VEPE

Vetytalous Etelä-Pohjanmaalla
Hydrogen economy in South Ostrobothnia

VEPE project WP2 Clean Hydrogen Ecosystem Blueprint

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ABSTRACT

This report covers the findings of Work Package 2 related to a clean hydrogen ecosystem plan for Southern Ostrobothnia. The project was funded by the European Regional Development Fund (ERDF), the Southern Ostrobothnia Regional Council, Vaasa University, and Seinäjoki University of Applied Sciences. To develop this study, the research team used a combination of conceptual and empirical approaches to create the initial model of a clean hydrogen ecosystem for Southern Ostrobothnia. Both primary and secondary data collection sources were necessary to provide key inputs for this work.

This study follows up on the knowledge from the T2.1 reports "Background mapping of hydrogen ecosystems" to design a clean hydrogen ecosystem for South Ostrobothnia in tasks T2.2 "Stakeholder mapping and ecosystem visualization", T2.3 "Creating ecosystem value and operations planning with stakeholder participation" and T2.4 "Ecosystem design".

Specifically, task T2.2 involved drafting a clean hydrogen ecosystem for Southern Ostrobothnia. This included identifying the stakeholders involved and their various participations within the ecosystem in a visual form. It also encompassed considering the regional actors identified in WP1, as well as national and international networks.

In task T2.3, the framework for an emerging clean hydrogen ecosystem was defined based on exploring how an ecosystem can create value for the operators of its key assets and, more specifically, for South Ostrobothnia. Here, potential ecosystem activities and operating principles were identified during the initial stages to support its long-term sustainability. Key aspects addressed in this task included: potential forms of interaction between stakeholders, the significant role of orchestrators in ecosystem development, and strategies for engaging ecosystem members.

Likewise, task T2.4 involved building upon the findings of previous tasks to produce the conceptual model of a clean ecosystem for South Ostrobothnia. The model concept developed called **"VetyVisio Ekosysteemi EP**" integrates a four-component structure: i) stage in ecosystem emergence; ii)

ecosystem map; iii) identification of needs to be addressed and value to be delivered; and iv) ecosystem architecture and processes.

This report offers relevant information for regional stakeholders in initiating public-private ecosystem structures around the energy transition, such as clean hydrogen. Both the literature-based framework on ecosystem emergence and the empirical approach, along with the use of diverse data sources, enabled the production of a model that can serve as a reference for other research efforts on the same topic and contribute to a better understanding of the dimensions involved in ecosystem emergence. This report connects with the tasks of work package 3 of this same project related to potential hydrogen value chains and the associated competitive requirements in South Ostrobothnia.

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1 WP 2: Clean Hydrogen Ecosystem Blueprint

1.1 Scope of the analysis

This report has been prepared as part of the VEPE project related to work package 2. The project has been financed by the European Regional Development Fund (ERDF), Regional Council of South Ostrobothnia, University of Vaasa, and Seinäjoki University of Applied Sciences. The aim of this report is to follow on the findings of T2.1 and continue to cover the tasks T2.2, T2.3 and T2.4. Therefore, the present document comprises:

- Key findings of T2.1 Background mapping of hydrogen ecosystems ((Pinilla-De La Cruz 2025)
- T2.2 Stakeholder mapping and ecosystem visualization
- T2.3 Ecosystem value creation and operational planning involving stakeholders
- T2.4 Ecosystem design

Particularly, in task T2.2 a draft of a clean hydrogen ecosystem in South Ostrobothnia was drawn up. First, by identifying actors involved and participating in the ecosystem in diverse ways. It includes taking into consideration the regional actors identified in WP1 as well as national and international networks. Furthermore, it covers the visual representation of findings into a visual form of the overall picture to perceive and communicate more effectively. The ecosystem draft was refined and complemented based on the findings in WP3.

In task T2.3, the framework for an emergent clean hydrogen ecosystem was defined based on the exploration of how an ecosystem can create value for its key operators and South Ostrobothnia. This comprises drafting the ecosystem activities and operating principles during the initial stages to support its sustainability over time. Among key aspects addressed on this task were: those possible form of interactions between actors, leading role of orchestrators in ecosystem development and strategies for engaging members of the ecosystem.

Finally, task T2.4 encompassed building on the findings of previous tasks to produce the concept model of a clean ecosystem of South Ostrobothnia, including the forms of operation, possible forms of value creation and cooperation opportunities with national hydrogen networks.

1.2 Key insights from T2.1: Background mapping of hydrogen ecosystems

The study on the background mapping of hydrogen ecosystems was developed based on literature and publicly available sources. This research work indicates that ecosystems play an essential role as social structures enabling synergies between public and private actors (Pinilla-De La Cruz 2025). The collaborative nature of ecosystems creates bonds of trust and reciprocity that promote the development of a shared value proposition at the system level and further sharing risks among partners to push the hydrogen economy forward (Augusto et al. 2022; Pinilla-De La Cruz 2024; Tsujimoto et al. 2018). Building ecosystems includes various stages of their emergence from genesis to consolidation (Asplund et al. 2021a; Thomas, Autio, and Gann 2022). Each stage of emergence is crucial to progressively create a cohesive and aligned structure able to deliver a system value proposition. Here, four processes can describe in general terms the dynamics of the ecosystems during the emergence as value discovery, collective governance, acquiring resources and contextual embedding (Jacobides 2018; Thomas et al. 2022). In the emergence of ecosystems, the role of the orchestrator is particularly relevant in defining the “architecture” and vision of the ecosystem as well as the vision, as well as providing direction for the implementation of the “rules of the game” on how the social structure will operate (Kola et al. 2020; Valkokari et al. 2017).

Besides emerging ecosystems, other larger social structures like hydrogen valleys appear in the international and national landscape as ecosystems that have reached an advanced level of maturity, large-scale hydrogen production, and wide scope in the hydrogen value chain (Pinilla-De La Cruz 2025). The existence of hydrogen valleys near potential hydrogen production areas would help connect stakeholders more effectively and boost the ecosystems emerging around them. Likewise, the presence of hydrogen-related networks also provides important support for emerging ecosystems, acting as connection points with different actors interested in the development of the hydrogen economy.

1.3 Methodology

This study corresponds to the initial steps to build a clean hydrogen ecosystem in South Ostrobothnia. Current academic literature on the topic suggests that the development of public-private ecosystems typically begins with raising awareness among key stakeholders through an informal and relational approach (Asplund et al. 2021a; Pinilla-De La Cruz 2024; Pinilla-De La Cruz, Rabetino, and Kantola 2022a). Given the complexity of introducing the clean hydrogen ecosystem as a new topic in South Ostrobothnia, our data collection plan has been adapted throughout the project in response to the level of engagement from local and regional stakeholders. Accordingly, we have adopted an iterative, multi-method qualitative approach that integrates both empirical data and conceptual frameworks to ensure methodological robustness and relevance.

This study is made up by a combination of conceptual and empirical approaches to create the initial model of a clean hydrogen ecosystem for South Ostrobothnia. Here, primary, and secondary sources of data collection were necessary to provide key inputs for this work (Table 1). Primary sources include workshops, semi-structured interviews, and a survey with key stakeholders in South Ostrobothnia and national companies and networks, and secondary sources comprise the latest academic literature and relevant reports on clean hydrogen.

Table 1. Type of data sources used in the study WP2

Type of data sources	
Secondary	Academic literature
Secondary	National/international reports, VEPE report WP1 "Current state of the hydrogen economy in South Ostrobothnia", VEPE report T2.1 "Background of hydrogen ecosystems"
Primary	(3) Workshops with key stakeholders
Primary	(15) Semi-structured interviews with key stakeholders
Primary	(1) Survey with ecosystem core team members

1.3.1 Secondary data sources: academic literature and reports

First, secondary data sources such as our previous project reports, for instance, the VEPE report WP1 "Current state of the hydrogen economy in South Ostrobothnia" (Siekkinen 2024) , VEPE report T2.1 "Background of hydrogen ecosystems" (Pinilla-De La Cruz 2025). Furthermore, academic literature and national and international reports, especially the literature on ecosystem emergence, have been particularly useful in positioning the clean hydrogen case study in the South Ostrobothnia region within a framework that allows the phenomenon to be observed from the perspective of ecosystem emergence. This framework also enables the planning of necessary actions to collect relevant data, providing an ecosystem design with a logical architecture that can be implemented by regional stakeholders. National and international reports helped the research team connect the realities of the region and provide references to existing networks and ecosystems that can help the region better understand the ecosystem emergence process.

1.3.2 Primary data sources: workshops

In terms of the methodology for designing the workshops, we took into consideration the need to create a dialogue with informants to reach our goal of a collective discovery on how the emerging ecosystem in South Ostrobothnia might be able to create value. In so doing, we based our design on the "group decision-making approach" developed by Nummi, 2021). This specific approach has been widely used in Facilitator's Certification Programs in Finland to lead successful workshops. This is part of the latest approaches for dealing with complexity derived from the so-called "dynamic facilitation as a group sense-making tool" (Martin 2014; Nummi 2021; Olmstead and Turpen 2017). We applied an emergent and convergent approach on the three workshops as it enabled a collective dialogue during the decision-making process (Figure 1). Some advantages of this approach are for instance the possibility to benefit from pooling group knowledge, facilitate the acceptance and commitment to innovative ideas, and lead to concrete actions. Co-creation through a dynamic dialogue allows the actors to collaborate and provides a better understanding of how innovations can emerge.

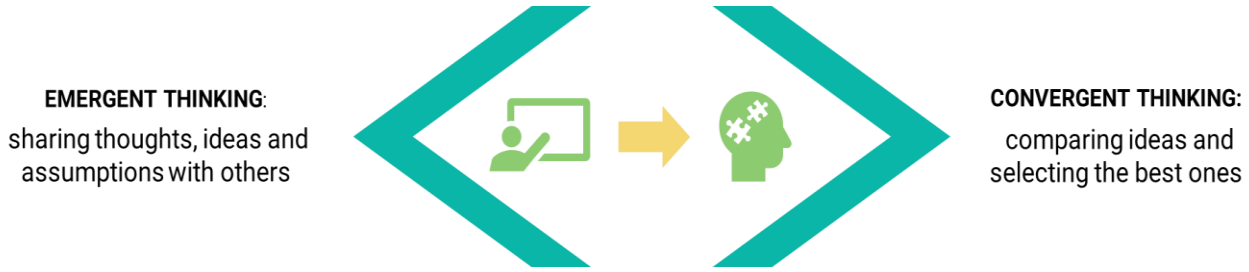

Figure 1. Emergent and convergent thinking is applied in workshops. Developed by Nummi (2021)

The workshops as one of the sources of empirical data encompassed three events taking place during the execution of WP2. One in-person event in Seinäjoki, and two online sessions. The first workshop called "*Puzzling the pieces of the hydrogen economy in South Ostrobothnia: the vision of an ecosystem*," took place in Seinäjoki on March 2025. For running this in-person workshop, we joined forces with the project team of a connected regional development project by the University of Vaasa and SEAMK called "Hydrogen economy opportunities in the food chain" (VEP). We found this a good

opportunity to think strategically on a suitable agenda for empirical approach where regional stakeholders with a greater group of researchers in clean hydrogen. This workshop was promoted through three main channels as i) direct emails sent to key representatives of the target group in the region, ii) an announcement published on the SEAMK website and, iii) LinkedIn posts on the VEPE project profile LinkedIn page.

The goals of the first workshop were to identify potential actors to be involved in a future clean hydrogen ecosystem and get insights from ground to build the first draft of the ecosystem in a visual form and collect ideas about the value proposition that a new social structure in clean hydrogen could deliver for regional actors.

The second and third workshops were running online using Microsoft Teams during September and November 2025. These events took place after a long process of refining ideas about the clean hydrogen ecosystem and concluding that an efficient way of progressing with the tasks requires in the first place from the support of a "core team" of regional actors to validate and discuss our results. The process of formation of the core team will be described in the next chapters of this report.

1.3.3 Primary data sources: semi-structured interviews

Alongside the workshops, we adopted a complementary data collection technique by conducting a set of 15 semi-structured interviews to approach key target actors individually. For that purpose, we selected a group of some of the potential ecosystem members identified on the WP1 and the first workshop. Data collection started in May 2025 and finalized in December 2025. Interviews were conducted via Teams and automatically transcribed. This set of interviews were conducted in Finnish language by the team of SEAMK. The general setting of the interviews included questions related to the following:

- *What kind of opportunities do you see from the hydrogen economy in South Ostrobothnia?*
- *What kind of role do you see your organization playing in possible future clean hydrogen projects and especially in South Ostrobothnia?*
- *What could be the potential challenges for the development of the hydrogen economy in South Ostrobothnia?*

Additional questions included in the questionnaire have been used as an input for the implementation of other work packages (Appendix 1).

This research material was translated into English for analysis by the team of the University of Vaasa. Here, the software tool VOSviewer version 1.6.20 was used to analyse the data from interviews based on its text mining functionality to build and visualize co-occurrence networks of key terms extracted from the interviews' text (van Eck and Waltman 2013; Pinilla-De La Cruz, Rabetino, and Kantola 2020, 2021).

1.3.4 Primary data sources: short survey

The third empirical technique used for data collection corresponds to a survey about operational aspects of the clean hydrogen ecosystem. This survey was responded by 10 stakeholders during November 2025. For this purpose, we used the software tool Webropol to create the survey consisting of three questions and collect and processing answers (Webropol 2026).

Overall, data analysis included an iterative process of contrasting findings with scientific literature and the latest international and national reports on clean hydrogen ecosystems and collaborative networks. The findings and conclusions related to Tasks T2.2, T2.3 and T2.4 on the following chapters.

2 Stakeholder mapping and ecosystem visualization (T2.2)

This task focused on developing a preliminary draft of the clean hydrogen ecosystem in South Ostrobothnia. First, it is relevant to highlight that ecosystems have been defined by several scholars as complex systems in which a diversity of agents interacts with each other and with their context, and whose interactions largely determine both its structure and roles (Anderson 1999; Han et al. 2022; Peltoniemi 2006). For South Ostrobothnia in particular, we aim to provide a vision of an ecosystem according to the identification of those key potential actors that eventually would participate or contribute to the ecosystem in various roles. This process of sketching the structure before the actual specific interactions around clean hydrogen happen would help the regional actors to understand the connection between actors in various levels.

Therefore, the visualization of the ecosystem at this stage serves as a blueprint for those regional actors that would take the leading role on the implementation of this vision. This ecosystem has been structured in a visual format to provide a comprehensive overview and facilitate clearer communication of its components and interrelationships. The resulting draft would serve as a representation of a potential regional hydrogen ecosystem in South Ostrobothnia.

2.1 Identification of actors involved and participating in the ecosystem

Based on background study of T2.1 "Hydrogen Ecosystem Background Mapping", we were able to develop an initial draft of the ecosystem' structure, which encompassed type of potential stakeholders identified in WP1 and the first workshop (March 2025) and complemented with information from reports of national hydrogen networks. This first draft allowed us to recognize the diverse nature of stakeholders and connection with key sectors as energy, food and agriculture, education, and hydrogen (Katri Valkokari et al. 2021; Nousiainen and Vienamo 2019; Pinilla-De La Cruz 2024, 2025)

To this new social structure, we called the "**VetyVisio Ekosysteemi EP"**(*Future-oriented clean hydrogen ecosystem in South Ostrobothnia*), as this is the first attempt to produce an ecosystem architecture built as a vision of regional actors in South Ostrobothnia to develop the hydrogen economy.

2.2 Visual form of the ecosystem

The "**VetyVisio Ekosysteemi EP"**was visually represented to be understood and communicated more effectively. We used the map proposed by Valkokari et al. (2021) and Nousiainen and Vienamo (2019) as a basis to organize the identify potential public and private stakeholders into categories according to the nature of actors (grey – capital letters) and subsequently, to the sector/role on the ecosystem according to the hydrogen value chain (green) (Figure 2).

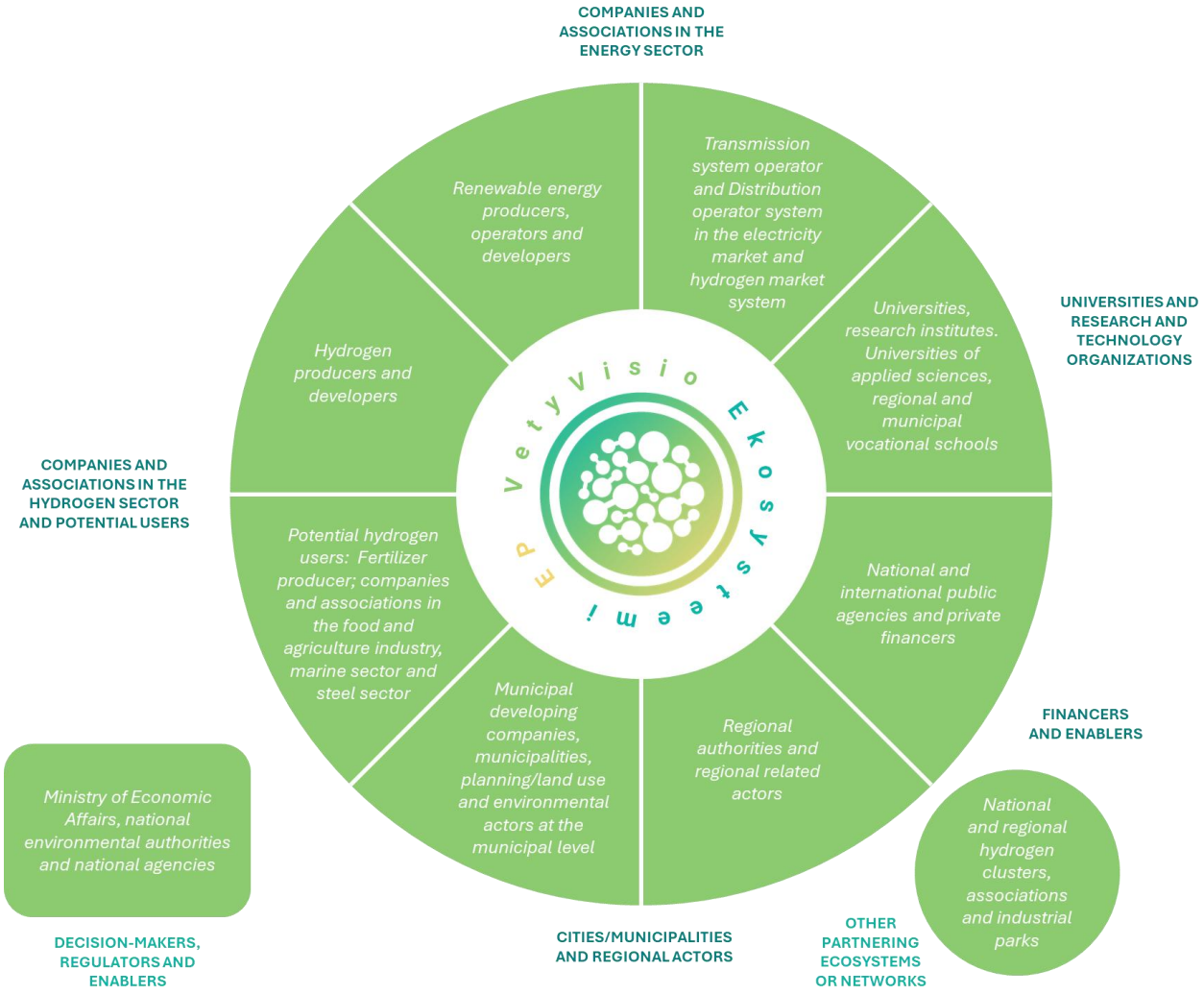

Figure 2. The "**VetyVisio Ekosysteemi EP**" ecosystem visualization. Based on Valkokari et al. (2021), and Nousiainen and Vienamo (2019)

*__Note__: Names of individual actors identified in this task are not available in this public report due to data management rights.

Hence, broad categories (capital letters) correspond to i) companies, enterprises, and users; ii) municipalities, regional authorities, and other regional and national actors; iii) universities and research and technology organizations; iv) financiers and enablers. The above-mentioned categories are accompanied by two support categories as i) Decision-makers and enablers, and ii) Other partnering ecosystem networks.

A more specific categories (in green) are related to the connection the hydrogen value chain segments identified in WP3 and supporting sectors on the development of the hydrogen economy in South Ostrobothnia (Business Finland 2023; Laurikko et al. 2020). Those categories are: i) stakeholders in the renewable energy sector; ii) stakeholders in the transmission system operator (TSO) and distribution operator system (DSO) sectors; iii) hydrogen producers; iv) hydrogen users; v) cities and municipalities; vi) other regional and national actors; vii) public and private funders/financers; and viii) high education institutions and research organizations.

After generating the first picture of the **VetyVisio Ekosysteemi EP,** we proceeded to locate the specific categories of public and private stakeholders identified into a multi-layer ecosystem structure model, which locates actors based on their level of involvement (Figure 3). This model was originally developed by Valkokari et al. (2021). This multi-layer model provides a visual information on the process of ecosystem emergence, particularly on how **potential members** identified during the *ecosystem genesis* progressively could be engaged in this social structure as **active members, partners**, or even part of the **ecosystem orchestration team** (Figure 3).

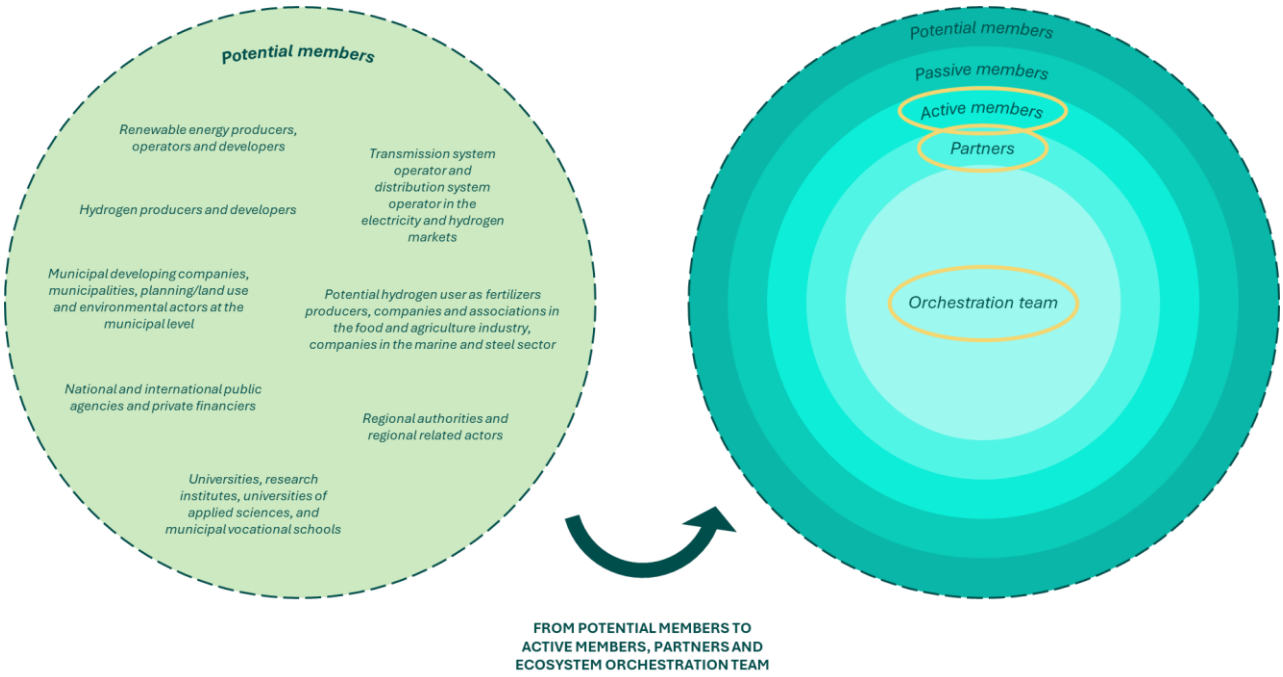

Figure 3. The "**VetyVision Ekosysteemi EP**" according to the multi-layer ecosystem structure model based on the level of involvement. Adapted based on Valkokari et al. (2021)

In the multi-layer model developed by Valkokari et al. (2021), the outermost layer is related to the potential members of the ecosystem. This layer corresponds to those actors that have been identified as potential stakeholders in the ecosystem as they work in areas of interest or related topics, but they are not yet involved. The following layer corresponds to the **passive members,** who are not actively involved in the ecosystem's development work, they follow the ecosystem activities, and they can take other roles in the ecosystem by the time. Subsequently, we can find those actors located in the layer of **active members** are expected to engage in co-creation, collaborative projects, and development of initiatives by contributing with resources and expertise to the ecosystem. Concerning the layer of **partners,** it is expected that this ecosystem members collaboratively shape the ecosystem's vision and make by the time meaningful investments to support its development and growth. Finally, in the innermost layer we find the **orchestration team or "core team,"** where members are expected to provide coordination and guidance to the ecosystem in emergence.

3 Ecosystem value creation and operational planning involving stakeholders (T2.3)

This task is focused on defining the framework for the "**VetyVisio Ekosysteemi EP**" as an emergent public-private clean hydrogen ecosystem in South Ostrobothnia. Here, we examined how an ecosystem can create value for its key assets' operators and most commonly South Ostrobothnia. Furthermore, we present a preliminary proposal of the ecosystem activities and operating principles that would potentially maintain and support development of the ecosystem, those actors whose active role is central to ecosystem development and orchestration, as well as strategies for ecosystem development engaging members in the ecosystem. We used the findings from our workshop in March 2025 and from the set of semi-structured interviews. Our empirical findings were validated with scientific literature and recent national and international reports.

Here, we consider the "**VetyVisio Ekosysteemi EP**" as social structure in its initial stage or in its "*genesis*" (Asplund et al. 2021; Pinilla De La Cruz 2025; Pinilla-De La Cruz and Rabetino 2024). This stage is characterized using relational approach to connect with potential members, as well as raising awareness about the initial vision and the implications for the region. By discussing and looking for consensus among potential members was possible to build a more refined idea of the ecosystem and its potential form of operation.

3.1 Potential forms of ecosystem value creation

According to Adner (2017) and Kolagar, Parida, and Sjödin (2022), ecosystems align diversity of partners around the aim to materialize a system-level value proposition. For this purpose, one of the first steps was to work on establishing a dialogue with regional actors to build a realistic picture of ecosystem potential ways of operation and value creation was the recognition of the context including opportunities and challenges for South Ostrobothnia. Notably, the region outstands in Finland due advantages to support the hydrogen economy in the near future. Although the current plans for the

hydrogen pipeline networks not yet include the area, this region could play a key role on the Finnish clean hydrogen picture due to its large renewable energy projects particularly in terms of wind power and solar photovoltaics that is expected a significant addition of electricity capacity to the Finnish energy system in the coming years (Siekkinen 2024). This, combined with plans to strengthen the transmission lines, represents a major advantage in promoting the role of hydrogen as a flexible resource for energy systems. Additionally, more than 60% of the region's gross Finnish national production is based on the value chains of various parts of the food system, where South Ostrobothnia produces about 12% of the total value of production in the entire Finnish food industry (Siekkinen 2024). These advantages also include proximity to surrounding cities such as Kokkola, Kristiinakaupunki, Tampere, and Pori, to establish synergies in the integration of the hydrogen value chain.

Taking these contextual aspects into account, we explored during the first workshop (March 2025) the current needs at the regional level that a clean hydrogen ecosystem could try to address over time. Key findings in terms of regional needs and in terms of how a potential clean hydrogen ecosystem could deliver value to the region are presented below (Table 2):

Table 2. Key findings from the workshop March 2025

First workshop - regional needs and initial idea about value to deliver

Workshop with regional actors and companies in March 2025

Key findings	
Regional needs	Identify, consolidate, and effectively communicate opportunities for clean hydrogen projects.
	Fostering collaboration and synergies between stakeholders across the clean hydrogen value chain and potential investors.
	Explore and optimize the use of existing industrial side streams to integrate them into the clean hydrogen value chain and maximize value creation.
	Support regional job creation through clean hydrogen initiatives.
How a potential clean hydrogen ecosystem could deliver value to the region	Supporting and integrating the clean hydrogen value chain in South Ostrobothnia
	Enabling the growth of key industries, attracting investment in projects
	Delivering sustainable value for stakeholders

From the abovementioned findings, the "**VetyVision Ekosysteemi EP**" could be conceptualized as:

> *"A social structure that could supports and integrates the clean hydrogen value chain in South Ostrobothnia, enabling the growth of key industries, attracting investment in projects, and delivering sustainable value for stakeholders".*

The connection between this preliminary concept of the ecosystem added to the identified regional needs provide together valuable insights to reach a better understanding of the nature of this emerging public-private ecosystem.

From the concept of the "**VetyVision Ekosysteemi EP**," we continued to assess potential members' perceptions of how their organizations relate to the hydrogen economy and the opportunities for value creation, drawing insights from the responses provided during the semi-structured interviews. This approach has been vital to this work, as the hydrogen economy is a relatively new topic still largely unexplored in current regional economics and projects. Therefore, one-on-one dialogues can provide a realistic understanding of how potential members perceive this emerging phenomenon and its connection to the development of the hydrogen economy, even before specifically discussing potential participation in the ecosystem. This activity includes some national actors and regional actors in the surrounding areas. For regional actors in South Ostrobothnia, this dialogue also serves to raise awareness about the hydrogen economy as it is needed in the genesis of public-private ecosystems by posing key questions and fostering debate among stakeholders.

By using the software tool VOSviewer to visualize the link strength between terms from informants' answers in the form of clusters represented by lines and dots in assorted colours (van Eck and Waltman 2013). The first data analyzed with VOSviewer was related to the potential roles that organizations would play in the hydrogen economy in South Ostrobothnia. Results are presented below (Figure 4).

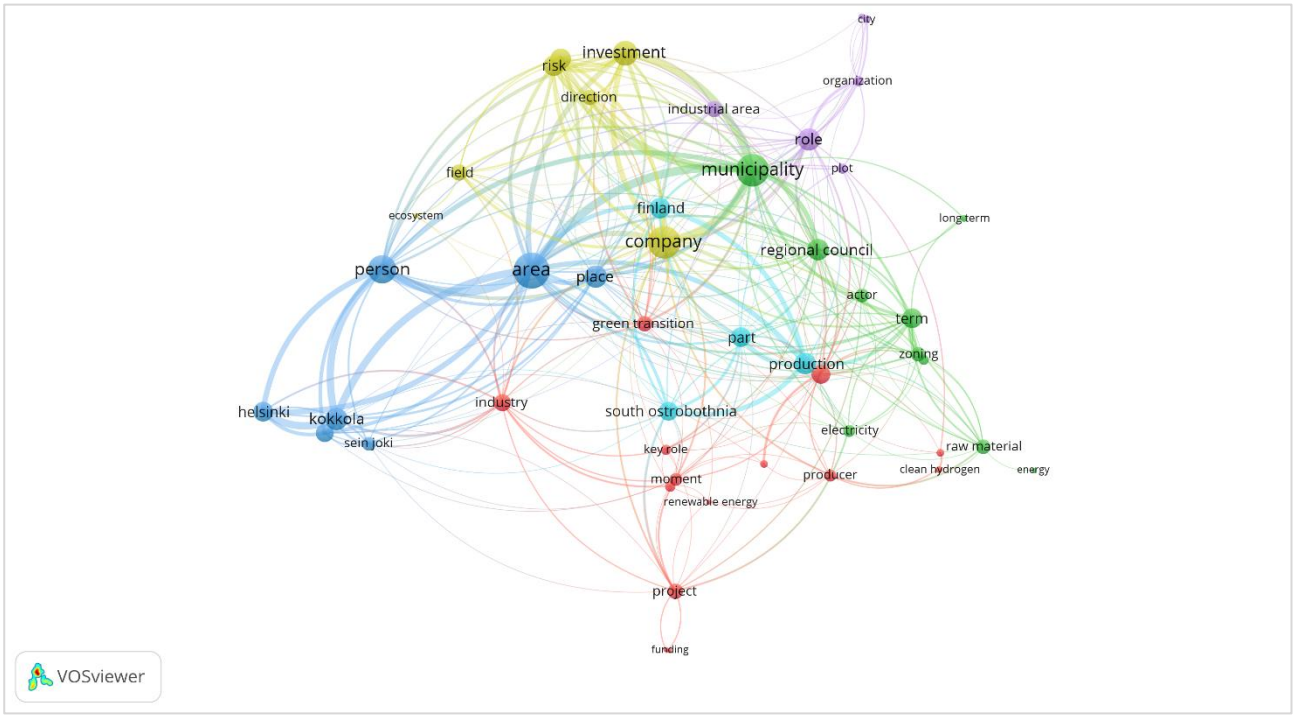

Figure 4. Cluster visualization of roles that organizations could play in the hydrogen economy in South Ostrobothnia

In terms of the role that informants mentioned as their organization would play in potential clean hydrogen projects and especially in South Ostrobothnia, we identified five clusters that enclosed key roles based on the VOSviewer analysis that are described below (Table 3).

Table 3. Key findings semi-structured interviews in terms of the role of organizations (based on VOSviewer analysis)

Role of organizations in clean hydrogen

Based on data analysis using VOSviewer Figure 4

Key findings	
Cluster in yellow	Connecting actors as companies related to investment and direction of the ecosystem
Cluster in green	Information about possible regional and municipal public actors as the Regional Council and Municipality in relation to activities such as zoning, long-term planning, use of raw materials and electricity
Cluster in red	Connection between industry, projects, clean hydrogen production, renewable energy and funding
Cluster in purple	Connection between the city and industrial areas; and finally
Cluster in blue	Connection of South Ostrobothnia with hydrogen industrial areas as Helsinki and Kokkola through ecosystems

Regarding the analysis of opportunities perceived from the hydrogen economy in South Ostrobothnia, we could identify four major clusters (Figure 5).

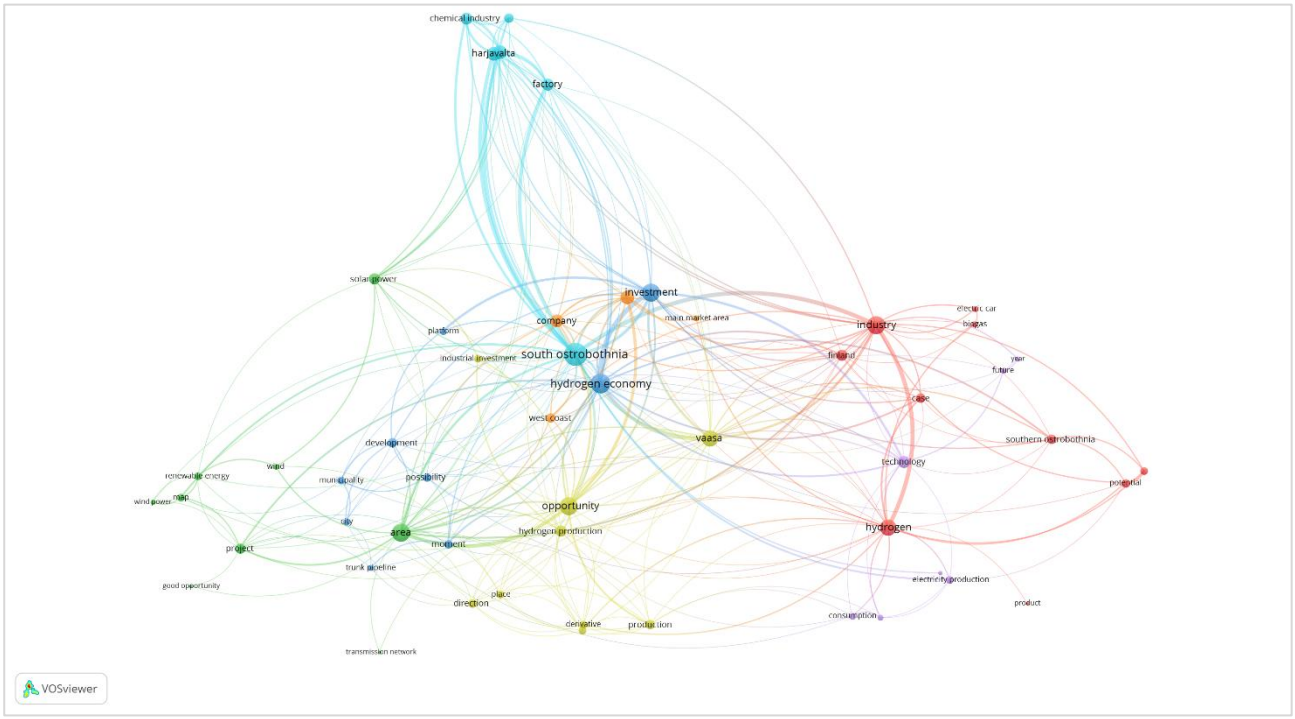

Figure 5. Cluster visualization of opportunities from the development of hydrogen economy in South Ostrobothnia

According to our findings, there are positive attitude towards the hydrogen economy, and informants already identified connections with opportunities in the regional and national levels. Key insights are described below (Table 4).

Table 4. Key findings semi-structured interviews in terms of the opportunities for South Ostrobothnia (based on VOSviewer analysis)

Opportunities from clean hydrogen for South Ostrobothnia

Based on data analysis using VOSviewer Figure 5

Key findings	
Cluster in green	Renewable energy appears as a good opportunity to develop the hydrogen economy in the region.
Cluster in red	Connection that informants see from hydrogen with industry, electric cars, biogas and even food shortage. This last concept is interesting because is linked to the hydrogen value chain related to green ammonia-to-fertilizer production.
Cluster in yellow	Concepts related to the opportunities that stakeholders identified from the connections between industrial development with hydrogen production and hydrogen derivatives and the surrounding areas as Vaasa region.
Cluster in light blue	Informants relate the opportunities in hydrogen economy with some examples of the current projects in Finland as the “Harjavalta plant” and the chemical industry.

Finally, in relation to potential challenges for the development of the hydrogen economy in South Ostrobothnia, we used the density visualization map in VOSviewer to show what are the most relevant aspects identified by informants, as it is shown in the figure below (Figure 6).

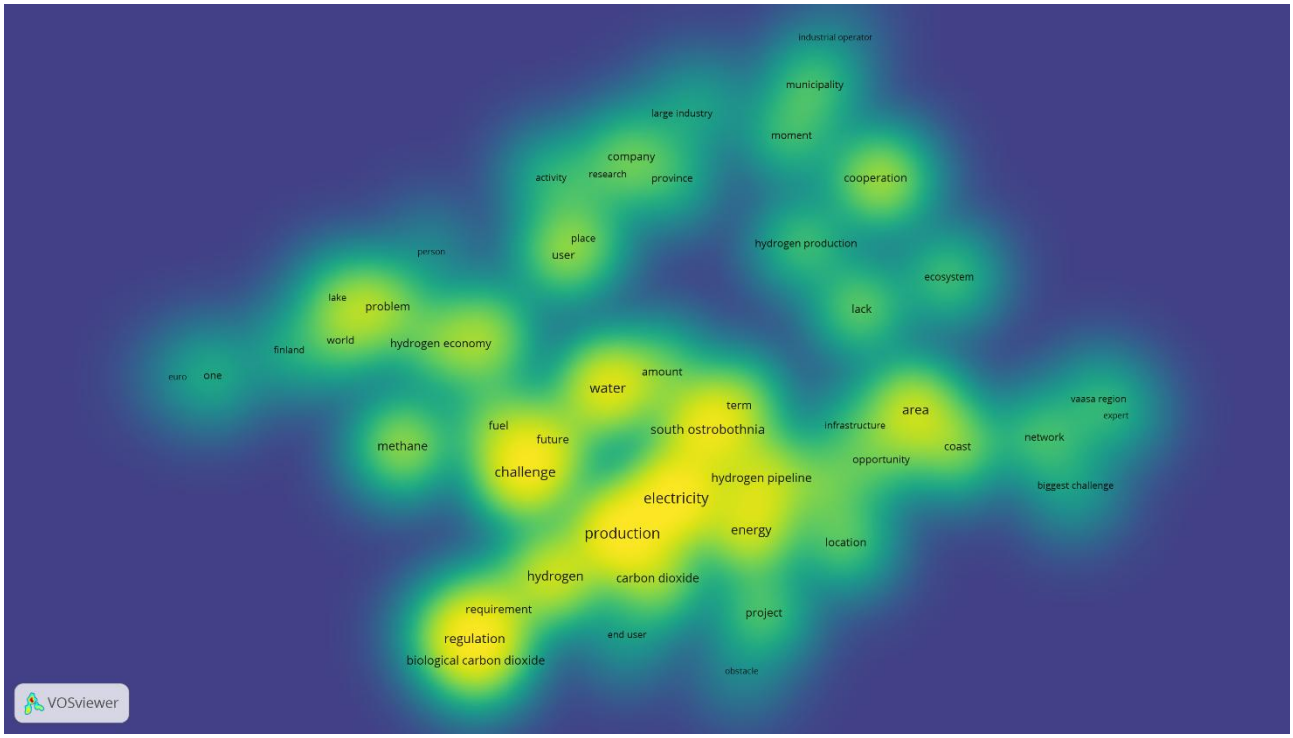

Figure 6. Density visualization of potential challenges for the development of the hydrogen economy in South Ostrobothnia

From the density map it is possible to observe that aspects of clean hydrogen production, for instance, the amount of water and the amount of electricity appear as relevant for actors in terms of challenges. Particularly, the potential water consumption has been highlighted by informants since South Ostrobothnia lacks seawater sources. Likewise, the lack of sources of carbon dioxide in the region appears in the map as a key challenge for the production of synthetic fuels as eMethane, eMethanol or eSAF (sustainable aviation fuel). Other aspects appear on the analysis in relation to the need of engage end users and industrial operators to boost the hydrogen economy in South Ostrobothnia. These aspects are summarized in the table below (Table 5).

Table 5. Key findings semi-structured interviews in terms of challenges for South Ostrobothnia

Challenges for South Ostrobothnia

Based on data analysis using VOSviewer Figure 6

Key findings
Water and electricity amounts for hydrogen
Lack/need of hydrogen pipeline
Lack of carbon dioxide/biological carbon dioxide
Requirements/regulation
Need of end users for hydrogen
Need of large industry/industrial operators/experts
Coast areas connected to hydrogen
Need of cooperation among actors

Some important reflections on this set of semi-structured interviews can also be found in the article entitled "*Voiko Etelä-Pohjanmaasta tulla vetytalouden edelläkävijä?*" written by Jenni Lind, who is part of the VEPE project team (Lind 2025) .

It is worth noting that the key findings have been a relevant input for determining the operational planning of the ecosystem during its genesis as described in the following section.

3.2 Operational planning involving stakeholders: core team as an orchestration team of the ecosystem during the genesis

Building on the experience gained from planning the initial workshop as well as in discussions with the project's steering group and semi-structured interviews, the strategy focuses on initiating stakeholder engagement within the "**VetyVisio Ekosysteemi EP**" by starting from its innermost layer called the "**core team**". We formed this "core team" with those regional actors who have expressed any interest in participating in the initial discussions around hydrogen economy (Figure 7). This core team would act in the genesis of this emergent ecosystem as the orchestration team, by providing direction about how the ecosystem should work. As the hydrogen economy is a new topic in the region and at the time of drafting this report there was not any concrete hydrogen project or investment in South Ostrobothnia, the core team would be integrated mostly by public regional and municipal actors.

These findings are aligned with the literature of ecosystem emergence, where public actors play a significant role in genesis of public-private ecosystems, particularly by bringing together organizations that may not have previously been linked or related to one another, and when private organizations are not yet willing to participate or commit (Asplund et al. 2021a; Dedehayir, Mäkinen, and Ortt 2018; Dedehayir and Seppänen 2015). In this early stage, public regional actors could perform as "orchestrators-facilitators", as they are pursuing common interests at the regional level and a wide spread of diffusion of ideas around clean hydrogen among actors, to build synergies and collaboration pathways. In a further stage of the ecosystem development, it is possible that a "orchestrator-player" could take the leading role by pushing commercial goals (Addo 2022).

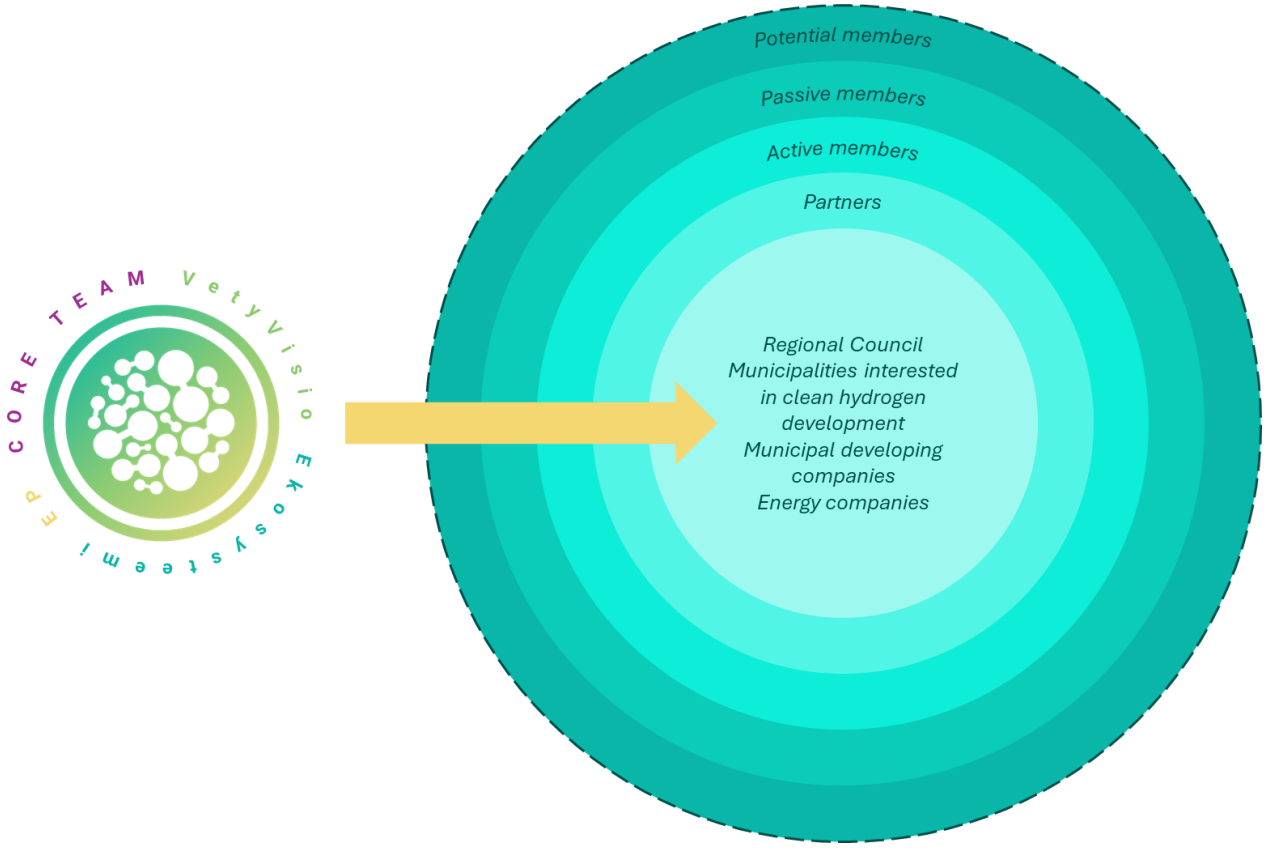

Figure 7. Core team of the VetyVisio Ekosysteemi EP

The aim of the core team of the **VetyVisio Ekosysteemi EP** was to form a group that meets to discuss hydrogen-related themes relevant to the region. The group acts as an engine for development, building a common understanding and vision of the region's ecosystem. At the same time, the core team is expected to help in the discussions for preparing the region for the development of the hydrogen economy and the opportunities associated with it. The core team will have regular meetings, create a common understanding, and discuss the group's methods of operation. Therefore, the core team covers several approaches in parallel for the orchestration of key processes related to ecosystem emergence such as value discovery, contextual embedding, and collective governance (Thomas et al., 2022) (Figure 8).

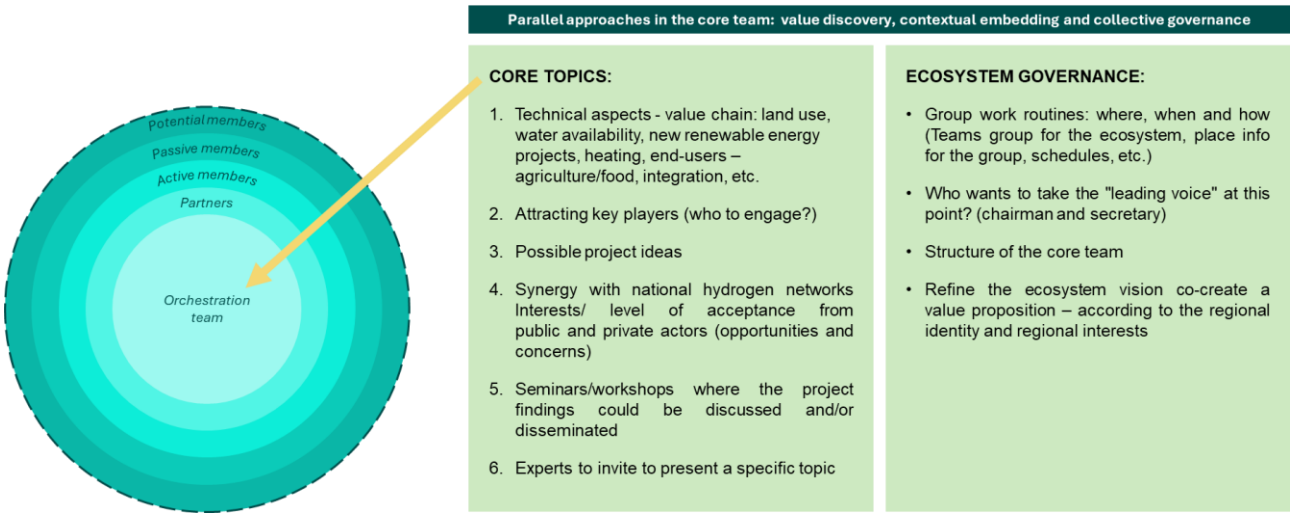

Figure 8. Parallel approaches covered by the core team of the VetyVisio Ekosysteemi EP

The initial settings of the operation of this core team consist of periodic meetings with ecosystem members each time there are technical presentations and workshops. Additionally, a Teams group was created to facilitate communication among core team members. This Teams group comprised six folders where the core team members could find information about: the aim of the group, summary of meetings, informative material, events, other business, and data management (Figure 9).

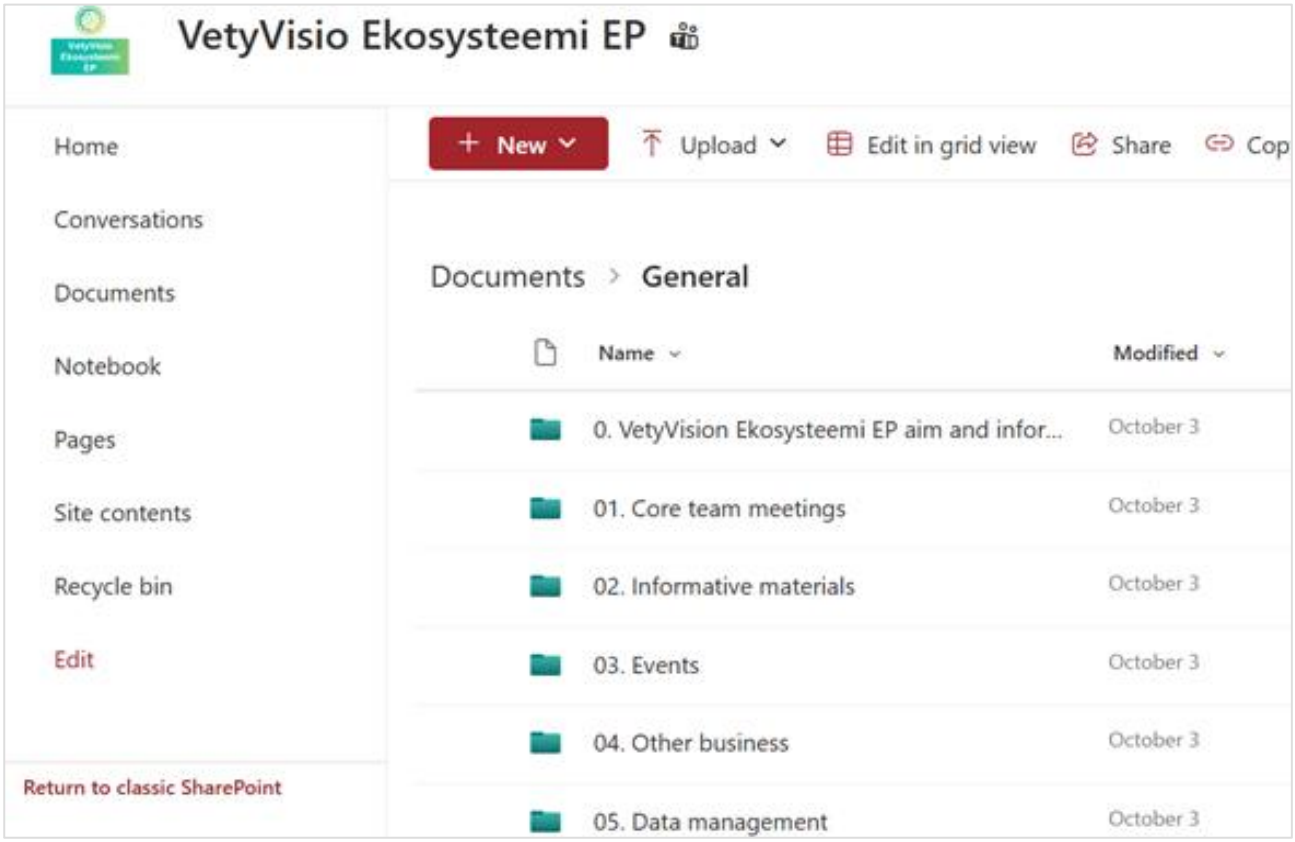

Figure 9. Screenshot of the Teams group created for core team of the VetyVisio Ekosysteemi EP

The core team started in September 2025. As of this report, two meetings have been held to present and discuss partial project results, and two workshops have taken place (September and November 2025), whose results have contributed to the refinement of the ecosystem model. In these events organized by the project team, the University of Vaasa has taken on the role of organizer of the meetings and the content, and SEAMK's role has been related to facilitating the workshops.

Besides the technical discussions on the position of South Ostrobothnia to develop the hydrogen economy, these meetings have also been used as space to connect and learn from the best practices of national hydrogen networks. By providing the chance to discuss with members of other successful social structures in clean hydrogen, core team members would understand the implications of the hydrogen economy and build an ecosystem for this purpose.

3.2.1 Core team: first workshop

The first workshop with the core team of the VetyVisio Ekosysteemi EP took place in September 2025 via MS Teams. In this event, the project team introduced the proposal for ecosystem design based on the partial results of this project and continue delivering two presentations called "*From hype to reality: hydrogen opportunities for Finland and South Ostrobothnia"* and "*What is needed to develop a hydrogen value chain focused on green ammonia at a regional level?* as a focus on the workshop activities. The aim was to discuss the perceptions of stakeholders from the regional point of view on the relevance for the organizations they represent at the regional level. Key findings are presented on the table below (Table 6).

Table 6. Key findings: core team workshop September 2025

Core team workshop September 2025
Key findings
Perception of clean hydrogen as a new topic in the region without commercial significance now with opportunities and challenges
Clean hydrogen requires proper discussions about important aspects in this matter related to advocacy issues, water availability, planning, heating, infrastructure, etc.
There is a recognition on the high relevance of fertilizers in the region as an agriculture region connected to the hydrogen value chain.
Cooperation and the need of building an ecosystem with regional actors is perceived as a key point for the hydrogen economy's development.

3.2.2 Core team: second workshop

The second workshop was held in November 2025 via MS Teams. This session was planned to provide information about examples of existing networks/ecosystems in Finland to show a social structure emerge, develop, and consolidate, and open a discussion with informants about their perceptions on it. For this purpose, members of the **BotH2nia network** and **BotH2nia valley** provided a detailed and illustrative presentation about the process of emergence of the network from the regional perspective (Both2nia 2026). Ket findings of the workshop are presented below (Table 7).

Table 7. Key findings: core team workshop November 2025

Core team workshop November 2025

Key findings
Perception of the BotH2nia network as a successful example of a social structure stemming from early and active involvement of key stakeholders, particularly companies and industry experts, combined with professional coordination that ensured efficient information exchange and rapid learning for newcomers.
The BotH2nia network exemplifies a well-functioning, diverse collaboration, encompassing businesses, municipalities, public organizations, and the education sector, with strong information and contact sharing.
The BotH2nia network's multidisciplinary approach, structured workshops with follow-up communication, and continuous company engagement appear as critical factors according to informants.
Informants also discussed the role of public actors in the BotH2nia network, how the network works in practice, and what structure would be suitable for South Ostrobothnia.

3.2.3 Core team: stakeholders' engagement and periodic meetings

As the stakeholder's engagement is a key activity specially in the genesis of the ecosystem, we run a brief survey in November 2025. By using the online software Webropol, we sent the survey to core team ecosystem members to get feedback about which topics are currently most interesting to those

organizations, what is the preferred frequency for holding meetings, and their intention to be officially part of the core team ecosystem. The results of the survey indicate that the most interesting topics to approach in meetings are related to i) water use in hydrogen and green ammonia production; ii) other additional topics as: hydrogen applications, hydrogen value chains and ecosystems, regional cooperation within the ecosystem, and the development of the hydrogen economy in Finland and the EU; and iii) green ammonia production process requirements (Figure 10).

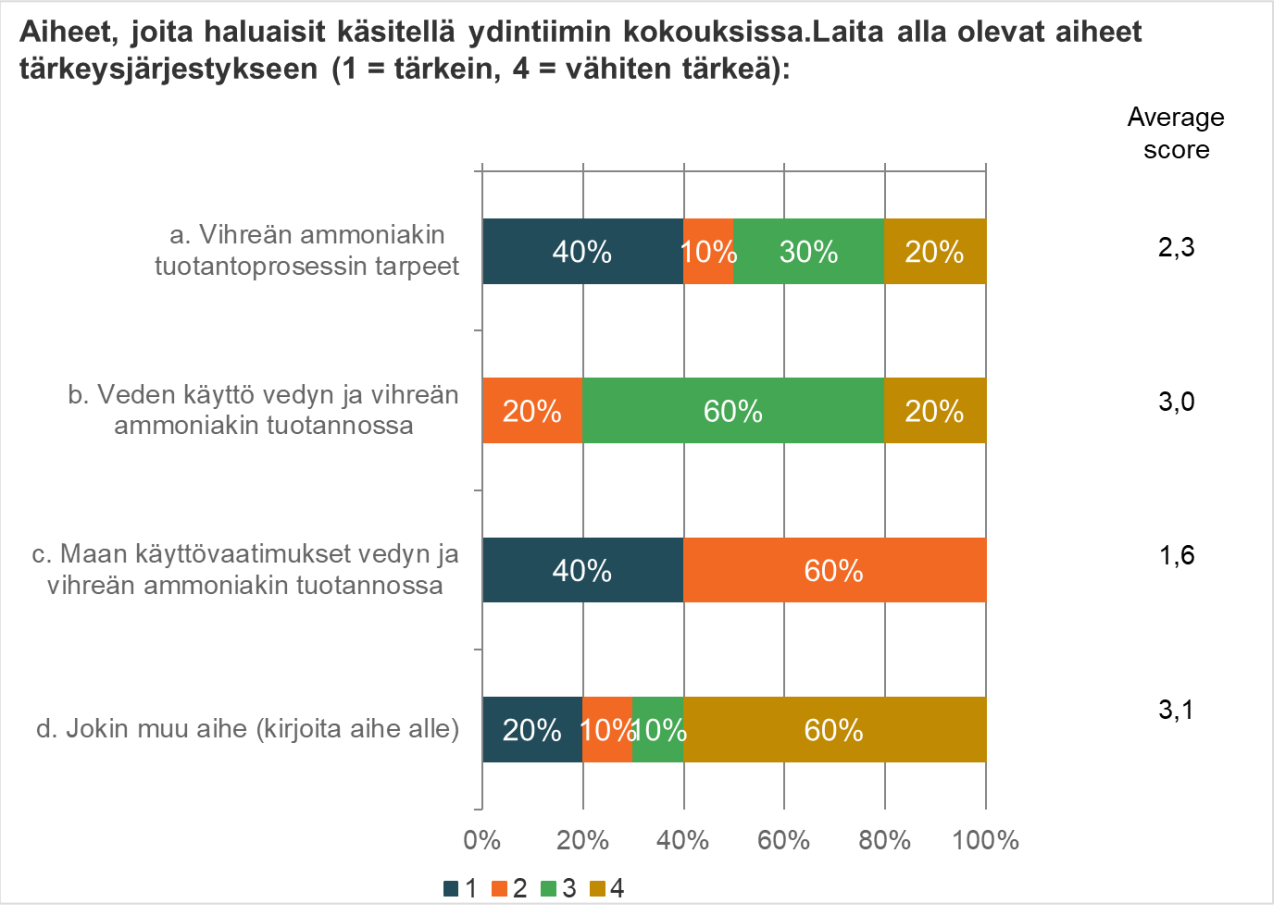

Figure 10. Answers on the most interesting topics for organizations in the core team VetyVisio Ekosysteemi EP (results in Finnish)

In relation to the question about how often the core team should meet, all members answered that they prefer to meet three or four times per year (Figure 11). This indicates that current members do not see an urgent need to promote more frequent interactions, as there are no concrete projects or

investor interest in the region. Therefore, the topic for discussions around clean hydrogen does not appear to be a short-term priority for regional stakeholders.

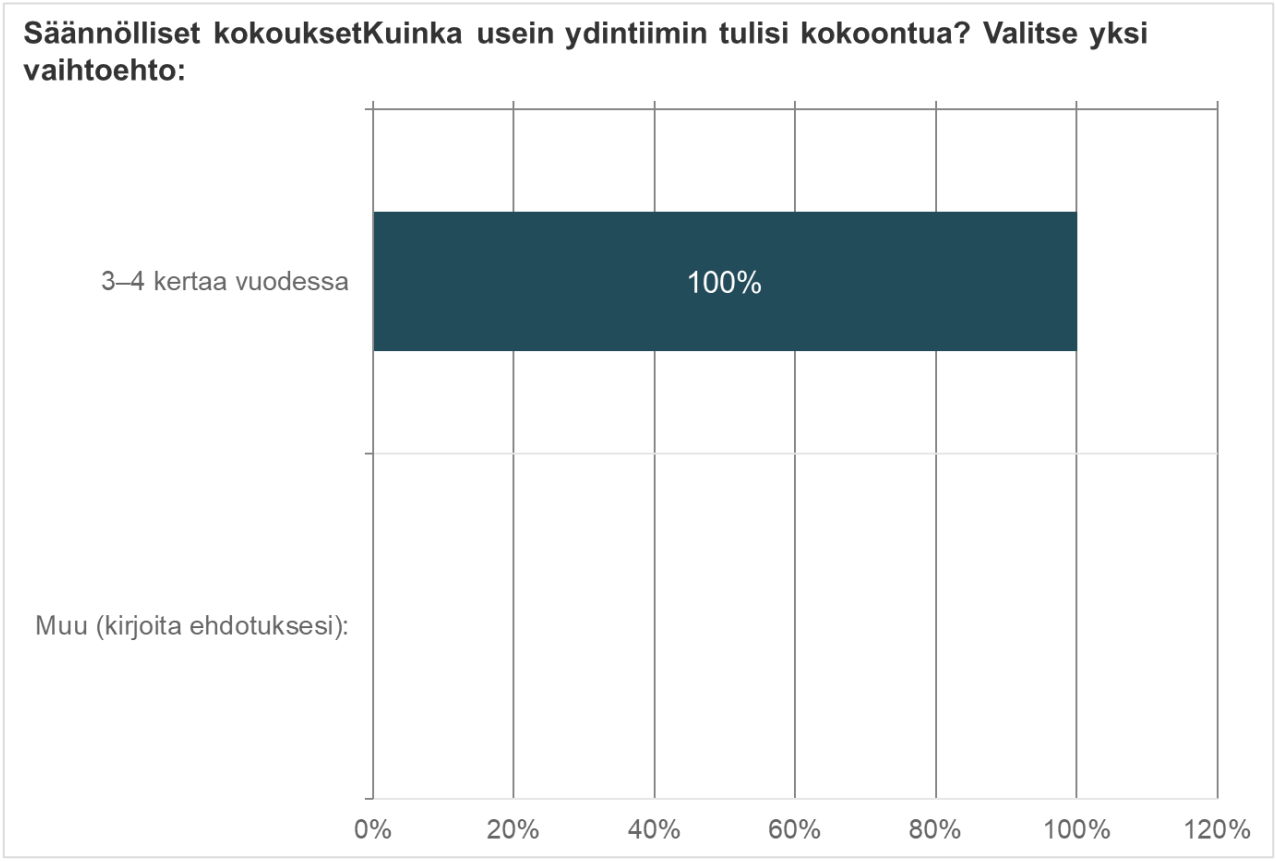

Figure 11. Answers on the preferred frequency for holding core team meetings (results in Finnish)

The final question corresponded to the willingness of respondents to officially belong to the core team ecosystem. Here we found that 20 % of the respondents are interested in participating as members of the core team and 80 % see their participation as a possibility (Figure 12). According to the answers, it is possible to infer that current members are in mayority not expected to commit to official activities in the ecosystem yet. This could be influenced by several factors, firstly, the lack of interest at the moment from any investor in running a hydrogen project in the region, but also as a result of delays in final investment decisions on key projects in Finland during 2025.

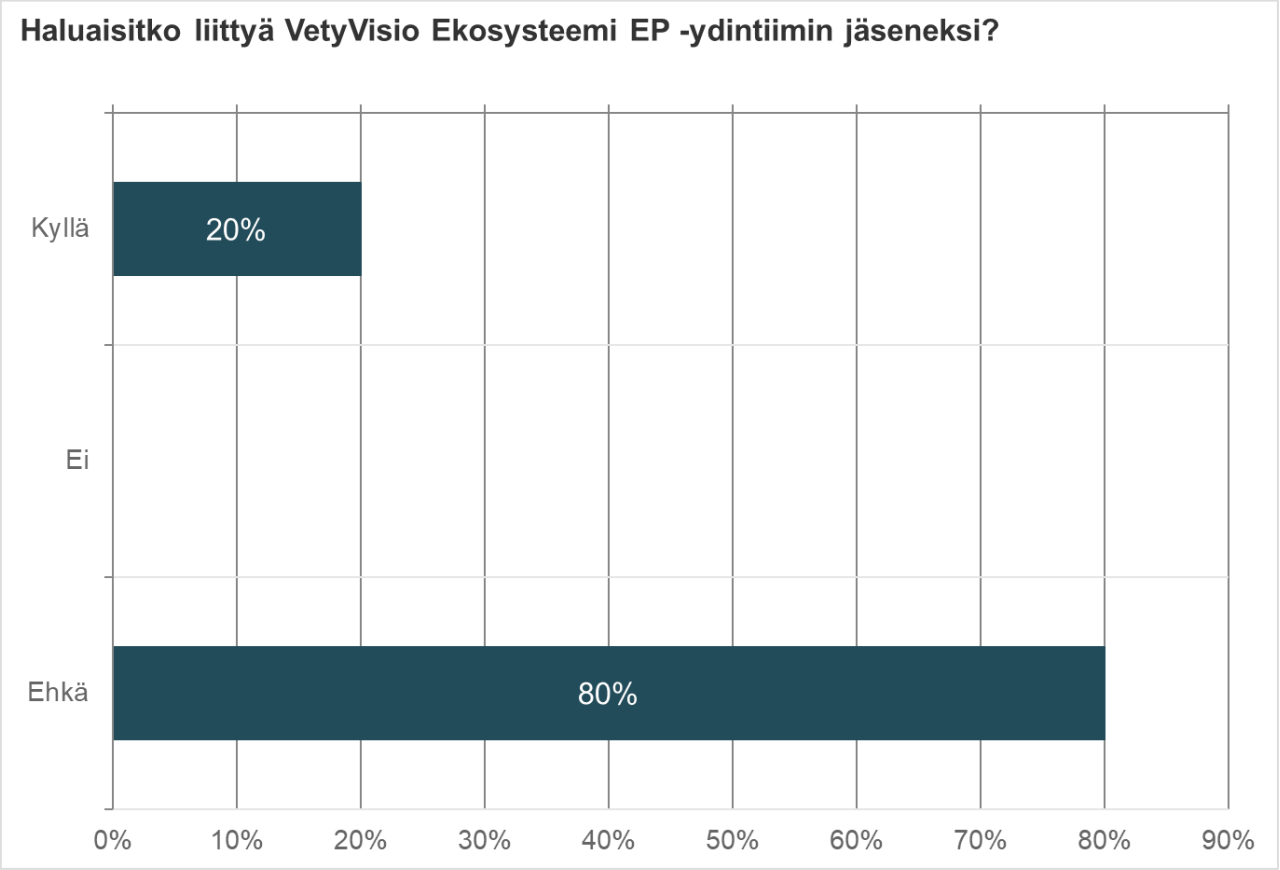

Figure 12. Answers on the willingness to belong to the core team ecosystem

Overall, the results indicate that stakeholders in the core team are interested in getting a better understanding of the specific implications of the hydrogen economy in South Ostrobothnia (water, green ammonia) and regional cooperation through ecosystem, as well as hydrogen economy in Finland and Europe. These results are positive as show the different edges of the topic which to be addressed by the time to get consensus on the regional strategy in clean hydrogen for the next years.

On the other hand, in relation to the frequency of meetings and the willingness to officially belong to the core team it is possible to infer that the topic is still perceived as a future phenomenon that is not that close yet to be materialized in the region. Therefore, the engagement activities at this stage are recommended to be related to keep a continuous discussion among actors interested in the topic.

4 Ecosystem design (T2.4)

The model developed for the VetyVisio Ekosysteemi EP integrates the key elements discussed in the previous chapters. It consists of a four-component structure derived from the data collection and analysis carried out during WP2 as: i) stage in the ecosystem emergence; ii) ecosystem map; iii) identification of needs to solve and value to deliver; and iv) ecosystem architecture and processes (Figure 13). Grounded in conceptual approaches from ecosystem emergence literature, the model has been adapted to the specific characteristics of the South Ostrobothnia region. Since ecosystem emergence and consolidation occur in stages, beginning with the genesis stage, which forms the cornerstone of this social structure, the initial version of the model is presented here. This model can be updated over time to reflect the ecosystem's evolving needs. The four components of the model are described in detail below.

4.1 Stages in the ecosystem emergence

According to recent literature on ecosystem emergence, the process of public-private ecosystem emergence consists of distinct stages in which processes such as value discovery, collective governance, contextual embedding, and ecosystem continuity resources are explored and strengthened (Asplund et al. 2021a; Thomas et al. 2022). Each stage ends with the consolidation of some of these processes to a level that allows the ecosystem to achieve the necessary robustness to progress to a higher evolutionary stage until its consolidation (Gifford, McKelvey, and Saemundsson 2021).

4.2 Ecosystem map

The ecosystem map synthesizes the composition of the **VetyVisio Ekosysteemi EP** in terms of the type of actors that potentially would integrate this social structure. Those actors are categorized according to their nature, and next to the sector/role in connection to hydrogen value chain. In the category of companies and associations in the energy sector, the type of actors is related to renewable energy producers, operators, and developers, as well as transmission and distribution operators

in the electricity, and those in the emerging hydrogen market. In terms of the categories related to companies and associations in the hydrogen sector and potential users, it is possible to find the hydrogen producers and developers, also those potential users in hard-to-abate sectors as fertilizer producers, food and agriculture industries, and marine and steel companies. As for the category related to cities/municipalities and regional actors encompassing for instance the municipal developing companies, municipalities, planning/land use, and environmental actors at the municipal level, as well as those regional authorities and other regional related actors even in surrounding areas.

Concerning the category of financers and enablers we find those national and international public agencies and private financial institutions able to provide financial resources for hydrogen-related projects. The last category of actors inside the ecosystem is connected to the universities and research institutions, and technology organizations, which includes not only universities and research institutions but also universities of applied sciences, regional and municipalities vocational schools. These organizations are relevant to provide the appropriated training and job skills for the hydrogen economy needs. Additionally, two categories are adjacent to the ecosystem exerting influence on the ecosystem, these are related to the decision-makers, regulators and enablers, and other partnering ecosystems or networks. Here in these adjacent categories are identified relevant entities as Ministries, national authorities, and national agencies, as well as national and regional hydrogen clusters, associations, and industrial parks.

4.3 Identification of needs to solve and value to deliver

In ecosystem literature, the value discovery process appears as one of those that occupies the most attention of the actors during the early stages, given that there is an expectation of the actors about the possible implications and benefits that could be obtained for the participating organizations from participation in the ecosystem (Autio 2022; Hannah and Eisenhardt 2018; Thomas et al. 2022).

In connection with the literature, from the interaction with actors in workshops, the findings indicate at this stage that the concept of the ecosystem appears to a social structure supporting the integration the clean hydrogen value chain in South Ostrobothnia, enabling the growth of key industries,

attracting investment in project, and delivering sustainable value for stakeholders. It is worth clarifying that this concept serves as a starting point for the first approach to an ecosystem-type social structure, but this idea is susceptible to change or updating as discussions become increasingly focused on aligning actors towards a shared value proposition.

4.4 Ecosystem architecture and processes

The last element of the ecosystem model corresponds to the architecture and processes. Here, we would like to illustrate how this emerging public-private ecosystem constitutes a multi-level structure where actors reach different positions within this structure through continuous interactions in terms of building a collective governance framework, discovering their individual and collective value to deliver, to achieve a higher relevance on the regional, national o even eventually international context, and securing resources for the continuity of the social structure as such.

- **Ecosystem multi-level structure**: *five levels of stakeholder engagement* (Valkokari et al. 2021; Valkokari et al. 2017). Potential members progress from the outer to the inner layers of the ecosystem structure. The core team is located at the innermost level, comprised of ecosystem members with orchestration roles. At the time of writing, most actors are at the outermost level as potential members, except for those core team members who, according to the survey results, are still unsure about formally joining this layer. It is expected that, as the ecosystem emerges, actors will become more evenly distributed across the layers.

- **Collective governance**: *collective negotiation related to the rules and roles, defining the architecture of the ecosystem* (Thomas 2022; Thomas et al. 2022). The core team acts as a driving force for regional readiness for the hydrogen economy. The core team meets regularly to foster a shared understanding and discuss the group's operational procedures. The dynamics of interaction among core team members align with discussions organized by the research team on topics relevant to ecosystem development, including governance issues and more technical aspects of the potential hydrogen value chain. As mentioned previously, an MS Teams group has been created as a digital platform for the core team.

- **Value discovery**: *designing a system-level value proposition and identifying individual strengths* (Thomas 2022; Thomas et al. 2022). The value discovery aims to build common understanding on hydrogen-related themes relevant to the region, attracting and engaging key actors, discussing opportunities. This process becomes the central axis of interactions among ecosystem members, identifying how their individual competitive advantages can be combined and complemented by those of other actors to form an assembly that can deliver a value proposition at a system level. This process includes reflection on resources, capabilities, and knowledge that might otherwise go unnoticed but could become crucial with the development of the hydrogen economy. This reflection also highlights the need to open organizational structures to allow for collaboration with actors in a new value chain that may include other economic sectors or industrial activities, as well as actors from the public sector and academia.

- **Contextual embedding**: *gaining acceptance in a wider societal context* (Thomas 2022; Thomas et al. 2022). This process includes to build synergies with national hydrogen networks and regional actors in surrounding areas, and participation in public events and discussions. Contextual embedding is crucial for the evolution of an emerging public-private ecosystem as it provide the validation and legitimation among key stakeholders and decision-makers. When an ecosystem achieves successful contextual integration, there are good opportunities to receive support from different organizations and a willingness to commit to the ecosystem's activities from its emergence to its consolidation.

- **Ecosystem continuity**: *securing resources to support the ecosystem emergence and development* (Thomas 2022; Thomas et al. 2022). This process relates to the secure availability of resources for the ecosystem's operation and the commitment of its members to support its functioning over time. This process is particularly challenging during the early stages of ecosystem development due to a lack of commitment from stakeholders. Sometimes, public support is necessary to keep initial activities going until a higher level of maturity is reached and the ecosystem is integrated into the broader context.

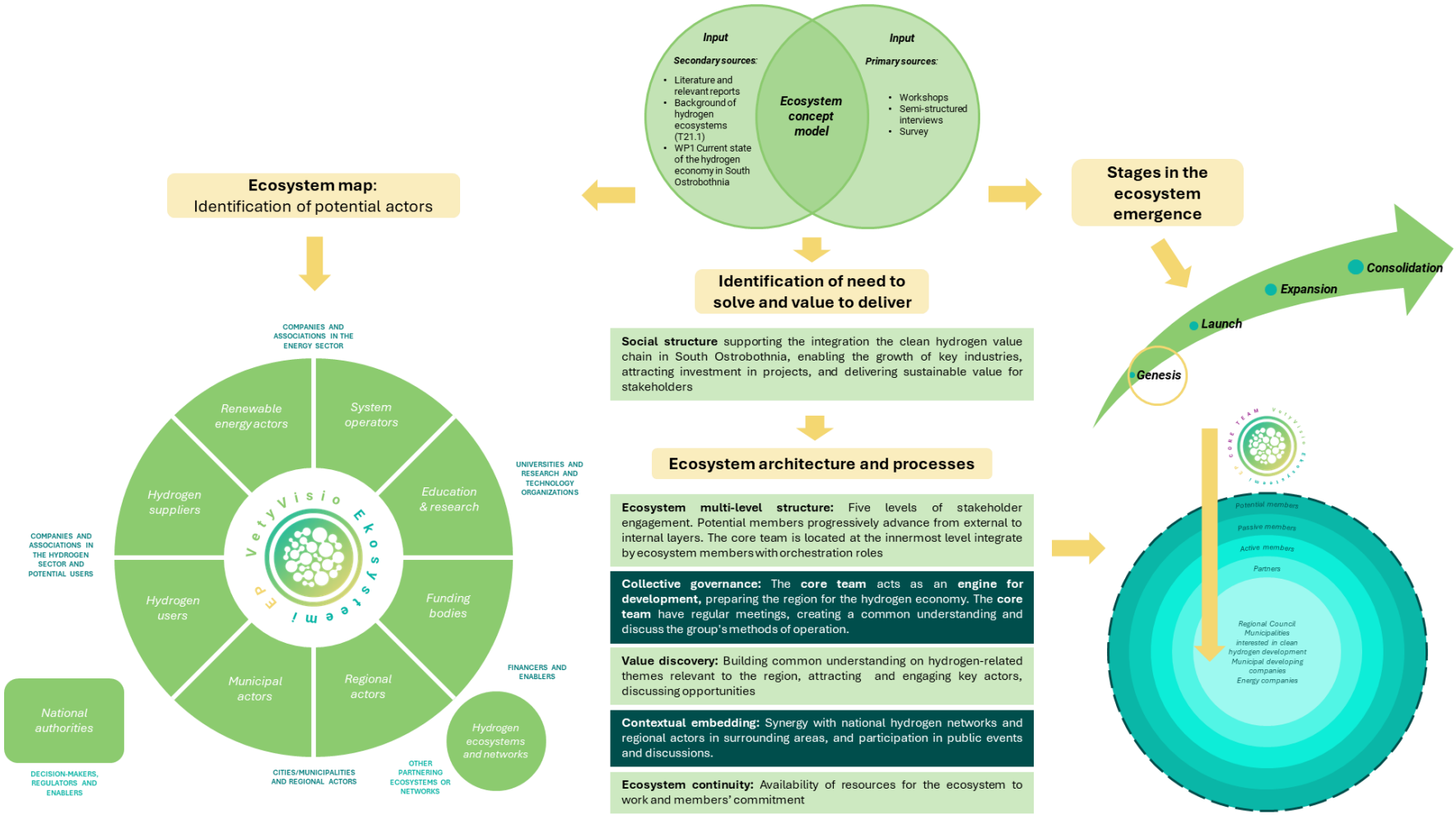

Figure 13. WP2 Ecosystem design. Based on Valkokari et al. (2021), Nousiainen and Vienamo (2019b), and Thomas, Autio and Gann (2022)

5 Conclusions

The present report on the work package 2 of the VEPE project offers relevant information for regional stakeholders in initiating public-private ecosystem structures around the energy transition, such as clean hydrogen. Key findings of this work can serve as a guide for starting ecosystem building processes from scratch, as the process is described in detail in this document.

In terms of T2.2 "Stakeholder mapping and ecosystem visualization", the ecosystem was visually represented for better understanding and communication. We called this new social structure as the "**VetyVisio Ekosysteemi EP**" (Future-Oriented Clean Hydrogen Ecosystem in South Ostrobothnia). This is the first attempt to produce an ecosystem architecture built as a vision of regional stakeholders in South Ostrobothnia for developing the hydrogen economy.

In T2.3 "Creating ecosystem value and operations planning with stakeholder participation", a a preliminary proposal of the ecosystem's activities and operating principles is presented for the ecosystem. It includes the identification of actors with potential roles in the ecosystem's development and orchestration, and strategies for ecosystem development and stakeholders' engagement. Regarding how a potential clean hydrogen ecosystem could deliver value to the region, the key findings indicated that the ecosystem could help by: i) supporting and integrating the clean hydrogen value chain in South Ostrobothnia, ii) facilitating the growth of key industries and attracting project investment, and iii) delivering sustainable value for stakeholders.

Finally, in T2.4 "Ecosystem design", the model developed for the **VetyVisio Ekosysteemi EP** integrates a four-component structure consisting on: i) stage in ecosystem emergence; ii) ecosystem map; iii) identification of needs to be addressed and value to be delivered; and iv) ecosystem architecture and processes. This model can be updated over time to reflect the evolving needs of the ecosystem.

Future avenues and recommendations:

- It is strongly recommended to maintain the core ecosystem team as a regional structure to develop internal discussions and advance the understanding of the clean hydrogen economy, even though there are no tangible projects in the short term. At the same time, it is important to connect with broader networks or ecosystems to stay informed about potential opportunities, attend relevant events, and connect with potential investors or private organizations working in this area.

- The ecosystem, as an emerging social structure, could be useful for connecting with actors in key value chains in the region, such as the renewable energy and food and agriculture sectors. The region could leverage this social structure to harness technological innovations, thereby strengthening the ecosystem.

- Regional public actors can act as orchestrators in the initial stages, but they should strengthen their capacities to enable the creation and extraction of value from the ecosystem. This requires specific actions to ensure the mobility of knowledge within the ecosystem and coordination to guarantee its stability (Addo 2022).

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7 Appendices

Appendix 1. VEPE interview guide

VEPE Interview guide
1. General questions
• What kind of opportunities do you see from the hydrogen economy in South Ostrobothnia? • Has your organization discussed the potential of clean hydrogen? • What kind of role do you see your organization playing in possible future clean hydrogen projects and especially in South Ostrobothnia? • What could be the potential challenges for the development of the hydrogen economy in South Ostrobothnia?
2.1 Developing companies and municipalities
• How is the hydrogen economy included in municipal or regional strategies? Has any action been taken in this regard? • How do you see clean hydrogen connecting with key regional industries, such as agriculture and the food industry, logistics, heavy industries, among others? • How to involve key industries in the development of the hydrogen economy in South Ostrobothnia?
2.2 Power sector
• How is clean hydrogen connected to your industry or operations – or is it at all? Do you see any business opportunities related to clean hydrogen? • How do you perceive the use of clean electricity (wind, solar, etc.) for clean hydrogen production? • Concerning your current wind and/or solar PV projects in South Ostrobothnia, how could this existing or additional capacity be leveraged for clean hydrogen production? Do you have any plans or projects in this regard?
2.3 Food and agriculture
• How is clean hydrogen connected to your industry or operations – or is it at all? Do you see any business opportunities related to clean hydrogen? • How relevant do you perceive the use of clean hydrogen and green ammonia in the production of fertilizers used by the food industry in South Ostrobothnia? • Do you see potential in shifting towards low-carbon fertilizers and increasing the self-sufficiency of fertilizer production in Finland and South Ostrobothnia with the use of clean hydrogen and green ammonia? • Are you in discussion with any fertilizer provider regarding this topic?
2.4 Fertilizers and related industries
• How is clean hydrogen connected to your industry or operations – or is it at all? Do you see any business opportunities related to clean hydrogen? • What is your interest in switching to green ammonia in fertilizer production? Are there any current projects related to this topic in your organization?

- What conditions would make South Ostrobothnia attractive for investing in low-carbon fertilizer production?

2.5 Industries closely related to hydrogen

- How is clean hydrogen connected to your industry or operations – or is it at all? Do you see any business opportunities related to clean hydrogen?
- What is your current role in the hydrogen value chain (production, storage, transport, end-use) and projects in this regard?
- Which sectors are you targeting for hydrogen end-users (e.g., transport, steel production, maritime, chemicals, etc.)?
- Are you working or planning to work with local stakeholders in South Ostrobothnia to develop hydrogen networks or hydrogen initiatives?