TOWARDS A RESILIENT NORTH SEA REGION

EMERGING VALUE CHAINS

Interreg North Sea Region RIGHT
European Regional Development Fund
EUROPEAN UNION

RIGHT
RIGHT SKILLS FOR THE RIGHT FUTURE

Emerging Value Chains

An Interreg North Sea Region Project

RIGHT Project

RIGHT SKILLS FOR THE RIGHT FUTURE

Authors: Jeltje Talen, Harm van Lieshout & Mein Bish, Hanze University of Applied Sciences Groningen

Lead Partner: Vestland fykleskommune

May 2022

Contributions from the RIGHT Partners

Design by Visual Arts Lab

Table of Contents

On behalf of the INTERREG B project RIGHT desk research has been conducted as an additional basis for the RIGHT project, and the policy recommendations and tools it will present. The core of the RIGHT project was about ensuring competitive North Sea regions by future-proofing the workforce, building knowledge about our industry needs and strengthening (innovative) capacity amongst our SMEs, regional governments, and educational institutions. Within this context skills development is regarded as crucial. The aim of the project was to show that access to a strong and adaptable workforce with the necessary skills to support future growth will ensure and maintain a competitive regional economy and build innovation support capacity through increased regional knowledge. The RIGHT approach is to connect smart specialisation strategies (SSS) in the North Sea Region (NSR) to human capital and skills. Through collaboration it will define:

- existing and potential regional growth sectors and sub-sectors (blue and energy)
- skills gaps to unlock innovation capacity by testing new models to overcome skills barriers

The goal of the project is to increase regional innovation capacity through increased and shared knowledge. The project has developed methods for increasing the pool of competences available to companies in blue economy and energy and manufacturing sectors of the regions that participate in the project. The pilots analysed in work package 4 of the RIGHT project provide an important basis for this. The purpose of work package 5 was to package the experiences from the previous work packages into tools for policy making and knowledge mapping.

The RIGHT partners agreed on the following definition of a value chain. A value chain is an extended input-output or buyer-supplier chain which includes final market producers, and first, second and third tier suppliers that directly and indirectly engage in trade and which is comprised of multiple sectors or industries. Section 4 will discuss what we learned on value chain developments in energy and blue sector from our RIGHT pilots and regions.

Since those pilots included in work package (WP) 4 (by definition) concerned more themes than value chain development, and vice versa, could not cover everything relevant for value chain development, some additional desk research was carried out. On the one hand, RIGHT is not the only project concerned with the Energy transition, human capital, labour market, business models and value chains. Early 2020, a Knowledge Transfer Workshop on transnational collaboration was held in Copenhagen amongst various INTERREG projects in this field (Aahave, 2020). While RIGHT is the most focussed on

labour market, education and training, various other projects deal with interesting projects more on the business and value chain side of innovation. Since they are a nice addition to the RIGHT pilots of WP4, we present a brief overview in Section 5 to provide a somewhat expanded basis for our analysis in WP5.

For the same reason, section 3 provides an up-to-date look on the apparent acceleration of a hydrogen value chain in the Dutch area of Groningen. Hydrogen was already a subsector included in the regional educational innovation program Gas 2.0., one of the pilots analysed for WP4 (Talen, Lieshout, & Fokkens, 2022). Not only has a similar, new but more specifically hydrogen-targeted educational and labour market program been developed and started since; there are other new interesting developments in other parts of the developing hydrogen chain in that region. On the one hand, these developments are a good example of both the challenges in developing new sub-sectors still in need of important technological and economic improvements, and potential ways to address them. On the other hand, this subsector (at least in theory) offers an excellent potential for increased co-operation between these North Sea nations and regions, since many interesting developments can be at (the North) sea (i.e., electrolysers at sea-based windmill platforms) or its shores. Section 2 will first introduce the concept of value chains and value chains development based on some recent international reports.

Section 6 finishes this paper with a summary of a 2020 JRC status report on employment in the energy sector.

Value chains in international policy

The Skills Outlook 2017 had a special focus on skills in the Global Value Chains (GVCs) (OECD, 2017):

> *Workers need to have strong literacy, numeracy and problem-solving skills, skills in the use of technologies, social and emotional skills, and the capacity and motivation to learn. When workers have the mix of skills that is well aligned with the needs of the most technologically advanced industries, and when qualifications reliably reflect what workers can do, countries can develop a comparative advantage by specialising in these industries. Having the right skills can also help workers face the potential negative impacts of global value chains: having communication and decision-making skills make workers less vulnerable to the risk of offshoring.*

The RIGHT project will therefore contribute to the supply of a rightly skilled workforce of the specialised industries of the partner regions, in order to compete on global markets.

GVCs encompass the cross-country, end-to-end processes by which goods are produced, consumed, and dealt with at the end of their life cycles (WEF, UNDP & A.T. Kearney, 2019). Diverse entities coordinate activities across them, from raw material extraction through to processing, forming, assembly, distribution and either disposal, reuse, or recycling. Industrial and business strategies have relied on and helped shape global networks of production that underpin GVCs. A value chain "describes the full range of activities that are required to bring a product or service from conception, through the intermediary phases of production and delivery to final consumers, and final disposal after use" (Kaplinsky & Morris, 2012; cited in Ripley, 2021). Value chains describe how value is created from the conception of a product or service to its final consumption, including the different stages of input supply, design, production, distribution, and retail. The term value chain is more often used with a developmental connotation, addressing issues of value capture and distribution across the chain (Ripley, 2021, p. 12). A schematic overview of a value chain can be presented as follows (figure 1).

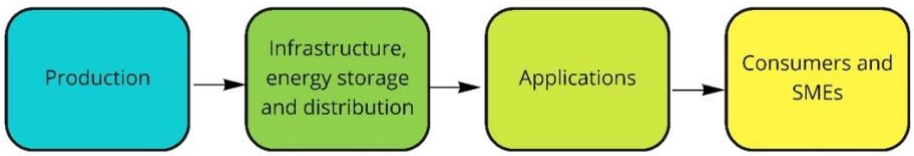


Figure 1. Schematic overview of a value chain.

We will introduce the concept of Global Value Chains further through recent international reports of the World Economic Forum (WEF), International Labour Organization (ILO) and Organisation for Economic Cooperation and Development (OECD).

Reshaping global value

GVCs play an important role in the development of businesses and national economies (WEF, UNDP & A.T. Kearney, 2019). More than two-thirds of world trade takes place within the framework of GVCs. Rapid expansion of GVCs created opportunities for many countries (particularly developing countries) to participate in global markets and drive their economic development. Businesses have benefitted from GVCs by reducing production costs and gaining access to new resources and technologies. The extent and nature of participation in GVCs varies, with benefits unevenly distributed between and within countries.

The World Economic Forum and the United Nations Development Programme (UNDP) have undertaken a joint effort to develop a better understanding of the ongoing transformations in production and GVCs from both a corporate and broader sustainable development perspective. In collaboration with A.T. Kearney, the partners developed a new Strategic Value Framework that helps stakeholders understand the likely impacts and implications of disruptions across GVCs, and thus what needs to be done to adapt to them, when and by whom (WEF, UNDP & A.T. Kearney, 2019). The paper (WEF, UNDP & A.T. Kearney, 2019, p. 4):

- Offers a new Strategic Value Framework to test hypotheses and understand the implications of disruptive trends on GVC.
- Identifies capabilities that can help businesses, governments, and public-private partnerships to prepare for those disruptive trends, stay ahead of potential negative effects and continue to grow value.
- Makes a case for change and issues a call to action for businesses, governments, and public-private partnerships to ensure an inclusive transition towards the future GVC landscape, including by rethinking their strategies and pathways to economic growth, and considering wholly new approaches to economic planning, policymaking, capacity development and business practices.

The framework first profiles a current GVC in terms of three pillars (WEF, UNDP & A.T. Kearney, 2019, p. 5):

- Economic value pool indicates where value is generated by industry and quantifies it in a value pool consisting of absolute revenues, relative profitability, and net-retained profit across five stages of value creation – extraction, processing, forming, assembly, and distribution.
- Geographic concentration of supply assesses the degree to which each stage in a GVC is supplied with production inputs from local, national, regional, and global groupings of suppliers across the five stages of value creation.

- Structural characteristics consist of nine factors that are crucial to GVC competitiveness at each stage, while considering the main interdependencies between countries and sectors most relevant to value-chain participation: reliance on economy of scales; cost of labour; labour intensiveness; innovation intensiveness; supply concentration; demand concentration; competitive landscape; relative wages; and other indirect costs.

The Strategic Value Framework then provides a scenario tool to envision a range of impacts of the three disruptive mega-trends and identify important opportunities and challenges for relevant GVC stakeholders. The 'suggested list of questions to address during GVC Deep Dives for businesses, governments and public-private partnerships has 'skills and capabilities' as one of 5 major topics (WEF, UNDP & A.T. Kearney, 2019, p. 13). These implications, in turn, may suggest new approaches, including strategies to develop capabilities that businesses, governments and public-private partnerships may require to upgrade their production base, improve their level of readiness for the future of production and participate in future GVCs.

The Strategic Value Framework helps stakeholders, especially businesses and governments, to understand the implications of disruptions in production systems and identify the capabilities required to proactively drive new value creation (WEF, UNDP & A.T. Kearney, 2019). It is meant to inform the development of new business strategies and policies, and to encourage new public-private partnerships and strengthen cooperation. By implementing the Strategic Value Framework, the World Economic Forum and UNDP are driving in-depth industry sector-specific analysis and regional and country dialogues to support the transition to the future of production and new global value chains. Multinational corporations to SMEs need to understand the risks and opportunities coming with these changes. For businesses this understanding should lead to define and change their strategies and nations to advance sustainable development (WEF, UNDP & A.T. Kearney, 2019).

Value chain development for decent work

The International Labour Organization (ILO) focuses on decent work (more and better jobs) in global value chains (in alignment with Sustainable Development Goal 8: decent work and economic growth) and has published the third edition of its guide to strengthen the focus on that aspect (Ripley, 2021, p. 2). Value chains shape how products are designed, developed, and disposed of, and determine who benefits from economic value-

creation. Value chain development can bring economic, social, and environmental upgrading. ILO pioneers a systems approach for value chain development, with the aim of supporting the creation of more and better jobs. It tries to achieve more impact with less resources, and in doing so, hopes to boost local ownership and sustainability of outcomes.

The guide provides an overview of how to take a systems approach to value chain development with the objective of creating more and better jobs; within a context of other manuals on value chain development, the aim of this guide is to strengthen the focus on decent work. Decent Work is 'productive work for women and men in conditions of freedom, equity, security and human dignity' (Ripley, 2021, p. 9). It refers to opportunities for work that are productive and deliver a fair income; provide security in the workplace and social protection for workers and their families; offer better prospects for personal development and encourage social integration; give people the freedom to express their concerns, to organize and to participate in decisions that affect their lives; and guarantee equal opportunities and equal treatment for all. The guide's aim is to provide a set of principles, steps and tools which can be used by value chain projects in their particular context (Ripley, 2021, p. 8).

A systems approach means going beyond the core value chain to understand the wider network of actors and factors influencing exchange (Ripley, 2021, p. 39). The world around a value chain transaction (at any link in the chain) is split into supporting functions and rules. Supporting functions are the context- and sector-specific functions that inform, support, and shape the quality of exchange; such as information, skills, infrastructure, finance, and access to markets. Rules are the legislative and regulatory environment, including policies, voluntary standards, and social norms that guide day-to-day attitudes and conduct. A systems approach means (Ripley, 2021, p. 74):

- Understanding context so interventions are led by an analysis of needs and opportunities
- Building local ownership so innovations play on both the incentive and capacity of local actors
- Lasting change comes from addressing the root causes of an issue – not just treating the symptoms

Skills outlook & global value chains

The Skills Outlook 2017 had a special focus on skills in Global Value Chains: we already quoted from their foreword in section 2.1. On average in OECD countries, one-third of jobs in the business sector depend on demand in foreign countries (OECD, 2017, p. 11). Thirty percent of the value of exports of OECD

countries now originates from abroad. Countries can help ensure that their participation in global markets translates into better economic and social outcomes, through a range of policy actions, where investing in the skills of their populations is paramount. Skills can help countries integrate into global markets and specialise in the most technologically advanced industries. Skills can help individuals face the potential negative impacts of global value chains. But so far, skills have accompanied the global integration of counties differently.

The International Labour Organization (ILO) focuses on decent work (more and better jobs) in global value chains (in alignment with Sustainable Development Goal 8: decent work and economic growth) and has published the third edition of its guide to strengthen the focus on that aspect (Ripley, 2021, p. 2). Value chains shape how products are designed, developed, and disposed of, and determine who benefits from economic value-creation. Value chain development can bring economic, social, and environmental upgrading. ILO pioneers a systems approach for value chain development, with the aim of supporting the creation of more and better jobs. It tries to achieve more impact with less resources, and in doing so, hopes to boost local ownership and sustainability of outcomes.

The guide provides an overview of how to take a systems approach to value chain development with the objective of creating more and better jobs; within a context of other manuals on value chain development, the aim of this guide is to strengthen the focus on decent work. Decent Work is 'productive work for women and men in conditions of freedom, equity, security and human dignity' (Ripley, 2021, p. 9). It refers to opportunities for work that are productive and deliver a fair income; provide security in the workplace and social protection for workers and their families; offer better prospects for personal development and encourage social integration; give people the freedom to express their concerns, to organize and to participate in decisions that affect their lives; and guarantee equal opportunities and equal treatment for all. The guide's aim is to provide a set of principles, steps and tools which can be used by value chain projects in their particular context (Ripley, 2021, p. 8).

A systems approach means going beyond the core value chain to understand the wider network of actors and factors influencing exchange (Ripley, 2021, p. 39). The world around a value chain transaction (at any link in the chain) is split into supporting functions and rules. Supporting functions are the context- and sector-specific functions that inform, support, and shape the quality of exchange, such as information, skills, infrastructure, finance, and access to markets. Rules are the legislative and regulatory environment, including policies, voluntary standards, and social norms that guide day-to-day

attitudes and conduct. A systems approach means (Ripley, 2021, p. 74):

- Understanding context so interventions are led by an analysis of needs and opportunities
- Building local ownership so innovations play on both the incentive and capacity of local actors
- Lasting change comes from addressing the root causes of an issue – not just treating the symptoms

Skills Outlook & Global Value Chains

The Skills Outlook 2017 had a special focus on skills in Global Value Chains: we already quoted from their foreword in section 2.1. On average in OECD countries, one-third of jobs in the business sector depend on demand in foreign countries (OECD, 2017, p. 11). Thirty percent of the value of exports of OECD countries now originates from abroad. Countries can help ensure that their participation in global markets translates into better economic and social outcomes, through a range of policy actions, where investing in the skills of their populations is paramount. Skills can help countries integrate into global markets and specialise in the most technologically advanced industries. Skills can help individuals face the potential negative impacts of global value chains. But so far, skills have accompanied the global integration of counties differently.

According to this Skills Outlook, the most important implication for skills-related policies is that in order to seize the benefits of global value chains, countries need to invest in education and training, make better use of skills, better coordinate skills-related policies (from education and migration policies to employment protection legislation) and align these policies with industry and trade policies.

Four specific pieces of advice are (OECD, 2017, pp. 12-13):

Equip graduates with reliable qualifications and strong mixes of relevant skills.

From early childhood through to adult learning, education and training systems need to equip all learners with strong mixes of skills. This requires maintaining a strong focus on cognitive skills while developing innovative teaching strategies, flexibility in the curriculum choice and well-designed entrepreneurship education. Countries can better align their skills characteristics with industries' skills requirements through high quality vocational and professional education and training that includes a strong work-based learning component, and specific policies to foster closer collaboration between the private sector, higher education institutions and research institutions.

Remove barriers to further skills development.

Adults need to continuously develop and adapt their skills, so countries should dismantle barriers to further skills development, especially for adults with weaker skill sets. Governments, employers, unions, and education and training providers need to work together to develop flexible on-the-job training opportunities, improve access to formal education for adults, and make it easier for workers to combine work and training. Greater recognition of skills acquired informally would help workers gain further qualifications and adapt their careers to changing needs.

Use skills more effectively.

Skills can enable countries to perform well within global value chains, but only if people are working in firms and industries that make the best use of their skills. Countries need to ensure that people can move easily into jobs where their skills can be used well, while providing flexibility to firms and security to workers. Countries could foster the development of effective management practices, design employment protection legislation, and regulate non-compete clauses in ways that enable expertise and knowledge to be shared across the whole economy more effectively.

Enhance international co-operation on skills policies.

Rather than competing to attract talent, countries could co-operate in the design of education and training programmes. Such collaborative efforts can ensure quality and maintain the knowledge and skills that countries need to thrive in global value chains. They can also improve skills in developing economies and facilitate the recognition of these skills by other countries. Countries could consider financing arrangements that better reflect the distribution of benefits and costs across countries in a world where both education and the production process have been internationalised.

An international perspective on the developing hydrogen market

In order to achieve the climate targets, traditional energy sources must be abandoned in favour of more sustainable forms of energy. More and more processes will be electrically driven. Wind and sun in particular have been used as renewable energy sources up to now. However, electricity alone cannot meet all energy needs. The transport costs for electricity are higher than for gaseous fuels and the transport capacities are lower. Moreover, there are periods when wind and sun simply do not provide enough energy in northwest Europe (RLI, 2021). Green hydrogen offers a solution to these problems. Electricity can be converted into hydrogen, stored in that form, and later converted back into electricity (RLI, 2021). Due to its molecular structure, hydrogen can also be used as a feedstock for the production of fuels, materials and products currently made from oil, natural gas, and coal, and in chemical processes such as plastics recycling. Hydrogen is expected to become an important component of the Dutch feedstock system (RLI, 2021). In order to be successful, Europe must develop an integrated strategy covering the entire hydrogen value chain: production, infrastructure, and applications (Schlegel, 2019).

Hydrogen is an important component of decarbonisation, although most technologies that can make a significant contribution are still in their infancy. Moreover, hydrogen can be used in many more applications than is currently the case. For the time being, hydrogen is the only climate-neutral alternative for generating high-temperature heat in industry and for producing clean fuel for aircraft and sea-going vessels. Furthermore, hydrogen can be used for heating buildings and as a clean alternative to natural gas. This can be particularly useful in situations where other forms of renewable energy are difficult or expensive to deploy. With lower costs and greater availability, hydrogen can therefore play an even more important role than today. Since hydrogen will be needed simultaneously in various branches of industry as a climate-neutral raw material for the production of basic materials (such as plastics, fertilisers, and steel), it forms an integral part of a new energy and raw materials system. In a new energy and raw materials system, it is an integral element that enables exchange between parts of this system. Flexibility and security of supply are thus guaranteed (RLI, 2021).

The upscaling of hydrogen production is seen as an important precondition for a cost-effective transition to climate neutrality (IEA, 2021a). The Council for the Environment and Infrastructure (RLI) states that green hydrogen will not automatically find a

place in national energy and resource systems. At present, both the demand for and supply of green hydrogen are insufficient. The infrastructure for transport, distribution and storage is not yet ready either (RLI, 2021). An active government commitment is needed, aimed at creating demand for hydrogen and investing in the infrastructure, but also at creating support, for example (2021). Active commitment is necessary not only to make the economy more sustainable, but also because it contributes to the earning potential. A hydrogen exchange, along the lines of the electricity and gas exchanges in the Netherlands, could then serve as an economic coordination mechanism and as a catalyst for a market for climate-neutral hydrogen (RLI, 2021).

Interest in the use of hydrogen for a sustainable energy supply and the number of countries with hydrogen use strategies is growing very rapidly (IEA, 2021a). By 2021, 17 governments will have published hydrogen strategies, more than 20 governments will have publicly announced that they are working on developing strategies, and numerous companies will be trying to tap into the commercial potential of hydrogen. These efforts are timely, as future scenarios and potential studies show that hydrogen is an essential component of future climate-neutral energy systems (IEA, 2021a; RLI, 2021).

A much faster introduction of low-carbon hydrogen is needed to put the world on the path to a sustainable energy system in 2050. A major impediment however, to accelerating the production and use of low carbon hydrogen is the fact that at present the production of hydrogen from fossil fuels is by far the cheapest option[i] in most parts of the world. Although hydrogen is increasingly used as a clean fuel, its actual usage lags behind what is needed to achieve net zero emissions by 2050 (IEA, 2021b). The development of a global hydrogen market can help countries with limited domestic supply potential while providing export opportunities for countries with high renewable energy or carbon storage potential. There is also a need to accelerate efforts for technological innovation. Several key hydrogen technologies are currently in the early stages of development. The International Energy Agency estimates that USD 90 billions of public money should be invested in clean energy innovation worldwide as soon as possible - about half of which in hydrogen-related technologies (IEA, 2021a; IEA, 2021b).

A recent paper examines the current development of hydrogen technology in the manufacturing sector and the industrial policies enacted to support it across countries (OECD, 2022). In addition to continued R&D efforts, governments can already lay the ground for the deployment of green hydrogen by implementing five types of policies:

1) supporting R&D and demonstration for green hydrogen to bring down the cost of electrolysers and make them competitive

2) increasing the supply of renewable electricity
3) reducing the cost gap between green hydrogen and brown technologies through a comprehensive policy package, such as carbon pricing and the phasing out of inefficient fossil fuel subsidies
4) reducing uncertainty, for instance by promoting international standardisation, hydrogen
infrastructure, and sound regulatory standards
5) considering blue hydrogen as a short-term option to facilitate the transition to green hydrogen.

(National) Governance: the current state in the Netherlands

Although the need to develop and use more sustainable forms of energy, such as green hydrogen, has been recognised and many governments have also developed strategies, it is not a foregone conclusion that this development will actually come about. The Dutch council for the Environment and Infrastructure (RLI, 2021) states that green hydrogen will not automatically find its place in national energy and resource systems. In line with the international view presented in the previous section, both demand and supply of green hydrogen are still insufficient. The infrastructure for transport, distribution and storage is not yet ready either (RLI, 2021). According to the Netherlands Enterprise Agency (RVO) a crucial step towards a carbon-neutral future is the large-scale production of clean 'green' hydrogen. Equally important is distributing vast amount of hydrogen. Innovations in The Netherlands in the field of hydrogen are contributing to the development of a hydrogen economy (RVO, FME & Topsector Energy, 2021), thus a hydrogen value chain

It will require an active commitment from the government, aimed at creating demand for hydrogen and investing in the infrastructure, but also, for example, at creating public support (RLI, 2021). Active commitment is necessary not only to make the economy more sustainable, but also because it contributes to the earning potential. A hydrogen exchange, along the lines of the electricity and gas exchanges in the Netherlands, could then serve as an economic coordination mechanism and as a catalyst for a market for climate-neutral hydrogen (RLI, 2021).

A recent policy letter to Dutch parliament presents the current state of the Dutch government views and policies regarding the development of a hydrogen market (Staatssecretaris van Economische Zaken en Klimaat, 2021). The opening line states the main case succinctly (Staatssecretaris van Economische Zaken en Klimaat, 2021, p. 1):

> "The government sees the development of the Dutch hydrogen market as necessary for the sustainability of the

> Dutch economy (...). But the development of the hydrogen market is not a goal per se but must occur within the broader challenges facing the Netherlands in the area of climate change. The public interest is central. The public interests with the energy supply that the government focuses on are sustainability, security of supply, affordability, security, and spatial adaptability. Those same public interests are central to the governance and development of the hydrogen market."

It also has a clear view on the governance issue of such markets and the role of the state in this (Staatssecretaris van Economische Zaken en Klimaat, 2021, p. 2):

> "Market organization comprises the set of rules and laws which determine which parties (public and private) may operate or enter a market under which conditions (rules, regulation), as well as which rights and obligations final customers have. By organizing a market, the government can adjust it in its development or functioning so that the public interests involved are sufficiently safeguarded "

But the view is international:

> "As with natural gas and electricity, the market for hydrogen is expected to develop into a European market with cross-border trade. (...). As with (natural) gas and electricity, the European framework will largely determine the Dutch market organization for hydrogen."

The Netherlands (and in particular the Groningen region as its main supplier) faces a rapid transition from a primarily natural gas-based energy system towards an alternative (Talen, Lieshout, & Fokkens, 2022). In terms of transaction costs, it is therefore relevant that a study concluded that the existing infrastructure for natural (earth) gas can be deployed for the transport of hydrogen, leading to the conclusion that the development of a transport network for hydrogen is achievable and desirable.

This study, commissioned by the Ministry of Economic Affairs and Climate Policy (EZK), relates to the question of whether and under what conditions part of the existing natural gas transmission network can be used for the transport of hydrogen. Based on the conclusion that the development of a hydrogen transmission network is indeed feasible and desirable. An implementation plan is planned for 2022 (Staatssecretaris van Economische Zaken en Klimaat, 2021, p. 4).

Strengthening and innovating the chain: a view from the Groningen region

From this (inter)national basis, for illustrative purposes a developing value chain in hydrogen in the Netherlands will be further mapped out from a primarily regional perspective (the Dutch region of Groningen) in order to get an understanding of interactions in innovation and skills development along this chain. In the field of green hydrogen, a lot of innovation projects are taking place. To structure these projects a chain could be formed based on the topics and areas of these projects, starting with the production of green hydrogen, and ending with consumers who are using hydrogen (products) in their households and SMEs working equipment and component manufacturing (figure 2).

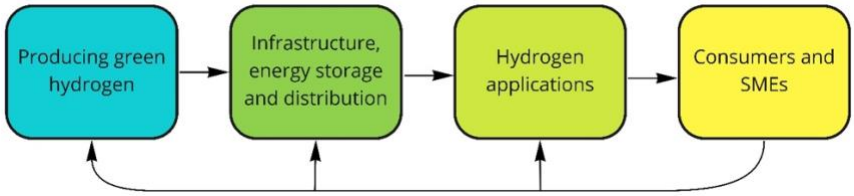


Figure 2. Value chain of green hydrogen innovation.

One cross border project was found integrating all the elements of a green hydrogen value chain. The project HEAVENN in the Northern Netherlands over 6 years creates a fully functioning green hydrogen chain, also called Hydrogen Valley (H2V). This large-scale triple-helix undertaking is divided in four clusters with multiple projects in each cluster, also dispersed across different locations in the region. The outcome of these demo-projects can serve as a blueprint for replication across Europe and beyond, this through developing replicable business models for wide-scale commercial deployment of hydrogen across the entire regional energy system. Also, the project states that the ultimate objective from the replication task is to enhance the value of international cooperation to increase the market size and create economies of scale, facilitating better value of future invested capital and de-risking investment across several EU regions (HEAVENN, sd). Collaborating parties are mainly larger companies. New Energy Coalition, a North-Netherlands network organisation of knowledge institutions, businesses, government bodies and NGOs working together to accelerate the energy transition for a sustainable future, is the coordinator of this project. With human capital on their agenda, this project is bringing parties together to create, connect and share relevant knowledge and skills (inter)nationally (31 public and private partners from 6 European countries) (HEAVENN, sd).

Producing Green Hydrogen

On the first link of the chain - producing green hydrogen – an interesting project is the pilot PosHYdon. This seeks to validate the integration of three energy systems in the Dutch North Sea: offshore wind, offshore gas, and offshore hydrogen. It will involve the installation of hydrogen-producing plant on the Neptune Energy-operated Q13A platform. The cooperation and the results of the PosHydon project are to indicate the next steps that need to be taken towards safe, large-scale green hydrogen production at sea. The outcomes are second lives for old gas platforms in the North Sea. TenneT can bring wind-generated electricity from the sea to land requiring less investment in expensive cables and other electricity infrastructure. Hydrogen can be partially transported through the existing pipelines. The owners of the platforms have the prospect of a new business case now that gas production at sea is ending in many places. Manufacturers of electrolysers - devices that split water into water and oxygen, but which are currently used exclusively on land - will develop a new generation to be used at sea. This is an example of a project where collaboration between different parties is necessary towards a common (sustainable) goal, where new skills are developed through transformation of business and new knowledge in developments on sea. The pilot also aims to accelerate the expansion of generating green hydrogen at sea on other old gas platforms (Pekic, 2021).

Two more interesting projects involving the production of hydrogen were found. Gas transport company Gasunie (a company from the Groningen region) is going to build a hydrogen plant in the German North Sea together with Shell, the German RWE and the Norwegian Equinor under the name 'Aquasector'. The aim is to produce 20,000 tons of green hydrogen annually with electricity from German offshore wind farms starting in 2028 (RWE, 2021; Geijp, 2021). The green hydrogen will initially be transported to the island of Helgoland by a pipeline that is still to be constructed. Helgoland must become a future hub in a future European hydrogen network. The plan is to then transport the green hydrogen from Helgoland to the German mainland and use it there (Economie Groningen, 2021a; Buljan, 2021; RWE, 2021; Geijp, 2021).

Gasunie, Shell, RWE and Equinor, together with Groningen Seaports, also form the consortium behind NortH2, which intends to produce green hydrogen on a large scale in Eemshaven from the sustainable electricity generated by Dutch offshore wind farms. NortH2 is initially focusing on the industrial clusters in the Netherlands, including the chemical park in Delfzijl (Economie Groningen, 2021b).

The projects mentioned are similar but differ in the location where the hydrogen is produced and the method of transporting the green hydrogen. The first project creates production at sea to then bring the produced hydrogen ashore by pipeline. If necessary, it can be converted into electricity there. NortH2 wants to transport electricity via cables to the Eemshaven and then make the green hydrogen there. Transporting hydrogen by pipeline is significantly cheaper than transporting electricity by cable (Economie Groningen, 2021b; Geijp, 2021).

Infrastructure, energy storage and distribution

The description of the projects in the previous section already shows that after the production of the hydrogen, the more infrastructural issues need to be considered. Project HY3 is an example of a cross border initiative to investigate scaling up green hydrogen. This project is a cooperation between the Netherlands, the German 'Bundesland' North Rhine-Westphalia and the Federal Republic of Germany looking into the feasibility of a transnational green hydrogen value chain that extends from the North Sea to the industrial clusters in the border region of the Netherlands and North Rhine-Westphalia. The project is looking into the transportation of hydrogen through the existing gas transport infrastructure from Gasunie, to deliver green hydrogen in the Ruhr area to reduce CO2 in the heavy industry. In this cross-border cooperation ministries of The Netherlands and Germany require, among other things, the alignment of laws and regulations for technology, safety, management, and supervision (TNO, sd). Collaborating parties are designated by the ministries of The Netherlands and Germany.

The infrastructure for hydrogen is needed so hydrogen can become available for companies, SME's and consumers, hydrogen fuel stations are important distributors to make this possible. Development in this field is going steadily. Hydrogen refuelling was only possible from 2015 onwards. In 2021 142 new hydrogen fuel stations were opened worldwide and at the end of 2021 685 hydrogen fuel stations were operational worldwide, of which 228 registered in Europe, almost half (101) in Germany. Prognoses are positive, data-collectors are expecting a progressive increase, in 2022 there are plans to build 252 stations. At this moment it's possible to refuel hydrogen in 33 countries globally (H2Platform, sd). In the Netherlands in early 2022, there are 11 (public) gas stations (H2Platform, sd). The city of Groningen has had a public green filling station since November 12th, 2021. Using the DKTI subsidy H2toGrow from the Ministry of Infrastructure & Water Management, Holthausen Energy Points has been able to establish a public and green hydrogen filling station on the Campus of Century Autogroep. It is not only the first public green hydrogen filling station in Groningen, but also

the first filling station where the green hydrogen is produced on site (Economie Groningen, 2021).

Hydrogen applications

Several projects were found with regard to hydrogen applications, mainly in production of vehicles and inland H2 vessel ships. Recently, hydrogen-powered vessels are gaining ground as a possible zero-emission solution for inland transport in Europe. The goal of the European Flagships innovation project was to commission the world's first commercial cargo transport ship powered by hydrogen. The new vessel, owned by the French inland shipping company Compagnie Fluvial de Transport (CFT), a subsidiary of the Sogestran Group, will be tasked with moving goods on pallets and in containers along the river Seine. It is equipped with a hydrogen energy generation system, i.e., hydrogen fuel cells, and was recently delivered. The Flagship project was awarded €5 million from the EU's Horizon 2020 research and innovation program in 2018, under the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) (Ovcina, 2021). The first project to produce the inland H2 vessel ship is called WEVA. WEVA is the Dutch acronym for Hydrogen Electric Cargo Vessel Antonie[ii]. Lenten Scheepvaart B.V has received a subsidy for the construction of the ship worth almost $5 million. The grant from the Ministry of Infrastructure and Water Management is intended to stimulate the development of the use of hydrogen as a fuel on the way to emission-free inland shipping. The ship is being built by Dutch shipyard Concordia Damen. In addition to the shipping company and the carrier, an engine manufacturer and a fuel cell manufacturer are also involved in the project, which is being supervised by the Dutch inland shipping cooperative (NPRC[iii]) (Bahtić, 2021). For both the Flagship project and the WAVE project it is mentioned that two additional new hydrogen ships are being built in the meantime (Bahtić, 2021; Ovcina, 2021).

One of the RIGHT pilot reports from WP4 discusses the pilot 'Hydrogen Booster' (Manickam, Bos, & Wolters, 2022) . The pilot of the Green Hydrogen Booster (GHB) consisted of two parts. One was the implementation of regional/ sustainable key performance indicators by EnTranCe – Centre of Expertise Energy. The other was the implementation of green hydrogen in regional SMEs. The aim of GHB was to improve the competences of employees of SMEs in the domain of hydrogen. This was done by linking the SMEs to potential partners, suppliers, shareholders, and customers and by trying to help them shorten their development trajectory of hydrogen related products and services. The idea was to help them collaborate with other parties in an open innovation environment to accelerate Green Hydrogen production, distribution, storage and various usages in household, industry and mobility, grid balancing and related

infrastructures for that. The specific added value of this booster is its part in developing a new domain (green hydrogen) since everyone is hesitant to take a step as they want to see how the green hydrogen roll-out will develop. The pilot connected new insights on developing innovation ecosystems to a new and emerging sector and value chains.

Also, skills are needed in designing technology in hydrogen passenger cars and heavy-duty trucks. As this development progresses, employees of garages and dealers also should develop new skills in maintenance in fuel cell vehicles. New skills in hydrogen techniques will be discovered and developed. Hyzon Motors Europe and Holthausen Clean Technology started a gigantic campaign for recruiting 300 new employees over the next 1,5 years (RTV Noord, 2021). In 2020 the American company HYZON Motors, producer of hydrogen trucks, and the Dutch company Holthausen Clean Technology started a joint venture for the production of hydrogen trucks, HYZON Motors Europe B.V. The two collaborating companies have set up an innovation centre and Hyzon Motors Europe opened the first European factory for heavy trucks both in the North of Netherlands. One of the owners and founders of Holthausen Clean Technology states:

> "The municipality of Groningen is one of our biggest customers and a party that made it possible for us to start with hydrogen. They gave us the opportunity and we want to do something in return. Now that we can tackle this on a grand scale with a foreign partner, we would like to keep it in the Northern Netherlands and preferably in Groningen. (H2Platform, 2020).

About 100 of the new recruited employees will be working on producing hydrogen fuelled trucks which are already ordered (Holthausen, sd).

Consumers and SMEs

According to the Hydrogen Council the costs for production, distribution, equipment, and component manufacturing is projected to decrease up to 50% in 8 years (Hydrogen Council, 2020). These cost-shifting projections are positive for all elements of the hydrogen value chain, as it can lower costs and allow for more market-led development through purchasing power of consumers (companies and citizens). At this moment the expenses for producing and using hydrogen (products) are still too high in comparison to the traditional energy technologies to allow for large scale consumption as an (economic) driver of hydrogen-based growth. For example, at this moment there are only a few hydrogen passenger cars, also known as a fuel cell vehicle (FCV), available for consumers. The costs are equal to other alternatively fuelled vehicles like battery electric vehicles (BEV's). But for the practical reason that there are too few

hydrogen stations nearby, consumers still choose the less 'green' BEV's filled with lithium batteries (Wilkinson, 2022). In addition, those consumers are often not even made aware of the hydrogen option. As witnessed by a hydrogen-related firm owner, car dealerships systematically would tell customers here were NO hydrogen options, even when their own brand did already produce one or more hydrogen cars (interview). Consumers with sustainability principles will buy alternative fuelled vehicles. At this moment FCV's are only becoming interesting options when car owners live in homes were recharging BEV's proves to be difficult, and a hydrogen fuel station is relatively nearby.

Research & development and skills development

In order to make the energy transition possible, cooperation between companies and other stakeholders at a regional level, but also nationally and internationally, is essential. By developing and testing new applications together, new knowledge and insights are acquired simultaneously. Such cooperation is already taking place in the various regions. For example, Denmark has the Energy Cluster Denmark. The Energy Cluster Denmark is Denmark's cluster organisation for the entire energy sector. The Energy Cluster Denmark is a neutral, value-creating and member-driven innovation platform for establishing and facilitating innovation collaborations between small and large companies, knowledge institutions and public players throughout the energy sector (Energy Cluster Denmark, sd). The Groningen region (northern Netherlands) has EnTranCe, a Centre of Expertise, where cooperation is taking place in order to accelerate clean, renewable, and affordable energy. Scientists, students, businesses, authorities, and social institutions all come together to share their knowledge at our centre of expertise. Through stimulating innovation, EnTranCe aims to speeding up the energy transition and strengthening the knowledge economy in the north of the Netherlands (EnTranCe, sd). EnTranCe is part of the New Energy Coalition, a network of knowledge institutions, businesses, government bodies and NGOs working together to accelerate the energy transition for a sustainable future (New Energy Coalition, sd).

In order to shape the energy transition, skilled energy professionals and outstanding scientists with specific professional knowledge and a broad understanding of the energy system are urgently needed. In an already tight market, it is of the utmost importance to fully invest in knowledge production and circulation among students, teachers and in companies and the people who work there, which was a central theme in the pilots that were conducted in work package 4 of the INTERREG B RIGHT project. The urgence of cooperation in research & development on the one side and skills development

on the other is added to the schematic overview of a value chain for energy transition in general and green hydrogen in specific (figure 3).

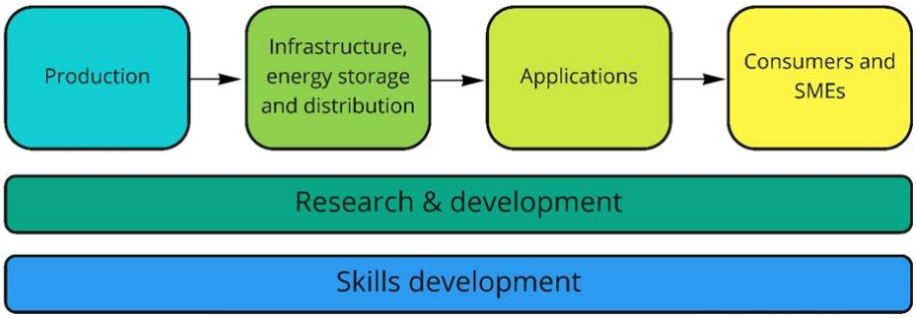


Figure 3. Value chain energy transition with R&D and skills development included

Hydrogen was one of five themes covered by the RIF program Gas 2.0 (Talen, Lieshout, & Fokkens, 2022). The RIF GAS 2.0 program was a regional multi-level, multi-stakeholder program for futureproof vocational education for the Northern Netherlands energy sector, sponsored by the Dutch Regional Innovation Fund (RIF). The RIF Gas 2.0 program combined 7 vocational colleges, 3 provinces, 4 municipalities and 47 SMEs and consisted of three pillars:

- Recruitment of students and side-entrants (for lifelong learning),
- educational innovation (knowledge & skills) and
- community of practice (active community).

The execution of the program was (seriously) hindered by the Covid-pandemic. However, it resulted in the development of a **learning module on hydrogen** and more modules will follow soon. Furthermore, the program was part of a larger development to spearhead energy transition in general (in the region).

In 2021, New Energy Coalition developed and was awarded a “Hydrogen works” program, somewhat in the wake of the still ongoing RIF Gas 2.0. As the province of Groningen aspires to become the centre of the hydrogen economy in the coming years, the Northern Netherlands has been declared the first hydrogen region: Hydrogen Valley. This creates great opportunities for the region: growth, innovation, and employment. For this new energy economy to succeed, the availability of sufficiently skilled expertise in the region is of vital importance. In the short term, the "Hydrogen Works" programme will realize a continuous learning trajectory in the region in the field of hydrogen, with education, training, and courses at MBO, HBO, WO, and post-initial (advanced professional) level. The educational institutions in the region are working together on a coordinated approach. This way continuous learning lines be developed and the synergy between the different levels of education can be achieved.

Cooperation between the business community, civil society organizations, knowledge institutions and governments are crucial for success. Educational activities will become better, more intensive and, above all, will be mutually aligned with the market needs and the investment task of the companies in the region, especially during the learning process. It also ensures that education, even after the end of the subsidized programme, is permanently guaranteed in the region. The regional investment programme on hydrogen offers great opportunities for the regional knowledge position and employment. The current strong knowledge sector in Groningen in the field of energy and the energy transition can grow into a European authoritative knowledge system in the field of education and applied research in hydrogen

Conclusions

The schematic overview of a developing hydrogen value chain provided insight into the phases of the energy transition – and the need for public and public-private stimulation of the (various segments of) hydrogen markets in multiple ways. The description of the projects shows that coalitions can be developed and be of great importance in making progress in the energy transition. Market demand and feasible business models are needed in order to be able to achieve the necessary innovations, to scale them up, and then to develop applications of hydrogen technology and roll them out on a larger scale. Developing that market demand, however, is difficult if consumers do not know about the possibilities or if it is not yet attractive to consumers to use that application. First, it is of utmost importance to use public funds in order to bridge the so-called 'valley of death' by creating supports such as public and/or public-private launching customers. Without such (government) funds, (product) innovations will fail to take place at a desirable rate.

Second, as with wind energy, the shared resource of the North Sea provides our North Sea regions and nations with an opportunity to pool resources in the development of this sector and its value chain. Not every region needs to build all necessary resources just by itself. R&D opportunities, for instance, at EnTranCe are available to international partners today. Other regions can profit from recent 'early mover' advantages of a region such as Groningen. Such 'early movers', in turn, will benefit from a larger (international) scale and resulting faster development of the hydrogen value chain. International matchmaking between companies and other stakeholders might be very helpful for this purpose. Enhancing the hydrogen value chain in the North Sea region might warrant its own RIGHT 2.0 project the following years.

The previous section presented additional desk research on the fast development of a hydrogen value chain in the Dutch region of Groningen. The speed of this development is surprisingly high. Within maybe 5 years between the creation of the RIGHT project development and its final upcoming conference, hydrogen has changed from one of many themes in the regional energy transition discussion and related labour market policies to the currently most dominant one. Two of our pilots in the region of Groningen directly relate to hydrogen: it was one of five themes in multi-level, multi-actor labour market and vocational education innovation program Gas 2.0, and the hydrogen booster was specifically aimed at helping value chain development by using innovation vouchers for firms to enhance their participation in this chain.

Having discussed this example from the Groningen area extensively based on additional desk research in the previous section, we will use this section to discuss relevant aspects from the other RIGHT regions and their pilots for value chain development. With the aim of contributing to the narrowing of the skills gap in the region and in the blue and energy sector, the RIGHT project launched (after concluding WP 3) 14 pilot projects. Even though the pandemic and the imposed restrictions delayed most of the pilots, the vast majority of the pilots finished in the way that was planned. In addition to the 14 originally planned pilots, the University of Ghent has launched a new transnational pilot based on the Marine Training Platform, which currently puts the total of planned pilots to 15. The RIGHT project and its pilots covered a much broader range of themes and topics than value chain development, so not all pilots are as relevant for a discussion of value chain development. We will limit our discussion in this report to the most relevant pilots for a discussion of value chain development.

Vestland (Norway; blue and energy)

Pilot Mongstad

Vestland has set a policy target for all industries to reach nett zero emissions by 2030 while also becoming the leading value creation region in Norway. The region carried out an entrepreneurial discovery process in 2021 in order to gain an overview over existing, emerging, and potential green innovation projects in the region. The process has mapped 250 such projects through broad dialogue with industry and networks. The criteria included the potential to realise new green value chains as well as a multiplying factor through industrial symbiosis and common infrastructure. The result shows the potential for 17 200 new jobs and investments of 124 billion Norwegian crowns within

the following sectors: bioeconomy, offshore wind, green metals, green shipping, CCU and CCS, seafood, and hydrogen.

Mongstad is one of Europe's largest oil refineries and the largest in Norway. It is situated about 60 km north of Bergen in the municipality of Alver in the sub-region of Norhordland and is the largest emission point in the county. The ongoing discussions in Norway around the uptake of oil and gas and the search for new oil fields is contentious and highly political. At the same time, we know the Green Deal and the EU taxonomy will affect Norway and businesses in Vestland. We see a clear shift in attitudes amongst businesses and the wish to green themselves and the economy is apparent.
The project findings show that the largest value creation sector in Alver municipality is, not surprisingly, non- renewable energy. Value creation in 2019 in the region was 8,6 billion Norwegian crowns and the region of Norhordland provided 12.395 jobs. The area of Norhordland had a total of 616 829 tonnes CO2 emissions in 2019 mainly from industry, oil, and gas as well as shipping – these sectors together represent 72% of the emissions in the area.

The municipality and business organisations have worked strategically over time to ensure the diversification of the industry in the area in a project, "Greenspot Mongstad". This includes upskilling for a skills base to ensure the green shift. The RIGHT pilot at Mongstad is part of this long-term strategy.

The pilot results show that there is a good match between the employees' skills and the region's need for skills, which lays solid ground for emerging value chains. However, indicators for potential green economic development for the region only show medium good access to qualified workers.
The area known as Fensfjord basin connects with the industrial areas at Mongstad, Sløvåg and Skiparvika and here we have seen several new businesses established on both sides of the fjord. Mongstad hosts an oil refinery, a processing plant and the world's largest technology centre for carbon capture from gas emissions. The Norwegian government has proposed to finance 3,9 billion Nok to the work with CCS i 2022 which will include some funding for the technology centre at Mongstad.

Gulen hosts a bunkering port where up to 80 000 tonnes of bunkering oil can be stored and there are plans to build Europe's largest dry dock. There are concrete plans to establish new businesses within marine and industrial sectors including services and sustainable energy.

Greenspot Mongstad includes plans for a complete supply chain for hydrogen for the maritime sector. Securing investments is key to ensuring that this project is realised, and the project has received Norwegian funding of 33 million Nok.

In order to ensure an industrial symbiosis, there are plans to build an “energy tunnel” where both new and existing businesses can share waste and excess heat. An aquaculture site on land is also under planning in addition to plans to build a slaughtering and packing factory in conjunction with a biogas hub. An important barrier here is access to enough waste to run the biogas site.
Another initiative under evaluation is the possibility to build a factory to recycle up to 166 000 tonnes of plastic which will be used to make pellets which can then be used to make new plastic products.

Existing infrastructure such as industrial areas and business parks as well as a well-qualified technical workforce are key to the new value chains which are now under development. Large investments are needed and the accessibility to competent and skilled workers is one of many variables to consider. We see signs to collaboration amongst the various investors and businesses with plans for industrial symbiosis in their business models, creating circular and geographically restricted circular value chains.

We know it is challenging to recruit new workers and to ensure upskilling and training for the new value chains emerging in the area. There is a need for closer cooperation between businesses and R&D to increase the innovation capacity, something the pilot at Mongstad also uncovered. Here there is also a good connection to other pilot run in Vestland in RIGHT, where a new flexible module was established by the Higher Technical College in order to answer the clear requirements for an emerging aquaculture on land sector.

Pilot RAS

The RAS pilot was set up in Vestland as a response to a clear demand from the aquaculture industry and SMEs. Recirculating Aquaculture Systems (RAS) have been proposed as one possible new technology to reduce the environmental burden in the Norwegian fjords and along the coastline in Vestland. The problems are mainly due to health of the fish and salmon lice. This is a barrier hindering further increases in production despite clear Norwegian ambitions to produce more salmon and develop other aquaculture species. Despite extensive funding and attempts to find solutions through research projects, the problem has not been resolved. By moving production on shore and by using technology to recycle or flow through the water the problem is moved away from the coast.

The development plans at Mongstad, the area where the other RIGHT Vestland pilot was carried out, also involve plans for onshore fish farming. Indeed, most of the 16 hubs described in Green Region Vestland project involve fish farming in some form,

many with plans for farming onshore. These projects are part of an industrial symbiosis where the value chain is dependent on a circular inter-dependency.

Another technology which is under development is a 'flow-through' system which brings seawater from depths well below the survival limits of salmon lice and poisonous algae. State-of-the-art treatment systems eliminate any harmful substances from entering the growing tanks. These on shore systems require large amounts of energy, investments, infrastructure for transport/export and clean water.

Vestland has perfect conditions and decades of experience in fish farming. There are many large businesses based in the county with a wealth of knowledge and experience. The innovation of moving fish farming from sea to land is costly and requires certain skills which have not been a part of the current curricula for fish farming technicians, especially in relation to chemistry, water quality and energy / electrics.

The new value chains we see emerging in the region which involve aquaculture are circular. Fish farming on shore requires large amounts of oxygen which is a by-product from hydrogen production and the waste material from fish farming can be used in biogas production. The new value chains emerging is therefore inter-dependent on other industry sectors and must share common infrastructure and be in close proximity.

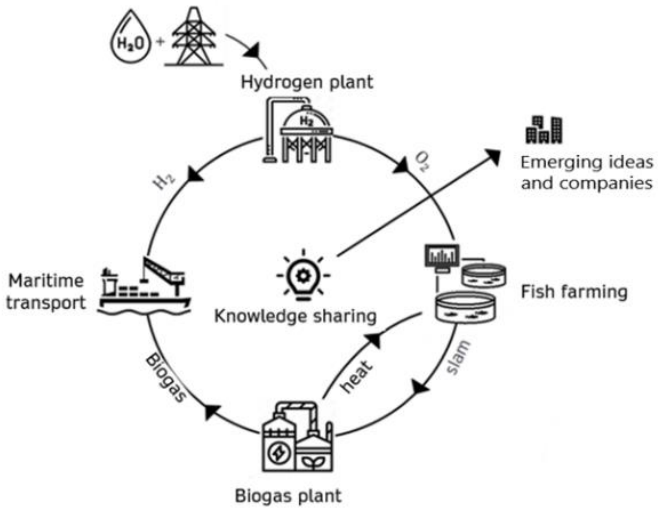


Figure 4. Value chains in Vestland for energy and blue; adjusted from «Vestlandsporteføljen 2021», EY, available at https://bit.ly/3zO9Mvv.

Above is a typical example of an industrial symbiosis involving on shore fish farming and biogas production. The element of hydrogen production is key since the maritime market for hydrogen is maturing fast and acts as a catalyst for the whole

symbiosis. This is at the same time the barrier since one element is dependent of the other to fulfil its potential.

The emerging value chains in Vestland are part of an ecosystem and a symbiosis which goes over and beyond a traditional value chain. Ideally the ecosystem should form a framework where the value chain should operate including R&D, clusters, services such as design and modelling, financial services, industry groups and networks. The cross over and interdependence of the sectors is key to the success of each industry or sector within the symbiosis. Skills is just one of several challenges and barriers in the new fluid value chains.

And the ecosystem could further benefit from linking with other regions, as value chain development may cross sector and national borders in ways unforeseen. Each already relevant in their own right, hydrogen value chains from Groningen might in the future link with fish farm innovation in Norway.

Provinces of Antwerp and East-Flanders (Belgium; blue)

The partners from Belgium have submitted conducted four pilots; Marine Training, Port Chances, Port Pro/ Port Academy and Triple E. They all tie into the import value chain development around the ports in the region. The yearly throughput of 289 million tons makes the recently merged ports of Antwerp and Bruges the largest export harbour in Europe and therefore an essential hub in worldwide trade and industry. The port specialises in handling containers, breakbulk and vehicles. Furthermore, Port of Antwerp-Bruges is home to 1,400 companies and accommodates the largest chemical cluster in Europe. The port provides – directly and indirectly – a total of around 164,000 jobs and generates an added value of 21 billion euros.

While the Port of Antwerp is Europe's largest port in terms of size and integrated chemical cluster activities, the Port of Bruges is Belgium's most important LNG hub and offshore wind power plant. Separately, both ports play an important role as fossil energy hubs for Western Europe. As a main focal point behind the recent merger, the Port of Antwerp-Bruges formulated the ambition to become a leading port in reconciling the 3 P's: Profit, People, Planet. Due to its unique role as a global logistics, maritime and industrial centre, the newly combined port authorities aim to lead in the transformation towards a low-carbon economy. Port of Antwerp-Bruges therefore actively invests in innovative solutions for a sustainable use of energy and materials. High on this agenda is the energy transition into

hydrogen powered marine, logistics and industry. Hence, Antwerp (and the harbours of Fife and Hamburg) are relevant partners for maritime value chain development in general, but also offer of specific chance for partnering in the specific hydrogen value chain.

An important challenge for the Port of Antwerp-Bruges, however, is adequately attracting and retaining employees with the right skills for this right future. A 2017 study on the future of the labour market in the Port of Antwerp (Esser, Sys, Vanelslander, & Verhetsel, 2017) showed that while the volume of low-skilled jobs is expected to be maintained, the complexity of both white-collar and technical functions increases. Digitization is expected to have a major impact across all sectors operating in the harbour, to some extent leading to job polarization where medium skilled staff's routine cognitive tasks are outsourced to computers in the maritime sectors. ICT and data skills are therefore becoming increasingly important. Like the maritime cluster, the chemical industry is subject to change due to more complex and high-tech processes that increase qualitative labour demands, both with regard to technical as well as personal and social competences.

Another important pitfall is a strong gender imbalance in the Port of Antwerp (only 17% female workers). A qualitative study pointed out that this imbalance can in part be explained by the image of jobs in the port (i.e., being unknown, dirty, and harsh work environment). In addition to the gender imbalance, also workers with an immigrant and/or disadvantaged background are underrepresented, particularly when comparing to the socio-demographics of the surrounding area. In this mismatch of the regional labour market lies an important opportunity for filling the quantitative and qualitative gaps between labour supply and demand.

In line with figure 3, the Antwerp pilots in the Right project particularly target supporting current and future value chains in the port by investing in skills development, i.e. by (1) attracting youngsters – particularly in the direct region of the harbour – to (education and training related to) jobs in the port and (2) developing hybrid learning environments connecting education and training opportunities in (adult) vocational education with future-proof in-company and simulated training facilities and practices. The RIGHT pilots 'Port Chances' (which developed a competence game that supported to discover their competences and match these to job and study fields) and 'Port Introduction Game & Port pro / Port Academy' targeted the goal of attracting youngsters. The second pilot builds upon the former and produced:

- an **economic card game** (Cardgo) accompanied by a website

- an **interactive presentation** in order to bridge the gap between Cardgo and the thematic visits to port companies
- Port Pro and Port Academy (in theme industry and theme shipping); **thematic visits** to port companies (Port Pro for youngsters who are looking for a professional challenge, Port Academy for youngsters who aim at higher education). The visits include a guided tour in the company and a theme-related activity

Both the Marine Training Platform of Ghent University (which offers a searchable catalogue containing hundreds of training and other programs for the blue and energy sector) and the Triple E pilot addressed the second goal. The purpose of the Triple E pilot was filling the skills gap for the bottleneck profession of electro mechanic in adult education, in turn supporting companies in order to keep up with innovation and increase their innovative character, be able to recruit, retain and train/ specialize their technical staff, be competitive and be/become a pioneer. This pilot resulted in the creation of an original trajectory electro mechanic in adult education (two cycles were completed and a third cycle started) and an emerged value chain of collaborating actors in accomplishing this (educational institute CVO Vitant, public employment agency of province of Antwerp, sector of metal manufacturing industry and technology (electro technics) and companies.

Hamburg (Germany; blue and energy)

Antwerp was not the only major port in our project. The Hamburg Metropolitan Area has a long and strong tradition in Marine Industries and also in the energy sector. The Hamburg project partners (HAW Hamburg) have long lasting relationships to the Maritime Cluster (Lawaetz Foundation) and the energy branch and some companies in the Marine Industries (especially sea food). The North German shipyards and their suppliers, one of the cores of the maritime economy, have reduced employment to a significant extent in recent years and have made considerable adjustments. At the same time, numerous shipyards have contributed their expertise to the planning and construction of renewable energy facilities and infrastructures

Currently, both sectors - the maritime industry and renewable energies - are facing the challenges of digitalisation. New business models need to be developed - and internal processes redesigned. Especially for the energy branch, digitalization was assessed as a highly important factor for innovation. As HAW Hamburg was engaged in the project 'Norddeutsche Energiewende' (North German Energy Shift) with the

participation of several North German Federal States and the German 'Competence Centre for SMEs', the project goal seemed to be achievable. Within the framework of the pilot projects, therefore, formats for consulting and competence transfer were developed:

- A cross-cluster kick-off event with overview-like lectures and a presentation of cluster-specific workshops
- Cluster-specific workshop: Develop your strategy to digitalization. (Developing an own strategy to digitization.)
- Cluster-specific workshop: New gadgets - do they matter? (How to assess relevance and potential of new technology.)
- Cluster-specific workshop: How to talk to your IT staff. (Analysing and defining requirements.)

As stated in the pilot report, due to COVID-19 and the economic crises of shipyards all over Europe, things developed different than expected. This still leads to relevant results for the overall goal of the RIGHT project - enhancing innovation. The situation during COVID-19 shows how organizations dealt with crisis and uncertainty as well as with digitalization. These results are embedded in a multi project situation, in that the Hamburg project partners can add contributions from other projects of their project portfolio to a multi perspective report.

Fife (Scotland; blue and energy)

The Fife region does not have a formal Smart Specialization Strategy – but it has key sectors and key industries that are supported in various action plans. The Blue Consortium and RIGHT project partnerships were an excellent opportunity to use the collective knowledge within the project to develop strategies in the area of the marine Economy/Energy, and international cooperation (possibility of a future partnership with Skåne region was discussed).

Although the name and concept may be relatively new terminology, the blue economy has long been significant to Fife and it will remain so through the energy transition in the coming years. Traditional industries such as fishing and shipbuilding, a strong heavy engineering base, particularly in subsea technologies, specialist manufacturers servicing the oil and gas industry, a growing coastal tourism and cultural industry are all important to Fife's blue economy which cuts across many industries and many key sectors. Four of the five key sectors as described by InvestFife: Food and drink, Tourism, Energy Industry and Manufacturing and Engineering are all relevant to the overall economy of the region. It is for this reason that Fife tries to adopt a cross sectoral approach with their Blue Consortium with the aim to enhance the overall Innovation

ecosystem by improving the relationships and interactions within the system.

The ultimate aim of the Consortium is to prove that a quadruple helix approach to improving the innovation ecosystem will act as proof of concept that the collaborative approach leads to better outputs when responding to the complex challenges and barriers faced by SMEs in skills development. There have been a number of learnings that have come throughout the RIGHT project and the Blue Consortium pilot has provided a platform to voice these in Fife. One example being the difficulty in SME's accessing funding potentially being improved through closer partnerships and support from academia and government.

The different components of the quadruple helix, education, business, government, and community often have different priorities, speak different languages, and hence have an incomplete understanding of each other's strengths and capabilities. The Consortium has been designed to be an intermediary here that can assist in demystifying and simplifying this map. If successful, this approach can be replicated for other priority sectors or groups of sectors with similar challenges. The scope of the group can also be broadened beyond skills to look more widely at regional development, resilience and how a quadruple helix model can support this.

The consortium has created new partnerships. These can help incorporate new approaches into our core employability delivery and academies. Fife has worked in an Environmental Access academy sub pilot with the Verdancy group (a Sustainability Training and Guidance SME) and aims to utilize their courses in all core employability delivery, for all (not just blue and energy) sectors. It is an example of how to use networks to enhance delivery in line with regional and national priorities.

In the 'Race to Zero' Innovation game pilot, Fife created an application game to focus on innovation and achieving net zero within the blue economy. The focus was on enterprise skills, net zero, and renewable energy sources. The game is aimed at high school students aged 12-16 and designed to introduce students to the concepts of net zero and carbon neutral ways of running a business, as well as the opportunities for careers within the blue economy. On the business side, understating of innovation (and its application and commercialisation), sustainable growth, value chains, interconnectivity of sectors was included, and digital technologies such as augmented reality were displayed.

In the Environmental Industrial Access Academy pilot, Fife explored increasing innovation capacity by addressing skills gaps, and higher levels of funding support to be allocated to green/energy jobs for SMEs. This would be a good way to use

existing funding such as No One Left Behind and the Young people's guarantee to promote and support the sectors.

The Blue Consortium upscales activities through the life of the RIGHT project and (hopefully) beyond. It has been designed to grow organically as people use their own networks and contacts to bring people along. The plan is to host series of events and seminars with the aim of engaging more SMEs and bringing them onboard. There is also the potential to collaborate/assimilate the consortium into other existing groups. The Consortium model could also be replicated for other sectors within Fife. Experience this far suggests that this would be beneficial as it would at the very least improve the overall knowledge base amongst the various organizations and improve our understanding of skills challenges and other barriers to innovation and growth within the sector. The consortium model provided a good basis and a good range of institutions to be able to bid on new and existing funding streams. One of the current actions is to map the green/funding situation with SMEs in mind but this could be useful to all partners within the group and even to the group itself.

IUC Syd & Region Skåne (Sweden; blue and energy)

The business support ecosystem in Skåne works in general quite well. There is, however, a gap between SMEs and the existing system of education and training. For various reasons, SMEs in Skåne often find it difficult to find the right skills for future needs. SMEs and actors in education and training need to work together for up- and reskilling as well as raising awareness of the [industry] as an attractive workplace. There has been a lack of structured cooperation between businesses and business support actors on the one hand, and education and training actors on the other hand, as well as a lack of tools that connect the different actors. In practice, SME skills needs have not been expressed and communicated properly, and hence have not been taken care of by education and training actors- and has not been passed on to younger people available for future work. The result is that potential growth in SMEs in Skåne has not (yet) been achieved.

Through participation in the INTERREG project Right Skills for the Right future, the cluster organisation IUC Syd and the regional development organisation Region Skåne have worked with two pilots, closely connected, with the potential of narrowing the gap between SMEs and the existing system of education and training. This includes enabling short term efforts such as validation of skills in the existing workforce as well as longer term efforts such as raising awareness of the industry as an attractive workplace

One pilot (Inventory of competences) has been to test an inventory of competence through validation (baseline measurement) as a way to highlight the lack of skills and ensure the future skills of employees in industrial SMEs. A new value chain of actors has been created through the pilot, which has contributed to new ways of working with inventory of competence through validation in Skåne. This can later be scaled up and disseminated nationally and internationally. We tested whether our validation test could be more attractive by using an already existing infrastructure in local learning centres and even with certain challenges it has proved to be a viable way.

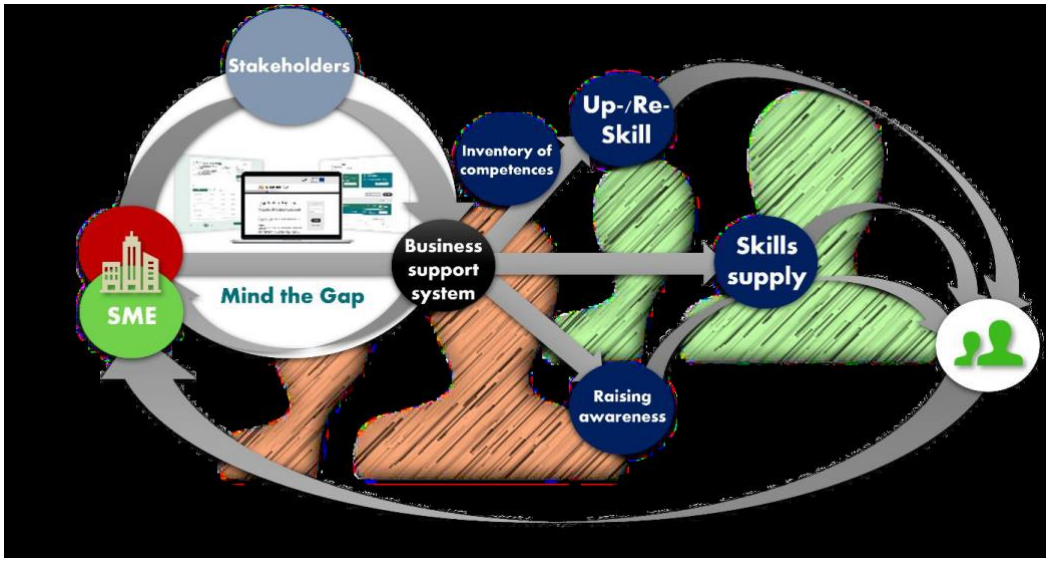
As part of a new way of working and a new business model at the regional level, this pilot has been brought together with the other Scånian pilot, Mind the Gap. Separately, these are important tools to use, but together in a chain, they become much stronger and more attractive. Central to the new value chain is the Mind the Gap tool, which has become the key to closing the SME skills gap. The purpose of this pilot was to develop a method of mapping skills needs and a digital tool that can make it easier for SMEs in the manufacturing industry to manage their long-term skills needs.

The output of the pilot was twofold. The first result achievement was support for companies that want to develop their business and get a clearer picture of what skills are needed along the way. The second achievement was a digital tool (Mind the Gap), based on a simple and user-friendly method, to connect the company's business strategy and the need for the right skills in the short and long term. Through Mind the Gap, business support actors have been given a better tool to help SMEs express and communicate their future skills needs.

When the two pilot projects were connected, a completely new value chain at a regional level was created. This value chain connects the SME skills needs with actors that ultimately can ensure individuals with the right required skills, both in the current situation and in the future, which could all lead to a more attractive, productive, and competitive business community in Skåne.

The tool Mind the Gap also created an incentive and interest in a new partnership to emerge; a partnership now consisting of the regional industry cluster organisation (IUC Syd), the regional development actor in Skåne (Region Skåne), the Skåne branch of the industry trade union (IF Metall) and the regional organisation connecting local industrial SMEs with relevant schools (Teknikcollege). These organisations are not new, but they have not worked together like this in the past. The new partnership is brought together with a common interest in giving the SMEs and their staff the right education and training. When this

partnership grows stronger, the value chain bringing SMEs and the education and training actors closer also grows stronger.



Vordingborg (Denmark; blue and energy)

Vordingborg – Skill Mill

With the participation in the DK2020 project, the municipal council in Vordingborg has committed itself to reducing CO2 emissions by 70% in 2030 and to being CO2-neutral in 2050. To achieve such goals, investments in green industries, such as the offshore wind industry, are vital. However, one thing is to invest in the green future, another thing is to ensure that the labour market is skilled to operate within these green industries.
The Skill Mill pilot in the RIGHT project from Business Vordingborg served to provide a greater understanding of how a region can transition into providing service for offshore wind electricity production - an industry that did not previously exist in the region. One finding was that the SMEs in the municipality had little to no skills or knowledge necessary for the offshore service sector. Therefore, it was necessary to discover how to overcome this skill gap and barrier.
After understanding the regional context and the gap in the market for offshore and wind knowledge, Business Vordingborg began building a knowledge base on what would be the future requirements of SMEs and windmill operators in the short to medium term. The purpose of the pilot was twofold. First there

was the purpose of attracting an offshore training operator in Vordingborg to cater from burgeoning offshore wind service industry and second there was the purpose of upskilling local SMEs for offshore service industry. Both aspects of the pilots have been completed. The pilot resulted in the establishment of an offshore training school, the upskilling of local SMEs (30 offshore safety certificates were attained), SMEs networking and working with multinationals and knowledge sharing and transfer between traditional vocational work and energy industry. The pilot made visible that the regional activities are a learning process where Business Vordingborg is likely to improve services by providing a more tailor-made solution for a specific business environment.

Vordingborg – Power to X

Even though the development and investments in the offshore wind industry continue in the municipality, a new, green industry is rising in Vordingborg and marks an extremely important milestone in the process of Vordingborg becoming a green municipality. Power-To-X is a completely new industry in Denmark and here the Port of Vordingborg will play a central role. Denmark has ambitions to become a green pioneer country and the rest of the world looks to Danish companies in their search for good green solutions. That must also be the case when it comes to the green fuels and green technologies of the future. Danish companies are on the verge of establishing a new Danish business adventure, and there is great potential for the future to say' Made in Denmark' on the green fuels that are filled on ships and aircraft worldwide.

Vordingborg Municipality has the ambition to become a strong centre for commercial Power-To-X companies that are pioneers in technology and size within the production of CO2 neutral and green fuels. Two large green companies are already planned at the Port of Vordingborg to produce green fuels for aircraft and ships.

Arcadia eFuels plans to establish the world's first large-scale production plant of CO2 neutral fuel for aircraft. Arcadia eFuels will produce eFuels (eDiesel and eJet fuel) using renewable electricity and water to produce Green Hydrogen and combine with Captured Carbon using proven technology. The process starts with renewable electricity to make green hydrogen, then combines hydrogen with carbon dioxide from direct air capture and/or other biogenic carbon sources to produce syngas. The syngas is then processed into eFuels using well known, commercially proven Gas to Liquids process.

Vordingborg Biofuel is planning a large-scale production of green bio methanol for shipping. The company will use straws from wheat grain fields, pressed into briquettes, to make the fuel.

During a bio fermentation process, the briquettes will be converted partly into biogas and partly into biofertilizer (the latter for use in agriculture). The biogas will then be converted to liquid bio methanol using surplus power from renewable energy sources.
In total, there are prospects for investments of up to DKK 10 billion within the next 3 years at the Port of Vordingborg. The Power-To-X industry will develop significantly in the coming years and provide growth opportunities for both existing companies and completely new types of companies. The location of these companies at the Port of Vordingborg is ideal, as there is plenty of space, good access to electricity from renewable sources such as sun and wind. At the same time, the finished products can be shipped directly from the port. Thus, the offshore wind industry and its renewable energy is a key factor for new, innovative value chains in Vordingborg (and in general), and inevitably creates a need for new skills and competencies.

Conclusions

After a deeper dive in developing value chains in (Dutch) hydrogen in section 3, we discussed developing value chains in the other regions in energy and the blue sector (and their relation to some of our pilots) in this section.

In no particular order, a first conclusion can be that the other regions indeed do offer interesting opportunities to expand value chain development relating to hydrogen across the North Sea and national borders.

Second, figure 4 from Vestland shows how hydrogen value chains can connect to those in fish farming; biogas; and maritime transport. We see even more possibilities from this broader, cross-sector perspective for international North Sea cooperation than for the hydrogen value chain by itself. The Power-to-X development in Vordingborg offer possibilities for biogas, and basically all the ports in all our regions can develop a mutual value chain for maritime transport. Crossovers between such value chains – such as the energy transition into hydrogen powered marine, logistics and industry in as mentioned for the Antwerp port – are perhaps the most promising to explore and expand.

The opportunities are, of course, not even limited to those value chains. The Eemshaven in Groningen (in the process of expanding with a Belgian-owned floatable LNG platform) can connect to the other harbours for LNG shipping. And besides expanding value chains for maritime transport between ports: while a proposed ferry to Edinburgh has not been realised as of yet, the actual *road* to Norway has been significantly shortened by a brand-new ferry from the Dutch Eemshaven to Norway

since this Spring. So even (electric) cars can more easily connect SMEs and workers for employment and learning within an easy night of sleep. As we already stated in section 3,4: not every region needs to build all necessary resources just by itself, at the same time. We can share and build upon them collectively.

Third, and perhaps the most general shared finding is that we indeed see that skills production is a shared and growing concern. Improving linkages between educational, training and labour market institutions and developing value chains is important, and our pilots explore a broad range of innovative steps that can be made here, in various links of value chains: from an R&D 'booster' to games that educate youth in innovation, business and career choices and much more. Connecting people and firms, and other relevant private and public organisations, by forming (triple or more) helix partnerships or consortiums, stimulates a programmatic and comprehensive approach to developing and implementing such steps and links; and they were found and developed in each region in one way or another.

The RIGHT project, a project in the context of the INTERREG North Sea Program, intends to support growth in the North Sea Region by connecting smart specialisation strategies to human capital and skills development of the workforce in order to support the competitiveness of the regions and the SMEs in these regions. Future-proofing the workforce, building knowledge about the needs of the industry, and building capacity amongst the SMEs, regional governments and educational institutions are related aspects that are explored within this project.

As a first step, seven regional reports and a trans-regional report were produced based on desk research, work sessions and interviews. These reports provide insights on the participating regions in terms of their regional innovation ecosystems, including labour market and education sector, with a specific focus on energy and/or blue sectors. The reports also provide insights in the key challenges identified by the SMEs. These challenges were knowledge gaps, funding, human capital, new business models and adequate support mechanisms and regulations. In the fourth work package of the RIGHT project pilots were conducted in order to contribute to these challenges. The previous section 4 discussed the most relevant findings regarding value chain development.

Since those pilots (by definition) do not cover all relevant aspects and developments, some additional desk research was carried out. We already discussed additional desk research into value chain development in (Dutch) hydrogen in section 3. This section reports desk research on other (INTERREG) projects concerned with the Energy transition. While RIGHT is the most focussed on labour market, education, and training, various other INTERREG projects deal with interesting projects more on the business and value chain side of innovation. Since they are a nice addition to the RIGHT pilots of work package 4, we present a brief overview in this section 5 to provide a somewhat expanded basis for our policy analysis in work package 5. This desk research is not intended to provide a complete overview and analysis of all projects. Instead, it is intended to illustrate and supplement the evaluation of the pilot projects.

INTERREG - European Territorial Co-operation

INTERREG (launched in 1990) is the EU's flagship scheme for cooperation across borders at regional and national level, for the benefit of all EU citizens. INTERREG is about cooperation between communities, regions and countries in the EU and its

immediate neighbours. INTERREG is organised under multiple strands:

- cross-border (INTERREG A),
- trans-national (INTERREG B),
- interregional (INTERREG C),
- outermost regions' cooperation (INTERREG D)

Cross-border cooperation (INTERREG-A)

European Cross-border cooperation, known as INTERREG A, supports cooperation between NUTS III regions from at least two different member states lying directly on the borders or adjacent to them. It aims to tackle common challenges identified jointly in the border regions and to exploit the untapped growth potential in border areas, while enhancing the cooperation process for the purposes of the overall harmonious development of the Union. Within the INTERREG-A program 60 (sub) programmes can be distinguished (European Commission, sd).

Germany – The Netherlands 2014-2020 program

The INTERREG[iv] Germany-The Netherlands 2014-2020 program is one of them. Within this program a total of 188 projects with 1.700 partners were executed, all with the objective to increase innovation in the border region and reduce the border barrier effect. Most projects (32) could be found on High tech systems & materials and second came the topic of Energy & Low carbon economy where 17 projects could be found. All projects were about collaborations between public and private parties from different fields. One project was found on skills development in Argo business and food. In the project 'Regional skills lab' (potential) employees and SMEs were collaborating in a physical test Centre to work together with the newest technologies and innovations to learn together and to develop innovative business propositions for new technologies (INTERREG Deutschland-Nederland, sd).

The first project within the INTERREG Deutschland-Nederland 2014-2020 program that will be described is the project Grenzeloos Talent! The main goal of the project **Grenzeloos Talent!** was to retain regional talent (skilled workers) for the regional labour market in the Northern Netherlands and Northern Germany. By allowing (nearly) graduated young people

from various educational backgrounds to gain experience with the business community and institutions in the region, students can experience what (small) companies are located in the region and what opportunities they have to work for such companies after their studies. Conversely, the region benefits from current knowledge that is currently being taught and developed within education. The traditional recruitment of large groups of jobseekers is no longer in line with the current economic situation in the region. There is a growing need from the education sector to facilitate regionally oriented education in cooperation with current themes on location in the business community. Through collaboration between education and labour market partners this region can directly anticipate on the current situation in the region. An important result of this project is that, partly based on the experience gained, customized concepts for matching between student and employer have been developed. These so-called Mikro projects can also be applied in other sectors and for other levels of education (Arbeidsmarkt Noord, sd).

- https://www.arbeidsmarkt-noord.eu/bouwstenen/grenzenlo-o-s-talent/

The second cross-border project is **PraktiTrans** in which the collaborating parties are different Dutch and German educational institutes, Arbeidsmarkt Noord and Wachtstumregion Ems-Achse. In this project non-formal learning is taking place by activating the curiosity of people in the border area towards each other through opportunities and possibilities by exchange (Arbeidsmarkt Noord, sd). For this purpose, several tools have been developed and made available:

- Escape Game: This game was developed especially for the German-Dutch border area and conveys cultural, historical, and linguistic backgrounds. The game is suitable as an introduction to the neighbouring country and can be played by elementary school students from grade 7. It is also suitable for team building or further training. https://www.noord360.eu/wp-content/uploads/2021/07/Flyer-Escape-Game-Grensgeheim-PraktiTrans-NL.pdf
- Digital Job-Bus: The digital Job-Bus is a proven tool to help people take their first steps across borders. Different groups can get in touch with the neighbouring country together. For pupils and students, the Job-Bus serves as a tool for career orientation. Teachers learn more about the education system of the neighbouring country during a digital Job-Bus to prepare their students for cross-border career orientation. Business groups use this opportunity to maintain cross-border networks, make contacts and learn about the economy of the neighbouring country. https://www.noord360.eu/wp-

content/uploads/2021/07/Flyer-Job-Bus-PraktiTrans-NL.pdf

- Serious games: Several games have been made available in which education and information are conveyed simultaneously through play. The digital company scavenger hunt combines cultural education and vocational orientation. In this game, students learn about educational opportunities and job profiles in the border region, how job applications work and what economic ties already exist in the border region. https://www.noord360.eu/wp-content/uploads/2021/07/Flyer-Schnitzeljagd-PraktiTrans-NL.pdf
- CULTURAL WORKSHOP "ESSENCE OF DIFFERENCE": Digital workshops will explain the cultural diversity - in general or on a specific topic - between Germany and the Netherlands. At first glance, there seem to be hardly any differences between the two countries. Yet this can look very different when working with a company from the neighbouring country. It's all in the detail. This workshop is about dealing with hierarchies, misunderstandings in communication, the educational systems, and the historical background of both countries. https://www.noord360.eu/wp-content/uploads/2021/07/Flyer-Kulturworkshop-PraktiTrans-NL.pdf

Sweden-Denmark-Norway (Öresund-Kattegat-Skagerrak) 2014-2020 Program

The Sweden-Denmark-Norway 2014-2020 program is another example of a program within the INTERREG-A program. Within this program a total of 88 projects, focused on one of the four themes (innovation, low-carbon economy, transport, and employment) were executed, all with the objective to increase innovation in the border region and reduce the border barrier effect (INTERREG Sweden-Denmark-Norway, sd).

The **CISKA** project was one of the projects that was conducted within this program. The main purpose of this project was to support the development of circular Scandinavian business models within renewable energy and waste / resource management thereby also contributing to sustainability and sustainable growth, and thus to development and jobs. The project was more specifically about GreenLab Skive and Esval Miljøpark in Nes Municipality in Norway. Via the CISKA project,

the two symbiosis parks were planned to be developed in new directions. Based on the experiences gained by the cooperation the development of a Scandinavian model for the start-up and development of industrial symbiosis parks was intended (CISKA, sd).

- https://www.energibyenskive.dk/projekter/ciska/den-skandinaviske-model

Trans-national cooperation (INTERREG-B)

The projects described in this section are part of the INTERREG North Sea program 2014-2020, one of the programs within the INTERREG – B program. In the context of this program a total of 73 projects with 800 involved project stakeholders and partners were executed. In the program there are four main priority themes indicated. These themes are Thinking growth (22 projects), Eco-innovation (19 projects), Sustainable North Sea Region (18 projects) and Green transport and mobility (14 projects). All projects fall within one of these themes (INTERREG North Sea Region, sd).

The first project to mention within the first priority theme (Thinking Growth) is **INN2Power**. INN2Power aims to expand the capacity for innovation and to improve access to the offshore wind industry and green hydrogen for SMEs by connecting offshore wind and green hydrogen businesses in the North Sea Region (INN2Power, sd). The project wants to strengthen the North Sea Regions by:

- supporting SMEs to collaborate and enter new markets through a Company Directory, focusing on Offshore Wind and Green Hydrogen https://northsearegion.eu/inn2power/company-directory;
- granting easy access to test and demonstration facilities. The developed testfacilities.eu aims to be a user-friendly web-based marketplace allowing companies to browse a full directory of international test facilities for the offshore wind industry which offers companies easy access to unique test facilities and a shortlist of common test facilities https://northsearegion.eu/inn2power/test-facilities/
- Improving knowledge, skills, and availability of qualified staff via
    - Offshore Wind Energy MBA for SME employees (a joint qualification offer of the University of Applied Sciences Bremerhaven (Germany) and the Business Academy Southwest in Esbjerg (Denmark). https://youtu.be/BNE5ItHKVAA

- Offshore Wind Escape Room (in order to make young people enthusiastic about the offshore wind industry, POM West Flanders (Belgium) developed an 'offshore wind escape room'. The main goal of the game is to raise awareness among youngsters of the economic, ecological, and social benefits of the offshore wind industry. At the same time, the study directions and career opportunities within the sector are also being highlighted). https://youtu.be/XzuVGIpdWwo

The North Sea Region is a key area for Europe's blue economy, with marine resources, technologically advanced industries, important port areas and increasing offshore activities. As a result of global drivers, the wider maritime, marine, and offshore economies are facing major challenges, with some sectors undergoing profound changes, including an increase in production (offshore wind energy in Denmark and Germany), but also stagnation and decline (oil and gas in the UK and Norway). The North Sea Region is going through a period of significant restructuring. The second project within the priority theme 'Thinking Growth', **PERISCOPE**, therefore aims at establishing a permanent innovation ecosystem in the North Sea Region to grow transnational innovation partnerships for sustainable business development in emerging blue markets (Periscope, sd). The new approach of establishing a permanent platform for strategic forecasting at the core of the ecosystem provides a new framework for bottom-up knowledge transfer, while the public sector can improve smart specialisation strategies and support businesses and knowledge institutions to take advantage of the opportunities and growth potential identified within the ecosystem. SMEs benefit by gaining access to strategic know-how, resources, and new cross-border knowledge partnerships, which can help develop new markets. The subsequent future readiness of North Sea Region players, especially maritime and marine clusters, and their members, can help strengthen the position of North Sea Region in the global blue economy. It has published a several tools and other relevant documents for both SMEs, educational institutions, governmental institutes, and other actors in the innovation chain in order to explore opportunities for business, cooperation and funding which are at least partially relevant for energy as well (Periscope, sd):

- country fiches
  https://vb.northsearegion.eu/public/files/repository/20191121094541_CFDenmark.pdf
  https://vb.northsearegion.eu/public/files/repository/20191121094731_CFNetherlands.pdf
  https://vb.northsearegion.eu/public/files/repository/20191121094907_CFNorway.pdf
  https://vb.northsearegion.eu/public/files/repository/20191121095027_CFScotland.pdf

https://vb.northsearegion.eu/public/files/repository/20191121095142_CFSweden.pdf

- National SME guides for help with transnational innovation for international collaboration on blue growth activities in the North Sea region

  https://vb.northsearegion.eu/public/files/repository/20210430113519_CFDenmark2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113651_CFNetherlands2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113715_CFNorway2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113748_CFScotland2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113811_CFSweden2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113557_CFEngland2.0.pdf
  https://vb.northsearegion.eu/public/files/repository/20210430113625_CFGermany2.0.pdf
- Document North Sea Funding Opportunities for Blue Growth in which funding opportunities for activities in the blue growth sector are portrayed. Relevant for SMEs, knowledge institutions and other players in the innovation chain.
  https://vb.northsearegion.eu/public/files/repository/20191120151053_Periscope_Poster_A2VersieI.pdf
- Market Opportunity Reports in which emerging market and technology trends, insights and good practices have been elaborated on. These reports are provided to SMEs, knowledge institutions and other players in the innovation chain for concrete innovation actions and business development. These reports are also useful for policy makers, authorities, and business support organisations as input to policies, strategies, and conditions for blue growth. These reports can be found via: https://northsearegion.eu/periscope/output-library/

Based on the various deliverables from the project, it can be concluded that the developments in this sector are very fast and that, as a result, the potential use scenarios and economic feasibility for new applications are difficult to estimate, especially if it concerns a niche application. At the same time, these are important concerns for the developers of these new applications. Nevertheless, even a smaller or larger niche application may simply be processed and generate revenue, if the development of the application does not cost too much. Investments are needed to bridge the valley of death. It is therefore very important to invest in both basic research and technology transfer, with industry and knowledge institutions working closely together. This relationship must also be extended to other

skills providers to ensure that the current and future workforce is engaged in developing the right skills to successfully exploit the opportunities offered by these sectors.

The third project in the context of this priority theme that will be elaborated on is **Northern Connections.** This project was a joint challenge to support and strengthen transnational innovation and cooperation and involve SMEs broadly and at the same time to develop a broader political backing to create coherence between political ambitions and cluster potential for innovation support. The aim of this project was to make public and private parties collaborate through improving and aligning innovation support and broaden opportunities for SMEs. In this way they will be able to participate in global markets and create new value chains (Northern Connections, sd) by increasing cooperation capacities of cluster and companies, by political and strategic support of internationalization and by Living Labs as a place to develop solutions for cities and regions. An important deliverable for this project was a toolbox for matchmaking aimed towards experienced matchmakers as well as people preparing their first matchmaking event, initiating, and facilitating innovative collaborations among SMEs and the public sector through the Living Lab Event concept developed in the Northern Connections project. Also, some general advice for improving cluster activities with support of innovation measures and for communicating to companies and other partners both locally and internationally are included:

- https://vb.northsearegion.eu/public/files/repository/20180419111418_northern-connections-toolbox-v10.pdf
- https://vb.northsearegion.eu/public/files/repository/20210122093301_toolbox-30-komprimeret.pdf

At the final conference of Northern Connections, a presentation was given by Professor Kårberger, Professor of Industrial Energy Policy and Director of the Energy Department at Advance at Chalmers University of Technology. The outcome for regions and governments was that the development of the energy system is wrong since the cost relationship has shifted. Renewable energy generation is more competitive than existing energy technologies, and the cost of renewable energy is getting even lower. The problem lies in the scale: 60% of all energy comes from fossil-based power generation. For governments, this raises questions about what the long-term interests of regions are in accelerating renewable energy projects to tackle the scale. Looking at the innovation and development of onshore wind power, governments should not think that it is not possible. In 2007, wind power was one of the most expensive forms of renewable energy generation; by 2020 it will be the cheapest, thanks to choices to invest in innovation and cross-border cooperation. This is an economic view of innovation that does not mention skills, conceivably many new skills have been developed in wind power generation since 2007. This raises the question of

how governments can make better choices in their governance by working together across borders to address the scale of renewable energy generation on the one hand, and on the other hand, that these innovations also reach the labour markets so that SMEs also benefit from them (Kårberger, 2020).

With regard to priority theme 2 (Eco-innovation: Stimulating the green economy) the first project that will be elaborated on is **ProCirc**. ProCirc is set up to experiment, implement and learn how circular economy and procurement can benefit the region. To fully benefit from circular opportunities and to contribute to the international development of circular economy, ProCirc planned 30 pilots to be conducted in order to demonstrate procurement opportunities (ProCirc, sd). Based on the experiences, a tool was developed that could also use circular procurement in energy and blue sector procurement within value chains (and certainly when substantial public funds are used for procurement). Since energy itself cannot be reused, we will not further discuss this project in the report.

- https://northsearegion.eu/procirc/procurement-toolbox/

The second project within priority theme 2 to be elaborated on is **SCALE-UP**. This project aims to create mutually beneficial cooperation between SMEs and large enterprises. Many corporates recognise the benefits of 'open innovation' and are keen to benefit from the innovations that emerge from the dynamic SME innovation ecosystem. For the purpose of stimulating cooperation between the mentioned parties several 'Meet the Buyer' events have been organised. During these events the SMEs had the opportunity to bring their products and services to corporate buyers, which were expected to lead to transformational opportunities for cooperation, growth, and profitability. The recommendations formulated on the basis of the experience gained in this project are divided into three types, namely financial policy recommendations, digitalisation recommendations and, finally, labour recommendations. Financial policy recommendations were formulated since restrictions on financing negatively impact the survival of SMEs. Digital recommendations are of importance because digital transformation offers great potential to boost the economy of SMEs. However, SMEs are lagging behind in terms of digital transformation (Scale-Up, sd). The gradual recovery of economic activity has also led to a surge in demand for workers and has prompted renewed concerns about labour shortages. Covid-19 has revealed the vulnerabilities of the European labour market and demonstrated the need for sustained investment in an adequate policy mix to address labour shortages and skills gaps.

- https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1637670438.pdf

Interregional cooperation (INTERREG-C)

Interregional cooperation, known as INTERREG C, works at pan-European level, covering all EU member states, and more. It aims to build networks to develop good practice and facilitate the exchange and transfer of experience by successful regions. It showcases what regions do well, to the benefit of those still investing. The INTERREG - C 2014-2020 program covers 4 interregional cooperation programmes (European Commission, sd). One of them is the INTERREG EUROPE program, which is a policy learning program for European public authorities promoting the exchange of experience and the transfer of good practices between actors at all levels in Europe. By encouraging the share of knowledge, the effectiveness of cohesion policy should be reinforced (INTERREG Europe, sd). In the context of this program a total of 258 projects with 2.000 involved project stakeholders and partners were executed. In the program there are four main priority themes indicated. These themes are Research and innovation (65), SME competitiveness (66), Low-carbon economy (60) and Environment and resource efficiency (67). All projects fall within one of these themes.

The project described in this section, ClusterFY, is part of the INTERREG Europe program 2014-2020. The aim of **ClusterFY** was to improve regional and national policy instruments seeking to intensify Key Enabling Technologies (KET's)-related clusterization processes, as well as stimulating interregional cooperation between and among clusters and business networks and encouraging their integration into innovative value chains (ClusterFy, sd). These developments are believed to advance the implementation of regional innovation strategies.

- https://projects2014-2020.interregeurope.eu/clusterfy/

The transition towards a green economy and a low-carbon energy system has profound employment implications worldwide and in Europe. We finish this desk research with a summary from a report from the European Commission's Joint Research Centre. It provided an overview in a 2020 report (Joint Research Centre, 2020) by gathering and presenting available statistical data and the results of recent reports assessing the employment effect of the green economic transition. This section summarizes this report.

The European Green Deal announced in December 2019 is the European Union's new growth strategy under the von der Leyen Commission. It aims to make Europe climate-neutral by 2050. Parallel to cutting greenhouse gas emissions, creating jobs, and making the transition inclusive and just are key elements of the strategy. Accounting for the employment effects of the green economic transition is crucial in order to determine the progress against these goals. The outbreak of the COVID-19 coronavirus crisis in early 2020 puts this in a new light, creating opportunity for an accelerated green transition parallel to economic and social recovery.

Within the context of moving towards a greener economy a solid and coherent method to track employment impacts of the transition is lacking. The results of studies estimating employment impacts and initiatives carrying out regular monitoring of employment impacts of particular elements of the green transition suggest that it is delivering positive employment effects. 18 million net jobs can be created by 2030 worldwide by limiting global warming to 2°C by the end of the century (ILO, 2018). The presence of green components is already identifiable in the case of many occupations. Based on the task content of occupations, 87.6 million jobs were green(able) in the EU-28 by 2016,
amounting to 40 % of employment that year (European Commission, 2019). Global employment in the energy sector reached nearly 58 million in 2017 (IRENA, 2020). About half of these jobs were in the fossil fuel industries.

Renewable energy employment has been continuously increasing globally, reaching 11 million total jobs in 2018 (IRENA, 2019). A third of global renewable energy source (RES) industry jobs were in the solar photovoltaic (PV) sector. China is the largest RES employer globally, accounting for 37 % of total RES jobs in the world. More than half of Chinese RES jobs are in the solar PV sector. Parallel to increasing deployment, PV manufacturing has also shifted to China and other Asian countries, while decreasing in Europe. In the EU-28 the number of total jobs in renewable energy reached over 1.5 million in 2018 (EurObserv'ER, 2019). Direct RES jobs have not increased significantly in the last decade. Underlying factors include the aftermath of the 2008 financial crisis, moving of some renewables manufacturing

capacities outside of Europe, as well as the change in the subsidisation of renewables within the EU. Solid biomass and wind are the largest European RES sectors, together accounting for nearly half of total EU RES jobs. Nearly a fifth of European RES jobs are in Germany. Here the leading renewables industry in terms of employment is by far the wind sector, followed by solar PV and solid biomass. At the same time, the leaders in renewables jobs per capita are less populous Member States, including Latvia, Estonia, Denmark, and Finland.

On the energy demand side, similarly to RES, accounting for specifically energy efficiency intervention related employment impacts is hampered by difficulties in isolating the relevant activities within economic sectors as they are currently defined. A net positive employment effect of energy efficiency in the EU-28 until 2030 was estimated by different studies relying on different methodologies and assumptions to be in the range of 0.41 – 4.8 million.

Skills mismatches inhibit the transition to a low-carbon energy system in Europe and beyond (Joint Research Centre, 2020, pp. 37-42). The workforce in the energy industry, especially in conventional energy sectors is male dominated and is aging. Digital skills and graduates in Science, Technology, Engineering and Mathematics (STEM) fields are in high demand. Parallel to STEM profiles, soft skills including costumer awareness, problem solving, team working, self-management, and communication and literacy are key employability skills in the energy sector. STEM education, especially Engineering and ICT studies are characterized by gender imbalance. This is an underlying factor of underrepresentation of women in the energy sector. Private companies have initiated their own training programmes and acted in partnership with the public and education sectors in order to influence education and skills policy in the context of the clean energy transition.

Policymakers in the context of a just green transition should (Joint Research Centre, 2020, p. 44):

- develop and implement strategies in an integrated manner in order to appropriately address complex impacts (e.g., climate, employment, social, education and skills, regional, digital, industrial strategies).
- ensure the provision of coordinated social and professional reskilling/upskilling support in declining sectors and regions. This is relevant both in case employees have to leave the active labour force, as well as in the process of entering other, including greening economic sectors.

The public and private sectors should take coordinated action, where appropriate in the form of public-private partnerships to (Joint Research Centre, 2020, p. 44):

- facilitate sub-sector, gender, and age disaggregated data collection in the energy industry in a comparable manner across the EU and globally, in order to better understand labour force characteristics and needs.
- improve and adapt STEM education profiles to market demand in the context of the expanding green economy.
- improve visibility and wider perception, incentivise STEM education both for men and women already from a young age.
- increase the availability of apprenticeships, as well as up- and reskilling programmes to ensure that enough job seekers with the required skill sets are available for the energy industry.

The private sector should take action to (Joint Research Centre, 2020, p. 44):

- better attract underrepresented workforce categories in the energy industry. These include female and millennial job seekers. This is expected to increase the number of suitable candidates, provide better access to energy jobs for a more diverse population, as well as to help overcome the challenges posed by an aging energy workforce.

improve policies to retain knowledge from workforce leaving the energy industry.

References

Aahave, L. (2020). Knowledge transfer workshop on transnational collaboration. Copenhagen: CLEAN.

Arbeidsmarkt Noord. (n.d.). *Grenzelo-o-s Talent*. Retrieved January 24, 2022, from https://www.arbeidsmarkt-noord.eu/bouwstenen/grenzenlo-o-s-talent/

Arbeidsmarkt Noord. (n.d.). *Praktikans*. Retrieved January 24, 2022, from https://www.arbeidsmarkt-noord.eu/bouwstenen/praktitrans/

Bahtić, F. (2021, June 3). *Damen secures order for hydrogen-powered inland vessel*. Retrieved January 24, 2022, from https://www.offshore-energy.biz/order-placed-for-damen-hydrogen-powered-inland-vessel/

Buljan, A. (2021, July 23). *Aquaventus offshore wind to hydrogen plan moves forward with aquasector project*. Retrieved February 28, 2022, from https://www.offshorewind.biz/2021/07/23/aquaventus-offshore-wind-to-hydrogen-plan-moves-forward-with-aquasector-project/

CISKA. (sd). *Ciska*. Retrieved February 25, 2022, from https://www.energibyenskive.dk/projekter/ciska/

ClusterFy. (sd). *Project summary*. Retrieved February 25, 2022, from https://www.interregeurope.eu/clusterfy/

Economie Groningen. (2021, November 4). *Eerste openbare groene tankstation voor waterstof in Groningen*. Retrieved February 28, 2022, from https://economie.groningen.nl/nieuws/eerste-openbare-groene-tankstation-voor-waterstof-in-groningen

Economie Groningen. (2021a, August 6). *Gasunie betrokken bij bouw waterstoffabriek in de noordzee*. Retrieved February 25, 2022, from https://economie.groningen.nl/nieuws/gasunie-betrokken-bij-bouw-waterstoffabriek-in-de-noordzee-2

Economie Groningen. (2021b, December 24). *Waterstofproject NortH2 in Eemshaven bijna grootste ter wereld*. Retrieved February 25, 2022, from https://economie.groningen.nl/nieuws/waterstofproject-north2-in-eemshaven-bijna-grootste-ter-wereld

Energy Cluster Denmark. (sd). *About us*. Retrieved February 25, 2022, from https://www.energycluster.dk/en/about-us/

EnTranCe. (sd). *About EnTranCe*. Retrieved February 25, 2022, from https://www.en-tran-ce.org/en/over-entrance/

Esser, A., Sys, C., Vanelslander, T., & Verhetsel, A. (2017). *De toekomst van de arbeidsmarkt in de haven van Antwerpen*. Antwerp: University of Antwerp.

EurObserv'ER. (2019). *The State of Renewable Energies in Europe: Edition 2019*. Retrieved from https://www.eurobserver.org/19th-annual-overview-barometer/

European Commission. (2019). *Sustainable growth for all: choices for the future of Social Europe, Employment and Social Developments in Europe 2019*. Retrieved from https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8219

European Commission. (sd). *Interreg A - Cross-border cooperation*. Retrieved February 25, 2022, from https://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/cross-border/

European Commission. (sd). *INTERREG V C 2014-2020*. Retrieved March 3, 2022, from https://ec.europa.eu/regional_policy/nl/policy/cooperation/european-territorial/interregional/

Geijp, J. (2021, July 28). *Gasunie stapt met Shell, RWE en het Noorse Equinor in waterstoffabriek in de Noordzee*. Retrieved February 25, 2022, from https://dvhn.nl/economie/Gasunie-stapt-in-Duitse-waterstoffabriek-op-zee-26963010.html

H2Platform. (2020, July 17). *Hyzon en Holthausen bouwen samen waterstoftrucks*. Retrieved February 28, 2022, from https://opwegmetwaterstof.nl/hyzon-en-holthausen-bouwen-samen-waterstoftrucks/

H2Platform. (sd). *Op weg met waterstof. Tanklocaties*. Retrieved February 21, 2022, from https://opwegmetwaterstof.nl/tanklocaties/

H2Platform. (sd). *Record aantal nieuwe waterstofstations*. Retrieved Febuary 21, 2022, from https://opwegmetwaterstof.nl/: https://opwegmetwaterstof.nl/record-aantal-nieuwe-waterstofstations/

HEAVENN. (n.d.). *About Heavenn*. Retrieved January 24, 2022, from https://heavenn.org/about/

HEAVENN. (sd). *New Energy Coalition*. Retrieved Febuary 18, 2022, from https://heavenn.org/partners/new-energy-coalition/

Holthausen. (n.d.). *Werken bij Holthausen*. Retrieved Febuary 4, 2022, from https://werkenbijholthausen.nl/

Hydrogen Council. (2020, January 20). *Path to hydrogen competitiveness - a cost perspective*. Hydrogen Council. Retrieved Febuary 21, 2022, from https://hydrogencouncil.com/: https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/

IEA. (2021a). *Global Hydrogen Review*. International Energy Agency. Retrieved February 28, 2022, from https://iea.blob.core.windows.net/assets/5bd46d7b-906a-4429-abda-e9c507a62341/GlobalHydrogenReview2021.pdf

IEA. (2021b). *Net Zero by 2050: A Roadmap for the Global Energy Sector*. Retrieved February 28, 2021, from https://www.iea.org/reports/net-zero-by-2050

ILO. (2018). *World Employment Social Outlook: Greening with jobs*. Retrieved from https://www.ilo.org/global/publications/books/WCMS_628654/lang-en/index.htm%0Ahttp://www.ilo.org/wesodata/?chart=Z2VuZGVyPVsiRmVtYWxlIiwiTWFsZSJdJnVuaXQ9Ik51bWJlciIsmc2VjdG9yPVsiQWdyaWN1bHR1cmUiXSZ5ZWFyRnJvbT0yMDEwJmluY29tZT1bXSZpbmRpY2F0b3I9WyJlbXBsb3ltZ

INN2Power. (sd). *About INN2Power*. Retrieved February 21, 2022, from https://northsearegion.eu/inn2power/about/

Interreg Deutschland-Nederland. (n.d.). *Regional Skills Lab*. Retrieved January 24, 2022, from https://www.deutschland-nederland.eu/: https://www.deutschland-nederland.eu/nl/project/regional-skills-labs-2/

INTERREG Deutschland-Nederland. (sd). *Interreg Deutschland-Nederland. Regional Skills Labs*. Retrieved January 21, 2022, from https://www.deutschland-nederland.eu/nl/project/regional-skills-labs-2/

INTERREG Europe. (sd). *What is Interreg Europe?* Retrieved March 3, 2022, from https://www.interregeurope.eu/about-us/what-is-interreg-europe/

INTERREG North Sea Region. (sd). *Priority themes*. Retrieved from https://northsearegion.eu/about-the-programme/priority-themes/

INTERREG Sweden-Denmark-Norway. (sd). *Interreg Öresund-Kattegat-Skagerrak*. Retrieved March 3, 2022, from https://interreg.eu/programme/interreg-sweden-denmark-norway/

IRENA. (2019). *Renewable Energy and Jobs Annual Review 2019*. Retrieved from https://www.irena.org//media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

IRENA. (2020). *Measuring the socio-economics of transition: Focus on jobs*. Retrieved from https://www.irena.org/publications/2020/Feb/Measuring-the-socioeconomics-of-transition-Focus-onjobs

Joint Research Centre. (2020). *Employment in the Energy Sector*. Luxembourg: Publications Office of the European Union.

Kaplinsky, R., & Morris, M. (2012). *A handbook for value chain research*.

Kårberger, T. (2020, September 9). *Northern Connections Final Conference 2020*. Retrieved from https://northsearegion.eu/: https://northsearegion.eu/northern-connections/news/final-conference-2020/

Manickam, A., Bos, A., & Wolters, R. (2022). *RIGHT Pilot Report Green Hydrogen Booster*. Groningen: Hanze University of Applied Sciences.

New Energy Coalition. (sd). *About us*. Retrieved February 25, 2022, from https://www.newenergycoalition.org/en/about-us/

Northern Connections. (n.d.). *Northern Connections*. Retrieved January 24, 2022, from https://northsearegion.eu/: https://northsearegion.eu/northern-connections/

Northern Connections. (sd). *Welcome to Northern Connections*. Retrieved January 21, 2022, from https://northsearegion.eu/northern-connections/about/

OECD. (2017). *OECD Skills Outlook 2017. Skills and global value chains*. Paris: OECD Publishing. doi:https://doi.org/10.1787/9789264273351-7-en

OECD. (2022). *Innovation and Industrial Policies for Green Hydrogen*. Paris: OECD.

Ovcina, J. (2021, April 7). *Flagships set to debut world's 1st hydrogen-powered commercial cargo ship*. Retrieved February 28, 2022, from https://www.offshore-energy.biz/flagships-set-to-debut-worlds-1st-hydrogen-powered-commercial-cargo-ship/

Pekic, S. (2021, July 22). *Netherlands grants PosHYdon offshore green hydrogen project*. Retrieved Febuary 21, 2022, from https://www.offshore-energy.biz/netherlands-grants-poshydon-offshore-green-hydrogen-project/

Periscope. (sd). *About*. Retrieved February 28, 2022, from https://northsearegion.eu/periscope/about/

Periscope. (sd). *Output Library*. Retrieved February 28, 2022, from https://northsearegion.eu/periscope/output-library/

ProCirc. (sd). *About*. Retrieved February 28, 2022, from https://northsearegion.eu/procirc/about/

Ripley, M. e. (2021). *Value Chain Development for Decent Work*. Geneva: International Labour Organization. Retrieved from https://www.ilo.org/empent/areas/value-chain-development-vcd/briefs-and-guides/WCMS_434362/lang--en/index.htm

RLI. (2021). *Waterstof. De ontbrekende schakel.* Den Haag: Raad voor de Leefomgeving en Infrastructuur. Retrieved from https://www.rli.nl/sites/default/files/advies_waterstof_de_ontbrekende_schakel_-_def.pdf

RTV Noord. (2021, May 21). *Hyzon werft 300 nieuwe werknemers in komende anderhalf jaar*. Retrieved from https://www.rtvnoord.nl/nieuws/820149/hyzon-werft-300-nieuwe-werknemers-in-komende-anderhalf-jaar

RVO, FME & Topsector Energy. (2021). *Excelling in Hydrogen - Dutch technology for a climate-neutral world*. Utrecht. Retrieved from https://english.rvo.nl/sites/default/files/2021/04/NL%20Dutch%20solutions%20for%20a%20hydrogen%20economy%20A4_DEF_Digi_v3.pdf

RWE. (2021, July 23). *Aquasector partnership on first large scale offshore park for green hydrogen in germany*. Retrieved February 25, 2022, from https://www.rwe.com/en/press/rwe-renewables/2021-07-23-aquasector-partnership-on-first-large-scale-offshore-park-for-green-hydrogen-in-germany

Scale-Up. (sd). *What we do*. Retrieved February 28, 2022, from https://northsearegion.eu/scale-up/what-we-do/

Schlegel, M. (2019, December 04). *Hydrogen Value Chain*. Retrieved from https://energy.danube-region.eu: https://energy.danube-region.eu/wp-content/uploads/sites/6/sites/6/2019/12/Matthias_Schl%C3%A9gel_FICHTNER-Hydrogen-Value-Chain.pdf

Staatssecretaris van Economische Zaken en Klimaat. (2021). Kabinetsaanpak Klimaatbeleid. *Tweede Kamer der Staten Generaal, vergaderjaar 2021-2022*(32 813, nr. 958).

Talen, J., Lieshout, H. v., & Fokkens, B. (2022). *RIGHT Pilot Report. RIF Gas 2.0*. Groningen: Hanze University of Applied Sciences Groningen.

TNO. (n.d.). *Project HY3 - Germany and The Netherlands investigate scaling-up green hydrogen*. Retrieved Febuary 24, 2022, from https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/hydrogen-for-a-sustainable-energy-supply/hydrogen-storage-and-transport/project-hy3-germany-and-the-netherlands-investigate-scaling-up-green-hydrogen/

WEF, UNDP & A.T. Kearney. (2019). *Reshaping Global Value - Technology, Climate, Trade - Global Value Chains under Pressure*. Geneva: World Economic Forum. Retrieved from https://www.weforum.org/whitepapers/future-of-manufacturing-and-production-report

Wilkinson, S. (2022, January 31). *Hydrogen fuel cells: do hydrogen cars have a future?* Retrieved Febuary 2022, 21, from https://www.autoexpress.co.uk/electric-cars/93180/hydrogen-fuel-cells-do-hydrogen-cars-have-future

[i] With fossil fuel prices rising rapidly, and the likely acceleration of this rise due to turmoil in the Ukraine and sanctions against Russia, the price differential between low carbon hydrogen and fossil fuel hydrogen will narrow.
[ii] The vessel will be named Antonie
[iii] Nederlandse Particuliere Rijnvaart-Centrale Coöperatie (NPRC)
[iv] The European Interreg subsidy scheme aims to contribute to spatial and regional development. The subsidy scheme has three programmes, which focus respectively on cooperation in the border region (Interreg A), cooperation between regions in different countries (Interreg North West Europe and Interreg North Sea Region) and cooperation interregionally and Europe-wide (Interreg Europe) (central government, sd).

TOWARDS A RESILIENT NORTH SEA REGION

EMERGING VALUE CHAINS

Interreg North Sea Region RIGHT
European Regional Development Fund
EUROPEAN UNION

RIGHT
RIGHT SKILLS FOR THE RIGHT FUTURE