact that partners are not required to pay an upfront fixed fee reduces their financial risk, potentially increasing overall participation in the OITB.

SUCCESS FEE WITH THE RIGHT TO SIGN CHALLENGES

1- Internal Policy Conflicts**:** The authority given to the SEP to sign contracts may conflict with the internal policies of some partners, raising concerns about control and accountability.

2- Uncertain Initial Returns**:** During the early phase of the project, the full potential of the OITB may not be realized, possibly resulting in lower-than-expected success fee revenues.

3- Complex Liability Definitions**:** Careful legal definition of liabilities and responsibilities is essential to avoid potential disputes related to the contractual obligations undertaken by the SEP.

5.2.3 Success Fee Without the Right to Sign

This alternative mirrors many aspects of the second option but with a critical difference: the SEP does not have the authority to sign contracts. Instead, the SEP focuses on lead generation and acts as a facilitator by connecting clients with the appropriate OITB members. The SEP's compensation in this case is purely performance-based, typically receiving a fixed percentage (for example, 10%) from the revenue generated by the partners.

SUCCESS FEE WITHOUT THE RIGHT TO SIGN ADVANTAGES

1- Avoidance of Policy Conflicts: By not signing contracts, the SEP avoids potential conflicts with the internal policies of partner organizations, ensuring smoother operational integration.

2- Performance-Based Motivation: Like Option 2, the SEP remains incentivized to drive business success since its earnings are tied to the overall project performance.

CHALLENGES

1- Reduced Partner Revenues**:** Since each partner must remit a percentage of their revenue as a success fee, their net income from projects will be reduced. This could be a deterrent for some partners if the fee significantly impacts their profitability.

2- Comparable Performance Risks**:** While avoiding contractual signing conflicts, this model still faces the risk of lower initial returns if the market does not quickly respond to the SEP's lead generation efforts.

5.2.4 Integrated Hybrid Model

The Integrated Hybrid Model has been developed to leverage the strengths of the previously analyzed alternatives while mitigating their limitations, creating a more balanced and adaptable fee structure. This approach introduces a lower fixed flat fee, making it more accessible and attractive to all OITB partners. This fee aligns with the one-time fee elements found in other options, ensuring affordability while maintaining a structured financial contribution. Additionally, the model incorporates a voluntary premium fee, allowing partners to opt into additional, resource-intensive services provided by the SEP. These services can be for example related to support the raising of funding from public and private sources etc. When combined, the base and premium fees equate to the total value proposed in the first option, ensuring financial sustainability while maintaining flexibility.

To further align incentives with performance, the Integrated Hybrid Model includes a percentage-based success fee, ensuring that SEP's earnings are directly tied to successfully completed projects. This element mirrors the approach in Option 3, reinforcing a results-driven framework that encourages project success. Furthermore, when the SEP assumes the responsibility of contract signing on behalf of the OITB, a project management fee is introduced to cover the additional oversight and administrative demands. This component, inspired by Option 2, ensures that the complexities associated with contractual obligations are adequately managed and compensated.

By integrating both fixed and variable financial elements, this model creates a structure that minimizes the initial financial burden on partners while maintaining strong incentives for commercialization and performance. The adaptability of this approach allows it to accommodate diverse partner needs and market conditions, fostering a sustainable and collaborative environment that supports the long-term success of OITB.

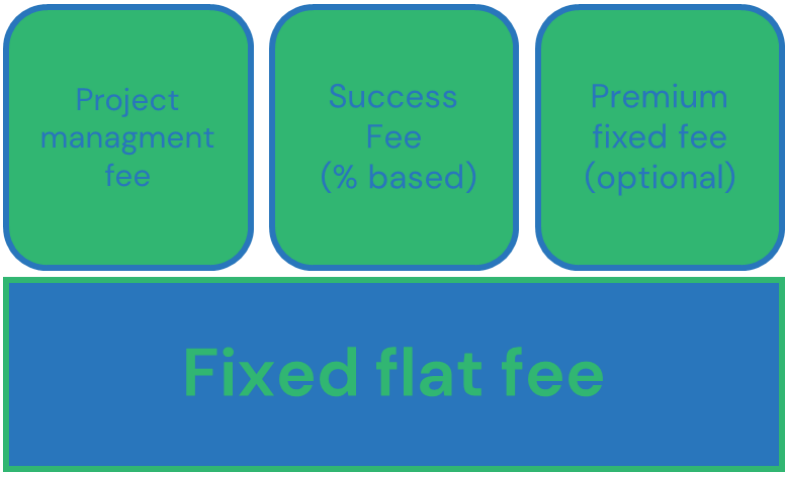

FIGURE 4 – HYBRID MODEL STRUCTURE

Each of the discussed models—Fixed Flat Fee, Success Fee with the Right to Sign, Success Fee without the Right to Sign, and the Integrated Hybrid Model—presents its own mix of benefits and challenges. The choice among them depends on the desired balance between predictable income and performance incentives, as well as on internal policy considerations of the OITB partners.

- Predictability vs. Performance**:** The Fixed Flat Fee model provides financial predictability, which is crucial in the early stages of the project. However, it requires a committed upfront investment from every partner. In contrast, the Success Fee models (with or without signing rights) align compensation with performance but may initially yield lower returns.

- Operational Control**:** Granting the SEP the right to sign contracts (Option 2) can streamline negotiations and project execution but risks clashing with some partners' internal policies. Removing this authority (Option 3) mitigates internal conflicts but shifts more responsibility onto the individual partners.

- Hybrid Approach**:** The Integrated Hybrid Model seeks to combine the stability of a fixed fee with the incentivization of performance-based rewards, while also offering additional premium services for partners who desire them. This model provides a versatile framework that could potentially meet the diverse needs of all stakeholders involved.

6 Conclusion

The definition and formalization of the SEP represent a cornerstone for the operational deployment of the CLEANHYPRO OITB and the delivery of high-impact services across the European clean hydrogen value chain. The work carried out, particularly under Task 2.1, has enabled the consolidation of a shared vision among partners, integrating multidisciplinary expertise and strategic inputs.

Through a comparative analysis of governance and remuneration models, a pragmatic and adaptable operational framework has been defined. This hybrid model—combining fixed fees, success-based mechanisms, and the SEP's ability to sign contracts—ensures economic sustainability, fairness among OITB members, and performance-based incentives, while accommodating diverse organizational and legal structures.

Functioning as a centralized access point, the SEP facilitates access to technical and business services, leverages existing infrastructures, and enables cross-sectoral technology transfer. Its role is instrumental in lowering barriers to adoption for emerging electrolysis technologies, especially for SMEs, thereby contributing to the objectives of the Clean Hydrogen Partnership and EU decarbonization strategies.

CLEANHYPRO addresses key challenges in the hydrogen sector, notably by providing shared testing infrastructures that allow validation of electrolysis technologies under industrially relevant conditions. This supports market readiness through long-term durability testing, high-pressure operations, and integration with intermittent renewables.

The project strengthens Europe's skills base and innovation capacity by fostering collaboration, knowledge transfer, and training activities. It also acts as a catalyst for strategic alliances between research institutions, technology developers, manufacturers, and end-users, accelerating time-to-market and attracting investments in hydrogen infrastructure.

By enabling the industrial deployment of efficient and competitive electrolysis technologies, CLEANHYPRO contributes directly to the EU's Fit for 55 and REPowerEU targets. Its systemic and integrated approach reinforces the European hydrogen value chain, from upstream R&D to downstream market applications, ensuring strategic autonomy and positioning Europe as a global reference point for hydrogen innovation, standards, and industrial leadership.

APPENDIX

- Deliverable 1.2 Initial analysis of potential regulatory, economic and technical barriers
- Deliverable 2.6 : Definition of SEP Governance model and CLEANHYPRO-OITB metrics