groenvermogennl | Innovatiemotor van de groenewaterstofeconomie

Green PowerNL HCA Learning Community Roadmap West

Emile Jackson, Yme Dikkerboom, Brahim Boukhari, Gijsbert Korevaar
May 31, 2024

Management summary

This roadmap marks the start of strengthened and partly new cooperation processes in the West Netherlands region for making industrial production, transport, storage and use of green hydrogen more sustainable. As part of Top Sector Program GroenvermogenNL, this development plan helps accelerate market development for industrial deployment on green hydrogen. The main objective is to present an inventory of parties in the hydrogen chain and connect these parties by stimulating the necessary knowledge development and exchange. The collaboration between stakeholders in the region has the formation of a Learning Community.

Region West, which includes Rotterdam's port-industrial complex, already has many years of experience in the production, logistics and use of, in particular, gray hydrogen. This existing expertise is the starting point for a smooth rollout of the green hydrogen economy, with Rotterdam as the green hydrogen hub of Europe. A trusted location for fossil resource processing, this region is now increasingly ready for the transition to renewable resources and also green hydrogen. Besides Europe's largest port ("maritime capital"), there is a huge industrial network with accompanying knowledge infrastructure. This is where hydrogen comes into its own, with many potential launching customers and supporting services such as banks, financiers, lawyers and administrative offices.

The collaboration between the public and private sectors in Rotterdam is cohesive and strategic, constantly looking for new opportunities, in direct connection with the many training and research institutes, hundreds of startups and pilot projects. Over time, this strategic governance has created an integrated ecosystem where innovation is at the forefront and working on a coherent approach to green hydrogen fits well. The roadmap hydrogen transition of GroenvermogenNL Region West, aligns with the Growth Agenda Zuid-Holland, the strategic agenda of Economic Board Zuid-Holland and the joint Human Capital Agenda Zuid-Holland.

In spring 2023, a liaison team set to work connecting network parties and organizing network talks. A total of three network sessions were organized with a large number of additional conversations to retrieve ambitions within Region West. To conclude this process, the final results were validated in May 2024, strengthening regional support for the implementation of this cohesive approach to hydrogen transition in this region.

Region West includes the province of South Holland and the Moerdijk industrial area: one of the most densely populated and industrialized areas in the world, with some 385,000 people currently working in the Rotterdam port-industrial complex. The strategic location with its direct connection to the hinterland makes this region face-dependent for developments around generation, import, transport, storage and wholesale consumption of green hydrogen. For Region West, current application areas have been divided into four distinctive clusters, with their own focus for the approach in this roadmap:

- Regional cluster around The Green Village in Delft (North): focus on mobility, built environment and horticulture;
- Regional cluster around the RDM Campus in Rotterdam (West-Middle): focus on process industry, including manufacturing, transport and storage;
- Regional cluster around Merwe4Havens in Rotterdam (East Central): focus on manufacturing;
- Regional cluster around Sustainability Factory in Dordrecht (South): focus on maritime sector.

In addition to the various areas of application, the regional clusters are also where insights are retrieved regarding social acceptance, business cases, legislation, standardization and safety. In the case of The Green Village, hydrogen applications in the built environment, both practical feasibility and technical operation, are strongly linked to the research taking place at TU Delft. At both the RDM campus and Merwe4Havens, there is the relationship with R&D research activities within the CoE HRTech of Hogeschool Rotterdam.

This roadmap is part of a national initiative, the developments of which were presented in the Hydrogen Roadmap of the National Hydrogen Program (NWP). The parties involved in this program consider the Human Capital Agenda of GroenvermogenNL an important prerequisite for the hydrogen economy. The said roadmap provides a current and future picture of the many initiatives, on which the active commitment in this region is well visible. On the basis of these existing and new regional developments, GroenvermogenNL is firmly committed nationwide to removing obstacles, focusing on both (existing and new) training courses, as well as the further professionalization of personnel at companies already working in the energy sector.

Figure 1 - Regions of Green PowerNL

Regional roadmaps are coordinated by regional liaison teams led by GroenvermogenNL (see also Figure 1) and flesh out solutions to bottlenecks in the region and the intended agenda. GroenvermogenNL is a temporary organization born out of the programming of three Top Sectors (Hightech Systems and Materials, Chemistry and Energy). The objective is to accelerate and scale up the hydrogen transition of the Netherlands, through research in the R&D packages, stimulating pilots and demonstrations, and by developing the Human Capital Agenda (HCA) for the hydrogen transition. In doing so, GroenvermogenNL focuses primarily on connecting and strengthening existing initiatives. Within each region, the liaison team is headed by a university of applied sciences. For region West this is Hogeschool Rotterdam.

Region West's ambitions are diverse and are fueled, among other things, through the chain from the Port of Rotterdam's greatest ambition, to develop the largest hydrogen hub for Europe for import and transshipment. For generation, a conversion park is being built for green hydrogen from green electricity from wind farms in the North Sea. The use of hydrogen for mobility, in the maritime sector, the built environment and horticulture is already visible. At the same time, new activity is emerging in the manufacturing industry for the various types of energy technologies and energy materials needed for a sustainable energy transition.

This affects the labor market balance, which is worrisome in this region. Scenarios for the period up to 2030 indicate that there will be significant shortages, especially for technically skilled personnel. Combined with an increasingly different demand for knowledge and skills, this means that the desired speed for transition cannot be achieved. However, a cooling of the economy is also expected from 2027 onwards due to lows in the economy, potentially widening the market for electrical engineers, machine mechanics, electricians, electronics mechanics and production leaders in industry and construction.

From GroenvermogenNL, it is advised to take the demand perspective**,** the labor market**,** as a starting point and deploy Learning Communities in conjunction. Both students in initial education, as well as education with a view to retraining and retraining workers, will be able to give an important impetus to the hydrogen transition. The interlocking of knowledge and innovation is important for municipal and provincial governments, industry and knowledge institutions in the form of public-private partnerships (PPPs) and other collaborations dealing with the hydrogen transition.

Given the diversity of networks and needs in this region, a cohesive structure is needed, while allowing for sufficient customization and flexibility. Educational institutions, companies and government must create a responsive infrastructure that supports the fulfillment of the HCA for the hydrogen transition and reduces the "time to job" for people who want to work on the hydrogen transition. The deployment of funds from the HCA Green PowerNL program facilitates the development of a responsive infrastructure for working, innovating and learning with four objectives: (1) From the four regional clusters (The Green Village, RDM Campus, Merwe4Havens, Sustainability Factory), regional campuses (with fieldlabs) are strengthened for the interaction of MBO, HBO and WO students and professionals from industry; (2) learning communities for hydrogen are stimulated and connected to technology campuses and fieldlabs; (3) By testing effectiveness of various existing programs and new pilots to be developed, lifelong development (LLO) offerings will be strengthened; (4) connection to the national elements of the Green PowerNL program will be provided, such as Make Hydrogen Work, teacher professionalization and the national knowledge platform.

Four building blocks were developed for operationalization, with a number of concrete activities, expected results and desired effects: (1) meet and inspire, (2) collaborate and deepen, (3) learn and develop, and (4) innovate. Four substantive themes are central to these learning communities: (1) labor market knowledge, (2) professionalization, (3) research and innovation and (4) safety and hydrogen. Thereby the development of facilities is linked to facilities of the many partners, such as the 5 mbo institutions, 2 hbo institutions, 2 universities, existing alliances and partnerships, as well as connections from programs such as the Human Capital Coalition Energy Transition, Port of Energy and PEOPLE. In a concrete proposal the steps for the four building blocks have been worked out per year.

Foreword

The Human Capital Agenda roadmap hydrogen transition of GroenvermogenNL Region West marks the situation at the beginning of 2024, one year after the start, where we as liaison team note that in the meantime new steps have also been taken and sufficient direction is given to the investments within and outside GroenvermogenNL. As liaison team in cooperation with the Human Capital Coalition Energy Transition, we have every confidence that the next steps will also be taken in good mutual cooperation and with all relevant parties, so that the envisioned green hydrogen transition in the West Netherlands region will actually be realized with the deployment of new, retrained and further-trained professionals from our own region.

The liaison team offers this roadmap on behalf of the Scheepvaart- en Transportcollege, Hogeschool Rotterdam, the Human Capital Coalition Energietransitie, Deltalinqs, Municipality of Rotterdam, Port of Rotterdam, The Green Village, I-EM Delft, Energy Switch, Duurzaamheidsfabriek Drechtsteden, and H2makers Drechtsteden. They represent and secure broad support for the roadmap, which is indispensable for its further rollout.

We wish you much reading pleasure!

The liaison team for Green PowerNL Learning Community Region West

Emile Jackson - Program coordinator Centre of Expertise HRTech - Hogeschool Rotterdam **Yme Dikkerboom -** Practor Energy Transition & Smart Industry - Scheepvaart en Transport College
Brahim Boukhari - Education Manager Automotive - Hogeschool Rotterdam
Dr. ir. Gijsbert Korevaar - Lecturer in Circular Energy Transition - Rotterdam University of Applied Sciences

Table of contents

Figures

1 Introduction

This roadmap focuses on Region West Netherlands, consisting of the province of South Holland and the Moerdijk port area in province of North Brabant, from now on this region will be referred to as Region West of GroenvermogenNL. Region West is currently developing with its sustaining ports and port industry as one of the national hubs for hydrogen with international impact. Rotterdam has already made great strides in bringing together the production, import, transit and use of hydrogen. And plans for the future are even more ambitious, in which the structural and logistical infrastructure must be built for a truly sustainable and future-proof energy supply. This is being done in close cooperation the Human Capital Agenda for green hydrogen, as established in GroenvermogenNL, the innovation engine of the green hydrogen economy.

1.1 Outline of Region West of Green PowerNL

The national growth fund program GroenvermogenNL aims to work on a cohesive approach to energy transition with green hydrogen. The West Netherlands regional liaison team is committed to connecting initiatives and joining forces. In this document, the liaison team presents the Human Capital Agenda roadmap hydrogen transition from GroenvermogenNL for this region. This widely supported proposal contains concrete steps to work actively and - certainly also in the following realization phases - in coherence to mobilize human capital.

The energy transition now and in the future entails many additional investments and above all a lot of work, for which we need sufficient and above all suitably qualified professionals. This is a major challenge for the West Netherlands region, because this highly industrialized region in particular faces a lot of competition from existing companies for qualified personnel. In addition, labor participation is relatively low, while young people show too little interest in technical training. However, it is expected that in the near future there will be a reduction in labor for fossil energy, making efforts to retrain now the first step towards realizing this essential hydrogen hub for energy supply in Europe. The ambitions are great and we have committed to long-term intensive cooperation to be able to take the next steps as well, but we will not do it alone.

As part of a larger energy transition, it will not be an easy process and good cooperation is essential to make it happen. Therefore, working on such a new infrastructure for production, import, transit and use of hydrogen requires enormous efforts from the entire region to develop, maintain and build on this new reality in the existing situation. The collaboration of three top sectors (HTSM, Chemistry and Energy) is exemplary of the complexity of the transition process, in which parties in education and in professional practice must also learn to work together differently in order to achieve the set goals in the short and longer term, with sufficient resilience even when there are (unavoidable) changes in the situation or other setbacks.

This new reality must be built step by step, parallel to existing processes and despite the current difficult labor market in this region for port and industry. Thus, the expansion of our network to the rest of the West Netherlands region has also begun. This requires a

clear goal and a common path towards it. And, given the great diversity of parties and expertise needed to realize this energy transition with green hydrogen, also a firm commitment to the mutual relationship for cooperation. This roadmap therefore emerged as the first result in building the Learning Community for Region West, with many exploratory conversations and meetings in which concrete agreements were made about the approach.

On behalf of the professional practice and vocational education in the Rotterdam region, Deltalinqs, Port of Rotterdam Authority, Municipality of Rotterdam, Shipping and Transport College, Techniek College Rotterdam and Rotterdam University of Applied Sciences have laid the foundation for the development and implementation of new labor market policy in which the transition to green hydrogen is central. Complexity and the need for a long breath characterize the processes of sustainable transitions and continuing such intensive cooperation over a longer period is therefore the intention of these six major parties. Here lies the basis for actually realizing this hub.

The lead agency for the GroenvermogenNL Learning Community Region West development project is Rotterdam University of Applied Sciences, with implementation started from the close cooperation with the Shipping and Transport College (STC). Together with the Techniek College Rotterdam (TCR), these educational institutions share educational facilities at the RDM Campus location in Rotterdam. In over 15 years, an ecosystem for industrial innovation has formed here within which various programs have been carried out with government and industry. This roadmap was developed over a period of more than a year, by a large number of parties committed to the ambition of stimulating the sustainable transition with the industrial deployment of green hydrogen in the West Netherlands region.

From this ecosystem and in consultation with the relevant stakeholders from the region in the field of hydrogen transition, the Human Capital Coalition Energy Transition (HCCE) for Rotterdam, the regional platform for transition initiatives aimed at attracting, retaining and developing talent, manpower and craftsmanship, was established in early 2023. The start of the HCCE is also in direct connection with the Taskforce Energietransitie the Economic Board Zuid-Holland. This launched a joint approach to attracting and retaining sufficient and qualified port personnel. Deltalinqs, Port of Rotterdam, Municipality of Rotterdam, Techniek College Rotterdam, Scheepvaart en Transport College and Hogeschool Rotterdam work together in this coalition to improve the connection between education and the labor market, which the energy transition needs. For now and in the future. This is also necessary to enable the energy transition in the port and industry of Rotterdam. The joint goal is to work on the realization of the energy transition with sufficient and well-trained professionals and, within that, on a healthy regional hydrogen economy, making use of existing ecosystems in Region West.

1.2 Work streams within the hydrogen transition region West

Figure 2 - Realizing sufficient HCA for hydrogen transition

GroenvermogenNL's activities are divided into several work streams, see Figure 2. Region West contributes to this within the triangle of innovate, learn and work. In the remainder of this roadmap, these four work streams will be further elaborated and scaled up:

1. Mapping the relevant areas of knowledge related to the implementation of hydrogen production, storage and use technologies in a socio-economic context;
2. Mobilizing educational institutions (both MBO, HBO, WO, and private), municipalities and companies by realizing and further expanding learning communities. With regard to the research and implementation of new developments in education, there is close cooperation with various practical chairs and lectureships in the region. This also includes teacher professionalization, in which teachers are given additional skills in training and testing in relation to the hydrogen transition.
3. Contribute to the National Knowledge Platform for learning communities within GroenvermogenNL and Make Hydrogen Work (formerly the Dutch Hydrogen Academy) in terms of research results for the hydrogen transition, knowledge development and training opportunities.
4. Delivery of educational materials, educational modules and training to business-program through partnerships with SMEs and co-creation.

1.3 The role of the port-industrial complex within the region

Within this region, the port-industrial complex (also referred to as HIC) of Rotterdam, with branch offices in Dordrecht and Port of Moerdijk, is a prominent player in this hydrogen hub. Many industries are located there that produce, store, transport and purchase hydrogen. The infrastructure is thus in place for large-scale transport and storage. The Port of Rotterdam is counting on a massive scale-up of hydrogen imports, which will benefit the further expansion of the infrastructure and the transit of hydrogen to

the hinterland. This could make use of the already existing backbone structure that a party like Gasunie currently uses for the large-scale transportation of natural gas, see Figure 3.

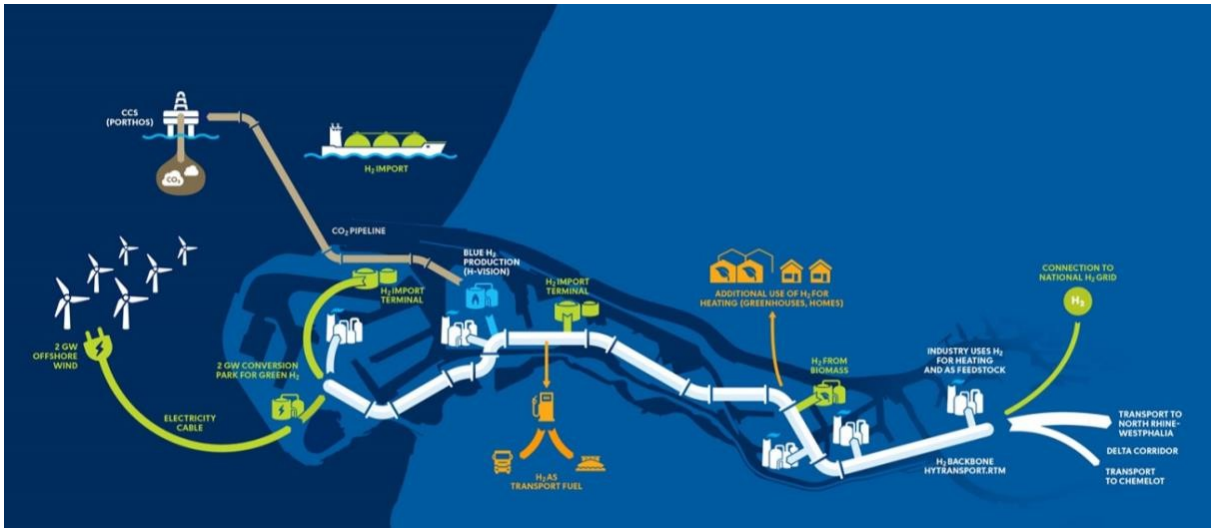


Figure 3 - Hydrogen in the Rotterdam port area.

Region West has some special characteristics compared to the other regions in the Green PowerNL program. It is a highly industrialized region with a high labor demand. On the other hand, labor market participation in industry is low and a large part of the population, especially around Rotterdam and Dordrecht, is low educated. The energy transition will cause industries to downsize, particularly in the fossil fuel industry, resulting in more technicians entering the labor market. By offering retraining and further education programs, these people can get to work in the energy transition to contribute to the region's ambitions: to become the hydrogen hub of Europe.

1.4 Application areas within region West

Both transport and storage and transshipment of these green energy carriers require large investments in the port area, even if use is made of existing infrastructure. Not only for the process industry, including production, transport and storage within the port-industrial complex (HIC) does green hydrogen play a major role in making energy supplies more sustainable, we also see growing potential in the region in the manufacturing industry, mobility, inland navigation, built environment and agriculture. Therefore, in this roadmap for Region West, application areas have been distinguished into four regional clusters:

1. Process industry, including manufacturing, transportation and storage
2. Manufacturing
3. Built environment and agriculture
4. Maritime

In the region clusters, many and especially appropriately trained people are needed. Each region cluster has specific characteristics and networks that need to be connected to. With GroenvermogenNL's HCA roadmap hydrogen transition, Region West is committed to correctly and sufficiently trained professionals and skilled workers for this transition.

1.5 Approach to the West liaison team

In the West Region, cooperation to arrive at a broad-based development plan for stimulating the deployment of green hydrogen started from the intertwining of the familiar and solid net weeks of education. Gradually, these networks were joined by other relevant parties willing to put their shoulders to the wheel. In the spring of 2023, the so-called liaison team, consisting of employees of the Shipping and Transport College and Rotterdam University of Applied Sciences, was started. In mid-2023, the liaison team started working with a number of network sessions to get a picture of the issues and many additional conversations to further identify the relevant parties and current issues for green hydrogen in this region.
To this end, connections were also sought with existing lectureships (HBO) and practorates (MBO). The network has been extensively introduced to the objectives and approach of the GroenvermogenNL program.

Active participants in the networking sessions and the Learning Community were representatives of municipal and provincial governments, knowledge institutions and companies, including the Port of Rotterdam. Together they developed a good picture of the labor market issues within the region. In addition, these sessions expressed the ambition to jointly develop programs and pilots for the West Region. In this way, the liaison team made the connection to and between the parties in the region needed for the hydrogen transition. In May 2024, the inventory round was completed with a series of validation sessions, to which again all participants from the three previous rounds were invited. The establishment of commitment, ecosystem participation and ambitions, are recorded in Appendix 3.

2 Reconnaissance environment

Region West includes the province of South Holland and the Moerdijk industrial area. South Holland is one of the most densely populated and industrialized areas in the world. The province has an area of 3404 km² and the population is 3,673,893, making South Holland the most densely populated province in the Netherlands. The province is home to the Port of Rotterdam, the largest port in Europe with a length of over 42 km. Currently, some 385,000 people work in and for the port and industrial area. The port of Rotterdam boasts an extensive industrial cluster, the port-industrial complex. Its strategic location with its direct connection to the hinterland makes the region a key location for the developments surrounding the generation, import, transport, storage and wholesale consumption of green hydrogen.

2.1 Labor market challenges within West region

South Holland has been struggling with growing tensions in the labor market for several years. The number of unfilled vacancies, at over 8,000 in 2022, is more than three times higher than in 2016 (UWV, 2022). In 2023 the shortages seem to ease but due to several factors, including the aging population, some tension will remain. We may have to start making national choices about what to do and what not to do (Wilthagen, 2023). Specifically for the region, in addition to the aging population, there is also the ongoing development of technology. On the one hand work is disappearing due to mechanization and automation, on the other hand more work seems to be coming in.

There are differences within the labor market regions. Drechtsteden has an above-average gray pressure, combined with an equally higher proportion of young people up to 20 years of age (the green pressure).
Rijnmond and Delft rank among regions with low gray pressure. Rotterdam and The Hague manage to attract and retain relatively many young people. The number of immigrants and the migration balance also differ greatly from region to region. In absolute numbers, the major cities of Rotterdam and The Hague together with the three other major cities of Amsterdam, Eindhoven and Utrecht have the highest migration balance. Given the demographic trends in the province, there are many opportunities in attracting young people and people with non-Western backgrounds to the energy transition tasks in the Port Industrial Complex (Port of Rotterdam Authority, 2024).

2.2 Exploring labor market and ecosystem interaction

Research and consultancy organization CE Delft conducted a labor market survey in early 2023 on behalf of GroenvermogenNL. The purpose of the study is an initial exploratory labor market survey aimed at systematically mapping knowledge needs and development in the field of hydrogen (Bachaus et al, 2023). The research consists of two parts: a preliminary exploration and a quantitative and qualitative study. The result portrays the relevant labor supply and the relevant labor demand up to 2030. In summary, it states:

- There will be significant shortages in the labor market in the period up to 2026, especially technically skilled personnel. This affects the speed at which the hydrogen economy can be realized. The demand for knowledge and skills to realize various transitions is very high and the available supply falls short;

- After 2026, the economy cools slightly due to low economic activity. As a result, the market for electrical engineers, machine mechanics, electricians, electronics mechanics and production leaders industry and construction becomes broader and HCA goals can be met more easily.

From various labor market surveys conducted by GroenvermogenNL, the following is advised in response to the findings:

- Make it possible to follow an individual learning path, see Figure 4
- Commit to scaling up learning communities;
- Take the demand perspective (the labor market) as a starting point;
- Explore national certification or rating, including for short-term offerings;
- Connect with existing courses that focus on the energy transition;
- Make it attractive for companies to play a central, driving role.

Figure 4 - Individual learning path

Green hydrogen within the energy transition has a clear place in initial technical education. About 12.5-15% of the study time is spent on energy transition and within this the topic of hydrogen also plays a role. This mainly concerns elective subjects in MBO and project education (Zegel et al., 2023). During the second knowledge event (October 2023) for Region West, the following results were retrieved regarding flexible education:

- Develop customized pathways for potential entrants (youth/women/ statusholders/non-Western natives/allochthonous);
- Customized work offerings from companies needed;
- Importance of attention to language, work structure reintegration guidance;
- Image Enhancement Energy Transition (imaging/contribution/co-operation/neighborhood approach);
- Make transition acceleration measurable (through labor market research);

- Less fragmented approach (role for government, social assistance, etc.;
- Support the commitment to broad energy transition education and embed hydrogen within it;
- Keeping an eye on the whole issue, including social disciplines and systematic infrastructure.

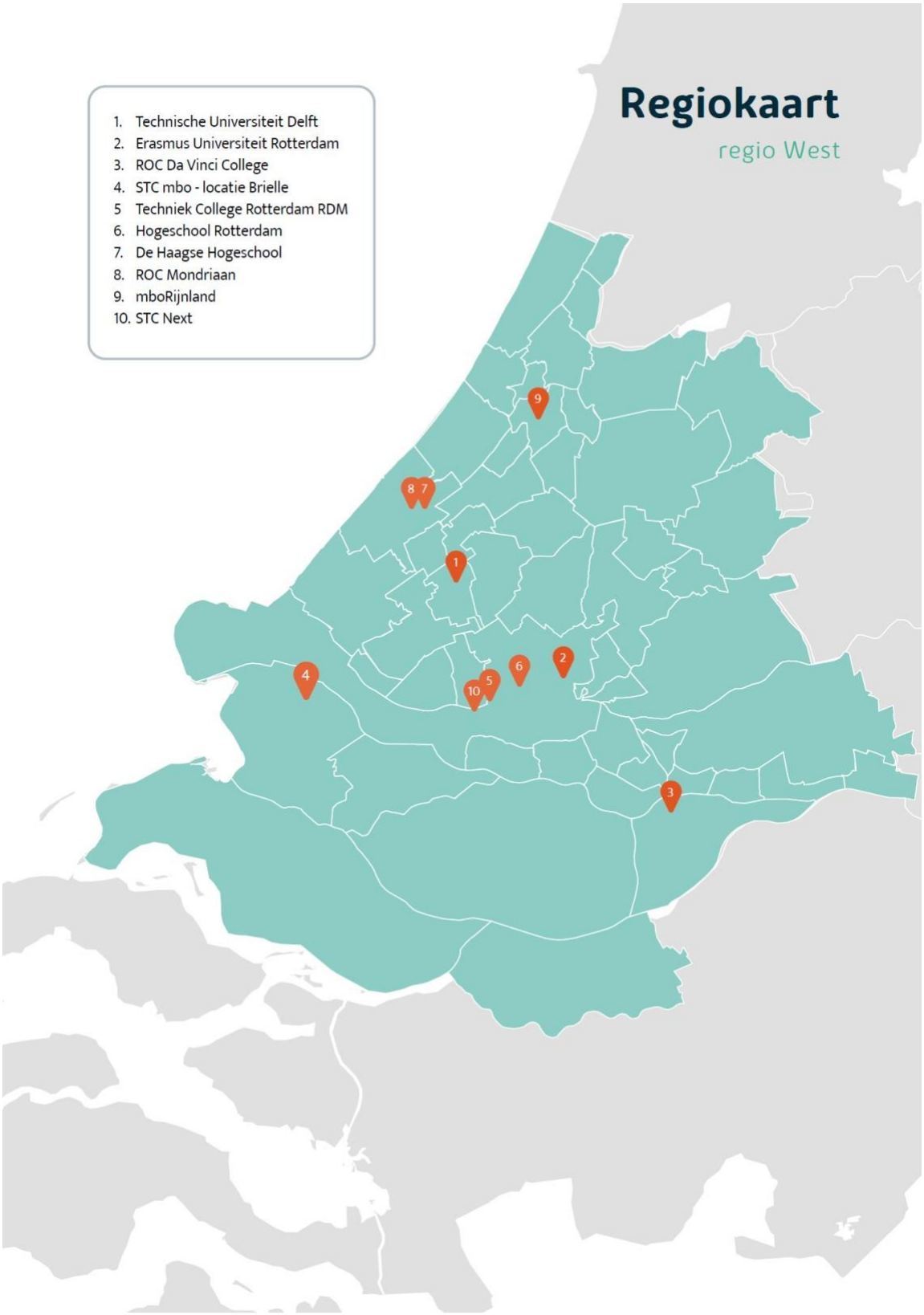


Figure 5 - Initial hydrogen and energy transition education providers

2.3 Relationship to educational offerings

Hogeschool Rotterdam and Techniek College Rotterdam share educational facilities at the location RDM Rotterdam (Heijplaat). In over 15 years, an ecosystem has formed here for industrial innovation in which various programs have been carried out with government and industry.
Examples include:

- The Innovation Connector program of Opportunities for West, within which the H2Energy Lab was developed
- The MRDH Energy Transition Lab program, in which the Port of Rotterdam Authority and companies from the HIC are developing education and educational facilities together with the Rotterdam University of Applied Sciences
- The MRDH program I-EM Delft in cooperation with the I-EM Delft Campus in which education around hydrogen technology is being developed

In 2023, the Taskforce Technological Industry of the Economic Board Zuid-Holland published its action agenda. An important point in it is the declining intake of technical education. There is a large dropout of technical personnel in the region and the City of Rotterdam expects that there will be a dropout especially from the fossil industry. To this end, the Municipality of Rotterdam is developing the Transition House in which personnel can be guided from job to job towards the energy transition. Within the Learning Community West, this plays a major role because the Learning Community is also committed to work-to-work guidance and utilizing untapped labor potential.
Figure 5 provides an overview of MBO, college and WO degree programs in the region that have connected with the Learning Community for the region during the ecosystem inventory. These locations offer courses in which hydrogen applications, hydrogen safety around storage and transportation, systems integration of hydrogen technologies, play an important role.
Students from these programs will be able to give a significant impetus to the hydrogen transition, in addition, these programs are also important starting points for flexible education, aimed at retraining and upskilling employees of companies in the region.

2.4 Regional partnerships

In addition to the initial educational offerings, several public-private collaborations and partnerships have emerged from municipal and provincial governments, industry and knowledge institutions that are working on the hydrogen transition. A detailed overview is provided in Appendix 1 and Appendix 2. Figure 6 shows the regional collaborations and fieldlabs in on the map of Region West.
By way of illustration and further explanation, a number of initiatives are additionally mentioned here. For example, The Green Village is part of TU Delft and connects practical scientific research with education at HBO, MBO and WO level. The Green Technology Campus of the STC in Brielle focuses on MBO education for industry and also develops teacher professionalization programs for teachers. In the Haaglanden region, I-EM Delft links various MBO courses and their teachers to innovation programs. Educational parties are linked in the region in various programs. Energy Switch, for example, maps out training and courses in energy transition. All the major education parties in the region are connected to this apprenticeship agreement.

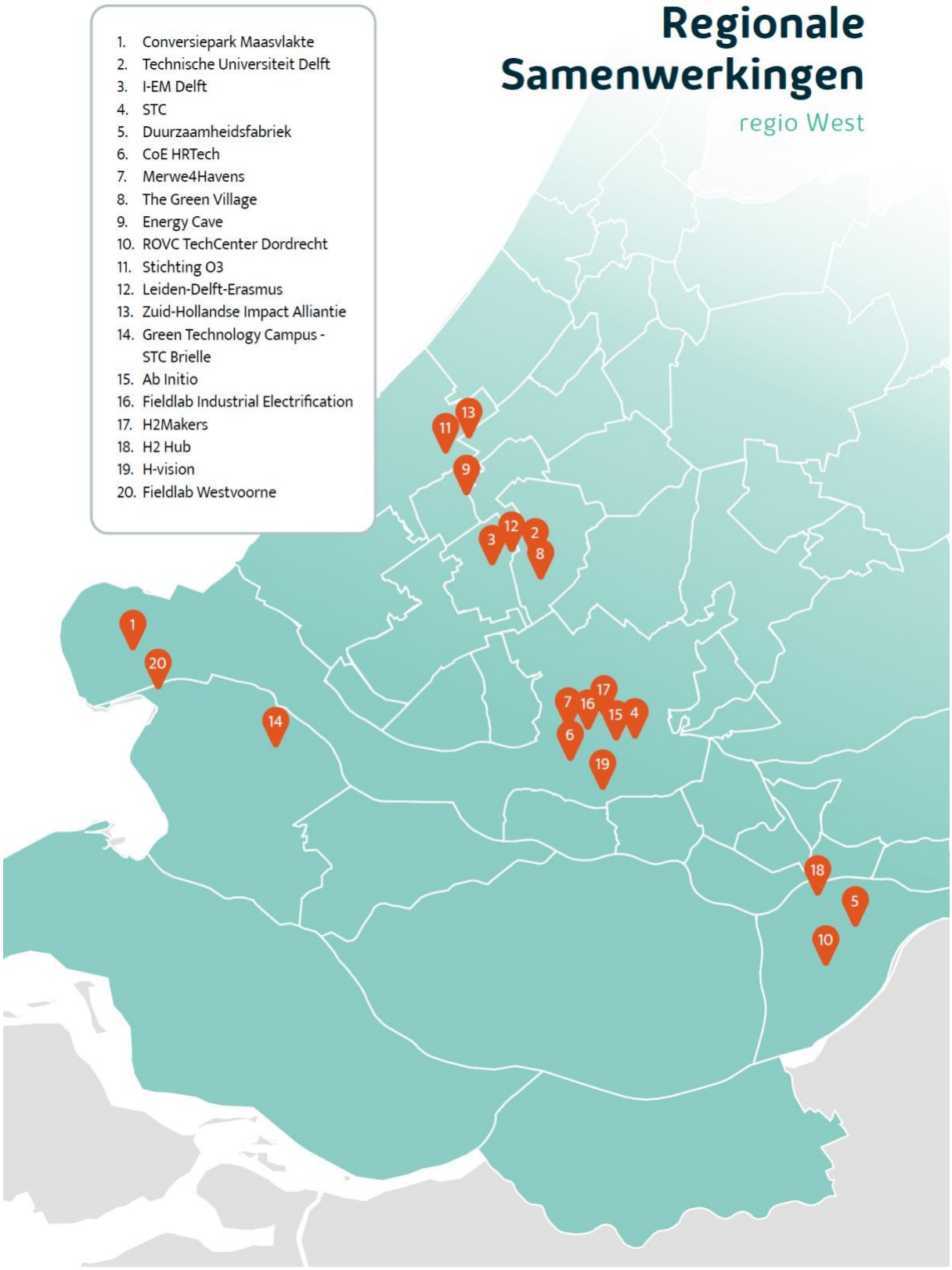


Figure 6 - Overview of partnerships and fieldlabs

2.5 Ambitions of the region and the role of the Port of Rotterdam Authority

The greatest ambition within the hydrogen transition lies with Rotterdam: the Port of Rotterdam Authority has the ambition to develop the hydrogen hub for Europe in the region. Eighteen million tons of green hydrogen will be imported, transshipped from the Port of Rotterdam area. In addition, green hydrogen will be generated. A conversion park will be built for generation. Uniper, Shell, BP and HyCC are building electrolysers here to produce green hydrogen from green electricity from wind farms in the North Sea.

This green hydrogen will on the one hand find its application in the process industry, including production, transport and storage, to replace gray hydrogen, and on the other hand be used in new applications to reduce greenhouse gas emissions. New applications include use for mobility, in the maritime sector and the built environment. Hydrogen-electric powertrains are increasingly being used to power heavy road transport and inland shipping. For example, the Shipping and Transport College in Rotterdam has the first inland vessel certified in Europe to run on hydrogen: the Ab Initio (Figure 7).

Figure 7 - STC barge: Ab Initio

These developments are creating new activity in the manufacturing industry, especially in small and medium-sized enterprises (SMEs). Innovative SMEs, including Zepp Solutions, Accenda, Battolyser systems, Flying Fish and Zero Emission Fuels, are active in Region West.

The hydrogen manufacturing industry connects in the West Region in the H2Makers platform to strengthen innovation and cooperation. This new manufacturing industry complements the existing manufacturing industry.
After all, the conversion park on the Second Maasvlakte, for example, is being built by Stork in cooperation with subcontractors. This is further strengthened and expanded in the interplay between the built environment and business activity in the cities of The Hague, Rotterdam and Dordrecht.

2.6 Gas infrastructure in relation to region West

Hydrogen and other green energy carriers are imported on a large scale, produced, stored and transported through a network of gas pipelines to various industrial clusters in the Netherlands and Germany. Gasunie (Gasunie, 2022) is responsible for large-scale transport, see Figure 8. This backbone infrastructure can also be used for hydrogen transport after the necessary modifications. In this way, the Rotterdam region is connected to Chemelot in Limburg, the Port of Antwerp and the Ruhr area. In addition, a network is being constructed for transport on green hydrogen, a zero emission corridor from Rotterdam to industry in North Rhine-Westphalia within the RH2INE project (DNV, 2021).

Figure 8 - Gasunie infrastructure for large-scale transport of hydrogen

These large-scale hydrogen activities will increase the demand for personnel with hydrogen knowledge. Not only will the hydrogen be transported but through the RH2INE project, for example, there will also be more applications for hydrogen, for example for transport and for aviation. For this reason, a large number of parties in the West region are working on developments around hydrogen, technologically, organizationally and also in terms of training.

2.7 Regional clusters and the hydrogen chain

The large number of initiatives, companies, focus areas, partnerships and trainers, calls for a further classification of Region West. Based on the networking sessions and subsequent validation sessions, see also Appendix 3, the following classification was chosen for Region West, see Figure 9:

- Regional cluster around The Green Village: focus on mobility, built environment and horticulture
- Regional cluster around RDMCampus (West-Middle): focus on process industry
- Regional cluster around Merwe4Havens (East Central): focus on manufacturing industry
- Regional cluster around Sustainability Factory: focus on maritime sector

Figure 10 shows how the four regional clusters can be positioned on the hydrogen chain.

Figure 9 - Regional clusters and partnerships in Region West

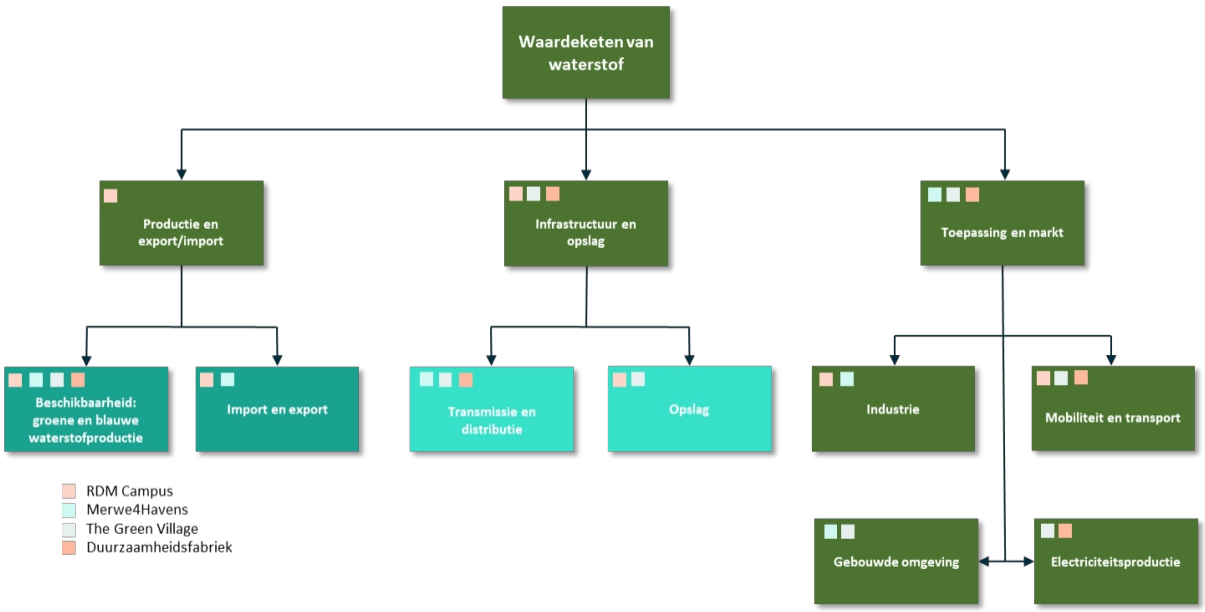


Figure 10 - The hydrogen chain of region West and the region clusters

3 Impact HCA-GVNL in Region West

The conclusions from the discussions with relevant parties during the various network sessions and validation sessions in the region confirm the need for a flexible infrastructure for training, further training and retraining and ensuring more influx and retention of people. An infrastructure that can grow with the expected increasing demand for well-trained personnel. In several places in the region, curricula in initial education are working on the energy transition in general and hydrogen in particular.
Some hydrogen initiatives are still in the early stages of development.

3.1 Responsive infrastructure

A cohesive approach is needed to bring together parties with extensive experience and those who are still developing. This requires working with the parties in the region, educational institutions, businesses and government, to create an infrastructure that can provide a rapid response to new, growing and changing labor market demands. In other words, a responsive infrastructure that supports the fulfillment of the hydrogen transition HCA and reduces the "time to job" for people who want to work on the hydrogen transition.

This responsive infrastructure will be created by identifying and capturing the needs of companies and ensuring that it matches societal and labor market developments. An effective and efficient responsive infrastructure for the hydrogen and energy transition ensures development of the necessary knowledge and skills, together with companies in the ecosystem, to be effectively and flexibly deployable in the hydrogen and energy transition for everyone who wants to work in the hydrogen and energy transition.

The deployment of funds from the HCA Green PowerNL program facilitates the development of this responsive infrastructure for working, innovating and learning. It supports the creation and testing of content for training, retraining and upskilling to hydrogen transition relevant occupational profiles and continuous learning lines in Region West.

This responsive infrastructure has four objectives, elaborated in four building blocks:

- To work from within the four regional clusters (The Green Village, RDM Campus, Merwe4Havens, Sustainability Factory) to strengthen regional campuses with field labs for the hydrogen transition where MBO, HBO and WO students and professionals from industry can come together and train in continuous learning lines.
- Encourages the development of hydrogen learning communities associated with engineering campuses and field labs.
- Test in practice the effectiveness of various existing programs and newly developed pilots for LLO offerings.
- Connect with the national elements of the Green PowerNL program: Make Hydrogen Work, Teacher Professionalization and the National Knowledge Platform.

3.2 Secure cohesive approach

The first pillar of the cohesive approach is the Human Capital Agenda 2.0 (EBZ, 2022) presented by the Economic Board Zuid-Holland. This provincial agreement describes the ambition to work on seven routes aimed at a sustainable and structural improvement of the labor market.
The second pillar of the cohesive approach in Region West is regional PPPs, partnerships and regional clusters. The PPPs still play a limited role in strengthening the innovative power of companies and lifelong development. The aim is for PPPs to further develop their networks into fully-fledged ecosystems around social issues. This requires a multi-level (MBO-HBO-WO), multidisciplinary and multi-sectoral approach.

3.3 Consistency between grants and other forms of funding

GroenvermogenNL's regional liaison team is positioned as an independent party to support and strengthen the coherence between the various national programs and the vision and focus of the province and stakeholders involved. The regional cohesive approach connects the acceleration ambitions and goals in the following way:

- **GroenvermogenNL** answers the question of what is needed? The roadmap outlines the regional ecosystem and identifies the needs and commitment of parties in the region. Together with the parties in the region, the HCA for the hydrogen transition will take on increasingly concrete form in the coming years. The regional liaisons are independent connectors: an important precondition for accelerating the transition and achieving a coherent approach.
- **Scaling up PPPs** aims to realize and perpetuate the infrastructure for what is needed. This is achieved by organizing running capability within ecosystems and permanently connecting education and business. This has resulted in the NGF application PEOPLE and JTF Rijnmond application, Port of Energy. Both projects were applied for and honored within the Human Capital Coalition Energy Transition (HCCE). Port of Energy and PEOPLE focus on an agile and resilient workforce through lifelong development, sustainable and inclusive employability, job coaching for job seekers, and talent attraction and retention.
- The **LLO catalyst** aims to continuously connect organizations and professionals to a rapidly changing society and labor market. The regional application for West is designed in conjunction with Via Delta, organizing walkability from the regional ecosystems and PPP clusters, and the LLO catalyst application should lead to LLO solutions for those same clusters.

4 Activities and Operationalization.

From the perspective of a responsive infrastructure and a cohesive approach within the region, this chapter explains what activities have been undertaken and how they are being operationalized. This takes place within the triangle of working-innovating-learning.

4.1 Work, Innovation and Learning

Work, innovation and learning in Region West are filled in from the trainers, partnerships, public-private collaborations and fieldlabs. In this way, there is a connection between training at the initial trainers, retraining within and together with fieldlabs, teacher professionalization from GroenvermogenNL and branch trainers. Regional work centers and life-long development (LLO) initiatives are consistent with this.
Innovation is done in the described regional clusters and together with the research centers on regional campuses with a clear connection to the R&D program within GroenvermogenNL. The results of innovation programs, practical research and scientific research then translate back into initial training. Figure 11 shows this work-innovation-learning triangle and its connection to training, retraining, upskilling, implementation, experimentation and research.

Figure 11 - Working, Innovating and Learning in Region West

4.2 Building blocks and activities

Support was expressed by the various partners in Region West during the networking and validation sessions to take an active role in the Learning Community Region West. Below, these activities are described in more detail using four building blocks:

- **Building block 1**: Meet and inspire
- **Building block 2**: Deepening collaboration
- **Building block 3**: Learning and development
- **Building block 4**: Innovation

These building blocks also describe activities that will be followed up in 2025 and beyond.

From the input gathered in Building Block 1, education and training facilities will be developed from the Learning Community (Building Block 2). This involves in-service training for teachers, retraining and refresher training for professionals and setting up work-study programs. Flexibilization of education has an important place in this: setting up a structure of microcredentials will be part of the program. Microcredentials will remain part of the program, which will provide them, and can be offered through the National Hydrogen Knowledge Platform (Building Block 3).

The port and the port-industrial complex have a huge impact with its strategic location and connection to its hinterland. This requires innovation and focus for the region. Region West's strategic focus is on safety and hydrogen throughout the value chain (Building Block 4).

4.2.1 Building block 1: Meet and inspire

Building block 1	**Meet and inspire**	
Activities	**Results**	**Effects**
3 Networking meetings '23-'24	Questions raised from the network	Inviting, accessible and approachable ecosystem. Hydrogen awareness growing among target audiences Content calendar, Letters of intent, Communication plan Website
Network development (Liaison)	Increase networking and build out Learning Community region West	
Participation in consultation national knowledge platform	Completing and expanding knowledge platform	
Working meetings with individual cartels in the hydrogen chain	Letters of intent, formalizing collaborations	
Participation Communication Platform GVNL	Visuals, communication policy	

4.2.2 Building block 2: Deepening collaboration

Building block 2	Deepening collaboration	
Activities	**Results**	**Effects**
Elaborate four themes within LC West region	Knowledge documents around the themes	Open and cooperative ecosystem for knowledge exchange
Organization of LC meetings by topic	2-3 Meetings per year	Tools for the development of the Center for Energy Transition
Development of a Center for Energy Transition (HCCE).	Content advice for facility development.	Labor Market: Supply and demand more in balance
Work-to-work pilot	Knowledge in the form of good and bad practices	
Workplace learning pilot	Knowledge in the form of good and bad practices	
Practice-oriented research	Practical research programs for students and professionals	

4.2.3 Building block 3: Learning and development

Building block 3	Learning and development	
Activities	**Results**	**Effects**
Start Teacher Professionalization March 21 (LLO)	Current knowledge among teachers Data on trainings, courses, practicums	Approachable and practical study programs for teachers MBO-HBO
Inventory of learning resources & facilities (NGF/ Test & field labs))	Regional field labs and training facilities in partnership with Center for Energy Transition	Collaboration between education, research and field
Knowledge Needs Assessment Workplace (LLO).	Package of requirements for courses, training and MOOCS	Active Participation LLO Communities Hydrogen module available
Development of learning resources (Modules & profiles).	Educational modules, practical materials, simulations and digital twins (including for the Center for Energy Transition))	Matching pilot group Matching pilot group
Elaborate work-to-work pilot (Labor market supply & demand)	Program with partners	Coupling R&D GVNL
Workplace learning pilot (Labor market supply & demand)	Program with partners	Customized offer
Start-up Practical Research (R&D).	Knowledge development agenda within the themes of the LC West region	
Develop program for microcredentials (LLO).	Program of competencies for microcredentials	

4.2.4 Building block 4: Innovation

Building block 4	Name	
Activities	**Results**	**Effects**
Connection of R&D packages in relation to Human Capital	Knowledge documents competencies and content	Contribution to research and innovation agendas.
Develop Fieldlabs, living labs & test facilities (Keep knowledge flowing)	Innovation and Knowledge Development by joining Fieldlabs TGV, FLIE and H2hub	Contribution to LLO programs for professionals and Docent researchers
Linking National Hydrogen Knowledge Platform	Communication on the National Knowledge Platform: Training materials (courses, teacher professionalization) are shared on the NKP.	Driving innovation Economic impact
Connecting to innovations in the region	Knowledge exchange with startups and scale-ups in multiple incubator locations within the region	

4.3 Output and quality of Learning Community region West

First, the output of the Learning Community consists of training. This can take the form of a course, training or be part of an existing curriculum. It can also be structured workplace learning or conducting research to increase one's own level of knowledge. In this way, it connects to existing initiatives and collaborations. After all, the Energy Transition Learning Agreement also aims to provide guidance from job to job and make use of unused labor potential. Another initiative that focuses on flexible units of education is LLO Catalyst. This program is also being implemented within MBO and HBO education in the West Region.

The quality of educational content has several aspects. One aspect is the theoretical content. KPMG's research shows that many educational materials now mainly describe the hydrogen chain and there are few more specialized courses. Another aspect is the structure of training and examination. The Learning Community includes both commercial trainers and trainers from the public domain. Among the public trainers there is extensive knowledge about testing and assessment. The quality of training and quality assurance of testing will continue to be ensured under the responsibility or in conjunction with the public trainers.

Public educators already have certification systems including digital certificates, so-called edubadges, which can be issued together with microcredentials, as part of existing educational programs. Within the Learning Community, in addition, there is sufficient knowledge about Openbadges to further develop such a certification system within the Public Private Partnerships as well.

A third aspect of quality is facilities. One of the goals from the HCCE consortium, funded by Port of Energy (Just Transition Fund - Rijnmond) and PEOPLE (National Growth Fund), is the start of the Center for Energy Transition on the RDM campus. Within this Center for Energy Transition there will also be training facilities to train professionals on hydrogen. Partners are currently being sought for the development of this facility and for investment.

The activities of the Learning Community region West will be partly funded by JTF Rijnmond and the National Growth Fund and partly by GroenvermogenNL (the liaison function).
In addition, there are flanking programs that align with the Learning Community of GroenvermogenNL that will allow the activities of the Learning Community to be secured within other programs in the coming years including: LLO Catalyst, NGF People, Energy Switch, JTF Port Energy and HCCE. These programs make extensive use of the same ecosystem and are therefore complementary to each other.

4.4 Themes within Learning Community Region West

As described earlier in the previous chapter, the Learning Community region West is committed to four themes:

- **Theme 1 - Labor market knowledge supply & demand**; Inventory of existing trainings and development needed new material. Optimization issues around workforce supply and demand. Work-to-work pilots, supporting employees from fossil sectors, among others, to work in sustainable sectors. For professionals, microcredentials (small educational units that are certified separately and are part of a larger program) and the development and provision of short training courses and education and training together with the companies involved. This involves working closely with private training partners.
- **Theme 2 - Professionalization employees knowledge institutions and education**; Connect to existing LLO programs, strive for optimization. Develop new forms of education for professionals and teachers within knowledge institutions. Inventory knowledge level of current teaching teams. Furnish educational environments and practical areas Deploy shared facilities that also add value to initial educational programs. Provide practical/learning situations.
- **Theme 3 - Research & Innovation (Hydrogen within Energy Transition)**; Under the leadership of professors, various innovation programs and research are initiated in cooperation with the field for the professionalization of professionals and education. New knowledge is developed and made suitable for educational purposes. Practice-oriented research is carried out in connection with the R&D work packages of Groenvermogen NL, in which new knowledge and techniques are quickly applied in the practice of companies in field labs with the associated education and training (in the workplace). Valorization, validation and implementation of practice-oriented research in line with GroenvermogenNL R&D. Concrete research on what is needed to develop a training center for energy transition and hydrogen. Setting up an Energy Transition Center specifically for training is one of the activities in this regard.
- **Theme 4 - Safety & Hydrogen**; Education will be connected to the Learning Community of Fieldlab The Green Village. In addition, together with the NIPV and the Tu-Delft, research is being initiated to link the theme of safety & hydrogen to applied technology in the chain.

4.5 Facilities and Center for Energy Transition

Prerequisites for good teaching and research are state-of-the art facilities. This realization within the region is a logical next step to the current status in the region. With 5 MBO programs, cooperation at the regional level between the 4 HBO institutions in the ZHIA alliance and the cooperation between Rotterdam University of Applied Sciences and TU Delft, there is a fruitful basis for strong cooperation in the field of Research & Education. Within the MRDH, there is a program for campus development related to Energy Transition.

From the programs JTF Port of Energy and NGF PEOPLE the partners, Shipping and Transport College, Techniek College Rotterdam and Hogeschool Rotterdam work together to further develop a Center for Energy Transition including for the port industrial complex. Reinforcement is sought with existing organizations, facilities and educational programs. The Center for Energy Transition will thus become the place where the innovations surrounding energy transition will be given a face and where students and professionals can go for training, education and research.

Hydrogen facilities will also be set up within this training center, both physically and in the form of digital twins. The training center ties in with the ambitions of GroenvermogenNL to establish a Dutch Hydrogen Academy as well as with the HCCE program and LLO Catalyst. It will thus become the place where education, companies and governments work on innovations.
Students and professionals find inspiration here, carry out experiments in the field labs and work on concrete results using a multidisciplinary approach. The strength of the region is the diversity of composition and focus on the various themes and it thus reinforces the ambitions of the region.

The size of the network grew during the start-up phase of the Learning Community hydrogen. Chapter three describes the parties in the ecosystem that participated in the first meeting and/or expressed interest in participating in another setting. This network should be expanded and concretized in the coming years. Via Deltalinqs, contact will be made with a number of multinationals and other larger players in the HIC. In addition, expansion will be made to the Moerdijk industrial area in North Brabant and the Drechtsteden region.

4.6 Operationalization

Technology and education are now finding each other in the West Region. Hydrogen is finding its way into education curricula and private educators are developing education with market players. The Learning Community can be described along three axes: first, the output; second, the quality of the content; and third, from the size of the network. This is shown per year in the overview below.

Year	Meet & Inspire	Deepening collaboration	Learning & development	Innovate
1	Two networking meetings Contribution consultation National Knowledge Platform Four MoU statements Visuals and communication plan	Kick-off meeting by theme Establish pilot labor market Teacher professional development phase 1 Practical research and composition LC	HBO/MBO teachers begin professionalization process Collecting data learning resources Opinions OCET Educational materials hydrogen accessible	Startup LC Safety & hydrogen Connection to R&D packages GVNL Knowledge exchange LC
2	Two networking meetings around expansion Ecosystem A consultation Knowledge Platform Four new MoU statements Visuals and communication	Two substantive meetings per theme Knowledge documents around the themes Conduct labor market pilots Development Center for Energy Transition	Teachers HBO/MBO & VO Professionalization PoEs courses and CoE Pilot programs Microcredentials	Companies join R&D programs Hydrogen & Heat Connecting broader network to innovation programs Letting knowledge flow WO-HBO-MBO
3	Two networking Meetings incl. Alumni A consultation Knowledge Platform Four Cooperation Statements Communication Plan	Six LC meetings Knowledge documents around the themes Evaluation of labor market pilots Workfield participation in education	Professionalizing teachers Develop courses and trainings Digital Twins and CvE Microcredentials	Innovation & R&D: knowledge exchange Knowledge sharing NKP Letting knowledge flow WO-HBO-MBO
4	Two networking meetings A consultation Knowledge Platform Four new cooperation statements Alumni & collaboration	Six LC meetings Knowledge documents around the themes Summarize good and bad practices	Teacher Professionalization Training and courses are offered from Center for Energy Transition Microcredentials ready	Innovation & R&D: knowledge exchange Knowledge sharing NKP Letting knowledge flow WO-HBO-MBO

4.7 Key-results and monitoring

The activities described in this roadmap dovetail with existing initiatives including the HCCE, the Apprenticeship Agreements and other JTF programs. What makes this roadmap complementary is that the goal is to develop practical education and research programs from within the Learning Community. Within the digital environment of the National Hydrogen Knowledge Platform, which is currently under development, many of the educational materials being developed will be offered. In addition, the National Hydrogen Knowledge Platform will serve for exchange of knowledge related to R&D and Innovations.

It will thus become the platform where the regional learning communities, including the Learning Community Region West share and make their knowledge available. With the drafting of the package of requirements, there is a clear work package in which, from Region West, a contribution will be made. Part of this platform will be the online section of Make Hydrogen Work, a platform around training professionals in the hydrogen transition. In the run-up year of '23, two knowledge events were organized to shape the Learning Community. The first event was for introductory purposes and at the second event, organized at RDM Rotterdam, the participating parties confirmed their ambitions regarding the development of education.

The parties that are part of the Learning Community can be divided into four groups:

- **Educators;** educators include both vocational schools in the region and providers of commercial initial and post-initial education. These are the parties who can retrain and upskill, provided they have the appropriate knowledge to do so. This role can also be taken by companies that possess specific knowledge.
- **Knowledge partners;** The knowledge partners develop substantive knowledge through research and development, for example in cooperation with companies.
- **Government;** The government has issues around the provision of labor from unused labor potential. In particular, the guidance from work to work, from the fossil industry the energy transition is an issue. The government thus has a training need which leads to training issues.
- **Professional field;** For the professional field and especially for the energy sector, the energy transition is a difficult issue where the focus is on the further development and application of technology. Increasingly, issues related to labor are also emerging. Filling vacancies for technicians remains difficult in every sector.

Cooperation in the Learning Community takes the form of projects, research, by developing education and by offering education (commercially). In addition, there is an ambition among the educational parties to establish a Center for Energy Transition and Hydrogen where training is central. This will be an additional facility where practical skills can also be taught and hands-on research conducted. This facility will offer learning resources in the form of hardware as well as the use of sensors, internet of things, digital-twins and other data- and software-based simulation environments. Energy transition goes hand in hand with digitization and monitoring to make everything smarter and more efficient.

5 Outlook

Over the past year and a half, much has been collected in Region West. Earlier in this document, overview maps of educators and partnerships in the region were shown. A classification of four regional clusters with their own distinct focus was presented. In the validation sessions, see also Appendix 3, an overview of the current status of what is in application and what is in progress in relation to the hydrogen chain was created. These overviews can be summarized that in the following five activities, which can be realized in the first year of the roadmap.

Activity	Building Block	Concrete outcomes
Start of development for Center for Energy Transition	Building block 3: Learning and development	Three trainings are being developed from the LC for hydrogen equipment at the Center for Energy Transition. Target audience for the trainings are teachers who will use this equipment in their teaching.
Fieldlabs related to the Center for Energy Transition	Building block 4: Innovation	Fieldlabs are being developed from the Center for Energy Transition and in conjunction with it. Linked to this is also the Fieldlab Industrial Electrification, initiative of TNO.
Connecting to Innovations in the Region	Building block 4: Innovation	The H2hub in Drechtsteden is now at an advanced stage and is looking to connect with GroenvermogenNL. Knowledge from this Fieldlab will be transformed into Learning Outcomes that will be made appropriate to Make Hydrogen Work.
Work-to-work pilot	Building block 2: Collaborate and deepen	Together with parties in the region, an inventory of existing programs is being made that could be a concrete example for a hydrogen program to be developed.
Increase network and expand LC	Building block 1: Meet and inspire	The network is being expanded to include industry partners. The expansion is carried out through Deltalinqs and the HCCE. New funding is being sought from these collaborations.

With the end of the first phase in which the start-up activities were developed, expansion and strengthening of the liaison team is desired. Due to the geographical and thematic formation of several clusters within the region and further operationalization of activities linking to other programs, expansion is necessary. In the hydrogen value chain, several sub-areas have been defined. For the continuation of the liaison activities and implementation of this roadmap, we propose a team with the following composition: a lecturer from Rotterdam University of Applied Sciences, a representative from TU Delft in combination with The Green Village, a representative from the Sustainability Factory and supported by a Learning Community director from the Centre of Expertise HRTech. This expansion does more justice to the differences between the clusters and creates a sharper management function and better assurance.

Appendix 1 - Ecosystem stakeholders Region West

Companies and businesses in region West

Energy Switch South Holland
Energy Switch is a partial agreement of the Human Capital Akkoord signed in June 2019 by 66 parties and sectors in South Holland. Provincie Zuid-Holland and Economic Board Zuid-Holland are the initiators of the Human Capital Akkoord, which aims to make the best use of the talent of working people. The purpose of Energy Switch is to scout, mobilize and then connect and develop people who want to help accelerate the energy transition. In doing so, the initiative is in the hands of TU Delft and The Green Village, the sustainable living lab located on campus (TU Delft 2021). From the inception of GroenvermogenNL there has been close contact and Energy Switch will also be involved in the further development of the Learning Community region West.

H2Makers
The existing activities around hydrogen in the Rotterdam-Moerdijk cluster and the ambitions of the Port of Rotterdam and the Province of South Holland create opportunities for the manufacturing industry in the region. H2Makers wants to support the South Holland manufacturing companies developing products around the hydrogen transition, with meeting, education and development opportunities. We encourage organizations to invest in innovation and cooperation. In this way, hydrogen can be used faster in industry, chemistry, aviation or shipping. The knowledge center H2Makers thus aims to share practical knowledge within the hydrogen manufacturing industry and was launched in 2023 (Innovation Quarter 2023). H2Makers also has the ambition to set up a test and training center for hydrogen. In terms of content, this training center could be linked to the Center for Energy Transition within the HCCE. Exploratory talks for further cooperation are ongoing. From their area of expertise and network within SMEs, a development step can be taken around innovation for that target group.

HiDelta
HiDelta connects manufacturing companies and suppliers, knowledge institutions, educators and governments in the technological sector in South Holland, particularly around the Drechtsteden. To this end, HiDelta organizes networking events including events specifically for hydrogen. With HiDelta, two test setups will be designed next year in the Drechtsteden region in cooperation with Krohne. The Sustainability Factory within which this will take place is part of the Ecosystem and the training column MBO-HBO.

I-EM Delft
The I-EM Delft Foundation is a PPP dealing with energy transition for mobility. Within I-EM Delft, an emphasis has been placed on hydrogen drives. I-EM Delft organizes research projects for MBO, HBO and WO students and offers short, practical courses in the field of hydrogen and energy transition, aimed at policy makers, among others. These courses are partly developed in cooperation with the Hogeschool Rotterdam. As described earlier, an active position will be taken within the LC Teacher Professionalization.

Zepp Solutions
Zepp solutions specializes in developing fuel cell modules that integrate all the necessary components required to produce electricity from hydrogen, from air to hydrogen supply and from hardware to software. Among other things, Zepp Solutions has developed powertrains for the Water Taxi in Rotterdam in collaboration with Enviu and Flying Fish (SwimH2 2022) and the powertrain of a truck for the European market (Zepp Solutions 2023). Several students from the Rotterdam University of Applied Sciences and TU Delft collaborated on these innovations in the form of internships. At the RDM Rotterdam location, Zepp Solutions has facilities and a field lab.

Accenda
Accenda develops sustainable energy systems for mobility in particular. One component of this is hydrogen drive lines. In doing so, Accenda collaborates with educational parties. A recent innovation, for example, is the Liebherr H2 excavator developed together with Mourik (Accenda 2021). The knowledge developed at Accenda finds its way to the affiliated educational institutions via I EM Delft.

Battolyser Systems
Battolyser Systems is a scale-up that has developed a battery that can also function as an electrolyser. Battolyser is building a factory in the Merwe-4 port area of Rotterdam to start serial production of these devices. Collaboration has been sought from Battolyser Systems with educational parties in the region to address their human capital issues.

Oceanco
https://www.oceancoyacht.com/Oceanco is a shipyard where luxury yachts are built. Together with the Rotterdam University of Applied Sciences, a research project has started on the powertrain for a racing boat. Its goal is to compete in the Monaco Solar & Energy Boat Challenge.

NIPV
The Netherlands Institute for Public Safety provides training related to hydrogen and safety. From that capacity, NIPV is also classified under the category of industry. After all, the institute could also fall under knowledge centers. Together with GroenvermogenNL, the NIPV organized the first knowledge event for the Learning Community. Active participation around Hydrogen & Safety is under discussion.

Uniper
In the Netherlands, Uniper has four gas-fired power plants for the production of electricity and one plant that produces electricity from pulverized coal and biomass. In addition to electricity production, Uniper trades in natural gas. Uniper participates in the Learning Community.

Deltalinqs
Deltalinqs is the entrepreneurs' association for companies in the HIC and works closely with the Municipality of Rotterdam and the Port Authority. Within large, umbrella, programs including the Human Capital Coalition for Energy Transition, HCCE. This is where the GroenvermogenNL program fits in. Deltalinqs is the platform for the Learning Community region West to connect with larger parties in the HIC.

Stedin

Stedin joined the Learning Community region West to seek deepening for its own business school. Stedin manages gas infrastructure and will need to be able to transport hydrogen in the future.

Gasunie

Gasunie transports gas in a network of gas pipelines in the Netherlands and joined the second knowledge event to contribute content to projects around hydrogen in order to increase its own knowledge and connect with education. As a follow-up, Gasunie is taking an active role in the first event around teacher professionalization that will start March '24.

Educators

Education parties provide educational programs and develop teaching and learning resources. During the 2023 start-up activities, several education parties joined the Learning Community kick-off meeting. Education parties can be public parties directly funded by the government or private parties offering commercial education.

Rotterdam University of Applied Sciences

The Rotterdam University of Applied Sciences is the sponsor of the Human Capital Agenda program component of GroenvermogenNL. Rotterdam University of Applied Sciences offers programs at different NLQF levels: associate degree (level 5), Bachelor of Science (level 6) and Master of Science (level 7). Within the technical courses, increasing attention is being paid to hydrogen within the energy transition. This is part of a broad educational program around Energy Transition.
Students massage knowledge in Years 1 & 2 and work to deepen in internship, minors and graduation.

STC

The Shipping and Transportation College (STC) is a vertical trade institution that focuses on maritime, inland navigation, transportation and industry in the Port and Industrial Complex. They are represented on the liaison team. STC offers full vocational training at the secondary and higher vocational level as well as contract education. STC also has a university program (Maritime & Logistics University of applied sciences). Within the MBO, STC offers elective modules of 240 credit hours. Two elective modules offered by STC are about hydrogen:
"Hydrogen technology" and "Renewable energy." Both elective courses are certified by the Cooperation Organization for Vocational Education and Business (SBB) and thus recognized by the Education Executive Agency (DUO).

STC-Next

STC-Next is the private arm of STC-Group. STC-Next has developed shorter hydrogen technology programs that specifically target business in and around the port and teaches them nationally and internationally. These programs last two to six days and have a practical component built in.

Techniek College Rotterdam

Techniek College Rotterdam (TCR) is a partnership between two vocational secondary schools in the Rotterdam region, Albeda College and ROC Zadkine. Both training centers have merged their technical courses. At the RDM Rotterdam location, courses in Process Technology and Installation Technology are provided.
Hydrogen technology is an established component within the Process Technology course because hydrogen has long had applications in the chemical industry. The TCR also offers the SBB elective module Hydrogen Technology. Meanwhile, the TCR is in the process of becoming more flexible to make the education accessible to professionals as well. This ties in with the NGF-People program.

Da Vinci College Dordrecht

Da Vinci College in Dordrecht is the vocational training provider for the Drechtsteden region and offers several technical courses. The Drechtsteden area is historically characterized by its connection to inland shipping. Hydrogen is also expected to play a greater role here. This is why Da Vinci College has joined the H2 innovation table in Drechtsteden. For this reason, Da Vinci College will also join the Learning Community.

TU Delft

TU Delft offers several educational modules related to hydrogen. In addition, research is being conducted into applications of hydrogen in energy transition. To this end, a Fieldlab has been set up (The Green Village) and a large number of research projects are being carried out within among others, the Dreamhall. TU Delft's various hydrogen-related modules and research are accessed through the Energy Switch network. In addition, TU Delft has an HSE department where issues of hydrogen and safety are involved in the research of The Green Village, among others. TU Delft contributes to solving urgent societal challenges. Increasingly, these involve complex and often interlocking transitions. For example, transition tasks in areas such as energy, raw materials, the living environment and health and welfare are closely intertwined.

The Hague University of Applied Sciences

The Hague University of Applied Sciences offers several technical courses at levels 5 and 6 in which hydrogen technology plays a role. Project education with hydrogen is done in cooperation with The Green Village of TU Delft. One is part of the program & Learning Community ET-TLC and there is thus a connection with the Sustainable Talent Development lectorate of The Hague University of Applied Sciences.

ROVC

ROVC is part of Salta Group and offers technical training that focuses particularly on technicians who are already working. ROVC has three TechCenters with facilities for practical education. In the West region, one of the TechCenters is located in Dordrecht. Currently, ROVC already offers a one-day course on hydrogen and safety.

NCOI

NCOI, like ROVC, is a part of Salta Group and offers college courses and parts of them, including in energy engineering.

Government

During the start-up facilities, contact was made with the Province of South Holland and the Municipality of Rotterdam. Both governing bodies are active with Human Capital in various initiatives. In the Leerwerkakkoorden, regional government, education and business join forces to find a better balance and match between supply and demand of work in the region. The imbalance is caused by an aging population on the one hand and a smaller influx of young people into the, especially technical, professions on the other. Apprenticeship agreements relevant to this roadmap:

1. Apprenticeship agreement on energy transition
2. Apprenticeship agreement port
3. Apprenticeship agreement construction and engineering

All Apprenticeship Agreements invest in three themes: from school to work (young people and school leavers), from work to work (labor market mobility) and to work (potential employees without jobs). All Apprenticeship Agreements also make a connection with Lifelong Development [LLO].

The Energy Hub and the Transition House

The City of Rotterdam's Human Capital Position Paper mentions two initiatives to reduce a mismatch between supply and demand for technical work in the labor market. The Energy Hub is a pool of workers in the energy sector who are surplus to requirements and are retraining for green energy technology. From that pool, they can be employed by parties involved in green energy. The Transition House is a similar initiative where workers are actively coached and financially supported to transfer to a party within the energy transition if they lose their jobs in the fossil industry.

Human Capital Coalition Energy Transition

Deltalinqs, Port of Rotterdam Authority, Municipality of Rotterdam, Hogeschool Rotterdam, Techniek College Rotterdam and STC (Shipping and Transport College) are working together in the Human Capital Coalition Energy Transition (HCCE) to provide a suitable labor and education supply for now and in the future, in order to enable the energy transition in Rotterdam's HIC.

Fieldlabs

Several Fieldlabs have been set up in the region for applied research. Three of them are now connected.

The Green Village

The Green Village is a Fieldlab where test facilities are being developed for practical applications of hydrogen. Various market players use those facilities for research and training purposes. The Green Village has constructed the hydrogen lane where grid operators can conduct research on hydrogen in natural gas pipelines and residential applications. In addition, The Green Village is developing research and testing capabilities for applications of liquefied hydrogen (LH2). Liquid hydrogen can find applications in aviation and heavy transportation.

The Green Technology Campus

The Green Technology Campus is part of the STC Group. At the location in Brielle, students are exposed to all facets of energy transition. Private parties can also use the facilities offered by the Green Technology Campus.

Fieldlab Industrial Electrification

The Fieldlab is a joint initiative of Deltalinqs, Port of Rotterdam, InnovationQuarter, FME and TNO and is being designed in close cooperation with the ERDF grant, the Municipality of Rotterdam and the Province of South Holland. In this Fieldlab, technologies can be tested on an industrially relevant scale in a practical environment. The Fieldlab also offers the opportunity to further develop ideas and validate business cases together with the entire chain (FLIE 2020).
Electrification is an important part of the energy transition and also of the hydrogen transition.

Training ship Ab Initio

STC has launched the inland navigation training ship Ab Initio, the first inland vessel to meet all European standards for hydrogen-powered navigation. With over 8,000 inland navigation vessels, the Netherlands has the largest fleet in Europe. On the Ab Initio, students can gain experience with the very latest technologies including propulsion with hydrogen and a fuel cell.

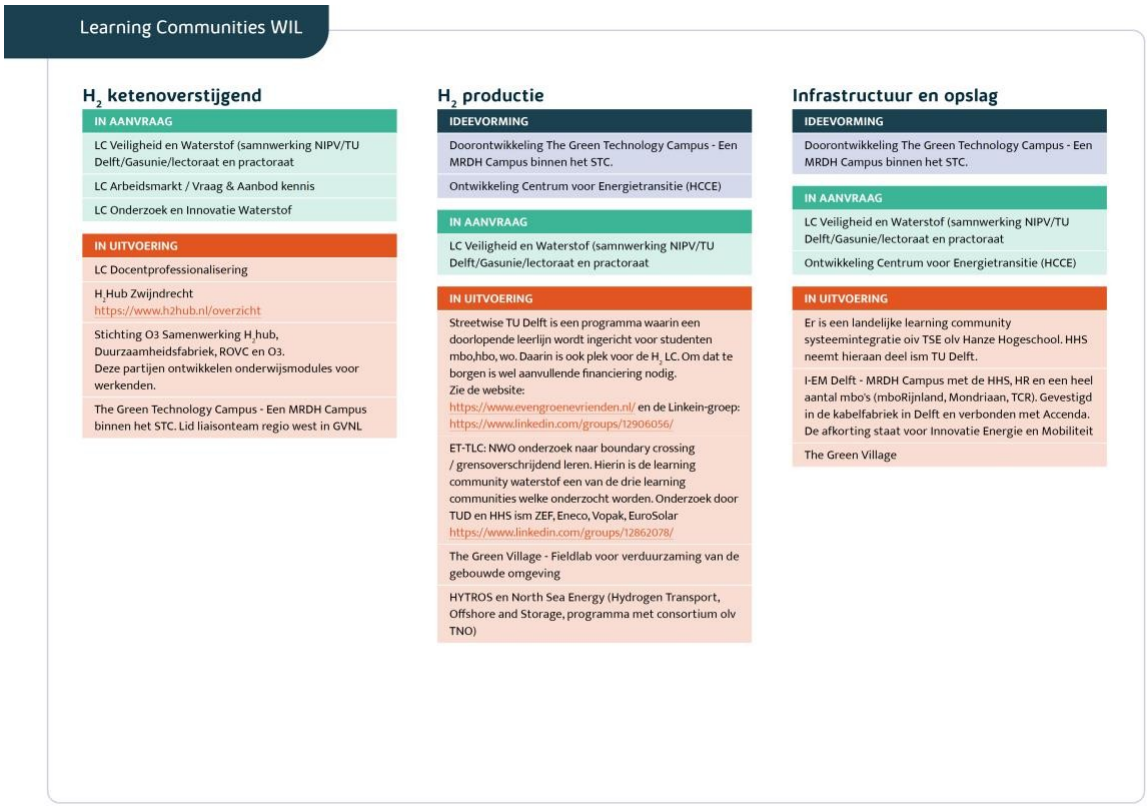
Appendix 2 - Partners Learning Community Region West

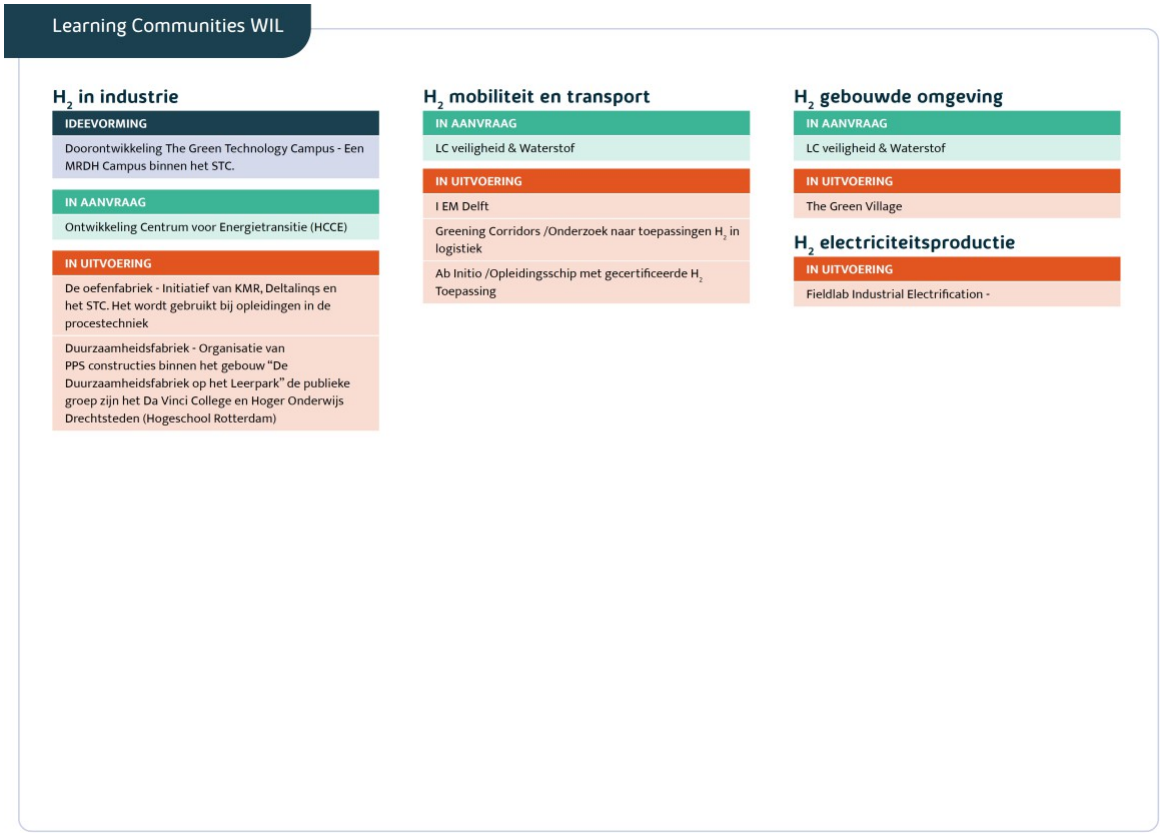
	Partner Learning Community	Role		Current connection
1	Port of Rotterdam	Connector	Semi-government	With CoE HRTech in PPP
2	Economic Board Zuid Holland	Connector	Business	
3	Rotterdam University of Applied Sciences	Sponsor program	Semi-government	Treasurer
4	H2Makers	Connector	Government	Network Partner
5	HiDelta	Connector	Semi-government	Network Partner
6	Entrepreneur House Drechteden	Connector	Business	Network Partner
7	Energy Switch	Connector	Semi-government	Consortium partner
8	I EM Delft	Connector	Semi-government	Project partner MRDH
9	Zepp Solutions	Technology and content	Business	Internship partner trainings
10	Accenda	Technology and content	Business	Internship partner trainings
11	Battolyser Systems	Technology and content	Business	Consortium partner NGF
12	Oceanco	Technology and content	Business	Internship partner trainings
13	TTA	Educator	Business	Internship partner trainings
14	MINDBASE Min. of Defense	Technology and content	Government	Consortium partner
15	Krohne Dordrecht	Technology and content	Business	Consortium partner
16	NIPV	Content and safety	Semi-government	Consortium partner
17	Uniper	Technology and content	Business	New partner
18	Deltalinqs	Connector	Business	Consortium partner
19	Rotterdam University of Applied Sciences	Sponsor, trainer	Education	Treasurer
20	Higher education Drechtsteden	Educator	Education	Consortium partner
21	Centre of Expertise HR Tech	Knowledge center, trainer	Education	Treasurer
22	Knowledge Center Talent Development	Knowledge center trainer	Education	Consortium partner
23	Knowledge center sustainable talent development	Knowledge center trainer	Education	Consortium partner

24	STC Group	Sponsor, trainer	Education	Treasurer
25	STC-Next	Educator	Education	Consortium partner
26	Techniek College Rotterdam	Educator	Education	Consortium partner
27	Da Vinci College Dordrecht	Educator	Education	Consortium partner
28	ROC Mondriaan	Educator	Education	Network I EM Delft
29	ROC Midden-Nederland	Educator	Education	Network I EM Delft
30	TU Delft	Educator	Education	Consortium partner
31	The Hague University of Applied Sciences	Educator	Education	New partner
32	ROVC	Educator	Education	New partner
33	NCOI	Educator	Education	New partner
34	Province of South Holland	Connector	Government	Consortium partner
35	Municipality of Rotterdam	Connector	Government	Consortium partner
36	The Green Village	Technology and content	Research	Consortium partner
37	The Green Technology Campus	Technology and content	Research	Consortium partner
38	Fieldlab Industrial Electrification	Technology and content	Research	Consortium partner
39	Stedin	Technology and content	Business	New partner
40	Gasunie	Technology and content	Business	New partner

Appendix 3 - Outcomes validation sessions.

Learning Communities





Educational offerings MBO

Onderwijsaanbod MBO

H_2 ketenoverstijgend

INITIEEL

IN UITVOERING
- Leerlijn Waterstof / STC Next

LLO

IDEEVORMING
- Ontwikkeling flexibel aanbod door private opleiders

H_2 productie

INITIEEL

IN UITVOERING
- Complete leermodule Waterstof van opwekking t/m toepassing/gebruik
- Leerlijn Waterstof / STC Next

LLO

IDEEVORMING
- Ontwikkeling opleidingsprogramma Gasunie

IN UITVOERING
- Knowledge centre for explosions and hydrogen safety

Infrastructuur en opslag

INITIEEL

IN UITVOERING
- Complete leermodule Waterstof van opwekking t/m toepassing/gebruik
- Leerlijn Waterstof / STC Next

LLO

IN UITVOERING
- I EM Delft
- Technicom
- Knowledge centre for explosions and hydrogen safety

H_2 in industrie

INITIEEL

IN UITVOERING
- Complete leermodule Waterstof van opwekking t/m toepassing/gebruik
- Leerlijn Waterstof / STC Next

LLO

IN AANVRAAG
- Knowledge centre for explosions and hydrogen safety

IN UITVOERING
- ROVC

H_2 mobiliteit en transport

INITIEEL

IDEEVORMING
- PPS Green Engine Technology, diverse modules waterstof aandrijving

IN AANVRAAG
- Ontwikkeling faciliteiten

IN UITVOERING
- TTA

LLO

IDEEVORMING
- PPS Green Engine Technology, diverse modules waterstof aandrijving

IN AANVRAAG
- Knowledge centre for explosions and hydrogen safety
- Ontwikkeling faciliteiten Werkplaatsen TCR

IN UITVOERING
- ROVC
- I EM Delft (Toegepaste technologie)
- Cursussen TTA

Onderwijsaanbod MBO

H_2 gebouwde omgeving

INITIEEL

IDEEVORMING
- Diverse modules in ontwikkeling vanuit PPS SCALE

IN AANVRAAG
- Ontwikkeling faciliteiten
- In aanvraag
- Ontwikkeling faciliteiten

LLO

IDEEVORMING
- Diverse modules in ontwikkeling vanuit PPS SCALE

IN AANVRAAG
- Ontwikkeling faciliteiten

IN UITVOERING
- ROVC
- Knowledge centre for explosions and hydrogen safety

H_2 electriciteitsproductie

INITIEEL

IN UITVOERING
- Complete leermodule Waterstof van opwekking t/m toepassing/gebruik

Educational offerings HBO

Onderwijsaanbod HBO

H_2 ketenoverstijgend

INITIEEL

IN AANVRAAG
- Ontwikkeling faciliteiten

IN UITVOERING
- Minor Energietransitie HR (30 ECTS)
- Chemische technologie

LLO

IN AANVRAAG
- Ontwikkeling Centrum voor Energietransitie
- Ontwikkeling flexibel aanbod door private opleiders

H_2 productie

INITIEEL

IN AANVRAAG
- Onderzoek Waterstof /Warmte
- Heat-Flex

IN UITVOERING
- Mission Transition (Masterclass programma)
- FLIE / Onderzoek Pilots Electrolyse
- Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG
- Ontwikkeling Centrum voor Energietransitie i.s.m. bedrijfsleven

IN UITVOERING
- Knowledge centre for explosions and hydrogen safety

Infrastructuur en opslag

INITIEEL

IDEEVORMING
- Microcredentials Waterstof

IN AANVRAAG
- Onderzoek Waterstof /Warmte
- Heat-Flex

IN UITVOERING
- Minor energietransitie
- Knowledge centre for explosions and hydrogen safety
- In uitvoering
- Minor energietransitie
- Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG
- Ontwikkeling Centrum voor Energietransitie

IN UITVOERING
- Knowledge centre for explosions and hydrogen safety

Onderwijsaanbod HBO

H_2 in industrie

INITIEEL

IN AANVRAAG
- Onderzoek Waterstof /Warmte
- Heat-Flex

IN UITVOERING
- Minor Waterworld
- Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG
- Ontwikkeling Centrum voor Energietransitie

IN UITVOERING
- Knowledge centre for explosions and hydrogen safety

H_2 mobiliteit en transport

INITIEEL

IN AANVRAAG
- Onderzoek veiligheid & waterstof

IN UITVOERING
- Minor energietransitie
- Knowledge centre for explosions and hydrogen safety
- H_2 EnergyLab RDM Campus

LLO

IN AANVRAAG
- Ontwikkeling Centrum voor Energietransitie

IN UITVOERING
- Knowledge centre for explosions and hydrogen safety

H_2 gebouwde omgeving

INITIEEL

IDEEVORMING
- PPS Green Engine Technology, diverse modules waterstof aandrijving

IN AANVRAAG
- Heat-Flex

IN UITVOERING
- Onderzoek Duurzame renovatie
- In uitvoering
- Onderzoek Duurzame renovatie

H_2 electriciteits-productie

INITIEEL

IN UITVOERING
- Minor energietransitie / Track Offshore

Educational offerings WO

Onderwijsaanbod WO

H_2 ketenoverstijgend

INITIEEL

IN UITVOERING

Master SET (Sustainable Energy Technologies); H_2-track is in ontwikkeling

Parallel aan de SET mastertrack H_2 wordt gewerkt aan een online onderwijsprogramma H_2 door TU Delft Extension School.

LLO

IN UITVOERING

Master SET (Sustainable Energy Technologies); H_2-track is in ontwikkeling olv Rene van Swaaij

Parallel aan de SET mastertrack H_2 wordt gewerkt aan een online onderwijsprogramma H_2 door TU Delft Extension School. Contactpersoon: Bertien Broekhans

H_2 productie

INITIEEL

IN AANVRAAG

Heat-Flex

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

LLO

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

Infrastructuur en opslag

INITIEEL

IN AANVRAAG

Stem af met Peter Lucas voor een actueel overzicht van R&D waterstof bij de TUD en partners

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

LLO

IN AANVRAAG

R&D Waterstof

Heat-Flex

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Onderwijsaanbod WO

H_2 in industrie

INITIEEL

IN AANVRAAG

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

H_2 mobiliteit en transport

INITIEEL

IN AANVRAAG

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

H_2 gebouwde omgeving

INITIEEL

IN AANVRAAG

R&D Waterstof

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

LLO

IN AANVRAAG

R&D Waterstof

Cursus voor ambtenaren: energietransitie in een dag ; deze wordt ontwikkeld door TGV en TU Delft Extension School. Contactpersoon: Stefan Hoekstra, TGV; Bertien Broekhans, TUD ES

IN UITVOERING

Voor al deze thema's geldt: er is zowel onderzoek als onderwijs op dit thema bij TUD; zowel initieel als LLO

Knowledge centre for explosions and hydrogen safety

Resource List

Bachaus, Amanda (2023), Martijn Blom, Emiel van der Toorn, Ward van Santen, Nard Koeman, Elene Lenders, and Henri Bussink, "*Labor Market Research Hydrogen Transition,"* CE Delft.

DNV (2021), "*Towards Zero Emission Transport Corridors*," retrieved May 29, 2024 from https://rh2ine.eu/rh2ine/kickstart-study.

Economic Board Zuid-Holland (2022), "*Human Capital Agenda 2.0*," retrieved May 29, 2024 from https://www.economicboardzuidholland.nl/human-capital/

Gasunie (2023), "*Gasunie starts construction of hydrogen network Netherlands,*" retrieved May 29, 2024 from https://www.gasunie.nl/projecten/.

GroenvermogenNL (2023), "*About GroenvermogenNL,*" retrieved May 29, 2024 from https://groenvermogennl.org/over-groen-vermogennl/wat-we-doen/

Port of Rotterdam Authority (2024), "*A new energy system*," retreived May 29, 2024 from https://www.portofrotterdam.com/nl/haven-van-de-toekomst/energietransitie/een-nieuw- energy-system

UWV (2022), "*Region in Focus 2022*," retrieved May 29, 2024 from https://www.werk.nl/arbeidsmarktinformatie/regio/zuid-holland-centraal/regio-in-beeld-2022

Wilthagen, Ton (2023), "*Tightness is choice, certainly now, but also later,*" Brabants Dagblad, Feb. 2, 2023

Seal, Stijn (2023), Eline de Haan, and Carlijn Schumacher, "*Green PowerNL: An Exploration of Initial Education."* Technopolis.

Justification: This track/program was made possible by GroenvermogenNL, a national program of the Ministry of Economic Affairs & Climate, funded by the National Growth Fund and facilitated by Regieorgaan SIA, part of the Netherlands Organization for Scientific Research (NWO)

groenvermogennl | Innovatiemotor van de groenewaterstofeconomie

www.groenvermogennl.org