

# Vanguard Initiative New Pilot Project Proposal on: **Hydrogen**



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**Acronym: H2**

**20.04.2022**

## FOREWORD

Hydrogen has become a bustling field of interest and action across the world in the last two years. Since 2020, we have seen more and more European nations voice their ambitions to unlock hydrogen as a sustainable source of energy that will contribute to the decarbonisation agenda in multiple ways.

In July 2020, the European Commission published their ‘Hydrogen Strategy for a Climate-Neutral Europe’ in line with the European Green Deal, which is setting a strategic objective to install at least 40GW of renewable hydrogen electrolyzers by 2030 and to produce up to 10 million tonnes of renewable hydrogen in the EU. The hydrogen strategy was also followed by the publication of the Fit for 55 package, including a revision of the Renewable Energy Directive, as well as the hydrogen and decarbonised gas package in December 2021, aiming to foster the development of a hydrogen market in Europe.

Several European countries manifested their hydrogen ambitions at a similar time, such as France in 2018 and Germany, Italy and Scotland in 2020, to name a few. Concurrently, a number of regions have also developed hydrogen strategies built on their local strengths and needs.

All these developments confirm the strategic role hydrogen will play in the future energy system.

Regions are at the forefront of the development of a hydrogen economy in Europe. How much clean hydrogen a region needs and what it is being used for differs greatly across different geographies and economic systems. At the same time, the hydrogen sector is continuously growing and evolving along the entire supply chain: from production, to transport and storage, to the many applications in different fields. However, at present, not all the potential is being exploited in a coordinated manner.

From conversations with Vanguard members, we see that a lot of challenges and barriers to commercialisation of clean hydrogen technologies are shared among regions. There is also a well-known “chicken and egg dilemma” inherent to any new economic activity, which means that stakeholders must collaborate in order to stimulate supply and demand at the same time. We see a strong opportunity in harnessing each Vanguard’s region passion for hydrogen and their expertise to tackle these barriers to market together. Incorporating the

strengths and challenges from the Vanguard partners, we see this pilot addressing the following areas in hydrogen:

- hydrogen production & production technology, plus standardisation
- business diversification into hydrogen & commercialisation of products
- hydrogen application opportunities (mobility, domestic & industrial energy usage)
- hydrogen distribution and export
- hydrogen skills requirements
- knowledge creation and translation

Recent developments in the energy sector have also propelled Europe’s interest in clean, locally produced energy. The rise in energy prices across Europe and the Russo-Ukrainian War have forced regions to consider energy security and fuel shortages as well as energy poverty more seriously. While not a short-term solution to the problem, hydrogen very much represents a key element of the European Commission’s vision to achieve a clean, more affordable, secure energy system.

The value in collaborating on shared hydrogen issues is recognised by many Vanguard members. Development of hydrogen and hydrogen-related technologies is an important element to create the regional ecosystem of innovation in one of the most promising components of Sustainable Energy smart specialisation.

We see the Vanguard methodology as a helpful tool to address these issues, considering commercialisation is an overarching barrier to market for many. Thus, we present the Hydrogen Pilot to the Vanguard board.

## EXECUTIVE SUMMARY

The proposed new VI Pilot on Hydrogen (H2 pilot) aims to bring the VI and its members to lead in the process of creating a hydrogen knowledge and innovation community with a particular attention to SMEs, and to play an important role in preparation of the milieu that will allow the EU's green hydrogen targets to be met.

The ambition of this new pilot is to support the growth of all parts of the European hydrogen value chains, which must be done with due regard for the environment and social acceptance.

The Hydrogen Pilot is proposed by 12 VI regions, with 2 other regions hoping to join once the pilot is established. In addition, more regions may be interested in joining the Pilot at a later stage.

The partnership will support the growth of the hydrogen economy and **pool the knowledge, skills and capacities of stakeholders to accelerate the transition to a more sustainable energy system** for industrial companies, including SMEs, and address three main goals:

- European competitiveness and technology leadership in hydrogen
- Transition to a clean and secure energy system
- A just transition and stimulating regional innovation ecosystems

The Hydrogen Pilot will be managed according to **VI founding principles** i.e., sustaining and stimulating the demonstration and deployment of hydrogen technologies across European regions, targeting SMEs as the main beneficiaries.

Building up the „HYDRO-COMP” demo case will be the initial objective of the hydrogen pilot. Interest has been shown for 4 other demo projects, which will be defined in more detail and started after the launch of the hydrogen pilot.

The governance structure of the Hydrogen pilot and its development process will be based on co-leading. Partner regions have prior experience in leading and/or participating in other

VI pilot projects and will follow therefore similar structures in line with the VI statutes and internal rules.

The functioning of the Hydrogen Pilot will be based on the activities carried out by the co-leading regions. The regions will provide (non-financial) support to the Pilot operations through in-kind expert contributions to lead and coordinate the Pilot. All participating regions will contribute to the Hydrogen Pilot development by means of regional payment of the VI annual fee, as per the shared funding model, and through in-kind contributions of the regional stakeholders involved. Funding will be requested by the co-leading Regions to the VI ASBL with reference to the Vanguard Initiative pilot budget based on regional fees and in accordance with the by the General Assembly shared funding model approved in November 2019.

To achieve the mass use of hydrogen as an energy carrier and thus overcome the chicken and the egg problem", intensive coordination of regions is needed. The ethos of Vanguard of building a strong value chain, is well matched to resolving the need to create economies of scale and improve the affordability of hydrogen-related technologies.

## CHAPTER 1

### 1.1 PILOT'S NAME

HYDROGEN

**Acronym: H2**

### 1.2 COORDINATORS OF THE PILOT

Candidate Regions:

- Lombardy (IT)
- Malopolska (PL)
- Slovenia (SLO)

### 1.3 REGIONS PARTICIPATING IN THE PILOT

Participating and committed regions

- Lower Saxony, Germany
- Saxony, Germany
- Norte, Portugal
- Gavleborg, Sweden
- Aragon, Spain
- Asturias, Spain
- Galicia, Spain
- Scotland, UK
- Wales, UK

The partnership has also been in contact with other Vanguard Initiative and non-Vanguard Initiative regions such as Lower Austria about joining the pilot at a later stage. Since there has been considerable interest in discussions, our expectation is that a few more regions will join the pilot once it is set up.

### 1.4 OTHER STAKEHOLDERS PARTICIPATING

Research institutes, Industry, Associations, Academia and SMEs interested in being involved in the pilot's objectives described in the proposal region, including:

- Polish Cluster of Composite Technologies, Malopolska, Poland
- Malopolska Regional Development Agency, Malopolska, Poland
- Institute of Metallurgy and Materials Science of Polish Academy of Sciences, Małopolska, Poland
- AGH University of Science and Technology in Kraków, Malopolska, Poland
- GoFar Sp. z o. o., Malopolska, Poland
- Carbon Design Sp. z o. o. Malopolska, Poland
- South Poland Cleantech Cluster, Malopolska, Poland
- Kraków Technology Park, Malopolska Poland
- National Institute of Chemistry, Ljubljana, Slovenia
- Strategic Value Chain for Circular Economy, Slovenia
- GP sistemi, Ljubljana, Slovenia
- RSE SpA – Ricerca sul Sistema Energetico, Milan, Italy
- Centro Nazionale delle Ricerche (CNR) – Italy
- Politecnico di Milano, Milan, Italy
- Simplifhy SB srl, Milan, Italy
- Bono Energia - Gruppo CANNON S.p.A., Italy
- Università degli Studi di Brescia, Energy Technology Group (ERGO), Italy
- Università degli Studi di Milano-Bicocca, Milan, Italy
- Technische Universität Dresden, Saxony, Germany
- ENSO Energie Sachsen Ost, DREWAG - Stadtwerke Dresden, German
- MOBINOV – Cluster Automóvel Portugal, Porto, Portugal
- Energylab Technology, Vigo Spain
- Indominus Advanced Solutions, Vigo, Spain
- Marine Technological Center, Vigo, Spain
- University of Vigo, Vigo, Spain
- Sandbacka Science Park, Gavleborg, Sweden
- University of Gävle. Gavleborg, Sweden
- Wirtschaftsförderung Sachsen GmbH, Saxony, Germany
- East4D GmbH, Saxony, Germany
- Herone GmbH, Saxony, Germany
- Leichtbau-Zentrum Sachsen GmbH, Saxony, Germany

## CHAPTER 2

### 2.1 GOVERNANCE, STRUCTURE AND ASSESMENT FRAMEWORK FOR PROJECTS GENERATION, SUPPORT AND MONITORING

The group of regions listed above in sections 1.2 and 1.3 will finalise the initial Pilot Governance model described hereunder.

#### Pilot Level

The Pilot will follow the VI Pilot governance model. More specifically, the governance will be based on:

- a Steering Committee (SC), in charge of the strategic orientation of the pilot
- a Technical-Scientific Committee (TSC), in charge of the scientific orientation and technical realisation of the Demo projects

The SC and TSC will supervise activities of the Pilot. SC representatives will be composed of members indicated by the Regional Governments participating in the Pilot and the Demo projects Leaders.

The TSC representatives will be appointed by the SC regional representatives. Each partner Region will be advised to set up a Regional Working Group (RWG) identifying interests, needs, opportunities expressed in the regions.

The Regional Working Group will coordinate the activities within the region establishing direct connections with regional stakeholders and companies, with a particular focus on SMEs.

The TSC will be in charge of developing demo cases, which will then be validated by the Steering Committee. The Steering Committee will be in charge of preparing the overall Action Plan for the pilot, with input from the TSC.

#### Demo Project level:

The governance for each demo project and workstream will have a separate lead, which can be comprised of one or more members of the pilot. Each demo project and workstream will get its own objectives in the yearly action plan. These are to be set after approval for the pilot has been received. For the HYDRO-COMP demo project, which is the proposal's most advanced demo project, these objectives are already established (see Appendix).

### New DEMO project proposal procedure

The initiator of the new demo case creates a "Document of Interest" which contains a brief description of the proposed demo project. RWG registers interest and submits the "Document of Interest" to TSC. TSC shares this document with RWGs of other regions to invite other candidates to participate in the proposed demo project. The demo project initiator takes on the role of demo project leader, creates an application for the new demo project in coordination with other candidates and submits it to the TSC. The demo project proposal is approved jointly by the SC and TSC, based on its alignment with the objectives of the Vanguard Initiative and the Pilot more specifically.



## **2.2 MANAGEMENT incl. OPERATIONAL GOVERNANCE AND ORGANISATION OF THE PILOT**

The Management of the Pilot will follow the Vanguard rules and will foresee the management of collective actions as described below:

### **1. Pilot management structure**

Every year, an Action Plan will be drafted by the Pilot Leaders in cooperation with all the participating Regions and their representatives. The Action Plan will include details on the following proposed activities:

- The general goal of the Pilot, with specific objectives and the associated actions to meet these objectives
- A list of Key Performance Indicators to review the progress of the plan regularly (including budget proposal)
- A plenary kick-off meeting (organised at the beginning of the first year)
- Yearly – 2-3 times per year, in person if possible - Pilot plenary meeting, which will be open to Pilot and Demo projects representatives. The meetings will aim to update all members on the developments of the Pilot and give a general overview from the Steering Committee members. It will provide an opportunity for participating regional stakeholders to meet and discuss current and potential cooperation related to the

Pilot’s objectives. The plenary meeting could also be open to new regions wishing to join the Pilot.

- The Steering Committee will meet 3 times per year and, where in person, the partnering regions may host according to a rotation principle. SC tasks will focus, indicatively, on:
  - Management of decisions requesting an SC approval (e.g., on Pilot management, Budget, etc.)
  - Demo project progress, barriers and needs
  - New demo projects start and/or modification in the existing demo projects
  - Pilot participation in interregional/international congresses and events
  - Strategy and cooperation with other relevant Hydrogen networks
  - Discussions on new hypothetical external partnerships
- The Technical and Scientific Committee will meet at least twice per year (suggested). If needed, TSC members may participate in the SC meetings.
- Twice a year, a dedicated **B2B matchmaking session** will be organised to enable the Pilot members to meet and identify common interests and possible actions. This matchmaking B2B session will be open to companies (SMEs) or RTOs from Hydrogen Pilot partner regions.

## 2. Demo Projects

The organisation of activities at demo project level will be decided by demo project leaders and communicated to the Pilot leaders, to be integrated in the Pilot Annual Action Plan. Each demo project is expected to organise several activities:

- Define and design the yearly Action Plan
- Develop Business Cases and project plans
- Monitor demo project progress and continuously improve the process
- Activate Workshop and B2B matchmaking
- Identify funding and investment opportunities (access to EU grants and other funding, EIB, other investors)

## 2.3 REFERENCES OF LEADING PERSONNEL OF THE PILOT

### Malopolska (PL)

- **Andrzej Czulak**, PhD, currently Leader of the Polish Cluster of Composite Technology, has over 20 years of experience in the composite technology industry. He focused on designing manufacturing technologies of structures for hydrogen transport and storage as a researcher at the Technische Universität Dresden, Institute für Leichtbau und Kunststofftechnik, and as a managing director in Polish and German companies in the composite materials industry. Founder and President in 2016 of the Polish Cluster of Composite Technologies (Polski Klaster Technologii Kompozytowych), which brings together 100 companies and institutions, and which was awarded the status of National Key Cluster in 2021. Member of the Polish Academy of Sciences, the Committee on Materials Engineering and Metallurgy and the Malopolska Innovation Council.

### Lombardy (ITA)

- **Fabrizio Guarrasi**, Project Manager for the Lombardy Energy Cleantech Cluster (LE2C). In the Cluster, he works in the Smart Energy System and Circular Economy areas and is involved in the management of European projects on green energy transition. Fabrizio has a Master's degree with honours in Innovation Design, with a focus on sustainable development.

### Slovenia (SLO)

- **Anamarija Borštnik Bračič**, PhD, head of Energy Division in GP sistemi, Slovenia, has a PhD in Physics and a Master's Degree in Business Administration. Until 2012 she was an assistant professor of Physics at the University of Ljubljana. In 2012, Anamarija founded the energy division of the company GP sistemi, formed a team and concluded a cooperation agreement with a large boiler manufacturer. Together they build large combined heat and power plants that generate electricity and technological steam from sustainable fuels.

## CHAPTER 3

### 3.1 GENERAL PILOT OBJECTIVES

The Vanguard Initiative Hydrogen Pilot seeks to foster interregional collaboration to accelerate the development of a hydrogen economy in Europe. The Pilot aims to join up activity along the nascent hydrogen value chain and address existing barriers to the deployment of hydrogen technologies.

Through the development of demo projects, the pilot is aiming to test innovative hydrogen solutions at interregional level across Europe, promoting opportunities in terms of practical collaboration.

By adopting a place-based approach and building on their local ecosystems, partner regions are aiming to develop networking and matchmaking activities to enable the sharing of knowledge between European regions and overcome the “*death valley*” that nowadays exists between different actors in the hydrogen’s value chain and holding back hydrogen development among these actors.

The Pilot will address three main objectives:

- Enhancing European competitiveness and technology leadership in hydrogen
- Transition to a clean and secure energy system
- A just transition and stimulating regional innovation ecosystems

#### Enhancing **Competitiveness and European technology leadership in hydrogen**

- Emergence of new fields of economic activity: technology for production of green hydrogen, equipment for hydrogen storage, equipment for hydrogen transportation via pipelines.
- Development of new technologies that allow the abandonment of fossil fuels in production processes, where high temperatures are crucial for the quality of the products.
- Creation of new business relationships among actors in the value chain, across regions.
- Focused on SMEs, direct and indirect effects for the adaptation of hydrogen technology in the sectorial integration into infrastructure and energy system.

### **Transition to a clean and secure energy system**

- Reducing the environmental impact of the energy sector: minimising fossil fuels consumption and CO2 emissions.
- Minimising environmental impact of production and implementation processes of the new technologies for the production, transport and storage of hydrogen.
- Positive economic effects on renewable energy systems for a resilient society.

### **A just transition and stimulating regional innovation ecosystems**

- Identifying and promoting skills requirements within the hydrogen economy, particularly for the benefit of regions that use traditional energy sources.
- Developing a regional ecosystem of collaboration, innovation and best practice in the hydrogen sector across Europe.
- Recognising the social footprint of new energy forms and promoting a "new" positive social acceptance and understanding of hydrogen.

## **3.2 SPECIFIC PILOT OBJECTIVES**

Hydrogen is expected to play an important role as an energy carrier in this decade. It enables efficient and affordable energy transmission over long distances, storage of surplus electricity and environmentally friendly mobility, especially over long distances.

The hydrogen pilot will consist of some of the top regions in the inter-regional partnership that are strongly committed to a fossil-free and sustainable transition. The partnership will support the adaptation of the hydrogen economy and pool the knowledge, skills and capacities of stakeholders to accelerate the transition to a renewable energy system for industrial companies, including SMEs.

Demo projects and workstreams will specifically address the following issues:

- Help SMEs to diversify into the hydrogen sector.

- Help SMEs and Research Centres to share their knowledge and infrastructures to co-participate in the development of new hydrogen projects at the European level by creating a platform to match supply and demand.
- Present specific ideas and solutions related to hydrogen technologies to entrepreneurs and encourage their active involvement in this sector.
- Progress the standardisation of the advanced manufacturing of high-pressure pipes, fittings and composite vessels for the storage and transport of hydrogen.
- Speed up development of advanced technologies for the synthesis of green hydrogen from electricity generated in photovoltaic panels and wind turbines through electrolysis and from sustainably harvested wood biomass through gasification processes.
- Promote and speed-up the use of green hydrogen in energy-intensive industries, such as glass and steel industry, through projects.
- Identify skills requirements in hydrogen manufacturing settings and elsewhere.
- Inform and support the development of Hydrogen Valleys in participating regions, where appropriate.

### 3.3 EMPOWERING INDUSTRIAL AND MANUFACTURING VALUE CHAINS

In its communication with the European Parliament, the Council, the European economic and social committee and Committee of the regions on Hydrogen strategy for a climate-neutral Europe, the EU Commission emphasised the importance of hydrogen in decarbonising industrial processes and economic sectors where reducing carbon emissions is both urgent and hard to achieve.

The Hydrogen Pilot will contribute to the achievement of the Hydrogen Strategy, for a climate-neutral Europe goal.

Furthermore, as a VI Pilot, the Hydrogen Pilot will involve industrial ecosystems, SMEs, regions and communities, representing an ecosystem of actors that mirrors the objective of an inclusive industrial strategy.

The Pilot explicitly aims to provide SMEs and industrial actors with accessible entry points toward state-of-the-art hydrogen technologies in the participating regions. By building on

an existing network of labs and initiatives at high maturity level, the Pilot complements existing national and regional initiatives in Europe, by:

- Facilitating the international scaling of regional solutions and service-providers in the field of hydrogen, particularly with a focus on SMEs.
- Assigning specialised resources and expertise from the industrial research environment to solve industry challenges and promote transnational cooperation.
- Unlocking additional markets and business verticals to regional actors (specifically SMEs) through the “special relationship” existing between Vanguard Regions.
- Promoting value chain capabilities at transnational (and cross-regional) level, ensuring interoperability and compliance of existing solutions at an early stage.

The Pilot will focus its activities on the entire hydrogen value chain, but it will explicitly target the industrial roll-out of hydrogen technologies and processes to generate added value and novel, excellent industrial relationships and ecosystems. In doing so, the Pilot will not only offer a purely technological and organisational support but it will also implement the upcoming Commission’s Skills Agenda to ensure a smooth and inclusive sustainable transformation of the EU economy with regards to hydrogen activity.

The Pilot will also accelerate public/private partnerships in hydrogen applications, by facilitating access to European, national and regional funding frameworks for SMEs to use and scale hydrogen solutions.

### 3.4 POTENTIAL POSITIVE SPILL OVER EFFECTS OF THE PILOT

In July 2020, the European Commission launched its hydrogen strategy for a climate-neutral Europe. The goal of the strategy is for hydrogen to be a cornerstone for a climate-neutral energy system by 2050. The European Commission's long-term expectation is that hydrogen will then account for about 25% of the EU's total energy needs. Green hydrogen is expected to reduce carbon dioxide emissions by:

- replacing today's grey hydrogen, produced from natural gas without capturing GHG emissions,
- reducing fossil fuel usage in hard-to-decarbonise and energy-intensive sectors like steel and cement,
- powering vehicles with fuel cells or with engines adapted for hydrogen operation which emit only water,
- storing electricity from variable renewable energy sources such as sun and wind.

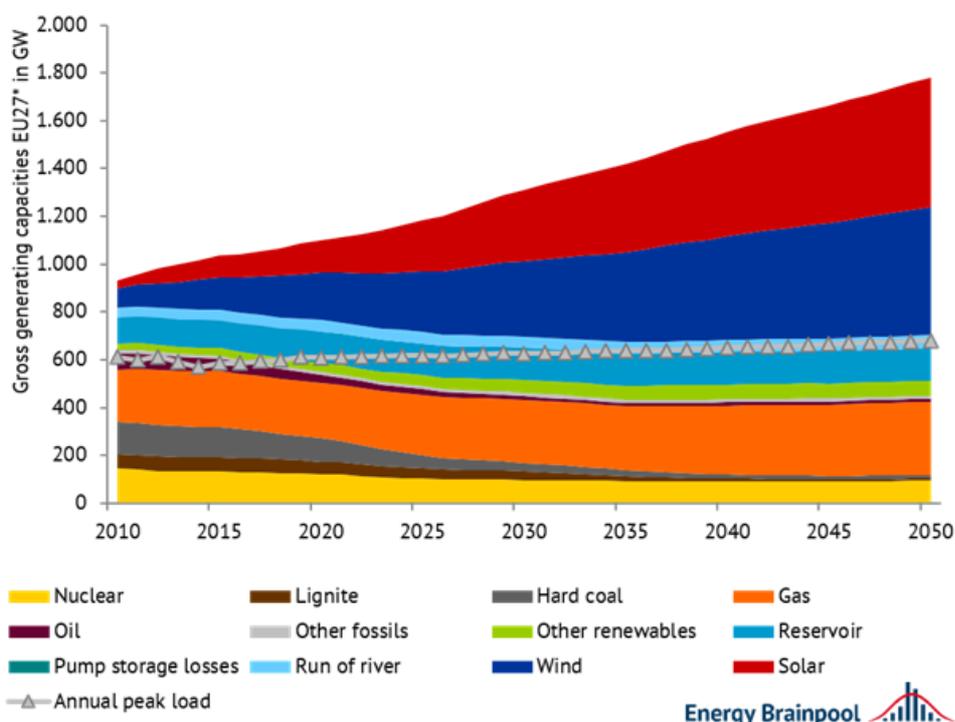


Fig. 1: Installed generation capacities in EU-27 plus NO, CH and UK by energy carrier (source: Energy Brainpool, 2021; EU Reference Scenario, 2016; entso-e, 2021)

As shown in Figure 1, EU electricity production is expected to increase by about 1,000 GW by 2050. In the same period, the use of coal and oil for electricity production is estimated

to be phased out almost completely. The total effect of this is that solar and wind energy are estimated to account for about 45% of the total electricity production in the EU by 2050. The increased presence of renewable energy means a potential reduction of electricity prices but also a greater variability of energy supply – both indicate a growing role for hydrogen as an energy carrier.

The hydrogen economy is complex and new, and its development will strongly depend on the sector connection between different energy systems. Different energy consumers (heating, industry, transport) must cooperate and collaborate so that different forms of energy (electricity, hydrogen, natural gas, biogas, biofuels, etc.) are constantly utilised as efficiently as possible. The Pilot will join different actors together to overcome key barriers in the practical application of hydrogen, contributing to a more positive business case for forming these connections at scale.

The development of the hydrogen economy is also characterised by a "chicken and egg" dilemma, which means that production and uptake must be timed concurrently across segments, to achieve the synergies needed for development at scale. Large, as well as small, pilot and demonstration projects will be of great importance for the initial development of the hydrogen economy, both globally and regionally. Proof of concept in key applications will encourage a wider adoption.

The hydrogen economy is estimated to generate jobs for a total of around 1 million well-educated workers in the EU by 2030. A predominant part of these future jobs will come from the green electricity needed to produce hydrogen, and from the equipment, infrastructure, services, research and training that will be needed for the hydrogen economy to grow. Multiple parts of the value chain will be involved in the Pilot – by creating an online tool we will increase visibility of opportunities for companies wishing to diversify their operations into hydrogen. For workers in the hydrocarbon or coal sectors, this also represents opportunities for a fair transition. At an individual level, participation in this Pilot's demo projects will allow regional participants to improve their expertise in hydrogen and take it forward in future projects.

This pilot will therefore contribute to the development of clean industrial and manufacturing value chains in Europe and the uptake of hydrogen in the energy mix.

### 3.4 POSSIBLE ADDITIONAL EXTERNAL INTEREST IN THE PILOT

At industry level, some of the planned activities of the pilot are also likely to foster interest. The planned HYDRO COMP demo case, for instance, has already gathered strong interest from companies working to introduce similar solutions, mainly composite high-pressure vessels for the transport and storage of hydrogen, to public transport, producers of hydrogen powered drones, or companies responsible for the transport of gas mixtures with hydrogen.

SMEs and industry stakeholders who have an interest in entering or growing in the hydrogen market often require information about opportunities across the value chain. Currently, there are industry associations in several European countries, and a few government-led hydrogen partnership bodies, but not every country has a national map of hydrogen supply and demand. This pilot will create additional online resources with valuable information about hydrogen research, supply and demand across the partner regions, which will lead to new commercial opportunities for the industry.

At European level, the Hydrogen Pilot will also work closely with key European networks and stakeholders in the hydrogen sector, such as the Smart Specialisation Platform on hydrogen valleys and the Hydrogen Europe Regional Pillar. Joint workstreams could be developed with some of these stakeholders on policy work, project development work, matchmaking or SME support.

The objectives of the proposed Hydrogen Pilot are closely connected with the objectives of the H2GreenTECH project (<https://www.h2greentech.eu/>) Interreg SI-AT. This project strengthens regional cooperation as well as research and innovation in the field of hydrogen technologies through cross-border cooperation of companies, research & development (R&D) centres and universities. The H2GreenTECH project aims to set up a hydrogen platform for networking and knowledge sharing, complemented by a cross-border roadmap for low-carbon technologies with commitments to implementation and dissemination. There will be three demonstration models and one educational module prepared for practical demonstration of the prototypes developed in the joint cross-border projects. The Hydrogen Pilot will consider how to share lessons with the H2GreenTECH project and other similar projects for our own collaboration platforms.

Several projects related to hydrogen technologies, e.g., hydrogen bottling plant, use of hydrogen for glass melting, metals recycling, are being implemented in LE and SMEs participating in the Strategic Research and Innovation Partnership – Networks for the transition to a Circular Economy, managed by the Chamber of Commerce and Industry of Styria and co-founded by the National Institute of Chemistry, Slovenia. These LE and SMEs are looking for the know-how and available technologies to address the goals of European Green Deal.

### 3.5 WHICH DEMO PROJECTS DO YOU PLAN TO INTRODUCE WITHIN THE PILOT?

The pilot currently has one well defined demo project (HYDRO-COMP). In addition to that demo project, the partners are interested in several workstreams which might lead to demo projects being developed once the pilot is up and running.

#### 1. **Workstream: Standardisation of hydrogen pipelines and vessels in HYDRO-COMP demo project:**

Interested regions include Malopolska & Saxony

Under this action, it is planned to create a guideline for prototype automated production line for high-pressure pipes, fittings and composite vessels for the storage and transport of gases, including hydrogen. The result will be a jointly created set of standards, requirements and conditions applicable across European regions. **More detailed information on this project's aims and activities is available in the Appendix.**

The virtual prototype automated production line should include:

- a. The area of quality verification of components included in the manufactured composite elements, especially thermoplastic liners and metal bosses.
- b. Production area of high-pressure pipes, fittings and composite vessels, together with an automated system for integrating measuring sensors:
  - i. Braiding on thermoplastic liner,
  - ii. Winding on a thermoplastic liner.
- c. Monitoring system for manufactured composite structures. Monitoring thanks to the integration of optical fiber, which are already active during the process of winding / braiding.
- d. The area of tests and validation of manufactured composite elements.

- e. Structural examination of composite elements made (e.g. computed tomography).
- f. Pressure testing of manufactured composite components.
- g. Area of packaging and delivery to customers.

## 2. **Workstream: Cooperation & Networking**

Interested regions include Lombardy & Scotland

In alignment with the Regional H2 Portfolios & Lessons Learned Workstream, we want to build and promote inter-regional collaboration opportunities for SMEs at European level. The workstream will focus on networking and matchmaking between the region's H2 SMEs and other stakeholders who can enable the SMEs' potential. To achieve this, the workstream will create a complete Database for sharing EU hydrogen opportunities, good practice and capabilities, mainly targeting SMEs across the value chain interested in participating in hydrogen-related projects. With an approach focused on Open Innovation, this workstream would play an active networking role in the sharing of information and knowledge (in terms of infrastructures and know-how) between all actors. A direct link will be established between them, facilitating - for example – a match between companies that want to invest in hydrogen, and universities, research centres and private laboratories that have the necessary infrastructure and expertise for a technological development, which will serve as enablers for new projects across the whole hydrogen value chain.

There is also a proposal to organise webinars for entrepreneurs where business representatives will be informed about development possibilities related to hydrogen technologies. In a similar form, a series of meetings will be prepared for representatives of universities, academics, higher education institution students and school students in order to educate them about new and efficient hydrogen technologies.

## 3. **Workstream: Regional H2 Portfolios & Lessons Learned**

Interested regions include Scotland & Wales

Early on in the pilot, we see the need to better understand each region's hydrogen ambitions and project portfolios, to identify expert knowledge and experience in

certain areas. ‘On the shoulders of giants’ we can share lessons learned with each other, where commercial confidentiality allows it, and ideally make connections between existing or planned projects. That can lead to inter-regional collaborations on projects, following the upscale idea of the Vanguard Methodology (learn – connect – demonstrate – commercialise).

This workstream will for instance explore the collation and sharing of “activity 1-pagers”. Each 1-pager will act as a shop window for the ambition of the project or activity that it describes, and will aim to encourage the sharing of knowledge and learnings between partners.

Pilot project members would need to engage with their networks of SMEs, academic institutions, RTOs, together with local, regional and national government representatives to try to get a complete a picture as possible of hydrogen and hydrogen related activities. This is particularly important for those projects and companies with relatively small projects who do not benefit from the international exposure that the larger hydrogen projects get.

This engagement would need to be maintained to ensure that the information captured within each 1-pager is correct and up to date. Only information that is for public domain dissemination will be included in these 1-pagers so that they can be widely shared between pilot members and any stakeholder within each and all regions. The sharing of confidential information between any stakeholders that chose to connect will be arranged between those sharing parties independent of the VI pilot. This is to ensure that an open and transparent approach is promoted.

All 1-pagers will be stored and version controlled via the established Vanguard Initiative Teams platform.

All entities featured in the 1-Pagers will need to know and consent to them being shared amongst the pilot network and beyond. Each 1-pager will require a VI pilot member to be named with contact details so they can act as the first point of contact for any reader who may not want to make direct contact with the organisations named within the 1-pager. This intermediary role will help break the ice when needed. If the 1-pager is describing a project or activity that has a website or any other digital presence on social media, then this should be included.

#### **4. Workstream: Hydrogen Skills**

Interested regions will be identified

The International Renewable Energy Agency (IRENA) predicts that employment in the energy sector will increase from 58 million in 2017 to 100 million in 2050. Turning away from unsustainable energy sources, such as oil and gas or coal, will leave many highly trained and educated workers without a job. It is critical to create new opportunities for these workers as many of their skills are transferable to the hydrogen sector.

Skills requirements for several hydrogen areas (production, mobility, grid connection, etc.) still lack definition and standardisation. An analysis of skills requirements and certificates related to hydrogen in production settings is required to identify possible gaps in training and create an accreditation of hydrogen skills. While hydrogen as an energy carrier has a huge value, it brings with it an opportunity of job creation and upskilling. The Pilot will monitor similar skills initiatives carried out by organisations like S3 to avoid duplication.

#### **5. Workstream: Small-scale Hydrogen Valley**

Interested regions include Central Sweden and Slovenia

Green hydrogen is considered by the EU and other global players as a key technology in the transition to CO<sub>2</sub> neutral societies and industries. For the Vanguard Initiative, a holistic mapping and update of the H<sub>2</sub> knowledge and activities is needed and close cooperation between a broad base of actors (universities, large companies, small and medium sized enterprises, industry associations, development organisations, municipalities) is to be started. The Hydrogen Pilot interregional partnership will together create the vision for how European actors can build successful ecosystems around green hydrogen, which in turn contributes to the Vanguard region's specialisation and innovation activities.

The small-scale Hydrogen Valley workstream aims to define a pool of concrete demo cases called "Hydrogen Vallys" where technologies connected with parts of hydrogen value chain will be deployed. This will create new business opportunities related to green hydrogen, and promote the regional transition to a CO<sub>2</sub> neutral society.

An example of Hydrogen Valleys are Green Hydrogen Valleys, where green hydrogen is synthesised in electrolyzers from renewable electricity produced from sun or wind. The hydrogen is stored in pressure vessels made from innovative

composite materials that will be created in the "HYDRO-COMP" demo project. The hydrogen is then transported via pipelines made of composite materials either to an end user located in the Green Hydrogen Valley or injected into existing natural gas pipelines.

Hydrogen Valleys presentations will be organised for interested prospective partners who have shown interest in previous stages. In these presentations, both technological solutions and the total cost analysis of the project will be presented, which will allow future partners to make an easier investment decision.

#### **6. Demo case: Replacement of fossil fuels for hydrogen in industrial processes**

Interested regions include Slovenia and Malopolska

A demonstration of the phase-out of fossil fuels, such as coal or natural gas, in synergy with the Just Transition Fund, focused on industrial decarbonisation.

A H2GLASS project proposed by Slovenian glass factory Steklarna Hrastnik will enable economically sustainable decarbonisation of their production process. The innovation revolves around replacing natural gas with green hydrogen and applying oxy-fuel combustion technology to avoid NO<sub>x</sub>. The development of a digital twin of the glass production process will provide information on a dynamic techno-economic assessment and allow accelerated study of material aging. The glass manufacturing process will thus move in the direction of Industry 5.0.

Similarly, industries located in the Malopolska that consume a significant amount of energy currently supplied in the form of natural gas and coal are interested in switching to environmentally friendly hydrogen and oxyfuel combustion technology and using it to avoid NO<sub>x</sub> emissions.

Exchange with similar regions will be encouraged, on technical knowledge, experiences with public-private investment structures and joint search for innovation support (R&D linkage).

## CHAPTER 4

### 4.1 ACTION PLAN as much as possible to be presented

The action plan is based on the previously presented action points.

General action plan: (based on the assumption that the pilot starts in July 2022):

1. Commission of administrative support for the Vanguard Hydrogen Pilot – **Q3 2022**
2. Kick-off meeting with all regions – **Q4 2022**  
Presentation of proposed workstreams and demo-cases  
Workstream interest to be gathered through a post-meeting questionnaire
3. Workstream: Regional H2 Portfolios – H2 portfolio session to introduce and discuss the regional H2 pipelines of projects, ambitions/targets, collaboration opportunities and lessons learned – **Q4 2022**
4. Workstream and demo-case kick-off meetings & creation of objectives and actions plans for each workstream – **Q4 2022**
5. Yearly Vanguard Hydrogen Pilot plenary meeting - **2023**

The rest of the action plan will follow on establishing the first demo project of the pilot (HYDRO-COMP), as described below:

Demo project – HYDRO-COMP – action plan for the initial 18 months of the pilot:

1. **State of the art.** Analysis of the current state of the art, comparison of technologies for manufacturing high-pressure pipes, fittings and vessels in the European Union countries.
2. **Barriers for high-pressure technologies.** Analysis of barriers to the introduction of the solutions for high-pressure pipes, fittings and composite vessels for the storage and transport of gases, including hydrogen, in European Union countries.
3. **Potential of innovative composite.** Exploring the potential of innovative composite technologies for the production of high-pressure pipes (TRL 5), fittings and vessels for the storage and transport of gases, especially hydrogen.
4. **Integrated monitoring system.** Definition of integrated monitoring system for production and operation of high-pressure pipes, fittings and vessels for the storage and transport of gases, including hydrogen.
5. **Standardisation of production solutions.** Creation of a technological line project allowing for economical and repeatable production of high-pressure elements of

high-pressure pipes, fittings and composite vessels for storage and transport of gases, including hydrogen.

6. **Preparation of project.** Preparation of a project allowing for the implementation of the identified solutions within the European Union, allowing for the integration of relevant manufacturers of high-pressure pipes, fittings and composite vessels for the storage and transport of gases, including hydrogen.
7. **Presentation of the DEMO PROJECT.** Presentation of the DEMO PROJECT results to VI Pilot group and stakeholders.

## 4.2 SHORT- AND LONG-TERM PILOT GOALS

### SHORT TERM PILOT GOALS

The Hydrogen Pilot will consolidate its Governance, selecting demo cases, preparing its Action Plan and launching the demo cases based on an analysis of the current situation. Explained more fully in section 4.1. - General Action Plan.

### LONG TERM PILOT GOALS

An ecosystem of companies providing technologies along the entire hydrogen value chain would enable the EU to independently meet the European Union's 2050 hydrogen target. To achieve this goal, the Hydrogen Pilot is pursuing the following long-term goals:

1. Set up a platform to connect EU companies, in particular SMEs, offering technologies along the entire hydrogen chain: for the synthesis of green hydrogen as well as for storage, transport and use of hydrogen,
2. Support R&D and technology ramp-up for those parts of the hydrogen chain where EU companies cannot yet offer adequate technology,
3. Develop cross-regional standards for manufacturing processes, considering safety issues and respect for the environment and ecology,
4. Introduce DEMO PROJECTS which will support the goals listed above,
5. Organise and attend annual conferences and fairs on hydrogen issues,
6. Find synergies and establish cooperation with other Hydrogen networks and/or institutions,
7. Find synergies and establish cooperation with other VI Pilot projects.

### 4.3 PILOT'S VISION/AMBITIONS

Hydrogen development is a topic of intense interest at the regional level in various fields, but still has a strictly national vision. Each region has its own characteristics and barriers (regulatory, technological, infrastructural) that currently prevent a broad development of the hydrogen economy at the European level.

The Vanguard Initiative Hydrogen Pilot, therefore, aims to bring the VI and its members to lead in the process of creating a knowledge and development community to standardise and homogenise as much as possible the processes that will allow the development of a Europe-wide hydrogen ecosystem. This ambition will be based on supporting the cooperation between various actors in the European hydrogen value chain, in order to boost the development of hydrogen in the industrial and technological phases.

### 4.4 KEY PLANNED FUTURE PILOT'S ACHIEVEMENTS ON ONE AND CHALLENGES ON THE OTHER HAND (briefly)

The new pilot partnership will open several opportunities for members to join other hydrogen-related communities and provide an advanced platform for the regions participating in the pilot project. The aim of this platform is also to complement and enrich existing initiatives and projects in the regional field by:

- Connecting industrial players and innovative Start-ups or Scale-ups
- Matching SMEs with possible customers
- Supporting technical cooperation on Demo Projects suggested by Industrial customers (e.g. Start-up, SMEs) and academic and industrial organisations
- Promoting the competitiveness of SMEs, start-ups and businesses by expanding their international reach and access to some of Europe's most advanced regional ecosystems.

Good communication with other VI pilots and European partnerships is needed to avoid duplication of cases and investment in the development of technologies and good practices. For example, standardisation of other aspects of the hydrogen economy, such as accreditation of “low carbon” hydrogen and safety testing, is already being driven by European institutions. The Pilot will take care to bring additional value through its activities.

#### 4.5 DESCRIBE 4 PHASES (learn, connect, demonstrate, commercialize) OF YOUR PILOT AND HOW DO YOU PLAN TO HANDLE AND ACHIEVE THEM

1. **Phase learn:** The first phase of the pilot will focus on learning. Regions will seek to raise awareness of the pilot with their regional stakeholders (SMEs, public sector, academia) in order to maximise learning between the Pilot partners. Partners will be asked to fill a questionnaire indicating the interests and capabilities in the hydrogen sector. This will enable the mapping of existing synergies and opportunities for collaboration. It will also encourage partners to share lessons learned and best practices.

The mapping questionnaire will be prepared and distributed through regional working groups to businesses, academic institutions and associations in the regions participating in the pilot.

The mapping exercise will be the basis for further activities, including the development of new demo projects.

The Learn phase is the foundation on which Connect, Demonstrate and Commercialise will be built and is therefore critical for this to be of good quality, have good coverage and be well maintained.

2. **Phase connect:** Information gathered from the mapping questionnaire will be used to define the most efficient strategy to rapidly increase the activities in the hydrogen pilot area. The following activities are planned:
  - Leverage existing local/regional partnerships and stakeholder engagement activities or regional clusters such as the SRIP Networks for the Transition to a Circular Economy (Slovenia).
  - Organise a pan-regional hydrogen match-making fair to bring together relevant stakeholders and to provide political and policy visibility.
  - Organise Hydrogen Pilot events (pitching, matchmaking, B2B/R2B).
  - Emphasise and possibly achieve inter-regional coordination between existing supporting regional and inter-regional instruments (e.g. Innovation Voucher Baden-Württemberg) in order to maximise the impact of such initiatives and avoid duplication.

- Launch calls through the hydrogen pilot to initiate new Demo Projects, selected on the basis of information provided by Regional Working Groups.
  - Mobilise the interregional networks by organising and/or participating in hydrogen conferences with a qualified team of appointed experts.
3. **Phase demonstrate:** This phase will focus on the activities of the Hydrogen Pilot demo projects run by the Pilot partners, including the HYDRO-COMP Demo Project. Hydrogen Valleys will be explored, in which existing or newly developed technologies for the production, storage, transport or use of hydrogen will be implemented to create a hydrogen value chain. Each Demo Project and workstream will have associated plans, KPIs, and data gathering procedures to track their progress and success.
4. **Phase commercialise:** In the commercialisation phase, the focus will be on SMEs. Owners of new technologies and business models will be supported in finding new customers and establishing (technological) processes that enable commercial production of products and services tested in the demonstration phase.

## CHAPTER 5

### 5.1-PLANNED/WISHED FUNDING (BESIDES VANGUARD FOR PILOTS AND (POTENTIALLY) CROSS-PILOTS ACTIVITIES, ANY OTHER LOCAL, REGIONAL, CROSS-REGIONAL AND/OR INTERNATIONAL)

#### PILOT LEVEL

For the first 18 months (the “observer period”), the Hydrogen Pilot will seek funding from the Vanguard Initiative for up to €30,000 as described in the call for the functioning of the Pilot. From 1 January 2024, funding for the Hydrogen Pilot will be requested by the leading regions and delivered by the Vanguard Initiative ASBL based on the regional annual Vanguard Initiative Fee, as per the agreed Vanguard Initiative funding rules. Members will therefore not be charged until 1 January 2024.

Most of the budget at pilot level will be used to procure external expertise to provide support to the pilot leaders for the day-to-day running of the pilot (organisation of meetings, admin, reporting etc.). Part of the budget will also be used for travel/meetings, as defined in the action plan.

The co-leaders of the pilot, as well as all the regions involved in the pilot, will also provide substantial non-financial support to support the pilot’s operation.

#### Demo project level

At demo project level, regions will provide substantial non-financial support to enable the development of projects. Where additional investments will be needed, partners will be exploring the following funding sources:

- A combination of local, regional or national funding sources. Funding for hydrogen is available at various levels in many European countries. Partners will aim to use funding available at national level to develop demo projects together.
- Where possible, partners will also aim to collectively apply for European funding to develop demo projects. Several programmes are providing funding for hydrogen, including (not exhaustive):
  - The Horizon Europe programme, including the Clean Hydrogen for Europe Partnership calls,
  - Interregional Innovation Investments (I3 Instrument),
  - Interreg Europe programmes,
  - Innovation Fund.

In particular - considering that the pilot objectives mainly relate to SMEs' involvement in hydrogen - the I3 programme can be, amongst other described funding schemes, an appropriate tool to enable the concrete implementation of this Pilot (with related demo projects) and exploit its real potential.

Given the complexity of the funding landscape for hydrogen technologies, each demo project will develop a more detailed plan exploring funding opportunities available at local, regional, national and European level, which could be used and combined.

**5.2-BUSINESS PLAN INCL. FINANCIAL PLAN AND EXPECTED OUTCOME IN 1 AND 3 YEARS (BOARD BEING AWARE IT MAY BE DIFFICULT TO WRITE THESE ELEMENTS AND CHAPTER, HOWEVER, AN INITIAL OUTLINE WOULD BE EXPECTED AND ANY CONCRETE ESTIMATIONS WOULD BE MUCH APPRECIATED).**

**Pilot level business plan:**

The Hydrogen Pilot will operate on the principle of non-profit organisations. In accordance with the goals set (objectives of the pilot and action plan), it will receive funds from the participating regions for the activities specifically described, especially in the first two phases “learning” and “connecting”. A large part of the planned activities will be carried out by representatives of the participating regions at their own expense, in the form of non-financial contributions.

At pilot level, the business plan will keep the balance between funding received from the Vanguard Initiative and pilot expenses.

**Demo project business cases:**

Specific business plans will be prepared by each demo project leader and approved by the Pilot governance structure. This process applies also for new demo projects that will follow at later stage.

Preliminary business plan of the Hydro-comp demo case:

Representatives of the participating regions will be responsible for preparing application for the calls and to support the activities of the demo case in the phase commercialisation.

**Expected outcome after year 1:**

- Drafts of documents for phases “learn” and “connect” will be ready: analysis of the current status of technologies, comparison of technologies, analysis of standards

and barriers, description of existing manufacturing technologies, description of options for integrating the monitoring system, draft document describing standardisation,

- Applications for funding will be submitted to fund the Demo Projects: EU, national or regional funds.

**Expected outcome after year 3:**

- For the HYDRO-COMP Demo Project, a draft of documentation for future investors will be prepared: a business plan (as required) and project documentation,
- Project funding for the Demo Projects will be provided,
- Discussions will have started with companies interested in further involvement in any Demo Project or workstream.

## CHAPTER 6

### HOW DO YOU PLAN TO INFLUENCE THE EU AGENDA?

Hydrogen is currently at the forefront of the EU’s energy agenda and a key element to ensure the implementation of the Green Deal. The European Commission also recently published a proposal for a hydrogen market regulation, which further highlights the importance of hydrogen in the EU policy debate.

European regions are key stakeholders to deliver the EU’s vision for hydrogen, as well as the Green Deal and Fit for 55 ambitions. To reflect the input of the participating regions, the pilot will actively contribute to the development of an EU agenda around hydrogen, by:

- Identifying key messages summarising the outputs of the pilot and using the existing VI channels of communication to disseminate these messages, including a new website and Twitter account.
- Highlighting the pilot, its demo cases and key outputs at various events, meetings and fairs attended by EU institutions representatives.
- The pilot leaders as well as pilot members will aim to establish a direct, strategic dialogue with relevant Commission DGS (DG RTD, DG Growth, DG Regio).
- Developing a strategic relationship with the Clean Hydrogen European Partnership, as the Partnership is key in the delivery of the EU’s hydrogen research and innovation agenda.
- Contributing to the Vanguard Initiative – wide policy work, including on industry policy for instance. The pilot will contribute to this policy work through the existing policy task group.
- The pilot will also work closely with other European stakeholders active in the hydrogen sector to influence the EU agenda. In particular, we will aim to work closely with the S3 platform on Hydrogen Valleys, as the S3 group also promotes interregional cooperation on hydrogen. Some pilot regions are also involved in the S3 Platform - we will aim to build on these relationships to foster collaboration and build on the policy influencing work the S3 Platform is already doing. The group will also aim to engage with Hydrogen Europe, including the newly formed Hydrogen Europe Regional Pillar.

## CONCLUSIONS

Renewably sourced hydrogen is an essential energy carrier for achieving COP21 climate targets. The gas can store and deliver energy anywhere, anytime, meeting demand regardless of generation facilities and end users. However, for Europe to harness the power and opportunity of hydrogen, multiple factors need to be secured: a reliable and safe infrastructure (including pipelines and control systems), opportunities for diversification into the H<sub>2</sub> supply chain, knowledge sharing among leading universities and educational institutes, major technical and policy (standardisation) advancements, skills accreditation, demonstration of applications in real scenarios, and much more.

The solutions proposed in the Hydrogen pilot realise the various ideas being discussed by member regions, elevating them from isolated to collaborative endeavours. Several workstreams are proposed under this Hydrogen Pilot, all based on real challenges that regions are currently facing. Our activities will provide highly requested platforms for inter-regional networking as a key activity to get closer to a solution.

## APPENDIX

### **HYDRO-COMP Demo Case**

„HYDRO-COMP” plans a comprehensive analysis of the design, manufacture, monitoring and testing of composite properties of pipeline elements and pressure vessels.

Planned actions:

1. Analysis of the current state of the art, comparison of technologies for manufacturing high-pressure pipes, fittings and vessels in the European Union countries.

Comparison of the state of the current infrastructure and manufacturing technologies for the storage and transport of gases between the countries participating in the pilot. The first stage will compare Poland and Germany, and in the next steps more countries (partner regions) will be added. Each stage will end with a report which will be presented at the Vanguard Initiative meeting and sent to all partners.

2. Analysis of barriers to the introduction of high-pressure solutions for pipes, fittings and composite vessels for the storage and transport of gases, including hydrogen, in European Union countries.

Based on the results of the first stage, an analysis of standards in the pilot's partner countries will be carried out and a report comparing these standards will be prepared. The differences between the standards existing between the countries will be identified as barriers and a proposal will be made to overcome these barriers. A report will also be drawn up on this stage, which will be presented at the Vanguard Initiative meeting and sent to all partners.

3. Conduct comparative studies between current solutions and those planned in a multi-material approach. Determination of the current performance level of the installation according to the region, or utility level.

Multi-material solutions will also be included in this task. This mainly concerns combinations of isotropic materials with anisotropic materials and their possible modification. In addition, the classical metallic materials of which fittings are made, unavoidable also in hydrogen storage and transport systems, will be analysed.

A report will also be drafted at this stage, which will be presented at the Vanguard Initiative meeting and sent to all partners.

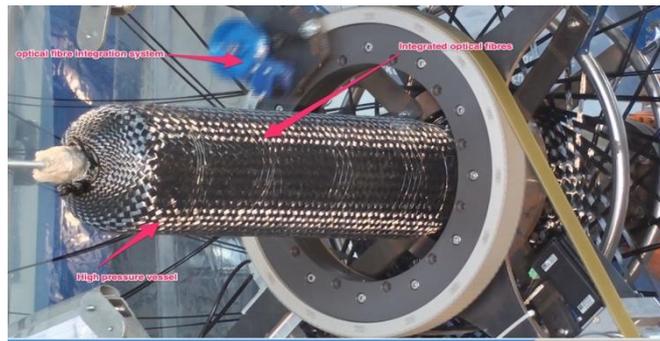
4. Exploring the potential of innovative composite technologies for the production of high-pressure pipes (TRL 5), fittings and composite vessels for the storage and transport of gases including hydrogen.

Currently, SMEs and institutions in the applicant regions (Małopolska and Saxony) have the production technology of high-pressure pipes (TRL 5), fittings and composite vessels for the storage and transport of gases including hydrogen. However, differences in standards do affect the differences in the manufacture, testing and monitoring of these composite structures. Cooperation in the exchange of experience and demonstration of solutions will allow for optimisation of the developed technology. Today, pilot partners produce vessels, fittings and composite pipes using pultrusion or blowing plastic technology in combination with winding or braiding technology on a thermoplastic core. Technologies vary in detail and the pilot will define predestined solutions for each component.

5. Definition of an integrated monitoring system for production and operation of high-pressure pipes, fittings and composite vessels for the storage and transport of gases including hydrogen.

Differences in standards and manufacturing technologies also lead to differences in the monitoring of high-pressure pipelines and pressure vessels for the transport and storage of gases including hydrogen. Internal corrosion and the impact of the external environment on the condition, functionality, transmission losses and, at the same time, on the safety of the entire environment must be borne in mind. As part of previous cooperation between the pilot's partners, a monitoring system was developed, based on the integration of optical fibres in the manufacturing process and the use of Optical Distributed Sensor Interrogator. The system developed was characterised by:

- Reduction in material costs with inexpensive optical fiber sensors
- Saving time and labour by instrumenting many sensing locations using a single optical fiber
- Interrogating entire fiber and all sensing locations with a single scan
- Controlling sensor locations and gage lengths in software
- Measuring temperature or strain with a single fiber
- Realising industry-leading measurement range and repeatability with extraordinary spatial resolution.



*Fig. 2. Jointly developed manufacturing system of pressure pipes, fittings and composite vessels for the storage and transport of gases including hydrogen and integration of optical fibres allowing to monitor the structure during manufacturing and operation*

6. Standardisation of solutions - creation of a virtual technological line project allowing for economical and repeatable production of high-pressure elements of high-pressure pipes, fittings and composite vessels for storage and transport of gases including hydrogen.

The developed technologies for the production of high-pressure pipes, fittings and composite vessels for the storage and transport of gases, including hydrogen, allow for a significant reduction in production costs, increased safety and ensuring the correct functioning of the systems in all cooperating regions.

This solution has proved its worth on several occasions during trials, and the aim of the partnership is to introduce such a solution as a standard system across Europe. As part of this measure, it is planned to prepare guidelines allowing for the production of the above-mentioned elements with the highest safety requirements and repeatability of production.

7. Preparation of a project allowing for the implementation of the developed solutions throughout the European Union, allowing for the the integration of the solution of all manufacturers high-pressure pipes, fittings and composite vessels for the storage and transport of gases including hydrogen.

The most important stage in the implementation of the project is the preparation of a joint project allowing for the introduction of solutions and standards to all countries of the European Union. All interested regions associated in the Vanguard Initiative, which have already been active during the pilot's implementation, will be invited to the joint project.

Systemised information concerning requirements, standards, safety conditions and technologies for the production, monitoring, testing and use of high-pressure pipes, fittings and composite vessels for the storage and transport of gases including hydrogen collected during the implementation of this pilot will allow the creation of a precise system operating in all European Union countries.

8. Dissemination of results through a jointly developed S2B and B2B website and supported events on hydrogen technology

Under this action, various presentations will be organised at fairs and conferences to present the results of the work.

An example is already this year Malopolska plans to organise a conference related to hydrogen and hydrogen-related technologies as well as industry fairs focused on hydrogen and composite materials for its storage. The conference and fair will be open to participants from all interested regions.

In addition, it is also planned to launch a website (e.g. as a subpage on the website of the Polish Composite Technology Cluster) where the developed analyses and solutions will be presented. It is also planned to publish articles in the "open source" magazine - Lightweight.pl, dealing with the topics of composite materials and solutions concerning hydrogen-related technologies.

9. Introducing DEMO PROJECTS based on the elaborated results (described in the following sections).

As mentioned in the previous point, the study will be demonstrated at trade fairs and industry meetings and distributed to members. The creation of an interregional association of manufacturers of high-pressure pipes, fittings and composite vessels for the storage and transport of gases including hydrogen will allow the creation of appropriate standardisation in all countries of the European Union.

As part of this task, selected business analyses of the project will also be prepared (costs of purchasing machinery, costs and availability of input materials, required human resources, etc.), allowing the offer to be presented to potential investors (SME's) and facilitating investment decisions.

It should be remembered that the project is of significant importance taking into account the economic aspects of production and operation of pipelines and pressure vessels made of high-strength materials, including composite materials. The results of the project will

allow for the selection and optimisation of technologies not only to be found in the gas industry and in hydrogen, but also in the wider future in green transportation.