FINAL REPORT

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Project Development Assistance for Regions II – Cohesion Countries, Outermost Regions, and Islands (PDA II)

Public extract

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1 Introduction

1.1. Context

The urgent need to decarbonise all sectors of the economy has made clear the need for clean hydrogen as part of a sustainable energy system. The share of hydrogen in Europe's energy mix is expected to grow from less than 2% in 2020 to around 12% in 2050[1] and be produced from increasingly renewable sources. Renewable hydrogen offers the potential to decarbonise hard-to-treat applications in multiple sectors such as industry and transport, while unlocking increasing penetration of renewables by providing bulk, long-term energy storage.

Despite interest in hydrogen increasing both across Europe and in other regions of the world, investment in hydrogen has so far been mainly concentrated in a small number of regions (such as Western Europe, California, Korea, China, and Japan). This presents a risk of imbalanced development of the sector; whereby certain regions are 'left behind' more economically developed nations.

Therefore, the implementation of hydrogen projects in these regions is a vital component of a Just Transition; these regions often most stand to benefit from developing hydrogen as a new economic activity and will be affected most significantly by the impacts of climate change. Project initiation in new geographies offers regions the opportunity to develop knowledge and skills around hydrogen, allowing scale-up of the sector, and economic development linked to emissions reductions.

Previous experiences in western countries show that early successes in deploying hydrogen technology have been most effective at a regional and city level. This approach, often in collaboration between local governments and industrial partners, has been able to secure significant investment for fuel cell and hydrogen (FCH) projects.

However, public authorities may not have the resources or knowledge required to develop the plans fully for all aspects of hydrogen project implementation, particularly in the less experienced areas outside of Western Europe. The *Fuel Cells and Hydrogen for Green Energy in European Cities and Regions* study[2] indicated that certain regions feel they need assistance to help them move from the concept stage to implementation of hydrogen technologies.

As a result, the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU) launched the Project Development Assistance for Cities and Regions initiative (PDA I), where consultants with expertise in hydrogen project development worked alongside regions to develop the concepts for regional hydrogen projects into detailed implementation plans. This ran for a

[1] Based on analysis by the International Renewable Energy Agency (IRENA): [Global Hydrogen Trade Outlook (irena.org)]

[2] [Study on Development of Business Cases for Fuel Cells and Hydrogen Applications for European Regions and Cities (europa.eu)]

12-month period in 2020 and 2021 and supported eleven regions across Europe including four projects in EU13 countries, namely Bulgaria, Croatia, Poland, and Slovakia.[3]

In 2022, building upon these efforts, the Clean Hydrogen Partnership launched the "Project Development Assistance for Regions" (PDA for Regions II – Cohesion Countries, Outermost Regions, and Islands) to provide support in developing detailed work plans for the implementation of green hydrogen projects, for regions or cities in cohesion countries, outermost regions, and European islands. These terms are defined by the EU thus:

- **Cohesion Countries** – countries eligible for support under the Cohesion Fund, an instrument that provides support to Member States with a gross national income per capita below 90% EU-27 average. The overarching aim is *"to strengthen the economic, social and territorial cohesion of the EU"*.[4] The list of "cohesion" countries for the 2021–2027 period is: Bulgaria, Czechia, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovakia, and Slovenia.
- **Outermost regions** – "*the European Union supports the development of its most remote regions, known as the outermost regions: Guadeloupe, French Guiana, Réunion, Martinique, Mayotte and Saint-Martin (France), the Azores and Madeira (Portugal), and the Canary Islands (Spain). The purpose of this support is to compensate for the constraints arising from the geographical remoteness of these regions*".[5]
- Islands – "*Island regions are defined as NUTS level 3 regions within the European Union (EU) that are entirely composed of one or more islands. Islands are defined as territories having:*
  - *a minimum surface of 1 km²;*
  - *a minimum distance between the island and the mainland of 1 km;*
  - *a resident population of more than 50 inhabitants;*
  - *no fixed link (for example, a bridge, a tunnel, or a dyke) between the island(s) and the mainland".*[6]

1.2. Objectives

The objectives of the PDA II programme were as follows:

- Support the development of hydrogen projects in up to 15 cities / regions in

[3] Clean Hydrogen JU PDA for Regions - European Commission (europa.eu)
[4] Inforegio - Cohesion Fund (europa.eu)
[5] Outermost regions (ORs) | Fact Sheets on the European Union | European Parliament (europa.eu)
[6] Glossary:Island region - Statistics Explained (europa.eu)

cohesion countries, outermost regions, and islands.

- Provide support to a minimum of three regions in cohesion countries and regions from at least five different countries.
- Assist in shaping and advancing hydrogen fuel cell (HFC) projects to a stage where they could begin implementation from the mid-2020s by providing expert consultancy support, e.g.:
    - Support regional outreach to industry through the development of requests for information (RFI).
    - Guide the development of stakeholder groups covering the entire hydrogen value chain for supported projects and advise on the governance structure and contracting arrangements between them.
    - Support development of business cases and guide the regions towards the most plausible models for their regional projects.
    - Provide guidance to regions on suitable funding programs and assist projects in attaining a level of maturity that enables them to apply for support if needed.
    - Advise on the national policy and regulatory framework required to support the implementation of hydrogen projects, reflecting recent European policy developments and experience from regions in Western Europe.
- Create opportunities for regions to network with one another and share lessons learnt through the Observer Network.
- Promote PDA II results through an extensive network of contacts in regional and national governments, industry, hydrogen, stakeholder groups, and relevant geographic networks.

1.3. Process

The initial task of the project involved launching a call for Expression of Interest (EOI). Subsequently, the responses were reviewed following a two-stage application process spanning six months:

- **Stage 1 – "Selection Phase":** Regions in cohesion countries, outermost regions and islands were asked "short answer" questions about basic information including the location of planned deployments, as well as several "tick box" and "free text" questions on eligibility, financing, regional potential, and technical capabilities. Up to 30 regions were to be shortlisted and invited to apply for Stage 2. Unsuccessful applicants were to be invited to join the Observer Network activities.
- **Stage 2 – "Award Phase":** The shortlisted regions were asked to provide further detail on their planned deployments, including regional

context, planned project, and current status. These applications were evaluated and scored.

Following the selection phase, all successful projects received dedicated support from a team of experienced hydrogen sector consultants, offering tailored support in detailed project planning and development towards implementation, based upon the region's specific needs. The consultancies involved in delivering PDA worked collaboratively throughout the programme to share best practices and discuss approaches to common challenges. PDA II has been carried out by Spilett alongside four subcontractors (ERM, Ariema, Reform Institute and deltaH) with extensive experience managing similar projects across Europe.

2 Overview of projects and regions supported in PDA II

A total of 14 different projects from cities and regions in nine different European countries were supported under PDA II. While there was interest in applications in various sectors (industry, transport (land and marine), and heat), road transport applications, in particular buses, were the most common target end use. The projects seek to develop new hydrogen production facilities, typically electrolysers in the low megawatt / low tens of megawatts scale for the initial phases of deployment, linked to existing and / or new build renewable electricity generation assets (typically solar PV and wind turbines), as illustrated in the following figure.

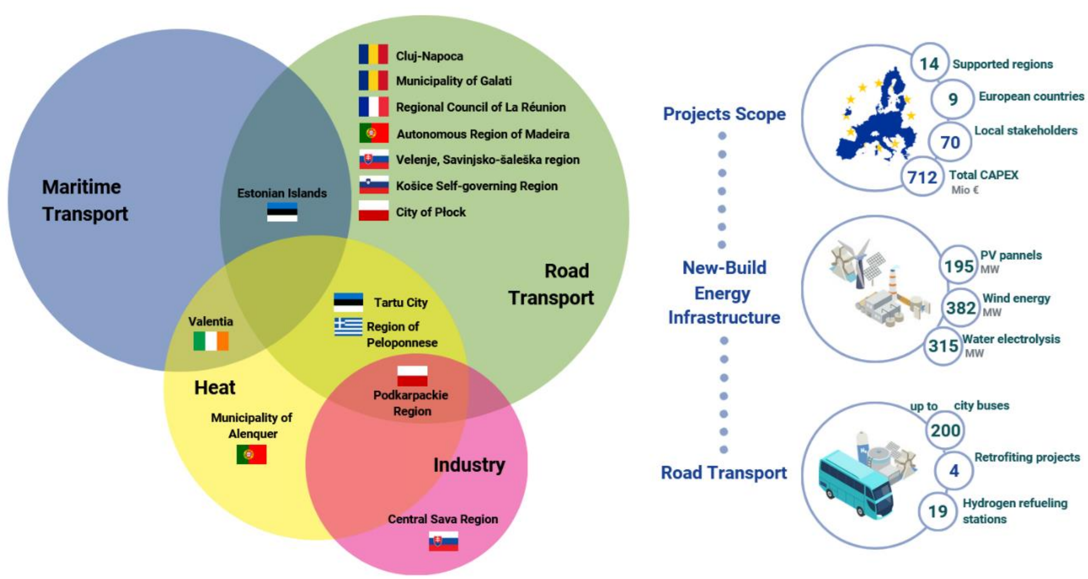


Figure 1: Overview of the regions and application areas supported under PDA II

As indicated above, most of the projects envisaged some use of hydrogen in mobility applications, and if realised, these projects will lead to the installation of new water electrolysis plants (WE) and hydrogen refuelling stations (HRS) in multiple locations across Europe as shown below.

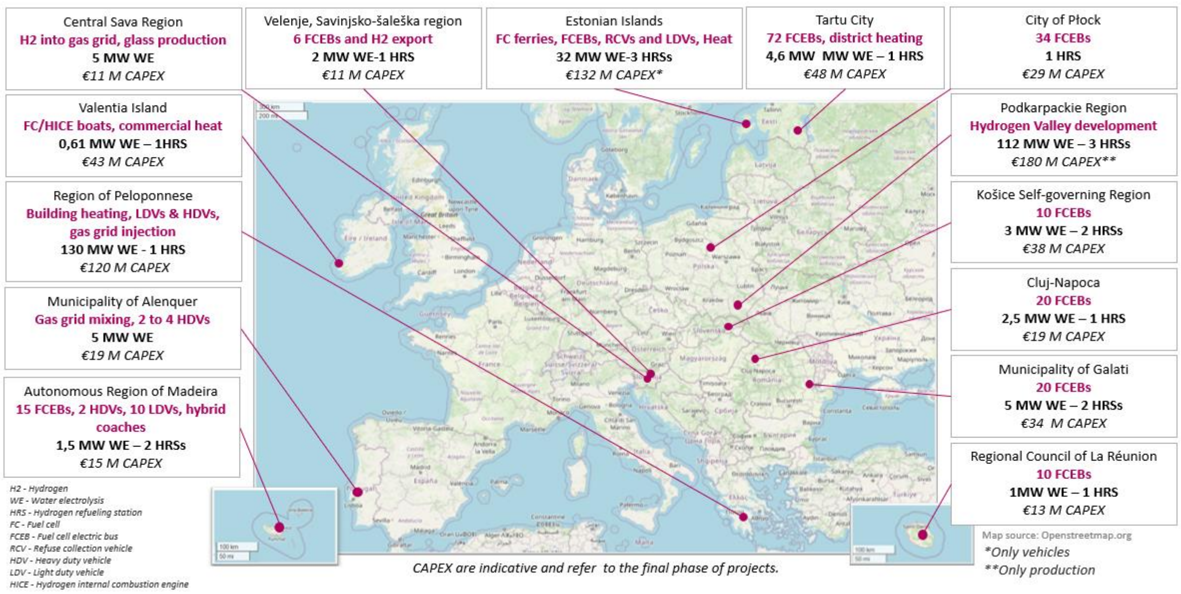
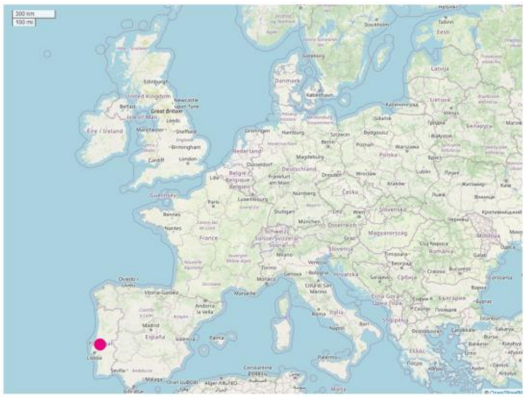


Figure 2: Map quantifying new hydrogen infrastructure capacities and CAPEX planned as part of the PDA II projects

2.1. Alenquer, Portugal



The project aims to capitalize on synergies with an existing hydrogen production initiative, implementing a pilot program to **showcase the advantages of a combined heat and power (CHP) fuel cell at Alenquer's Library.** Its overarching goal is to establish a pathway for scaling up hydrogen technologies in the region and neighbouring areas, with hydrogen availability targeted by the end of 2024.

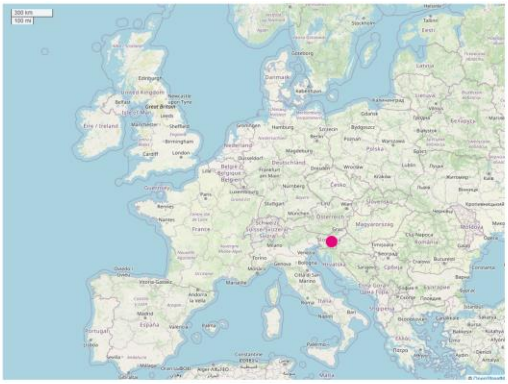
This endeavour presents several opportunities and local benefits, including accelerating the decarbonization of activities in Alenquer, raising awareness among the citizens about the benefits of sustainable practices, and positioning the region as a leader in early hydrogen technology adoption. By fostering a hydrogen economy, the project seeks to attract investment and stimulate job creation for municipal development.

However, there have been risks and challenges to project realization identified, such as the establishment of business initiatives for the development of the Hydrogen Economy (limited interaction with other projects and relevant hydrogen valley stakeholders) and securing support for the hydrogen-based solution compared to other less costly alternatives.

To mitigate these risks and advance the project, PDA II support has been instrumental. It has validated the project concept, identified technologies best suited to the needs of Alenquer's Library, and developed various options for the power generation system's dimensioning. Additionally, it has designed a storage system balancing costs and management ease, formulated a scale-up plan for the region based on local economic conditions, and calculated budgets to support the ambition of expanding the hydrogen economy.

The project's success hinges on collaboration among various partners, including the Municipality of Alenquer, which serves as the project coordinator, IrRadiare, responsible for dissemination and communication, EDP Produção, supplying hydrogen, IVECO, providing hydrogen trucks, and the Luis Simões Group, offering logistical support.

2.2. Central Sava, Slovenia



The project sets out to **transform the Steklarna Hrastnik glassworks production site** by transitioning its fuel source to a blend of hydrogen and natural gas. This ambitious endeavor will harness a total of 5MW of electrolysis from onsite and remote areas, to produce hydrogen, which will then be delivered through the existing gas network. The initiative also aims to establish a local energy market that facilitates dynamic energy trading. This market will enable households and public institutions to offer their energy surpluses, produced by photovoltaics (PV), to large energy consumers.

The benefits of this project are manifold. By decarbonizing the high-temperature heating processes essential to glass production, it significantly reduces the industry's carbon footprint. The project also promotes the development of local energy communities, which can enhance regional energy security and provide new avenues for renewable energy utilization. Additionally, it mitigates the problem of solar PV curtailment by creating a new market for renewable energy generators, ensuring that excess solar power is efficiently utilized.

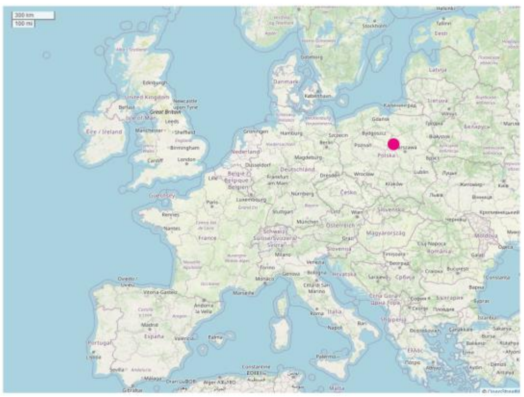
However, the project is not without its challenges. One of the primary risks is the concentration of hydrogen offtake at the glassworks, which could impact the project's viability if demand fluctuates.

Assumptions regarding customers' positive acceptance and willingness to pay a premium for green energy could be validated in a preliminary market analysis. Uncertainty about the commitment of the plant operator at the remote electrolysis site remains, potentially necessitating alternative partners for the project's success.

Support from PDA II was crucial, providing a comprehensive project concept review and cash flow modeling for the electrolysis systems. This included identifying suitable funding schemes, reviewing European hydrogen blending policies, and evaluating products for the Local Energy Community. The internal project delivery report includes details on the project's configuration, funding strategy, and risk assessment.

Key partners in this project are Steklarna Hrastnik, serving as both hydrogen producer and primary offtaker, and Plinovodi, the gas distribution network operator responsible for hydrogen blending. HSE will supply the required renewable energies and produce hydrogen, whereas the Zasavje Regional Development Agency coordinates the project and manages the local energy community. Other contributors include Offset Energy, KCSTV, Elektro Ljubljana, the National Institute of Chemistry, the Jozef Stefan Institute, and the Municipality of Hrastnik, all playing vital roles in ensuring the project's success.

2.3. City of Płock, Poland



The project entails a multi-phase deployment of fuel cell electric vehicles (FCEVs) to fulfil Poland's zero-emission public transport mandate. By the end of 2027, **36 buses are planned for deployment, followed by an additional 66 buses by the end of 2030**. Hydrogen for these vehicles will be supplied by a third party to a hydrogen refueling station (HRS) in Plock, with the municipality owning the FCEVs.

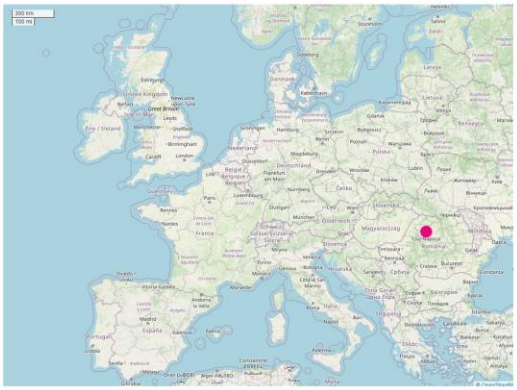
The ongoing project offers several opportunities and local benefits, including the decarbonization of the public transport fleet, thus reducing emissions and improving air quality. Procuring hydrogen from a third party initially allows the public transport company to gain experience with FCEVs before potentially investing in an onsite electrolysis system. Additionally, this procurement strategy supports local green hydrogen projects by creating demand certainty, potentially lowering hydrogen delivery costs.

However, there are significant risks to project realization. These include uncertainties surrounding public funding availability in Poland (leading to additional cost to the municipality and/or the consumer), potential performance issues with FCEVs, and the availability of the hydrogen refueling station. Such challenges may necessitate budget adjustments or alternative solutions, such as temporary reliance on decommissioned diesel vehicles.

To support the project, PDA II has provided valuable assistance, including validating the project concept, conducting techno-economic studies on hydrogen production in Plock, a cost-benefit analysis of various hydrogen supply options, and building a model to estimate FCEV purchasing and operating costs. Additionally, consultation documents were developed to engage potential hydrogen suppliers in Poland, and the impact of funding on hydrogen bus total cost of ownership was investigated.

Key project partners include the Municipality of Plock, which owns the FCEVs, the Public Transport Company responsible for operating them, and a third-party fuel supplier yet to be determined through pre-procurement consultation, tasked with delivering hydrogen and owning the HRS servicing the public transport fleet.

2.4. Cluj-Napoca, Romania



The pilot project in Cluj aims to **introduce 20 hydrogen fuel cell buses on urban routes**, forming part of a diverse zero-emission public transport fleet. Scheduled to commence operations in 2026, it includes a depot-based hydrogen refueling station equipped with a 3 MW electrolyser for on-site hydrogen production. Collaboration with the Technical University of Cluj provides opportunities for research and education on hydrogen fuel cell technologies.

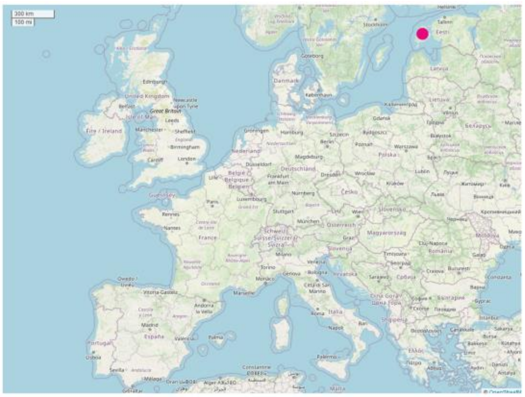
This initiative offers various opportunities and local benefits, such as developing green hydrogen production capacity for road transport in the Cluj-Napoca region, initially targeting buses but potentially extending to other transport applications. By deploying 20 hydrogen buses, it aims to accelerate hydrogen mobility activity in Romania while improving access to public transport services, particularly for high-mileage routes. Additionally, the project aims to enhance air quality, create job opportunities centred around green hydrogen technologies, and bolster Cluj's global recognition as a hub for testing new technologies.

However, there are significant risks to project realization, notably the need for a new legal framework to accommodate pressurized gases exceeding 200 bar and the requirement for substantial public funding. Despite these challenges, local partners demonstrate a high level of commitment to project delivery.

To support the project, PDA II has provided important assistance, including validating the project concept, outlining hydrogen refueling station infrastructure, exploring European and regional policy and funding opportunities, and analysing environmental and economic impacts. Furthermore, it has refined project actions and implementation plans, reviewed European high-pressure gases and hydrogen regulations, and investigated funding's impact on hydrogen bus total cost of ownership.

Key project partners include the Cluj-Napoca Municipality, responsible for project coordination and funding acquisition, the Technical University of Cluj-Napoca providing coordination support and research, CTP Cluj-Napoca as the municipality-owned bus operator, Hidroelectrica supplying electricity, and 4C offering technical design, feasibility studies, engineering, permitting, and procurement support for the hydrogen refueling station.

2.5. Estonian Islands, Estonia



The project aims to establish a **hydrogen system spanning multiple Estonian islands.** Kuressaare, located on Saaremaa Island, will host a hydrogen production site, while other sites will be established at key port locations on the Muhu, Hiiumaa, and Ruhnu islands. The project involves deploying a variety of hydrogen-fuelled vehicles, including 10 ferries, 10 school buses, 26 county buses, 11 intercity buses, 20 cars, and 7 refuse trucks, with refueling stations at production points and additional ferry refueling sites on Saaremaa. The deployment will occur in two phases, starting with Saaremaa in 2027 and expanding to other islands by 2030.

This ambitious initiative presents numerous opportunities and local benefits, such as producing over 1.000 tons of renewable hydrogen annually for various transport applications, developing refueling facilities for road transport, transitioning the public transportation system on Estonian Islands to hydrogen-fuelled options, enhancing energy independence, and fostering local hydrogen expertise through dissemination and knowledge sharing.

However, several key risks to project realization exist. Technical risks, including the availability of required electrolyser capacity, are being addressed through early engagement with suppliers.

Commercial risks stem from a significant funding gap between project production costs and transport operators' willingness to pay. Operational risks, such as the scarcity of operational or maintenance personnel, can be mitigated through knowledge sharing and training initiatives. Regulatory risks, such as permitting delays, are being addressed through early engagement with permitting bodies and a feasibility study phase to maximize public funding availability.

To support the project, PDA II has provided valuable assistance, including reviewing the project concept, identifying EU funding opportunities, preparing stakeholder engagement materials, assessing hydrogen and ferry costs, developing risk management and knowledge management plans.

Key project partners include the Saare Development Centre as the project coordinator, the Transport Agency representing ferry operators, and academic institutions like the University of Tartu and TalTech serving as knowledge sharing partners.

2.6. Galati, Romania

The project aims to produce green hydrogen to power a fleet of **20 buses in Galati municipality**, covering a daily distance of 200 km. Water will be sourced from the Danube River, while solar energy is expected to be the primary energy source. The project targets operational readiness by 2026.

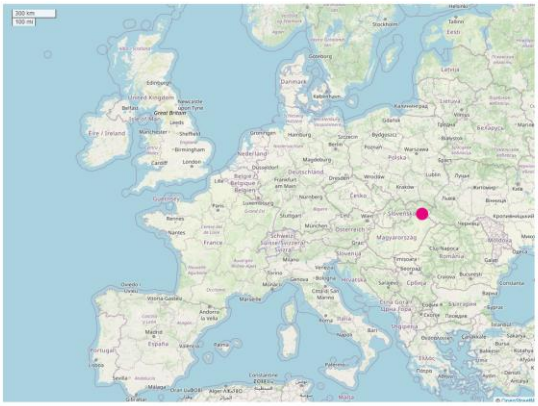
This initiative presents significant opportunities and local benefits, including the mitigation of over 2.300 tonnes of CO_2 emissions in a challenging sector, directly improving air quality in Galati. Moreover, the construction of renewable and hydrogen production plants is expected to generate direct and indirect jobs in the area, promoting technical-vocational training. Establishing a hydrogen ecosystem will enable various applications, contributing to a cleaner environment and positioning Galati as a hydrogen production benchmark in Eastern Europe.

However, several key risks to project realization exist. Potential delays in activity have been mitigated through regular project meetings and task-level coordination to ensure timely progress. The risk of insufficient equipment suppliers is mitigated by an ongoing search and considering long lead times in project planning. Safety concerns related to hydrogen functional testing are addressed through personnel training from project inception. Delays in permits are managed through active participation from the Galati municipality to update deadlines and expedite permitting processes.

PDA II support has been crucial, including the development of a pre-feasibility study evaluating three energy supply scenarios: green hydrogen production through a dedicated solar plant without grid connection, a hybrid system with grid connection, and a scenario solely relying on Power Purchase Agreements (PPA). Cost analyses of hydrogen production equipment were conducted for each scenario.

The project benefits from partnerships with several key organizations. Exe Green Holding is leading the effort to generate power, while Framatome is responsible for producing and distributing hydrogen. Additionally, the Municipality of Galati is not only managing the project but also driving communication, dissemination, and hydrogen consumption initiatives.

2.7. Košice, Slovakia



The project aims to establish a **hydrogen ecosystem in the Košice Self-governing Region** through three deployment phases:

- Phase 1 (2026): Deployment of 10 fuel cell (FC) buses, two mobile refuelers, and a 1 MW electrolysis.
- Phase 2 (2028): Scaling up to 20–40 FC buses and a 2 MW electrolysis, deploying one 1 ton/day hydrogen refueling station (HRS), and introducing a hydrogen boat.
- Phase 3: Further scaling up to 80 FC buses and a 3 MW electrolysis, with deployment of an additional 1 ton/day HRS and a refuse truck.

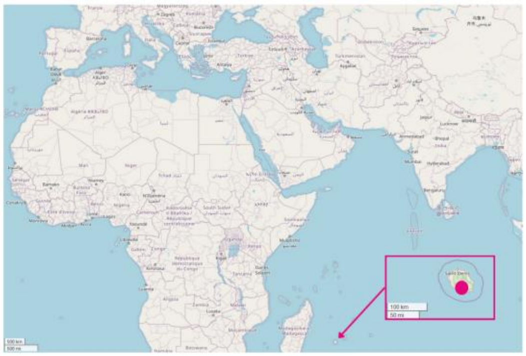
The project presents various opportunities and local benefits, including the decarbonization of transport, kick-starting the development of a hydrogen ecosystem in the region, infrastructure development in hydrogen refueling stations and electrolyses, and the enhancement of local skills in hydrogen-related operations and maintenance of equipment.

However, key risks to project realization include the need for significant funding and a scarcity of equipment suppliers with limited hydrogen activity in the region. To address this, the project has identified various funding schemes and conducted outreach to potential equipment suppliers.

PDA II support has been instrumental, refining the project concept into a phased approach to target funding schemes, providing technology overviews and Levelized Cost of Hydrogen (LCOH) analyses on electrolysis technologies, conducting bus supplier outreach, analysing potential funding routes, performing Total Cost of Ownership (TCO) analyses for bus fleet operation, assessing the Renewable Fuel of Non-Biological Origin (RFNBO) eligibility of project-produced hydrogen, and conducting technoeconomic analyses of mobile refueling configurations.

Key project partners include the Košice Self-governing Region, WH2H KSK, Autobusová doprava KSK, s.r.o., W2H2 KSK, s.r.o., the Technical University of Košice (TUKE), and Kosit.

2.8. La Réunion, France



The project aims to integrate **10 retrofitted fuel cell coaches into the existing fleets of La Réunion** and la CIVIS in two phases, with the first set of 5 vehicles deployed in 2025 and the remaining 5 in subsequent years (2026-2027). Hydrogen for these coaches will be generated using a 1 MW electrolysis connected to the grid, located at the service centre of a local fleet operator. To ensure efficient hydrogen supply, a 400 kg/day hydrogen refueling station (HRS) will be co-located with the production facility.

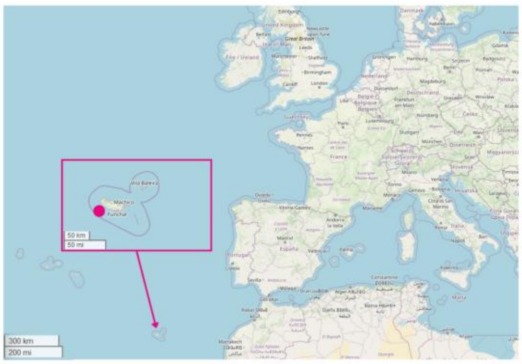
In La Réunion, an island facing energy challenges due to its remote location and heavy dependence on imported fossil fuels, hydrogen is identified as crucial for its energy transition, offering flexibility and decarbonizing potential for mobility. Given the island's mountainous terrain, fuel cell vehicles are preferred over electric battery alternatives for heavy-duty mobility. Retrofitting the coaches on the island not only benefits from local team training but also initiates hydrogen expertise development within the region.

However, key risks to project realization include fluctuating electricity prices, limited project scale affecting economic indicators and subsidy dependence, and the absence of retrofit experts in La Réunion. Initial retrofit proposals involve operations in mainland France, adding logistical complexities and costs.

PDA II support has been pivotal, offering strategic advisory on project scope, financial modelling, economic analysis, outreach to retrofit and equipment suppliers, and identification of funding opportunities.

Project partners include the General Council of La Reunion, the CIVIS (Communauté Intercommunale des Villes Solidaires), SPL Horizon La Réunion, and EDF.

2.9. Madeira, Portugal



The pilot project aims to implement renewable energy production, using wind and solar power, to produce and dispense hydrogen for a **fleet of 12 buses**. This project, set to be operational by 2026, will be executed in two phases, with hydrogen production centred in Canical. Various technology integration scenarios have been considered for different locations.

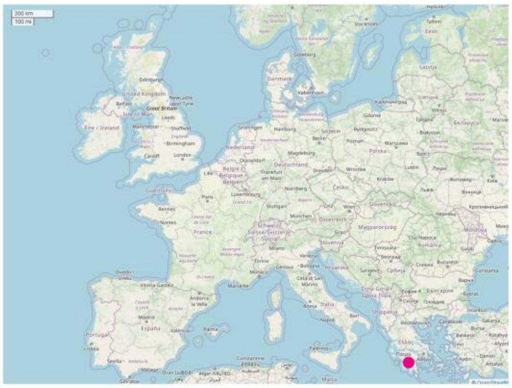
The project offers several opportunities and local benefits, including the development of infrastructure to supply an electrolysis capable of powering a bus fleet. It aims to decarbonize public transport with more efficient technology, which is particularly advantageous given Madeira's rugged terrain where fuel cell electric vehicles (FCEVs) outperform battery electric vehicles (BEVs). Additionally, the project seeks to improve public transport services and position Madeira as a model for island decarbonization through hydrogen projects.

However, key risks to project realization include the potential for insufficient renewable energy generation for hydrogen production or hydrogen production issues resulting from inadequate electrolysis performance. Madeira's challenges with energy supply and electricity system stability as an island further complicate the project.

PDA II support has been instrumental in reviewing the initial project approach, forming and organizing a project delivery group, conducting technical feasibility studies to dimension the main equipment facility, identifying potential partners, and developing a project implementation plan along with risk evaluation and a public acceptance plan. Additionally, PDA II has revised offshore wind production for more economical options, studied various locations and methods for renewable integration with production, and analysed the distribution and availability of hydrogen for the hydrogen refueling station (HRS). The project team has developed a comprehensive plan that addresses implementation details, risk management strategies, and community acceptance considerations for the multiple stage deployment of the 12 buses.

Key project partners include the Autonomous Region of Madeira as the project coordinator, Electricidade de Madeira for electricity supply, and Hórarios do Funchal for hydrogen distribution and mobility.

2.10. Peloponnese, Greece



The project aims to develop three distinct hydrogen applications—**CHP systems, mobility, and hydrogen injection into the gas grid and tourism**—integrated into the TRIERES Valley scalability strategy. Utilizing hydrogen from the EPHYRA project and REA and REAH2 infrastructure, the project is set to start operations in 2026. It will involve industrial, academic, and institutional sectors, aligning with national and European hydrogen strategies.

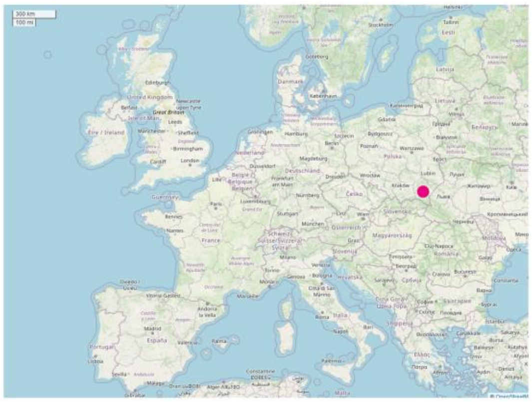
The opportunities and local benefits of the project include the planning and development of hydrogen production to decarbonize industry, deploying hydrogen vehicles for public mobility, and reducing air pollution by replacing natural gas with renewable hydrogen in CHP systems for public buildings. The project also aims to create a decarbonization concept for tourism, identifying potential consumers for a more sustainable sector, and fostering local knowledge and job creation.

However, the project faces key risks, including its dependency on other projects for hydrogen supply to various end-uses and uncertainties within the hydrogen sector that could impact equipment prices and delivery times.

PDA II has provided crucial support by reviewing and providing feedback on the project idea, forming and organizing the project delivery group, and analysing the potential for hydrogen production beyond the initial concept. It has also contributed to the development of the Zero Emission Tourism concept using CHP systems and FCEV mobility, explored project planning, risks, and the policy landscape, conducted a sensitivity study for additional hydrogen production in Megalopolis, sized equipment for CHP systems at headquarters, and calculated regional vehicle fleet replacement, gas quality for blending in the network, and preliminary sizing of tourism applications. Additionally, PDA II has developed project planning, budget, and identified interdependencies.

Key project partners include the Peloponnese region as the project coordinator, Watermelon Consulting as the project coordination supporter and reference consultant, Motor Oil Hellas and Hellenic Hydrogen for hydrogen production and dispensing, DESFA as the gas system operator responsible for hydrogen injection into the natural gas grid, NCSR Demokritos as a public research organization specializing in engineering and safety, FORTH/ICE-HT as a public research organization specializing in training, and the University of Patras for R&D.

2.11. Podkarpackie, Poland



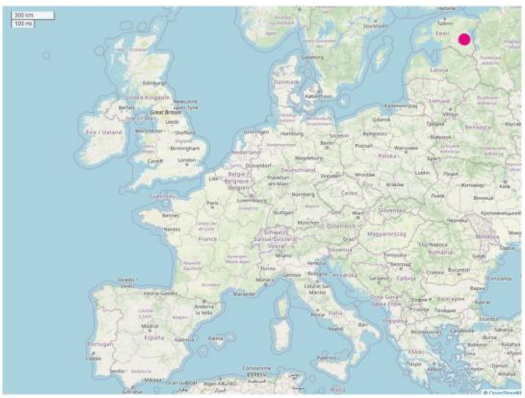
The project aims to initiate a **hydrogen valley** for decarbonizing regional ETS industry and transport while demonstrating hydrogen for electricity and heat supply in 3 local CHP plants with a total hourly demand of 1,1 t H2. It involves quantifying the potential regional hydrogen demand until 2035 and identifying the cost-optimum infrastructure setup along the value chain.

Opportunities and local benefits include an initial potential hydrogen use of over 14,000 tons per year. Hydrogen production from local resources may be economically viable. The local industry has experience with clusters, such as Aviation Valley, and a spatial distribution favourable to the setup of a hydrogen pipeline. The local cross-border tourism market with Ukraine and Slovakia has yet to develop clean mobility solutions, which could enhance the region's reputation and tourist experience. Local benefits also include the development of synergies between private and public sectors, increased energy independence, and securing a leadership position in the hydrogen economy in Central Europe. Key risks to project realization include limited popularity of knowledge of hydrogen technology among potential end users, an expected lack of bidders in procurement processes, and regulations not yet ready for hydrogen. As there are many manufacturers and researchers of hydrogen technologies in the region with own production of e.g. electrolysis, hydrogen buses and research and development equipment, one of the main challenges is the popularization of these technologies among local consumers. To maximize the chances of project implementation, the Hydrogen Valley will inform on technologies and legislative contexts, facilitate local networking, pool demand, match supply, and assist in project development, procurement processes, risk management, and financing.

PDA II has provided extensive support by offering an overview of the regional, national, and European regulatory environments and identifying relevant funding opportunities. They conducted a pre-study of potential hydrogen demand on a regional scale and quantified the potential for hydrogen production. PDA II further developed six regional use cases for green hydrogen and outlined the next steps toward projects. They also performed a risk analysis and management plan and further developed the Hydrogen Valley's management strategy.

Project partners include the Marshall Office of Podkarpackie Region, Subcarpathian Hydrogen Valley, Rzeszow University of Technology, Polenergia Elektrociepłownia Nowa Sarzyna Sp. z o.o., and Huta Stalowa Wola S.A. Oddział Autosan w Sanoku. These partners will work together to overcome challenges and successfully implement the hydrogen valley strategy by leveraging their collective expertise and resources.

2.12. Tartu City, Estonia



In 2029, Tartu is considering to **replace their public transport bus fleet to 100 % hydrogen powered buses.** A total of 72 hydrogen-powered fuel cell buses could be operated from one inner-city bus depot and fuelled with green hydrogen from regional production sites.

This ambitious project will unfold in two phases, beginning with a trial phase in 2024/25 involving up to three buses to test the technology and gather operational insights.

Additionally, the project includes a demonstration of a small local hydrogen district heating solution (off-grid) and the establishment of a Hydrogen Energy Community to enable broad social participation in the development and ramp-up of the hydrogen economy at an early stage.

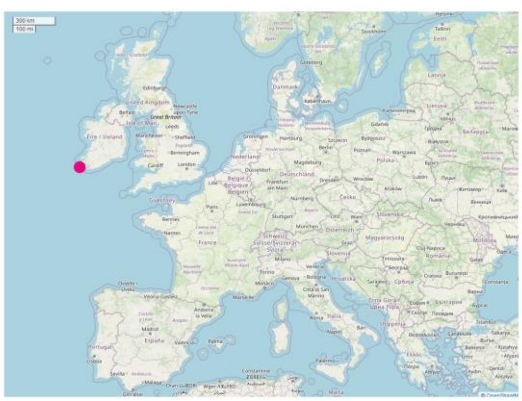
The project presents multiple opportunities and local benefits. Economically viable hydrogen production could be proven to be feasible, with the bus fleet serving as anchor customer. The initiative will contribute significantly to the decarbonization of public transport and showcase off-grid domestic heating in the regional energy economy.

However, the project also faces several risks. There is a possibility of insufficient political support for transitioning to a fully hydrogen-powered bus fleet. Additionally, the market readiness of hydrogen technology in Estonia is still unproven, and restrictions on local wind energy installations due to environmental protection zones might jeopardize the economic feasibility of the project.

The PDA II support included developing arguments in favour of hydrogen bus operations for political stakeholders, analysing the potential for hydrogen production from regional resources, and identifying cost-effective infrastructure setups. Additionally, a comprehensive project plan for the period 2024–2029 was developed to maximize support and minimize risks for the hydrogen bus project. Alternative owner- and operatorship models were presented and discussed to identify a suitable partnership model for the implementation of the project.

Several regional partners are involved in this project. The City of Tartu is responsible for shaping the public transport strategy, procuring hydrogen buses and infrastructure, and planning future public transport operator (PTO) services. AS Alexela will supply the hydrogen and provide a mobile fuelling station for the bus trial phase. Eesti Energia AS is tasked with developing renewable energy sources for hydrogen production, while Estiko Energia operates photovoltaic (PV) plants and plans a large PV field dedicated to hydrogen production. The Estonian Association of Hydrogen Technologies will coordinate the development of hydrogen technologies both nationally and internationally. AS Go Bus will operate the hydrogen buses and offer practical feedback from their use. The Tartu Regional Energy Agency will advocate for energy efficiency and contribute to the H_2 Energy Community. The University of Tartu will lead hydrogen technology research and support community education initiatives.

2.13. Valentia, Ireland



The project aims to address challenges posed by Valentia's remote location by **developing an industrial offtaker, primarily a data centre, off the island where grid capacity is available**. This setup will facilitate the offtake of local end uses, including **two passenger boats and a hotel**.

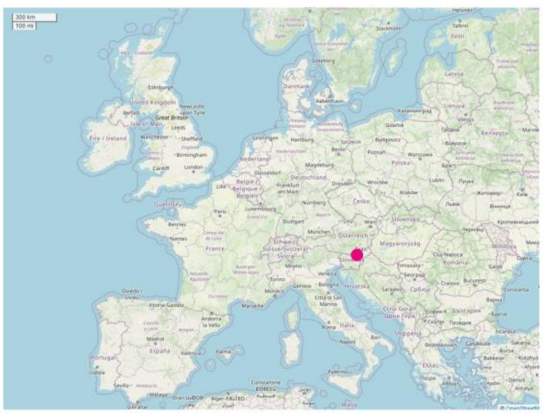
H_2ORIZON is positioned as an early mover for the Valentia region, aiming to catalyse hydrogen activities and bring economic benefits, jobs, and regeneration to the local community. Specifically, it aims to support the development of a green tourism industry on the island. The project also seeks to demonstrate a model where a large industrial offtaker enables smaller local hydrogen offtakers to develop, potentially transplanting the model to other remote regions in Europe to stimulate development and enhance energy security.

However, there are key risks to project realization, such as the challenge of finding an industrial partner willing to develop electrolyser and hydrogen distribution as part of the project. Further work is needed to bring in such a partner. Additionally, the data centre, which is intended to be part of the hydrogen demand, is not yet in place, requiring further efforts to bring in a partner for its development.

The PDA II support involved a comprehensive stakeholder analysis, assessing end uses through literature review and interviews with end users. A Levelized Cost of Hydrogen (LCOH) analysis identified project's scope and potential cost reduction routes. The cost comparison analysis, evaluating the current fuel use in local applications versus hydrogen conversion, was complemented by exploration of likely funding routes. For a better understanding of potential and acceptance from the demand side, the use of hydrogen fuel cells for ‘peak shaving’ in the data centre was developed, and technology availability for the different applications assessed.

Project partners include the Valentia Energy Island Cooperative, industrial stakeholders responsible for electrolyser and mobile refueller (though further project development is required to bring them in), data centre stakeholders responsible for its development (also needing further project development), and local stakeholders responsible for operating hydrogen boats and the hotel (similarly requiring further project development to engage fully).

2.14. Velenje, Slovenia



The project aims to deploy and demonstrate **six hydrogen fuel cell buses on urban bus routes** in and around Velenje. It includes a depot-based hydrogen refueling station with on-site production via a 2 MW electrolyser, with operations slated to begin in 2026. Key partners include KSSENA, representing the Velenje municipality, and HSE, which coordinates the North Adriatic Hydrogen Valley (NAHV) and owns the Šoštanj thermopower plant where the electrolyser will be sited.

Opportunities and local benefits include improvement of public transport services and local air quality, through decarbonising the local bus fleet as a local offtake for the hydrogen in the project's initial phase whilst maintaining low ticket prices for the public by continuing the local government funded subsidies for public transport. The scalability of the hydrogen production by factor 10 using electricity from floating PV on the Družmirsko jezero lake allows for initiating further decarbonization of local emission sources or can be used to support activities in the North Adriatic Hydrogen Valley in Slovenia. It is expected that the expansion plans will bring skilled jobs to the area in addition to an innovative hydrogen project.

However, key risks to project realization include securing sufficient funding for economic viability and regulatory uncertainties surrounding hydrogen refueling station (HRS) governance and safety.

PDA II support provided includes validation of the project concept, drafting and distribution of a Request for Information from bus suppliers, review of EU and regional policy and funding opportunities, overview of HRS infrastructure, investigation of funding impact on total cost of ownership of hydrogen buses, analysis of environmental and economic impacts, and refinement of project actions and implementation plan.

Project partners include the Velenje and Šoštanj Municipalities as investors and beneficiaries, KSSENA for project coordination and research& development, HSE for project development and hydrogen production, and Nomago as the local bus operator.

3 Observer network activities

3.1. Introduction on the Observer Network

In addition to providing direct support to regions, the PDA II programme also aimed to provide support on general topics which were broadly applicable to all regions through Observer Network activities. These were composed of a series of online seminars presented both by external speakers and by the PDA consultancy team, and written deliverables providing information on European hydrogen policy and regulations and providing a step-by-step set of actions required to develop a hydrogen project (glidepath document).

3.2. Online seminars

Seminar 1: Industry pitch - Green and clean H_2 production (27.06.2023, 10-12 CEST)
Hydrogen can be produced using various methods: electrolysis, gasification of biomass, and natural gas reforming. The EU defines green/renewable hydrogen as hydrogen produced through the electrolysis of water powered by electricity from renewable sources, through the reforming of biogas or biochemical conversion of biomass. Possible suppliers for renewable hydrogen presented the technology they have available, and how regions may engage with them should they be interested in purchasing this equipment.

Seminar 2: Islands Knowledge Sharing (04.07.2023, 11-12:30 CEST)
An online seminar focused on the projects being developed on islands was held in July 2023. Representatives from various island hydrogen projects were invited to present an overview of their projects, challenges faced, lessons learnt, and advice for follower projects. Members of the PDA II projects benefitted from the experience and insights provided from representatives of several Clean Hydrogen JU-funded projects.

Seminar 3: Overview on European policies and regulations related to hydrogen technologies (18.07.2023, 10-12 CEST)
EU Policy can support green hydrogen project deployment by decreasing the price of green hydrogen through subsidies as well as developing a market for green hydrogen technologies. Additionally, it can prevent the use of carbon-intensive alternatives by raising the price through tax systems or implementing a mandatory reduction of carbon intensive technologies. This seminar presented the EU policies in place to support the production, transportation, and refuelling of hydrogen as well as hydrogen use in mobility and industry, and how regions can leverage EU policy to benefit the business case for their projects.

Seminar 4: Industry pitch - Hydrogen Refuelling Technologies and Vehicles (12.09.2023, 10-12 CEST)
Vehicles can utilize gaseous (350 and 700 bar) and liquid hydrogen refuelling, and this hydrogen can be produced on-site or off-site. Currently, the existing HRS in Europe are of low capacity and utilise early technologies. According to the Alternative Fuels Infrastructure Regulation (AFIR), the next phase of HRS deployment should target

HRS with high capacity, reliability, and filling speed. Around 660 HRS will be required across Europe to fulfil the AFIR requirements of 2030. Representatives from three companies shared lessons learned and presented their product offering to regions and explained how regions may engage with them.

Seminar 5: Best practises in project design & development (17.10.2023, 10-12 CEST)
The PDA glidepath is divided into initial, development, and final stages representing increasing levels of project maturity and provides a step-by-step guide to develop a hydrogen project from initial ideas to a clearly defined project proposal. Components of a successful project can be categorised into documentation, technical scoping, stakeholders, procurement, permitting, siting, funding and financing. This seminar presented an overview of the PDA glidepath, with a full document made available to regions at the end of the project.

Seminar 6: Procurement and operatorship models (27.11.2023, 10-12 CET)
Five different solutions to procurement within hydrogen projects were presented, each with their respective advantages and disadvantages. These solutions consist of public tender for a whole solution, public tender for components, retrofitting, partnership models and aggregating demand. The consultancy team also presented best practices for the operation of hydrogen infrastructure, including on how to minimise downtime during operation and maintenance.

Seminar 7: Funding best practice (12.12.2023, 10-12 CET)
Projects will benefit from access to national and European grants to fund their projects, however the bidding process can be highly competitive with only the most mature and innovative projects receiving funding. This seminar sought to inform regions on how they can develop their project and write funding bids to maximise their chances of success. Several members of the consultancy team presented best practice, and a mock case study on a hydrogen bus project in Montenegro was presented. Regions and consultants were asked to feedback on the merits of different aspects of the presentation, as well as where the funding applicant could've improved the application.

Seminar 8: Funding and financing strategies (13.02.2024, 10-12 CET)
Once a budget for a hydrogen project has been established, regions will need to secure capital financing and potentially grants to enable investment and a viable business case. To do so, regions will need to approach institutions with relevant funding calls and/or the remit to finance such projects. Several of the institutions responsible for funding and financing hydrogen projects presented their offering and recommendations for how regions should approach them, including: *the Clean Hydrogen Partnership, CEF-AFIF, the Innovation Fund, and the EIB ELENA facility.*

3.4. Publications

EU Policy Support for Hydrogen

Currently, green hydrogen fuels are not yest cost-competitive with more emissions-intensive technologies. The European Union can support the adoption of green hydrogen technologies through the development of policies to limit the use of fossil fuel alternatives and to ease the use of green hydrogen. This paper summarised the current EU policies seeking to unlock renewable hydrogen production and end use. The policies to limit fossil alternatives can consist of the Energy Taxation Directive (ETD), the Emission Trading System (ETS), the Carbon Border Adjustment Mechanism (CBAM) and the Clean Vehicles Directive (CVD). Alternatively, the policies to ease the use of green hydrogen are the Alternative Fuels Infrastructure Regulation (AFIR), the Eurovignette Directive, and the Renewable Energy Directive (RED) II/III. Recommendations were set out in the paper for how regions can take advantage of these policy measures to unlock the business case for their projects. The paper was submitted to the Clean Hydrogen Partnership by the end of the PDA II project for publishing.

EU Regulations for hydrogen projects

Projects involving hydrogen production, transportation, refuelling and mobility must be developed according to regulations and standards to ensure safety-by-design. The projects and regulations may be new to relevant national and regional regulatory bodies, and early engagement is needed to minimise delays when the projects are ready to be submitted for permitting. This paper seeks to summarise all European regulations that should be taken into consideration when developing hydrogen projects, and signpost relevant national bodies that project teams will need to engage with in addition to local emergency services to support understanding of hydrogen incidents. The paper was submitted to the Clean Hydrogen Partnership for publishing.

Glidepath for hydrogen project development

The glidepath is a guiding framework divided into initial, development and final stages representing increasing levels of maturity and provides a structured approach for the development of a low-carbon hydrogen project. The document provides a checklist of activities to be completed by the project team before moving onto the next level of maturity, which aims to provide assurance that no aspect of the project has be missed (potentially causing delays when working towards implementation). These activities are broken down into the categories of Documentation, Technical Scoping, Stakeholders, Procurement, Permitting, Siting, Funding, and Financing. The project deliverables once the glidepath are complete are: a market feasibility study, letters of intent from stakeholders, technical feasibility study, operational plan, procurement strategy, and a financial feasibility study. Once the glidepath is complete, the project is ready to move to an implementation phase. The paper was submitted to the Clean Hydrogen Partnership by the end of the PDA II project for publishing.

4 Challenges and lessons learnt through the delivery of PDA II support

4.1. Introduction

As mentioned above, this round of Project Development Assistance is the second such programme funded by the Clean Hydrogen Partnership. As in the first round of PDA, the consultancy teams have taken the opportunity to reflect on and record common challenges faced in the different projects supported and lessons relevant to the design of any future PDA. These challenges and lessons learnt are grouped into the following categories:

- **Selection of regions for PDA** – addresses factors to be considered in selecting projects / regions to be offered project development assistance and degree of focus of PDA resources to maximise impact.
- **Structure and delivery of PDA** – considers questions relating to the composition of consultancy teams and recommendations for developing good working relationships with the local project teams.
- **Common challenges in developing hydrogen energy projects** – captures some of the challenges faced in multiple projects and discusses potential solutions.

4.2. Selection of regions for PDA and scope of support

Design of the selection process

Regions were invited to apply for PDA via a two-stage process: the first involved submitting an expression of interest (EOI) and this was followed by eligible regions being asked to submit full applications ("Stage 2").

The design of the selection process built on lessons from the first round of PDA and was successful overall. However, the level of detail and quality of the responses was very mixed, especially in the first stage. Additional guidance to the applicants was provided to increase the chances of higher quality Stage 2 applications. For any future rounds of PDA, a staged approach is recommended with a quick-to-complete EOI initially followed by requests for more detailed information on the proposed projects. This type of approach is used by other institutions offering project development assistance, for example the ELENA (European Local ENergy Assistance) programme run by the European Investment Bank and European Commission.[7]

Carefully consider eligibility criteria

This round of PDA was deliberately focused on projects in outermost regions, islands, and cohesion countries. These are areas which have seen lower levels of activity in terms of hydrogen energy project development (compared to western /

[7] ELENA – European Local ENergy Assistance (eib.org).

northern Europe) and bring specific challenges when it comes to developing and executing projects of this type. By focusing PDA support in this way, the Clean Hydrogen Partnership sought to support and accelerate the development of projects in areas that have historically been under-represented in its funded demonstration programmes. It is important to bear in mind that this decision brings a higher risk of projects failing to proceed to the delivery phase (due to issues such as remoteness, lack of scale, restricted pool of technology and service providers, etc.).

Focus of PDA resources

There are several aspects to the question of how PDA resources should be focused. One relates to defining which types of projects / entities are eligible for support. As noted above, this round of PDA exclusively focused on cohesion countries, outermost regions, and islands. Furthermore, as with the first round of PDA supported by the Clean Hydrogen Partnership, the beneficiaries of the assistance needed to be public sector bodies such as city councils. PDA has its origins in the "Cities and Regions" initiative, which began in the early to mid-part of the previous decade and was based on the observation that many of the leading hydrogen energy projects at the time were driven in large part by a commitment from public sector bodies. There have been significant developments in the policy and regulatory landscape since then, and most of the largest hydrogen energy projects in Europe are now being developed and delivered by private sector organisations. In the context of a sector which needs to achieve scale to succeed, and which needs to progress through a development phase (during which there are likely to be constraints in terms of capacities of suppliers to deliver and support products in service), careful consideration needs to be given to the role of different types of actors and how to maximise the impact of investments in project development assistance.

4.3. Structure and delivery of PDA

Consultancy team composition

The inclusion of the Poland-based Reform Institute in the consultancy teams for the Polish regions was highly beneficial. We found that the local project teams were more inclined to discuss a wide range of aspects of the projects with a more "local" organisation and the ability to communicate in the local language was also an advantage. In contrast, in some other regions there appeared to be a reluctance to engage with external consultants from some members of the local teams. While it is unlikely that all the required expertise to support hydrogen project development will reside in local consultants, mixed teams of international consultancies and more local partners are recommended.

Building a good working relationship between the consultants and local project partners

As with any project, developing open, trusting relationships between the individuals involved is critical to success. Starting the PDA with an in-person meeting between the consultants and the local team is recommended. This did not happen in all regions, and in some cases site visits took place mid-way through or later in the year-long period of support. Visiting the regions is beneficial in multiple ways: it allows individuals to meet each other in person and develop closer relationships, the consultants gain a fuller understanding of the local context, drivers for the project and constraints, etc. For future rounds of PDA, we would recommend budgeting for at least one (possibly more) in-person meeting with each region.

Committed local team with good leadership

While the consultants can provide advice and undertake specific pieces of analysis to support the development of projects, ownership of the project must lie with the local delivery teams. This was communicated clearly to all regions at the outset, along with the need for identified points of contact to lead the engagement with the consultancy teams. The role of the consultants was to help the regions mature their projects and steer the developments towards concepts with the best chance of being implemented, and to do this effective engagement with the local teams was essential.

Timing of PDA support

As indicated above, project development assistance was provided to regions between February 2023 and January 2024. The timing worked well despite a slow down during summer break, which was used by the consultancies to evaluate concepts and findings. This approach built on lessons from the first round which started in summer, resulting in a late project kick-off in many of the regions due to a lack of stakeholder availabilities. Furthermore, the conclusion of PDA II coincided with the launch of the Clean Hydrogen Partnership's 2024 Call, which meant that the regions had the opportunity to apply for funding to support the delivery of their projects (e.g. the Hydrogen Valleys topics). The 12-month-period of project development support seems to be appropriate, although some regions may have progressed faster if required. On the other hand, accelerating the process in Fall 2023 in some of the regions resulted in a reduced participation of meetings. To maximize participation and attentiveness of the regional stakeholders, their individual pace needs to be considered, as well as competing events and activities (e.g. election, other projects, political decision making…). It is important to align the project duration to the individual needs of the regions, to keep involvement high.

Establishing regular engagement with local teams

In some of the regions, the consultants struggled to establish regular engagement with local teams, with instances where communication lapses persisted for extended periods. To ensure that this will not occur in future rounds of PDA, monthly meetings with a project representative to review the latest updates from both the consultant and the project sides could be made a condition of support in addition to regular meetings with the regional project teams. Moreover, accounting for the slow response from the local teams, future teams should initiate request for information to key project partners early, allowing them ample time to prepare the necessary information.

4.4. Common challenges in developing hydrogen energy projects

Hydrogen demands

Clearly, identifying suitable demands for renewable hydrogen is a central element of any hydrogen energy project. It is important to remember that hydrogen is not a panacea, i.e. it is not an appropriate fuel for all applications and needs to be considered in the context of the full range of decarbonisation solutions. With the significant growth in interest in hydrogen and "hydrogen economies" over recent years, there is a risk of hydrogen being viewed as a silver bullet and being proposed for applications for which alternative low carbon / renewable solutions are better suited. For a viable hydrogen energy project, securing sufficient demands for renewable hydrogen in appropriate applications is critical. There are several considerations: scale and certainty of demand, profile of demand (i.e. variations by day / month / year), location of demand(s) relative to production sites, purity and pressure requirements, scope for growth in demands, and value of hydrogen / willingness of customers to pay. Note that this is not intended as an exhaustive list. One of the challenges encountered by several of the projects supported in this round of PDA was identifying and securing demands for hydrogen at sufficient scale (and which met the various other criteria listed) to allow a viable project to be developed. Based on projects that have achieved financial close / been implemented, project developers are advised to focus on reliable "anchor" demands for hydrogen, rather than seeking to develop a wide range of potential applications in which the case and demand for hydrogen is less clear.

Challenging economic case

In some of the sites there was considerable enthusiasm from stakeholders, including potential end users of HFC technologies, but without a full appreciation of the likely cost premium relative to incumbent technologies. Some potential hydrogen customers expressed a willingness to switch to hydrogen fuel but only if cost parity with fossil fuels could be attained – i.e. in some cases there was a low willingness to pay for renewable solutions. Achieving parity with fossil fuels whilst having an investable business case for the hydrogen producer(s) remains very challenging in most locations and applications. It is therefore important to manage stakeholders' expectations regarding the role of hydrogen technologies in the energy transition and the cost premiums involved with becoming early adopters.

Public procurement processes

PDA support was targeted at public sector bodies and where these organisations are central to the delivery of projects, public procurement processes must be followed. The need to comply with public procurement law can make the process of engaging with potential suppliers to collect information to inform the development of the project more difficult / complex relative to projects led by private sector organisations. A learning is to either implement collaborative projects including suppliers as a project partner, or to realize a pre-procurement process to request information from potential suppliers. The engagement of suppliers as project partners may be a challenge in remote regions or small-scale projects, as market demand for HFC technologies is high and thus willingness to engage as a project partner on own cost rather low.

Grid capacity constraints

A challenge with developing electrolyser-based hydrogen projects in remote areas, especially on islands, relates to grid capacity issues. These areas are likely to have relatively limited electricity grid capacity which can be a major barrier to installation of electrolysers. While electrolysers are sometimes seen as a way of creating additional demand for electricity in areas with high renewable resources (e.g. wind / solar), the business case for “islanded” systems (i.e. those that do not rely on any grid connection) remains very challenging due to the high investment needed and limitations on the load factor that can be achieved when only using intermittent renewable generation. Examples exist of where these challenges have been overcome (e.g. the Scottish islands of Orkney), but operating hours of the electrolysis of ~4.000 h/ year need to be achieved to result in acceptable business cases. In case of significant grid capacity constraints, it may be useful to develop and operate hybrid systems, including a biomass-based production unit (either CHP for electricity supply or pyrolysis for hydrogen and syngas production).

Remote locations

A common issue facing some of the projects supported in this round of PDA is their remote locations (especially the outermost regions and islands, which by definition are remote from major population centres and areas where most suppliers of products and services are based). This can lead to challenges in terms of identifying companies willing to supply and provide on-going support to the technologies needed to implement hydrogen energy projects. There is often also a higher cost relative to projects in more “central” locations – costs of shipping materials, travel for support staff, etc. tend to be higher for remote regions which makes the economic case more challenging. On the other hand, the tight-knit communities found in some remote regions (e.g. on islands) can be a strength in terms of garnering local support for projects.

Competition with larger projects

In the context of national and international targets to deploy tens of gigawatt of electrolysers in the coming decade, there is increasing focus on large-scale renewable hydrogen projects (tens / hundreds of megawatts and above). The projects developed by stakeholders in PDA tend to be at smaller scales, which can lead to difficulties when it comes to securing supplies of electrolysers and other technologies required. There is also a potential issue (at least in the short term) related to a limited pool of suitably qualified and experienced people to design, install, commission, and maintain / service hydrogen technologies. Projects being developed by regions in PDA II may find themselves in competition with others which the wider hydrogen industry may regard as more attractive. This could have a negative impact in terms of choice of suppliers and / or prices for equipment and services.

Developing regulatory support for first deployments

For some of the regions supported, the projects will be the first deployment of hydrogen technology in the country. This leads to an additional need for the development of national policy and regulatory support to enable the project. This was particularly clear for the project in one of the PDA II regions, which intends to produce green hydrogen for mobility applications but lacked awareness of the various legal frameworks associated with deploying a hydrogen project (for production, transport, and storage). The consultancy team supported this region by preparing an overview of the regulations of high-pressure gases and hydrogen in the UK and the EU as a reference point. Furthermore, consultancies should try to help projects engage with regulators to remove regulatory barriers for the deployment of hydrogen technologies. This is particularly relevant for permitting for hydrogen infrastructure. Early engagement is highly encouraged to inform regulators of plans and identify barriers ahead of time.

5. Survey results

Deviating from the original plan to implement surveys targeting the PDA II supported regions at three different times during the project to evaluate progress and performance of the support, it was agreed that three different target groups were to be approached by the end of the project to evaluate the suitability of the PDA format to develop regional projects and assess the need for other and / or different support mechanisms. A total of three surveys were thus designed by the project team according to the agreed upon guidelines and reviewed by the Clean Hydrogen Partnership in January 2024. The surveys were deployed and shared to PDA II supported regions, the project environment in PDA II supported regions, and PDA I supported regions.

The PDA II Regions Survey was directed at all the regions that received support in PDA II. The objective of this survey was to understand the challenges faced by the regions throughout the PDA support, to evaluate the impact of the PDA initiative and the level of satisfaction of the regions, and to identify the areas of potential improvement for future PDA support mechanisms. The survey was structured into three sections, respectively about challenges, progress, and future support.

The main results of the survey were:

(A) Challenges

- All regions stated that the **main challenges** applying to their project evolved in their perspective since the beginning of the PDA support. 78% of respondents indicated they were facing new challenges in their project since the beginning of the PDA.

- The same number of respondents stated challenges resulting from a **lack of information** on local demand for hydrogen, a third of respondents faced challenges with information on laws and regulations and every fifth of respondents lacked information on hydrogen technologies and existent suppliers.
- The reported **lack of skills** related challenges was less clustered and seemed to be of a lower significance to the regions. 22% of the respondents reported that technical system design and evaluation, system right-scaling, risk identification and management, and project management or communication are challenging due to lack of skills.
- Industries and potential local customers and political stakeholders are identified as the most challenging stakeholders to get in contact with, while networking with local authorities wasn't reported as challenging.
- **Lack of empowerment or motivation** seems to be an important challenge, with time, resources and motivation appearing as limiting factors for more than 40% of the responding regions.

(B) Project progress and learnings

- The **process of the PDA support** was evaluated beyond expectations by two thirds of respondents, while 1 region remained unsatisfied with the process. The satisfaction level regarding the results of the PDA support was high, with 78% of the respondents evaluating the results as "beyond expectations".
- Progress in **project maturity** was estimated being increased from an average of 14 before PDA to 66 after PDA on a scale of 0-100.
- **Important progress** was declared to have been made in the definition of project scope and options (89%), understanding of market availability and technology readiness (56%), installation of project delivery groups (44%), contact with potential technology suppliers (44%), funding and financing strategy development (44%), project implementation plan and timelines (44%), integration into regional strategies (44%), risk analysis and management plan (33%), and operation and ownership strategies (11%).
- **Relative progress** was achieved in identification and development of suitable operation and ownership strategies (78%), project implementation plan and timelines (56%), risk analysis and management plan (56%), integration into regional strategies (56%), contact with potential

technology suppliers (44%), funding and financing strategy development (44%), understanding of market availability and technology readiness (33%), definition of project scope and options (11%), installation of project delivery group (11%).

(C) Recommendations for future support mechanisms

- The respondents appreciated the use of different tools and support documents in the PDA support and requested additional calculation tools (LCC and LCA, digital twins to test proposed use case systems, technical information for CAPEX) and further information on mechanisms of funding, including engagement of private equity.
- Suggestions for a diversification of funding programs included a call for small pilot demonstration projects, support for the acquisition of H2 vehicles, funds dedicated to self-government authorities to develop the hydrogen regional strategies, and large-scale transnational deployment projects (like JIVE, JIVE2).
- The networking and exchange with experts and sharing of learnings from other projects and regions was perceived as very valuable and helpful in finding the right scale of own activities and understanding of implications of system settings. This activity should be continued in future initiatives.
- Suggestions to improve the PDA support process included starting with a site visit to understand region and its challenges, address specific questions from a practical perspective on an individual base outside the project team, and include financial support for a region's facilitator.

6 Conclusion

The primary conclusions from the PDA II initiative are as follows:

- The overall objective of the PDA II, i.e. to support the development of hydrogen projects in cohesion countries, outermost regions, and islands, has been met. The programme assisted development of a diverse range of projects in nine different countries covering all the target geography types. It will not be possible to assess the full impact of the PDA initiative for several years, as the projects will require further time to progress towards implementation.
- Several of the projects are developing into "hydrogen valleys" and starting the process of acquiring the funding and financing needed to deliver the planned activities. As with the first round of PDA (2019 – 2021), all projects are expected to require public funding to help cover the additional costs of implementing

clean hydrogen-based solutions relative to incumbent fossil fuels.

- Although the original aim of PDA II was to help applicants develop to a point where they can implement projects within two years of the conclusion of PDA services[8], experience from the first round of PDA suggests that full implementation may take longer. In total, 11 projects were supported during the first round of PDA, with an expectation that project implementation activities would begin within a year of the conclusion of the PDA services. However, many of these projects have changed scope or scale since, reacting to a dynamic project context, or remained in the planning phase and are yet to deploy the technologies two and a half years after the conclusion of the PDA support.

- Given that support in PDA II was targeted at projects in cohesion countries, outermost regions, and islands, there is a higher risk of projects not proceeding to full implementation in the envisaged time relative to the first round of PDA due to issues such as remoteness, lack of scale, restricted pool of technology and service providers, etc.

- Several common challenges were faced by many of the cities and regions in PDA II, a selection of which are described below. Further challenges and lessons learnt are included in the main body of the report. Challenges include:

    - Identifying suitable demands for renewable hydrogen in appropriate applications with the scale and certainty of demand needed to create a viable business case for all actors in the value chain (i.e. hydrogen producers through to consumers).

    - Difficult economic case for solutions based on renewable hydrogen – in some sites there was enthusiasm from stakeholders, including potential end users of HFC technologies, but without a full appreciation of the likely cost premium relative to incumbent technologies. Some potential hydrogen customers expressed a willingness to switch to hydrogen fuel but only if cost parity with fossil fuels could be attained. With current energy prices and under most existing regulatory regimes such a target is not feasible without subsidies to reduce the costs of hydrogen (and / or additional taxes on fossil fuel-based solutions).

    - Remote locations – seeking to develop innovative hydrogen

[8] This was one of the requirements of beneficiaries applying for support via the h2regions.eu website.

energy projects in remote regions can lead to challenges in terms of identifying companies willing to supply and provide on-going support to the technologies needed to implement hydrogen energy projects. Costs for delivering products and supporting them during operation also tend to be higher for remote regions compared to areas closer to population centres which makes the economic case more challenging.

- Competition with larger projects – as noted above, the projects supported under PDA II typically envisage initial phases of deployment with hydrogen demands that can be met by electrolysers in the low megawatts / low tens of megawatts scale. Many equipment suppliers are focusing on projects at the tens / hundreds of megawatt scale and above as the industry prepares to scale up in the context of targets to deploy multiple gigawatts of electrolysis capacity in various countries across Europe over the coming decade. In addition, funding programs increasingly aim at large-scale projects to accelerate decarbonization, which increases pressure on "fast followers" to start at higher scales than appropriate for a learning phase in a remote region.

- The consultancy teams also recorded lessons learned through the delivery of PDA to the regions, which included:
  - Benefits of developing close working relationships with the local delivery team – as with any project, developing open, trusting relationships between the individuals involved is critical to success. While most people have become accustomed to conducting meetings virtually, there is benefit to in-person interactions. In the context of PDA, site visits and in-person meetings between the consultants and local project teams are recommended early in the process.
  - Including consultants able to communicate in the local language (and ideally with a good understanding of the local context) is beneficial. While "local" consultants may not always possess the technical knowledge or experience of developing hydrogen projects, a mixed team comprising relevant experts and consultants with strong local knowledge and communication skills can be an effective solution.

Results of the surveys completed by the recipients of PDA were largely positive, i.e. most of the respondents rated the support as "satisfactory" or "beyond expectations" and the estimated maturity levels of the projects increased substantially as a result of the assistance provided. The regions also appreciated the “observer network” activities and the ability to network with and learn from other project developers, including those at more advanced stages of development. This highlights the importance and value of initiatives such as the Mission Innovation Hydrogen Valley Platform.

Selected quotes from respondents to the PDA II survey of supported regions

“*The PDA has been a significant contributor to the ramping up of the project. Gaining all the insights has tremendously helped us progress in our initiatives, and we are very grateful.*“

“*We strongly believe that presenting existing initiatives significantly increases the learning ability of those supported. Seeing other implementation variants has enabled us to better gauge the scale and all the implications surrounding the project.*“

“*We have obtained valuable information regarding the possible technical partnerships for project implementation, as well as the necessary regulatory requirements that need to be met”.*