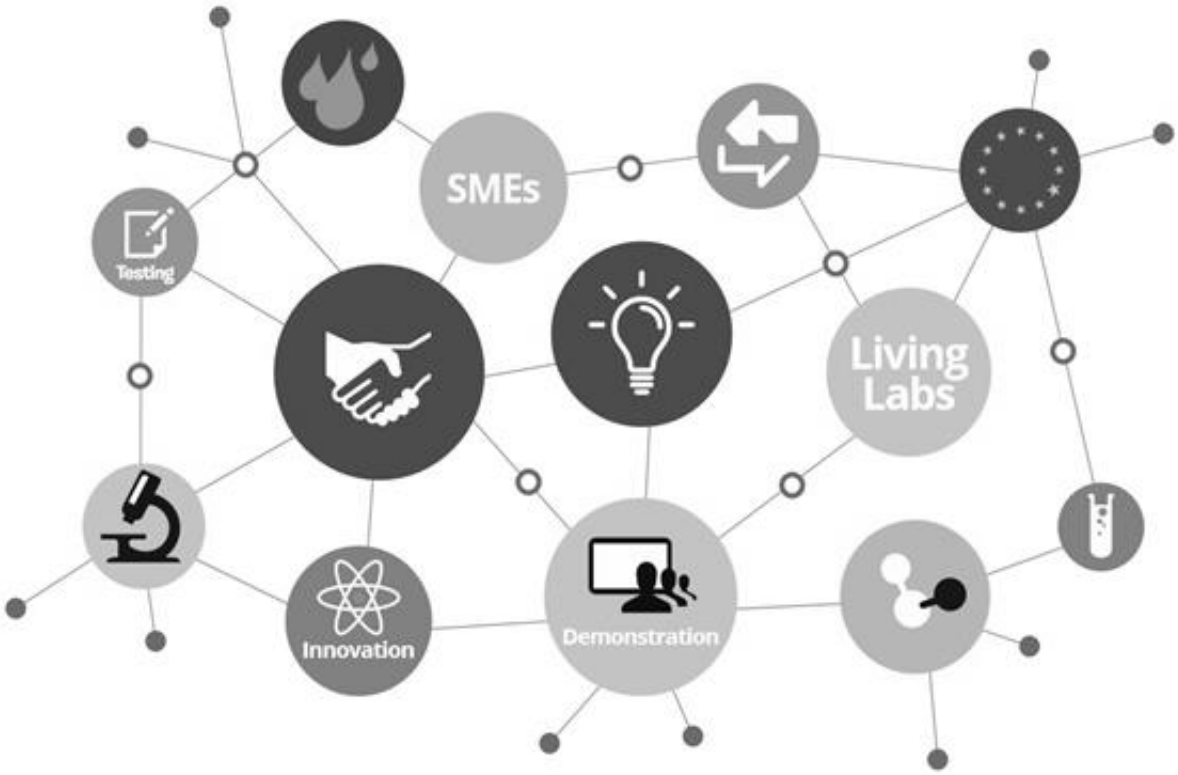

REGIONAL INNOVATION SYSTEMS FOR WATER TECHNOLOGY

REGIONAL INNOVATION SYSTEMS FOR WATER TECHNOLOGY

REPORT ON MODEL, EXPERIENCES, BEST PRACTICES AND FINANCING REGIONAL ECONOMIC POLICY ON WATER TECHNOLOGY. BUILDING ON GOOD PRACTICE FROM AROUND THE EU, INCLUDING THE ROLE OF REGIONS IN DEVELOPMENT, FINANCING AND OPERATION OF DEMO SITES FOR INNOVATION.

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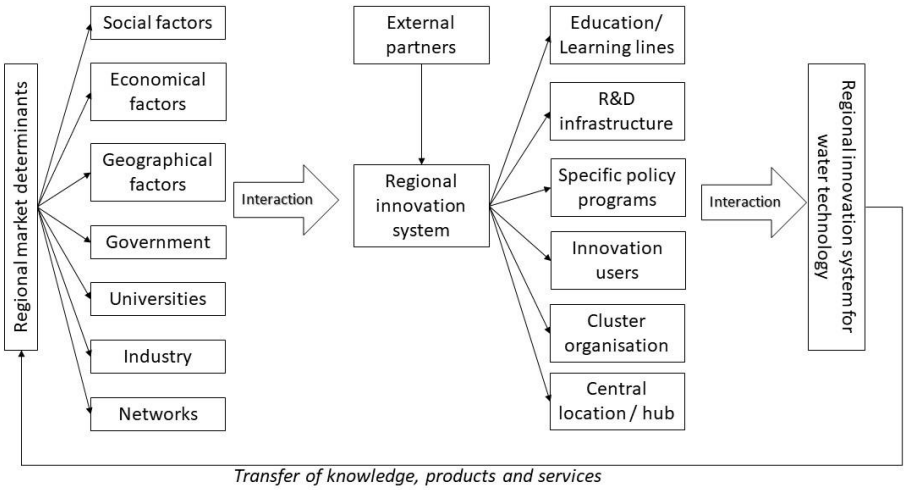
CONTENT

EXECUTIVE SUMMARY

The Water Test Network (WTN) project has been set up to help SMEs to bring products to market for the water sector by creating a transnational network of operational scale test sites. One of the long-term objectives of the WTN project is to develop a robust business model for the test sites. Therefore, it is important to gain insight into models and support mechanisms, which regions use to realize the innovation systems for water technology.



For this study a conceptual model for regional innovation systems (RIS) in water technology has been constructed, based on academic literature about innovation and its driving factors in European regions. The model contains 14 determinants, which influence the functioning of a regional innovation system for water technology. Based on statistical sources, internet research, interviews and surveys, the current situation in all six WTN regions has been described for each determinant. We then drew up a classification system, based on operational definitions, that match the collected information and gave the regions a score on all determinants on a 5-point scale. The purpose of this exercise is to provide stakeholders, particularly regional authorities, with some guidance if they want to improve the innovation system for water technology in their region. For each determinant, they can see what steps they can take to reach a higher level.

It appears from this study that the stronger the overall economy of a region is, the less specific water technology policy it has. With the exception of Scotland, this applies to all WTN regions. The strongest regions Baden-Württemberg and Gelderland score the lowest on specific policy programmes for water technology. The weakest region in terms of innovation, Friesland, has the most comprehensive policy for water technology. This connection is not illogical. Strong regions generally have several strong sectors and good conditions for innovative businesses, which means that incentives for small sectors are not really necessary. A specific policy for water technology is the umbrella for specific financial instruments for investments to strengthen and connect the determinants of the regional innovation system. The study shows that a specific policy leads to high scores on the other determinants of the regional innovation system.

Finally, we examined the extent to which the regions use European (ERDF) and regional funds to support water technology innovation. The total aid out of ERDF budgets for water technology during the period 2014-2019 seems to be limited to a few occasional projects and companies and nowhere exceeds EUR 3.5 million EUR. There is no support for systematic water technology programmes, although the available interventions can support the vast majority of the innovation cycle. This requires a clear political choice for water technology as a focal sector in the RIS, which has not been made in any region for the period 2014-2020.

In the top three regions with special policy programmes (Friesland, Scotland and Centre-Val de Loire) the funding of innovation projects and infrastructure in the field of water technology from regional funds is much higher than from ERDF. Over approximately the 2014-2020 ERDF period, the budget in Friesland will amount to almost 50 million euros. In Scotland the budget is about 20 million euros and Centre-Val de Loire makes about 10 million euros available.

1. INTRODUCTION

1.1 SETTING OF THE REPORT

The Water Test Network (WTN) project has been set up to help SMEs to bring products to market for the water sector. It will accelerate time to market and assist SMEs to develop products that are market-ready and linked to key sector needs. This is achieved by creating a transnational network of operational scale demonstrator sites (test sites), which offer a range of water types.

One of the long-term objectives of the WTN project is to develop a robust business model for the test sites. The test sites are part of the innovation cycle from idea to marketable product. Therefore, it is important to gain insight into models and support mechanisms which regions use to realize the innovation systems for water technology.

That is why a Report on regional innovation systems for water is included in the approved project proposal for WTN, in Work Package Long Term (WP LT) as Deliverable 4.1. This deliverable is further described as: *Report on model, experiences and best practices and financing regional economic policy on water technology, building on good practice from around the EU, including the role of regions in development, financing and operation of demo sites for innovation.*

Sub-partner province of Friesland is responsible for this Deliverable. Co-author of part of this report (chapters 2-4) is Thomas van Balen, master student of Economic Geography at the University of Groningen. During the second half of 2019, Thomas did an internship at the province of Friesland as part of his master thesis.

1.2 CONTENT DESCRIPTION

Chapter 2 deals with the design of the investigation. It discusses the definitions used, and the research methods and regional classifications applied.

On the basis of literature review, Chapter 3 discusses a number of scientific insights into innovation in general and water (technology) in particular. Based on these insights we arrive at a conceptual model for regional innovation systems for water technology.

In Chapter 4, we discuss a number of regional characteristics of the regions involved in WTN, which, according to the conceptual model, play a role in the regional innovation system. The regions can be compared on these characteristics using Eurostat data.

The other determinants (factors) that are important for the regional innovation system for water technology are discussed in Chapter 5. Based on a combination of information collected through surveys, interviews and desk research (Internet), we describe the situation in the WTN regions. We also consider the role of the regions in the development, financing and management (operation) of the test sites. At the end of this chapter we compare the regions per determinant on a five-point scale.

In Chapter 6 we will discuss the financing of regional innovation systems in the WTN regions. For the various phases in the innovation cycle, we focus on the possibilities offered by the ERDF programmes in the region and to specific regional funding.

Chapter 7 provides a summary with a number of comments and conclusions.

Annex A describes six projects and programmes from the WTN regions that can serve as examples of good practice to stimulate innovation in the water technology sector.

2. STUDY DESIGN

2.1 DEFINITIONS

To establish the parameters of this research, the definitions of the following subjects are used within this paper: the water technology sector and innovation.

Water technology sector

In literature, such as reports of governmental institutions or consultancy firms, various definitions are used to describe the water sector or the water technology sector. Some countries have data on the number of firms who are considered to belong in the water sector. Sometimes, regions conducted their own research about the water sector. What the information has in common is that all studies refer to exact numbers of companies that are considered as part of the water sector. However, it is unclear which companies or institutions belong to the water technology sector as there is are no data available for statistical purposes which sets a clear definition. Most companies that are in the water sector are intertwined with other sectors. For example, soda factories and beer brewers, who need water as a vital component for their production but which are not considered to be within the water sector. As a result, the water sector can be defined in different ways which leads to different outcomes. Therefore, it is necessary to set a clear line to define water technology and the water sector in this report.

The water chain is hard to define since water is used within all kinds of other sectors, therefore the water sector does have a broad scope (Bogardi, et al., 2012). Based on the purpose of the Water Test Network this study describes water technology as below:

Water technology includes: (Reitsma & van der Hoek, 2015).
- Drinking water, process-d and industrial water, waste water treatment, reuse of water (for instance recovery of energy or nutrients) and sensor technology.
- All activities that treat or process water in one way or another with the use of technology.
- All technologies and techniques that are being developed and used for treatment of water through R&D conducted by knowledge institutions.

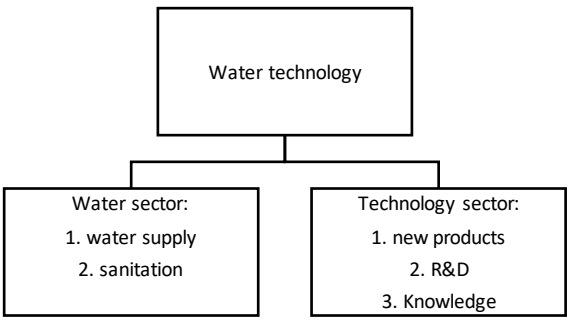


Figure 2.1: Water technology divided into its different segments

It is **not** defined as:
Delta technology: dikes, dredging, water management and nature and environment protection.
Maritime technology: ship building and repair, off-shore activities and harbour services.

Innovation

The aim of the WTN-project is to stimulate innovation within the water technology sector. Due to the development of test sites for the use of SMEs to shorten the time to market for their innovative products. Innovation is a concept which could be implemented in different ways. In this study, innovation is divided into two subjects: technological improvement and improvement in policy and governance (Science for Environment Policy , 2015).

- *Technological Improvement*

Innovation by technological improvement refers to the methods to establish new products or a new process or procedure to produce new products. This is in line with Schumpeter's (1941) view on innovation, 'doing things differently' and his theory of creative destruction (Reinert & Reinert, 2006). In his research, innovation is defined as a paradigm shift. As seen in Figure 2.2, innovation for past years is divided into different waves. As soon as new techniques develop that are more suitable and creative than previous methods or products, the old techniques will come to an end due to 'creative destruction'. This pattern can also apply to the products the SMEs try out on the test sites under the WTN project. Their products could have significant impacts which might lead to fundamental changes or shifts in the water sector and other sectors as well. It can be argued that the WTN supports the 6th wave to green technology and sustainability seen in figure 2.2. (Schumpeter, 2010).

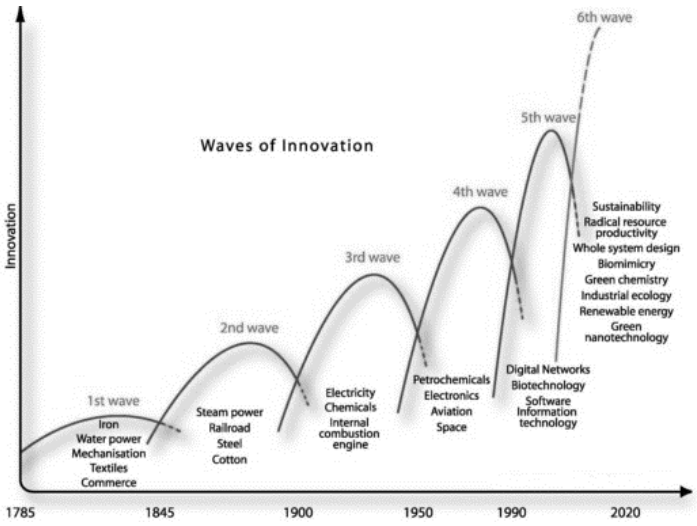


Figure 2.2: The innovation shifts proposed by Schumpeter (1941). Source: The Natural Edge project (2004).

- *Improvement in policy and governance*

Innovation in the water sector can also comprise fundamental changes in policy within different themes that support water technology. A definition is made, based on the work of Moore, et al., (2014) who conducted research about water-policy-literature in a 5-year time frame from 2009 till 2013. Their findings about definitions for innovation in water policy were very diverse. For policy makers and practitioners there is not a clear and agreed definition of innovation. Therefore, they divided the various definitions used into different themes which will be used in this report (see section 3.6). We use these themes when considering what support for innovation in the water sector is present for each of the regions participating in the WTN.

2.2 RESEARCH METHODS APPLIED

In writing this report, various research methods have been used, some of which have been applied sequentially, some in parallel and some iteratively.

In April and May 2019, while in Scotland for a project meeting, questionnaires and interviews with Scottish partners and stakeholders were conducted as a pilot.

As part of his thesis, Thomas van Balen conducted a scientific literature study into innovations in the water sector. Analysis of this led to a conceptual model for regional innovation systems for water technology (Chapter 3).

In addition, he collected statistical data from Eurostat for information on regional economics and demographics of the regions in the WTN project (Chapter 4). Based on the Eurostat data for European regions at a NUTS 2 level, comparisons between the regions of the WTN are possible. Eurostat harmonises the definitions, classifications and methods for European official statistics, together with the national statistical institutes; making these comparisons possible.

Furthermore, desktop research was also carried out into the various political programmes at national and regional level that had possible influences on innovation in water technology.

Subsequently, questionnaires were sent to all the (sub)partners in the WTN project. However, the role of the partners within the triple helix (government, industry, university) differs. Thus, as far as possible, each region was sent three surveys to cover the whole triple helix within every region. Based on their answers about the interaction with each other and their role within the RIS, the complete model of the triple helix and partners is outlined in Chapter 3. Further questions which derived from the questionnaires were answered during interviews with WTN-partners who attended the Aquatech trade fair in Amsterdam in November 2019.

The information collected in the above research methods has been analysed with the aim of filling in the conceptual model in Chapter 3 for the WTN regions. Unfortunately, these results were disappointing. In our opinion, there were two reasons for this. Firstly, the subject is probably too complex for a written survey. Secondly, not all determinants from the conceptual model were included in the survey, because the model was partly developed in parallel with the surveys.

The interviews conducted during the pilot in Scotland and interviews conducted during the Aquatech, yielded much better results, therefore it was decided to conduct an additional series of face-to-face interviews. Unfortunately, this plan did not entirely succeed, because travel from March 2020 proved impossible due to the COVID-19 pandemic. Telephone interviews, intensive email exchanges and targeted desktop research on the Internet were undertaken instead in an attempt to identify the missing information as much as possible.

2.3 REGIONAL CLASSIFICATION

Eurostat harmonises the definitions, (regional) classifications and methods for European official statistics, together with the national statistical institutes. Comparisons between the regions on geographical or socio-economic data are often possible at the so called NUTS2-level[1] (Eurostat, 2015). Which regions are we talking about when we talk about regional innovation systems?

In the first instance, we are talking about the regions in which the test sites are located (see Table 2.1). These physical sites can always be linked to a region at NUTS-2 level (see Figure 2.3). Secondly, we must deal with the regions in which the WTN partners are located. The location of the office can be allocated to a NUTS-2 region (see Table 2.2). Although several partners also have offices in other regions, and these also belong to their area of work.

[1] Nomenclature of Territorial Units for Statistics (NUTS) at a regional (2) level.. The region has a minimum of 800.000 inhabitants and a maximum of 3 million inhabitants.

Test Sites of the Water Test Network	NUTS-level 2 (region)
1. De Blankaart. Diksmuide, Belgium	Province of West-Flanders (BE25)
2. VEG-i-TEC. Kortrijk, Belgium	Province of West-Flanders (BE25)
3. DVGW Water Technology Centre (TZW). Karlsruhe, Germany	Karlsruhe (DE12)
4. Antonius Hospital. Sneek, The Netherlands	Province of Friesland (NL12)
5. Dairy Campus. Leeuwarden, The Netherlands	Province of Friesland (NL12)
6. Water Application Centre. Leeuwarden, The Netherlands	Province of Friesland (NL12)
7. Wetsalt Desalination and Blue Energy. Harlingen, The Netherlands	Province of Friesland (NL12)
8. Wetterskip Fryslân Municipal Wastewater Treatment Technnologies. Leeuwarden, The Netherlands	Province of Friesland (NL12)
9. Sentec - Sensor Test Centre. Glimmen, The Netherlands	Province of Groningen (NL11)
10. Waste Water Treatment & Resource Recovery Centre. Apeldoorn, The Netherlands	Province of Gelderland (NL22)
11. Bo'ness Waste Water Development Centre. Bo'ness, United Kingdom	Eastern Scotland (UKM2)
12. Gorthleck Water Development Centre. Near Inverness, United Kingdom	Highlands and Islands (UKM6)
13. James Hutton Limited. Aberdeen, United Kingdom	North Eastern Scotland (UKM5)
14. Prime. Orleans, France	Centre-Val de Loire (FR24)

Table 2.1 Location (NUTS-2 region) of the WTN test sites.

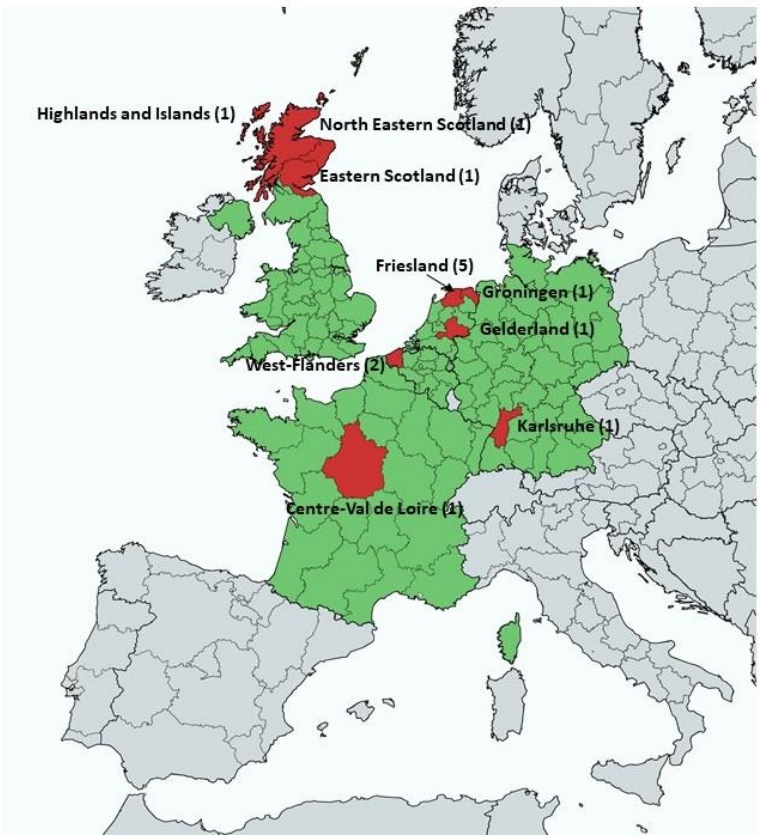


Figure 2.3 Regions where the WTN test sites are located (numbers between brackets)

Sub) Partners of WTN	NUTS1-LEVEL	NUTS2-level: Region
1. Scottish Water: *Lead partner*	Scotland (UKM)	Eastern Scotland (UKM2)
2. James Hutton Limited	Scotland (UKM)	North Eastern Scotland (UKM5)
3. DVGW Water Technology Centre (TZW)	Baden-Württemberg (DE1)	Karlsruhe (DE12)
4. VITO NV /Vlakwa	Flanders (BE2)	Antwerp (BE21)
4a. De Watergroep	Brussels (BE1) & Flanders (BE2)	
4b. Ghent University	Flanders (BE2)	Province of East-Flanders (BE23)
5. Centre of Expertise Water Technology	Northern Netherlands (NL1)	Province of Friesland (NL12)
5a. Province of Friesland	Northern Netherlands (NL1)	Province of Friesland (NL12)
5b. Water Alliance	Northern Netherlands (NL1)	Province of Friesland (NL12)
6. French Geological Survey (BRGM)	Bassin Parisien (FR2)	Centre-Val de Loire (FR24)
7. Water Authority Vallei and Veluwe	Eastern Netherlands (NL2)	Province of Gelderland (NL22)
7a. Clean Tech Region	Eastern Netherlands (NL2)	Province of Gelderland (NL22)

Table 2.2 Location (NUTS-1 and NUTS-2 region) of the (sub)partners of the WTN-project.

The NUTS 2 level of Eurostat is thus in itself well aligned with the locations of the test sites and reasonably close to the core areas from which the different (sub)partners of the project operate. However, it falls short of the level at which the regional authorities in the various countries implement their (economic) policies. Administrative boundaries and powers have their own history in each country. For one region, the regional innovation system is easy to describe at NUTS-2 level, but not for another. During the implementation of the study, we only gradually gained insight into the situation in each region. Based on the data we were able to collect; we chose the most pragmatic regional classification for each country (see Figure 2.4).

In Germany, we opted for Baden-Württemberg (NUTS-1 level). In Germany, the federal states have many responsibilities. The ERDF programme and a number of stakeholders also operate at the level of the federal state of Baden-Württemberg. We could not find much specific information about the innovation system for Karlsruhe and Region Mittlerer Oberrhein.

In France, the administrative boundaries coincide with the geographical boundaries of the NUTS-2 region Centre-Val de Loire, which made the choice of NUTS-2 here logical.

In Belgium, Flanders (NUTS-1) was chosen. During the interviews, it emerged that as a result of budget cuts, the economic power and responsibilities of the province of West Flanders (NUTS-2) are decreasing in favour of Flanders. For the (sub)partners and stakeholders we spoke to, Flanders also turned out to be their reference area.

In the Netherlands, the NUTS-2 areas Friesland and Gelderland were chosen as regions for the comparison. Although the RIS3 and the Operational Programmes for the ERDF are written for NUTS-1 level (respectively North Netherlands and East Netherlands), Friesland and Gelderland also have their own economic programmes. In addition, in the implementation documents of their ERDF programmes, data can be found at NUTS-2 level.

In the United Kingdom, Scotland has been chosen. In statistical terms, Scotland is a NUTS-1 region, but one with far-reaching powers and, in the eyes of most Scots, it is a seperate country. All relevant

policy documents and the ERDF programme are related to Scotland, so a further subdivision into NUTS-2 regions was not appropriate.

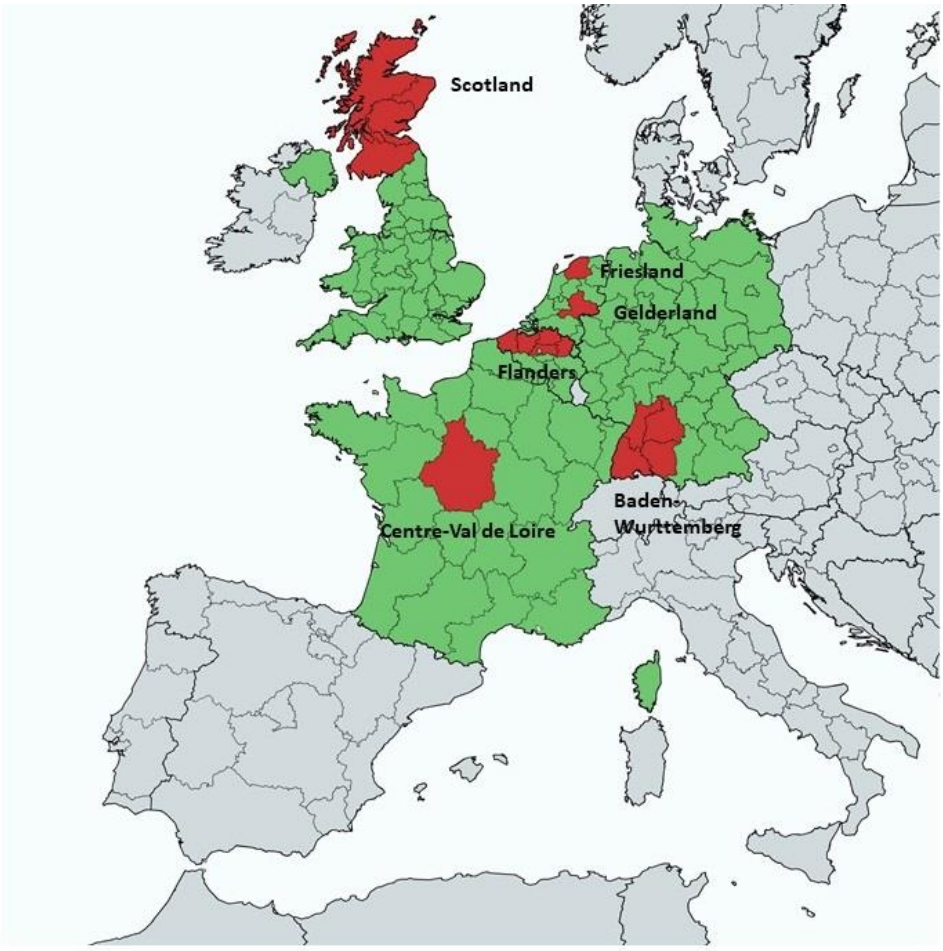


Figure 2.4 Administrative regions used for comparison of regional innovation systems for water technology

3. THEORETICAL FRAMEWORK

This chapter sets out the academic research of innovation and its driving factors in European regions. At first, the difference in quality between regions in Europe is described. These different aspects lead to different interactions between determinants of innovation systems. Secondly, the triple helix model is discussed. This model, and its evolution, is widely used across European innovation policies for the development of a competitive knowledge-based society, yet there is some criticism on the effectiveness of the model. Thirdly, the importance of clusters in today's innovation environment is taken into account. A concept brought to the fore by Michael Porter (Porter M. , 1990) and Paul Krugman (Krugman P. , 1991). Cluster development has since become a focus for many government programs. Fourthly, the determinants of regional innovation systems (RIS) are identified and analysed. These factors form the basis of an innovation system. Measurement of these individual factors is hard to carry out, therefore, an understanding of the whole system is necessary. Lastly, innovation in water policy and its determinants are outlined. These factors, together with the components available in a RIS, form the basis of Regional Innovation Systems for water technology which are portrayed into the conceptual model.

3.1 GOVERNANCE QUALITY

Innovation is one of the key concepts of the European Union's 2020 strategy. The aim is to foster economic growth by stimulating high quality research, technological development and innovation to reach the goal of a smart, sustainable and inclusive economy for Europe as a whole (European Commission, 2012). To achieve these standards, different instruments have been used such as the Regional Innovation Strategies (RIS3) and ERDF funding programmes. However, Europe's innovative policies have had limited success in improving the innovation potential of the, in particular, peripheral regions of the European Union (Rodríguez-Pose A. , 2001). The most common reasons for these failures are issues such as the distance to the technological frontier (Greunz, 2003), shortages in human capital (Sterlacchini, 2008) and geographical distances to the main economic and innovative areas (Moreno, Paci, & Usai, 2005). Yet, several studies have shown that institutions have a significant role in innovation (Asheim & Coenen, 2005). Their results showed that governmental institutions have an impact on organisational mechanisms and collaborative institutional structures. Most of these analyses, however, are conducted at a national level. In the European Union (EU), strategic interventions and political programmes to stimulate innovation, are set out at a sub-national level or at EU-NUTS2 level. This trend is reinforced by decentralisation which leads to an increase in innovation policy domains (OECD, 2011). At the same time, more pressure and responsibility is being transferred to local regions, which may or may not be able to implement and design an innovation strategy based on the capacity of sub-national governmental institutions.

Research carried out by Rodríguez-Pose and Di Cataldo on the basis of the growth rate of patent applications has shown that there is a positive impact in the quality of the public institutions of the European regions around the quality of governance and regional innovation (Rodríguez-Pose & Di Cataldo, 2015). Based on their conclusions there is not a simple single approach to innovation policies. The same innovation strategy might lead to different results in different regions. This raises the question, which factors determine the effectiveness of regional innovation systems if a good government is in place.

3.2 THE TRIPLE HELIX MODEL

A knowledge based economy is defined as production and services based on knowledge -intensive activities that contribute to an accelerated pace of technical and scientific advancement, as well as rapid obsolescence (Powell & Snellman, 2004). However, knowledge is a concept that is tricky to define. This is due to the fact that there are no unambiguous methods to measure the effectiveness of a knowledge based economy. Henry Etzkowitz and Loet Leydesdorff were the first researchers in the 1990s to develop a theoretical framework for economic and social development. Their model is based on three different actors; university, industry, and government; and the interactions between them (see Figure 3.1). Where the government has a controlling function in the market, the Industry is responsible for the production of goods and services and the university's main objective is the generation of knowledge (Etzkowitz & Leydesdorff, 1995).

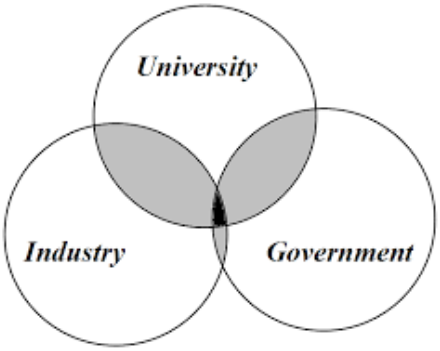


Figure 3.1: Triple Helix model based on the insights of Etzkowitz and Leydesdorff (1995).

Over time, interactions increase within this framework. Each component can evolve to adopt characteristics of the other institutions. This will result in the rise of hybrid institutions. However, differences may arise, and the model may develop in several ways. According to the researchers, this depends on the strength of interactions between university, industry and government. In a statist model, the government is the driving force, interactions are being made using top-down implementation. In contrast, in a Laissez-faire model[2], the market is regulating itself. So, it depends on the economic system which institution is the leading force. Therefore, the triple helix model differs by region. In a knowledge-based economy it is argued that universities will play a major role since education is the foundation within that system (Leydesdorff, 2012).

Building on to the model of the triple helix, it was first suggested in 2009 by Elias G. Carayannis and David F.J. Campbell to add an extra component to the model; civil society. Within the Triple Helix, the researchers claim that there could be a mismatch between the emerging technologies and the needs of society. Therefore, the potential impact could be limited. The transformation to the quadruple helix model would close the gap between innovation and civil society (Carayannis & Campbell, 2009). A year later, they then added another helix into the model; the environment (Figure 3.2). This helix views the society and the environment as drivers for knowledge production and innovation in a region (Carayannis, Barth, & Campbell, 2012). However, there is still a debate around how to define these helices. Some researchers see them as additional helices while others see them as overarching helices which influence the system as a whole (Höglund & Linton, 2018).

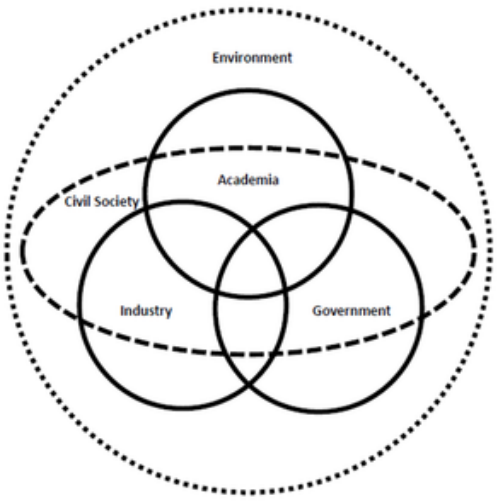


Figure 3.2: Quintuple helix as suggested by Carayannis and Campbell (2010)

[2] French: laissez faire, lit. 'let do' is an economic system in which transactions between private parties are free from any form of government intervention such as regulation, privileges, imperialism, tariffs and subsidies.

3.3 CLUSTERS, A COMPETITIVE ADVANTAGE

Another important aspect of a good functional innovation system are geographical clusters. Brought to the fore by Michael Porter and Paul Krugman. One would conclude that increasing globalisation, diminishing transport costs and corporate networks should lead to a decrease in importance of geographical locations. However, it was Porter who concluded the opposite effect happened in practice. This paradox of geographical location in a global market is what Porter describes as a competitive advantage (Porter M. E., 1998). So, geographical locations do matter in today's economy. Yet, the function differs. In the past, some geographical locations such as ports or other strategic locations along trade routes did have comparative advantages. Nowadays, transport costs are just one of the many factors that determine the geographical location. Other aspects such as access to skills, suppliers, customers, specialised information and complementary products and services are also important. Porter therefore described clusters as geographic concentrations of a critical mass of interconnected companies and institutions in a particular field whereby proximity leads to shared advantages through the aggregation of expertise and specialised resources.

Paul Krugman noticed similarities in his research. Based on his work which is now known as 'new economic geography,' he analyses the effect of economies of scale (Krugman P. , 1991). By scaling up the manufacturing of products and services in a particular sector, a region can provide lower transportation costs that leads to increasing returns of scale. Krugman states that these regions with economies of scale will emerge in places with high demand. However, because of production concentrated in nearby areas, demand will rise in these places as well. This is where agglomerations occur, these hotspots are what Porter calls clusters. Due to this research, cluster development is becoming a focus for many policy programs in the Western world (World Bank, 2009).

In line with the ideas of Krugman and Porter, other researchers added the concept of innovation to the clusters. These new clusters of innovation (COI) are defined as: global economic hot spots where new technologies germinate at an astounding rate and where pools of capital, expertise, and talent foster the development of new industries and new ways of doing business (Engel, 2015). The business clusters explain how areas specialised in a particular sector gain competitive advantage due to economies of scale and decreasing transportation costs. However, it did not explain why highly innovative clusters were able to support innovative growth firms who diverge from the original business cluster, an effect which many have become aware of due to the success story of Silicon Valley (Saxenian, 1994).

A cluster in the form of a hub, campus or valley can play an important role in fostering innovation. Not only for the reasons mentioned before but also because of the transfer of knowledge. According to Engel, there are three key components in an innovation-centred business cluster: Government, Universities and Entrepreneurs. These components form the basis of the cluster in every region (Figure 3.3). Although, their roles might differ by region. This concept is almost identical to the triple helix theory. However, a physical location or place where these institutions can transfer knowledge is sometimes not taken into account. It is at these locations where tacit knowledge[3] finds a way to transfer itself. Therefore, it is argued that a physical location fosters innovation by transferring knowledge between the institutions (O'connor, 2004).

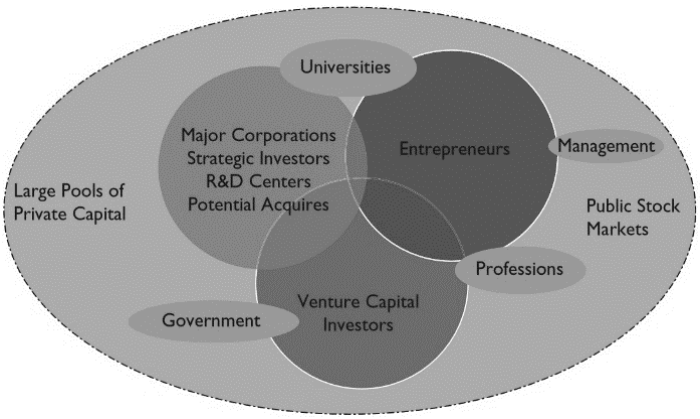


Figure 3.3: The cluster of innovation model (Engel, 1995)

[3] Tacit knowledge (as opposed to formal, codified or explicit knowledge) is the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalizing it.

3.4 THE DETERMINANTS OF REGIONAL INNOVATION SYSTEMS

In earlier research, the determinants of regional innovation systems have been studied. It was the Oliveira et al. (de Oliveira, Echeveste, Cortimiglia, & Gonçalves, 2017) who carried out a qualitative literature review of these factors influencing the RISs. Based on their findings, they suggest different factors influencing regional innovation. These factors are respectively: proximity and close relationship with Higher Education Institutions (HEI), a government system to intermediate relationships with knowledge actors outside the regional system, mechanisms of relationship network and knowledge absorptive capacity of the firms within the innovation system and public support such as incentives, funding and settling of the right infrastructure. Based on these results the researchers came up with the conceptual model for RISs seen in Figure 3.4. In this study, the triple helix is present as well. However, the authors elaborate on interrelationships between the different institutions. Furthermore, they add extra determinants such as public support. In their study, the authors also recognise the geographical distance between the institutions, but they do not mention the need of a physical location.

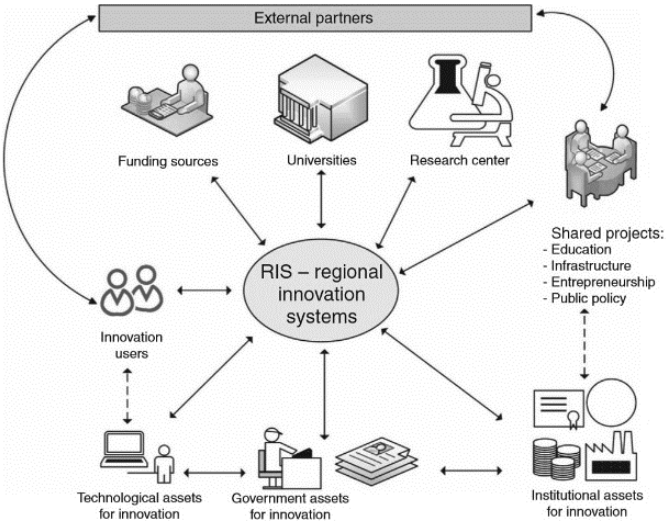


Figure 3.4: Components of Regional Innovation Systems (de Oliveira, Echeveste, Cortimiglia, & Gonçalves, 2017)

In the literature overview of Pino and Ortega the need for this physical location becomes clearer (Pino & Ortega, 2018). Regional Innovation Systems have relationships outside their own geographical and sectoral boundaries as companies and knowledge organizations increasingly interact. Therefore, clusters became part of the same system. Yet, one should take into account that the specificity for clusters and the sector orientation of RIS can differ (Asheim & Coenen, 2005). Clusters that rely on tacit knowledge and not so much on scientific knowledge favour a central place where knowledge transfer can take place.

Thereafter, the authors discuss the different methods regarding measuring effectiveness of RISs. In their study, they make a distinction between 4 different approaches: the organisational approach (1), institutional approach (2), capability approach (3) and the assessment approach (4). All methods have their pros and cons (Pino & Ortega, 2018). However, water technology has many cross-overs. The scope can vary between the different RISs. Therefore, it is complicated to compare the RISs of the regions in the WTN. As a consequence, this study examines the organisations, the institutions and the interrelationships and not their capabilities and their functionality.

3.5 NATIONAL INNOVATION SYSTEMS, AN OVERVIEW OF THE FRAMEWORK

This study is focussing on RISs. However, one should take into account that stakeholders in an innovation system within a regional or constitutional boundary are often part of a wider system of National Innovation Systems. Within this research, national characteristics are not taken into account. However, it is noted that these characteristics and frameworks always play a role in shaping the regional innovation systems (OECD, 1999). The OECD theorised their findings into a framework (Figure 3.5). Based on their findings, the authors included the triple helix system as a core element. The interaction between the market factors (Macroeconomic and regulatory context, Product market conditions, Factor market conditions, Education and training system and Communication infrastructure) determine Country performance (growth, jobs and competitiveness). The differences between the regional system and the national system can be seen in the size of the market and the regional deviations of the market factors.

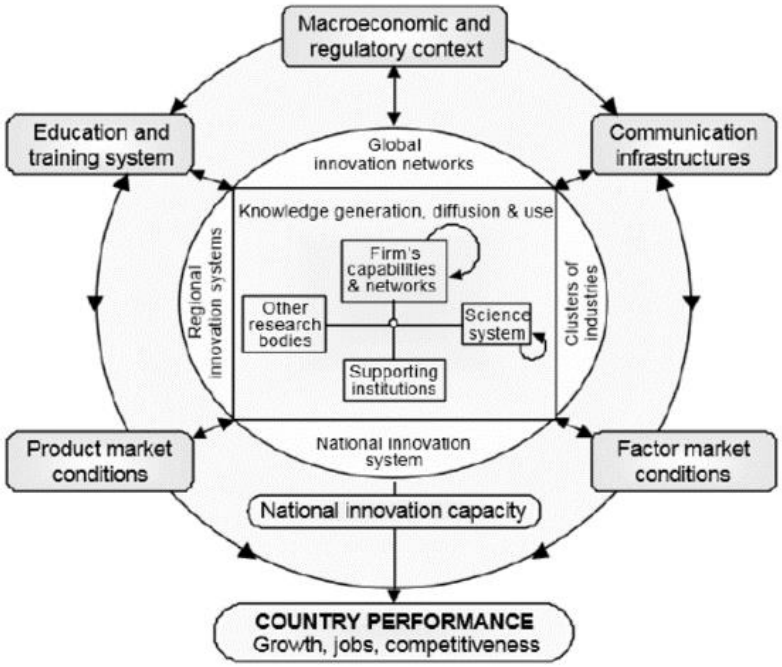


Figure 3.5: OECD framework of national innovation systems (OECD, 1999).

3.6 FACTORS FOR INNOVATION IN WATER POLICY

Every regional innovation system has more or less the same type of actors. However, the scope and market often differ since the focus is not always on the same products and services. For innovation in water technology the scope is hard to define. This is not only because of definition problems but also due to the fragmentated market water technology is embedded in (Krozer et al., 2010). For many sectors water technology is important, it could be a subject on its own to stimulate the regional economy. However, water technology can also be a component of a lot of other sectors and end-users such as the food industry, ecology and circular economy.

Due to these differences, it is unclear how policy makers should stimulate innovation in water technology. Moore et al. (2014), recognise these problems for water policy in general. They conducted a systematic literature review over a five-year time frame between 2009 and 2013. The authors came to the conclusion that there term innovation is used in different ways. So, they made a typology for innovation in water policy, based on six different themes (Table 3.1). The researchers concluded that water policy is a transformative change process within complex systems.

hemes for innovation in water policy	Description
Legal and political reforms	Decentralisation of national water governance (Petit & Baron, 2009).
Policy entrepreneurs and change agents	Individuals who promote and influence policy changes.
Networks and collaborative approaches	Organisations collaborating in a network are more likely to be innovative.
Social learning	Due to learning in interregional multilevel cooperation, sharing experiences and pooling the related science, new innovative solutions should be achieved (Martins, et al., 2013).
Adaptive, integrated approaches	An adaptive integrative approach underpinned water technology and innovation.
Niche experiments	The need for safe spaces for policy experiments in order to support innovation and change.

Table 1.1: Themes that enable innovation for water policy (Moore, von der Porten, Plummer, Brandes, & Baird, 2014).

Policy programmes are hard to place in one theme. Policies should stimulate and contribute to innovation as defined in the Table above. According to the authors, innovation in water policy includes decentralisation and change agents. Specific problems ask for customised solutions. They also recognise the importance of network collaboration to transfer knowledge and to stimulate social learning. It is argued that an adaptive and integrated approach should encourage these steps. Lastly, they see the importance of niche experiments; policy makers should be able to test innovative policies at small scale to allow flexibility (Moore et al., 2014).

3.7 CONCEPTUAL MODEL

Based on the discussed scientific literature the following conceptual model is constructed (Figure 3.6). This model can be seen as a kind of cherry picking from the economic and innovation models used to describe the factors of a regional innovation system in water technology.

The following explanation should be noted for the model: every region has its weaknesses and its strengths. Despite this, innovation should be a priority for all regions in Europe. Hence, every region in the European Union has made a regional research and innovation strategy for smart specialisation (RIS3). In this strategy, every region sets out their knowledge specialisations that best fit their innovation potential, based on their assets and capabilities. Smart specialisation involves businesses, research centres and universities working together to identify a regions' most promising areas of specialisation (European Commission, 2014). However, this triple helix does not function in the same way in every European region. Social factors, such as the presence of human capital, the level of education and the drive for entrepreneurship; differ between European regions. Therefore, economic factors vary by region. Some regions have a higher GDP which often leads to more expenditure in R&D and a rise in human capital. Of course, geographical factors influence these aspects as well. Peripheral regions in particular are affected by negative economic factors. In these regions, the educational level and R&D expenditure are often lower than the European core regions.

These regional factors influence the triple helix system of Government-Industry-University and their interrelationships and interactions. Also, the strength of the interaction differs by region and it is not always clear which party is the driving force in the framework. Additionally, other factors are important as well: clusters and their drive for innovation are comprehensively discussed; and a physical location, such as a campus, valley or hub

is seen as an added value for technology transfer and the exchange of tacit knowledge from external partners and partners within the region.

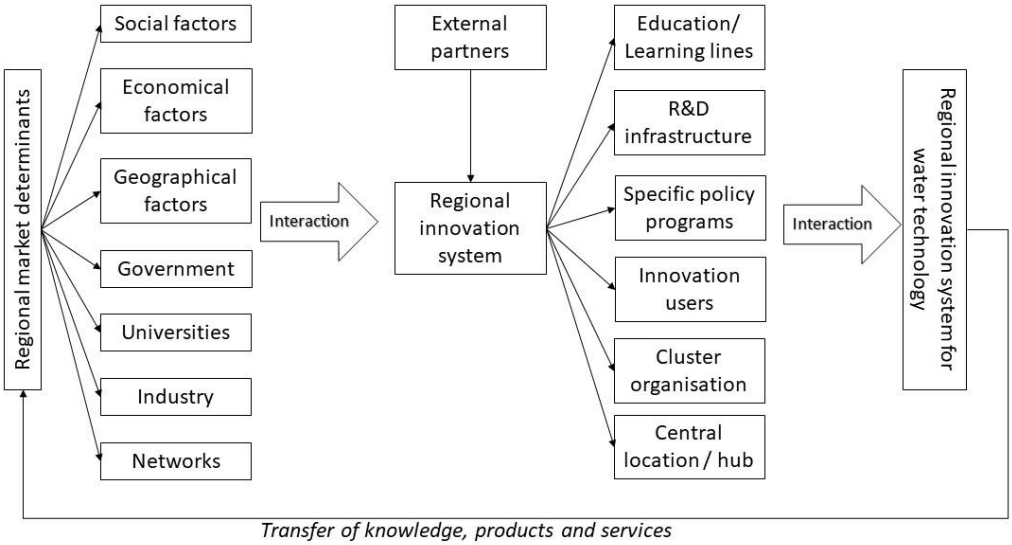


Figure 3.6: Conceptual Model for RISs in water technology based on the triple helix (Etzkowitz & Leydesdorff, 1995), Components of Regional Innovation Systems (de Oliveira, Echeveste, Cortimiglia, & Gonçalves, 2017) and the determinants for RISs (Pino & Ortega, 2018)

Cherry picking sounds a little disrespectful. However, when putting into practice the theory of regional innovation models within the Water Test Network project, you encounter a problem. The water technology sector is a very specific sector, which is not included in economic statistics as an independent sector. Even within water technology, the WTN regions have different focus areas. Thus, there is little or no quantitative data available on the water technology sector and a quantitative comparison between regions is even more difficult. We therefore rely mainly on qualitative information, which we were able to obtain from surveys, interviews and internet research.

On the left side of the model (regional market determinants) we have incorporated information from the scientific theories on the regional, geographic, economic and social factors and the components of the triple helix. On the right side of the model (Regional Innovation System determinants) the theories about clusters and the determinants in RISs find their place. The determinants on education, (R&D) infrastructure and specific policy programs are found in de Oliviera's research under the heading Shared projects (de Oliveira, Echeveste, Cortimiglia, & Gonçalves, 2017). We have included them in the model as separate determinants, because it is interesting to compare the extent to which these determinants are present in the WTN regions.

4. REGIONAL CHARACTERISTICS

This chapter describes the regional characteristics of the areas involved in the WTN at NUTS 2 level. We give an overview of the relevant social, economic and geographical factors that influence the interaction in the Triple Helix system. The differences per region can result in the actors in the Triple Helix having different roles and interrelationships. In addition, regional characteristics affect the quality of innovation capacity and thus have an impact on the Regional Innovation System. By comparing these variables by region, this research tries to visualize these differences in innovation quality and thus their interactions in the regional innovation systems. The data used in this chapter is taken from Eurostat's database and can be found in Annex C.

4.1 DEMOGRAPHY AND LANDAREA

The regions of the WTN differ a lot in size and population. Comparing the land surfaces results in significant differences. West Flanders is the smallest by area (3,144 km²) and the Highlands and Islands the largest (41,974 km²). The statistics on population size show an entirely different picture. Highlands and Islands are the smallest with a population of 470,743. The region of Karlsruhe (DE12) has the largest population (2,795,783). For the analysis, combining both population size and density, is important. According to Krugman's theory, there is a greater chance of economies of scale in regions with a high population density than in others, because the demand in these areas is also greater. Therefore, the development of clusters will be more suitable for these regions (Krugman, 1991). The regions with the highest population density are: West Flanders, Karlsruhe and Gelderland, respectively. For Friesland and the Scottish regions, the population density is below average for the WTN-regions. Therefore, opposite effects may occur here. These regions have less demand and have a smaller labour force to deplete.

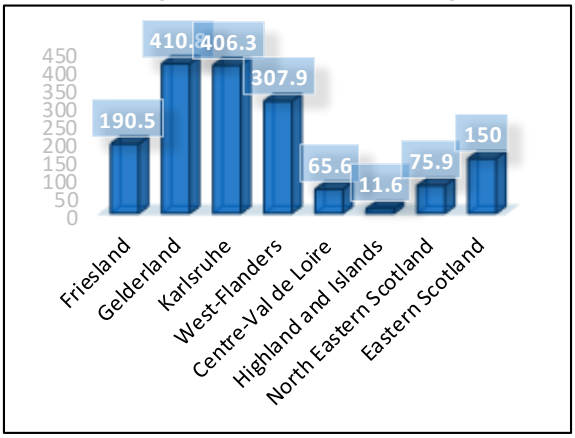


Figure 4.1: Population density in km2 (2017) of the regions in the Water Test Network.

4.2 GDP, R&D AND THE WORKFORCE

Other indicators to consider are gross domestic product and the regional labour force. Regions with a high GDP per capita have more resources and thus more assets to invest. The largest regions often have the highest GDP because there are more inhabitants within these regions. To compare the different regions of the WTN, GDP per capita is used. As can be seen in Figure 4.2, the European core regions Flanders, Karlsruhe and Gelderland have a higher GDP than the other regions, with the exception of Northeast Scotland. Their GDP per capita of €42,000 is even higher than the Karlsruhe region. However, this score is mainly caused by the income from oil and gas. It is therefore questionable to what extent the whole region benefits from these high figures. Additionally, the R&D investments also give an indication of the regional innovative strength. Figure 4.2 shows R&D investment as a percentage of GDP. For Scotland, research and development is measured for all regions combined. Karlsruhe

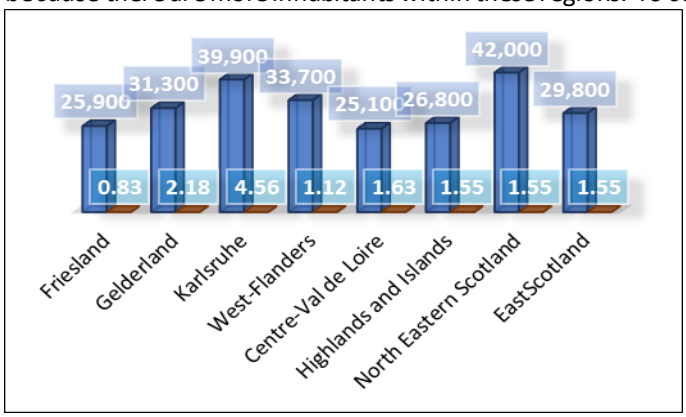


Figure 4.2: GDP per capita (2017) per NUTS2 region and the percentage of GDP spend on R&D investments (2016).

is the region with the most R&D investment. The Province of Friesland comes in last with less than 1% of GDP in R&D expenditure.

In addition, we can compare general labour market statistics by region (Figure 4.3). An active and skilled labour force is beneficial for stimulating innovation. The activity of the labour force is expressed in the employment ratio (the number of people in employment divided by the whole population). This ratio ranges between 53% in North-East Scotland and 37% in Centre-Val de Loire. This low rate is partly due to the relatively high unemployment rate in Centre Val de Loire (8.6%). This is almost the same as France's national score (8.5%), but still 2% higher than the EU-28 average. The biggest differences can be seen in tertiary education levels[4]. Most regions score between 30% and 40%, with Friesland just below that with 29%. Outliers are the Scottish regions, which score 15 to 20% higher. The reason for this could be that university education in Scotland is free.

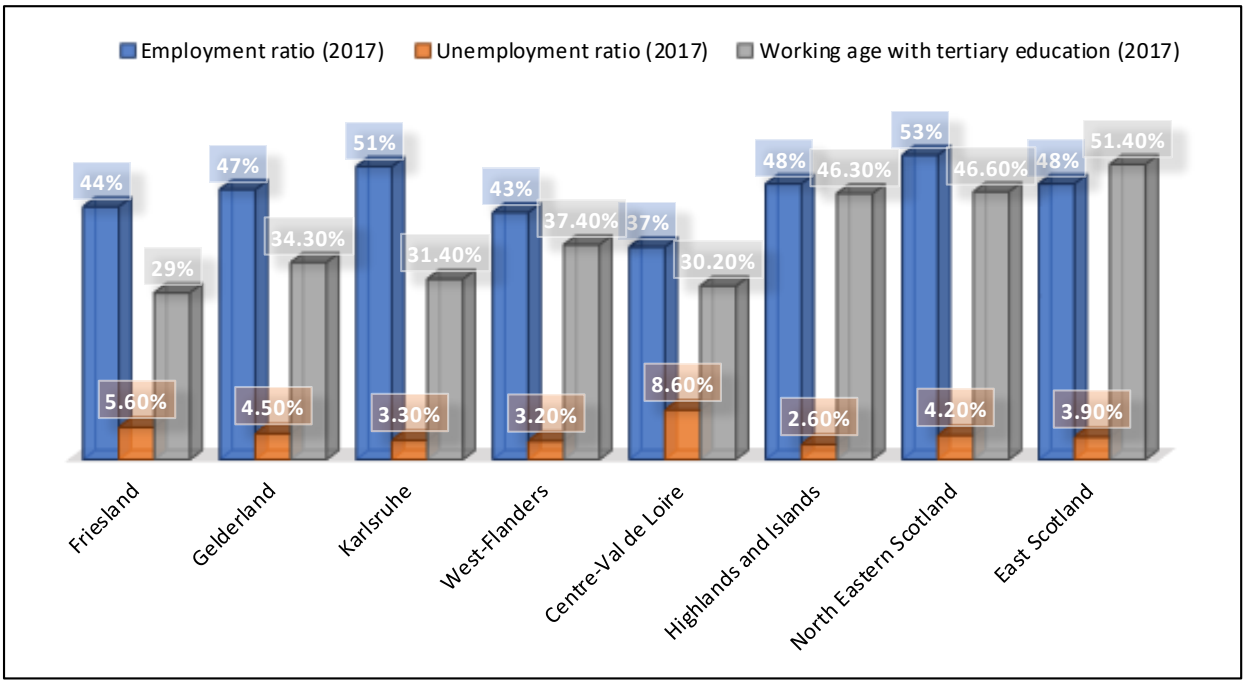


Figure 4.3: Labour market statistics, employment ratio, unemployment rate and educational level per region in 2017.

The above provides an overview of a number of basic geographical, economic and social indicators. With the help of scientific studies and extensive data collection, these have been further refined over the last decade in order to compare European regions at NUTS-2 level. The EU Regional Competitive Index and the Regional Innovation Scoreboard are of particular relevance for this study. These are discussed in the following sections.

4.3 THE EU REGIONAL COMPETITIVENESS INDEX

The Regional Competitiveness Index (RCI) has been measuring the major factors of competitiveness over the past ten years for all the NUTS-2 level regions across the European Union. The Index measures more than 70 comparable indicators on the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work (Annioni & Dijkstra, THE EU REGIONAL COMPETITIVENESS INDEX 2019, 2019).

The RCI is composed of 11 pillars that describe the different aspects of competitiveness (Figure 4.4). They are classified into three groups: Basic, Efficiency and Innovation. The Basic group includes five pillars: (1) Institutions; (2) Macroeconomic Stability; (3) Infrastructure; (4) Health; and (5) Basic Education. These represent the key basic

[4] Education at universities (of applied science).

drivers of all types of economies. As a regional economy develops and advances in its competitiveness, factors related to a more skilled labour force and a more efficient labour market come into play as part of the Efficiency group. This includes three pillars: (6) Higher Education, Training and Lifelong Learning; (7) Labour Market Efficiency; and (8) Market Size. At the most advanced stage of a regional economy's development, drivers of improvement are part of the Innovation group, which consists of three pillars: (9) Technological Readiness; (10) Business Sophistication and (11) Innovation.

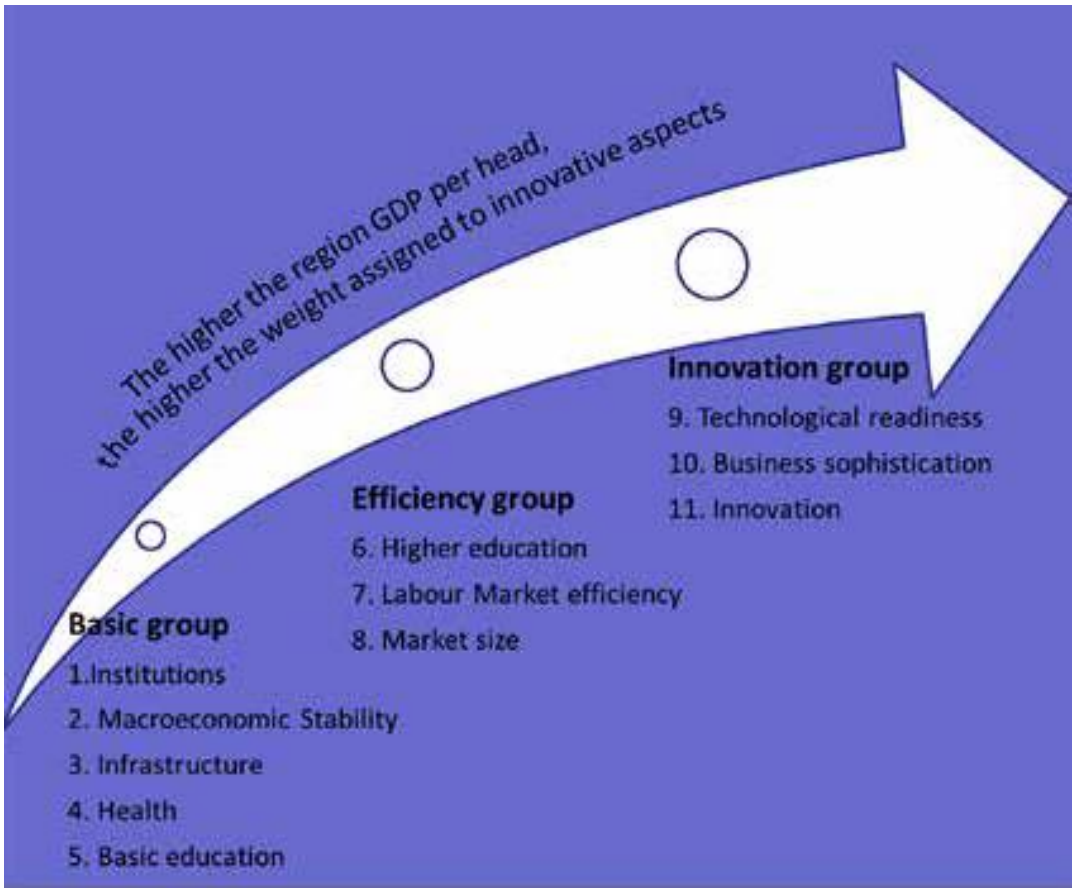


Figure 4.4: 11 pillars that describe the different aspects of competitiveness. (Annioni, Dijkstra, & Gargano, The EU Regional Competitiveness Index 2016, 2017)

Together these pillars determinate the score of competitiveness for European regions at NUTS2-level. Based on this index, the following score is calculated for the regions in the WTN seen in Figure 4.5. According to the RCI, European core regions score better than peripheral regions. Karlsruhe has the highest score and is ranked 15th of all European regions. Highlands and Islands, one of Europe's most peripheral regions, has the lowest score and is in 147th place of the total 268 regions in Europe. In conclusion, densely populated places in European core regions score the most points. Therefore, it is no surprise that the regions of Karlsruhe and Gelderland have the highest overall scores.

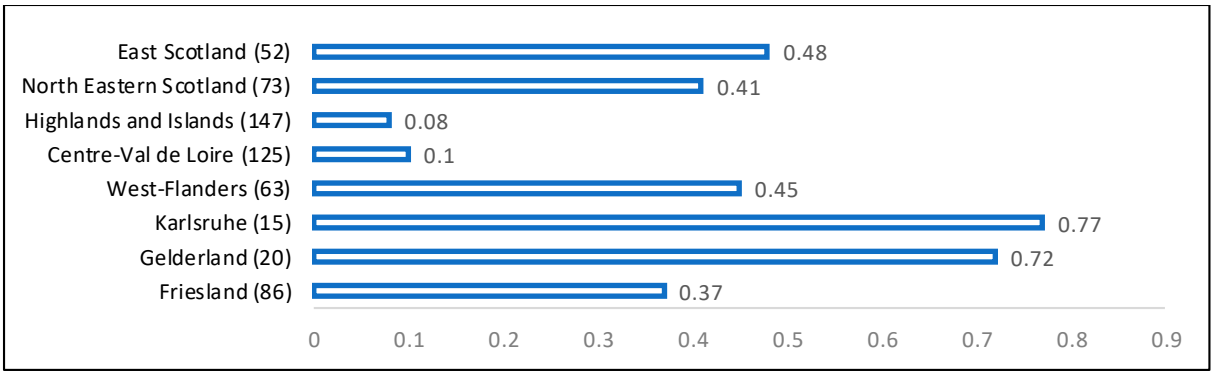


Figure 4.5: Regional Competitive Index (RCI) and the regions overall position in the EU between the parentheses.

4.4 THE REGIONAL INNOVATION SCOREBOARD

The Regional Innovation Scoreboard provides a comparative assessment of the performance of innovation systems across 238[5] regions of the 23 EU Member States, Norway, Serbia, and Switzerland. In addition, Cyprus, Estonia, Latvia, Luxembourg and Malta are included at the country level (Regional Innovation Scoreboard 2019, 2019). The RIS complements the European Innovation Scoreboard (EIS), which assesses the performance of national innovation systems. Where the EIS provides an annual benchmark of the innovation performance of Member States, regional innovation benchmarks are less frequent and less detailed due to a general lack of innovation data at the regional level. The Regional Innovation Scoreboard addresses this gap by providing statistical facts on a regions' innovation performance. Europe's regions have been classified into groups of regional Innovation Leaders (38 regions), regional Strong Innovators (73 regions), regional Moderate Innovators (97 regions), and regional Modest Innovators (30 regions). A more detailed breakdown of these performance groups is obtained by splitting each group into a top one-third (assigned with a '+'), middle one-third and bottom one-third (assigned with a '-'). The most innovative regions are typically in the most innovative countries. The Innovation Leaders perform well on all indicators, in particular on those indicators measuring the performance of their research system and business innovation.

The measurement framework of the European Innovation Scoreboard (EIS) consists of four groups:
FRAMEWORK CONDITIONS: Human resources ; Attractive research systems; Innovation friendly environment
INVESTMENTS: Finance and support; Firm investments
INNOVATION ACTIVITIES: Innovators; Linkages; Intellectual assets
IMPACTS: Employment impacts; Sales impacts

In the Regional Innovation Scoreboard, regional innovation performance should ideally be measured using the full measurement framework of the EIS, i.e. using regional data for the same indicators applied to measure innovation performance at the country level. However, for many indicators used in the EIS, regional data is not available. The Regional Innovation Scoreboard is limited to using regional data for 17 of the 27 indicators used in the EIS. For several indicators, slightly different definitions have been applied, as regional data would not be available if the definitions were the same as in the EIS.

The (ideal) regional classification at NUTS-2 level cannot be used either for the Regional Innovation Scoreboard in all cases. Some regions need to be aggregated to a higher level of aggregation in order to obtain the necessary data on the indicators. In the case of the WTN regions, this concerns the Scottish regions and West Flanders, which are included under Scotland and Flanders, respectively.

[5] In comparison with the Regional Competitive Index a number of regions have been joined together.

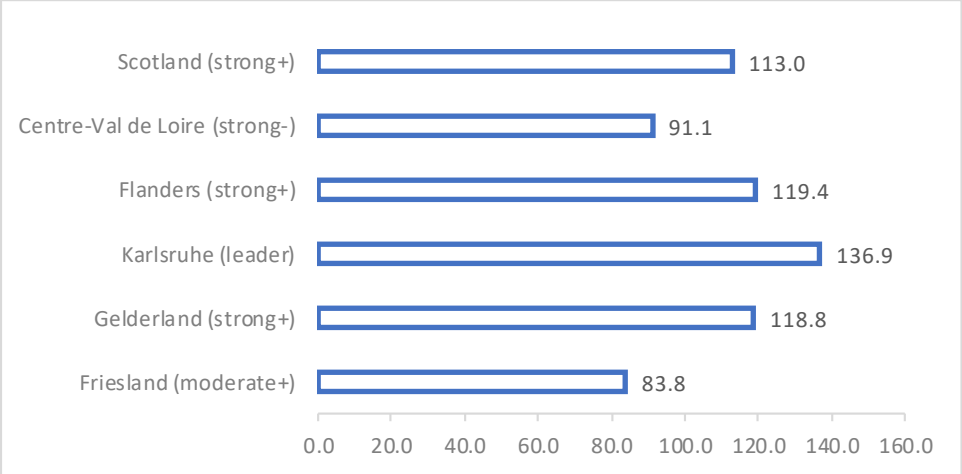


Figure 4.6: Regional Innovation Score 2019 relative to EU-average (100) and corresponding category between parentheses.

The region of Karlsruhe is also the strongest of the WTN regions in terms of innovation. It is the only region in the Leaders category and they rank 14th in the U top 25. Gelderland, Flanders and Scotland all score above the EU average and belong to the Strong+ category. The innovation climate in Centre-Val de Loire (category Strong-) and Friesland (category Moderate+) fall below the EU average.

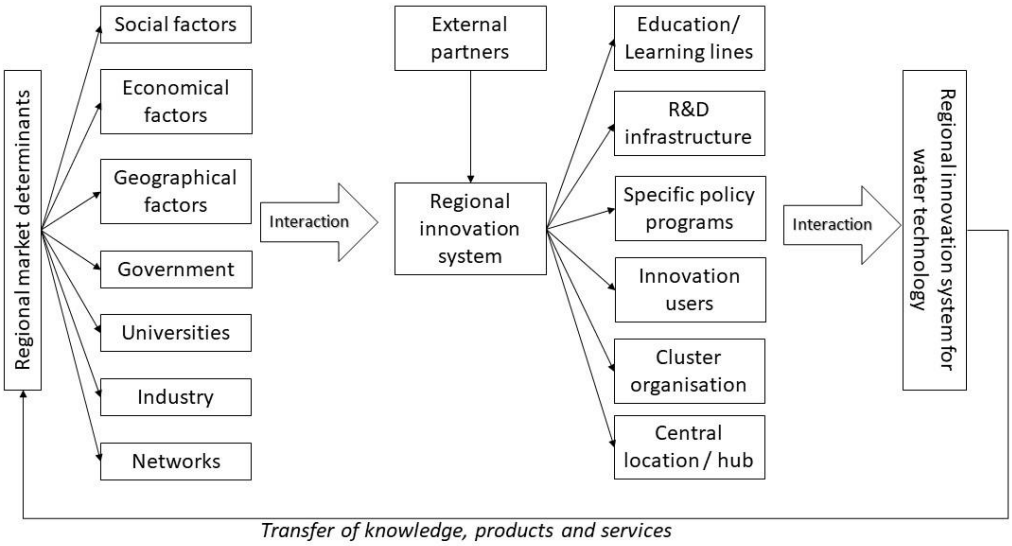
As with the Competitiveness Index, the core European regions score better than the more peripheral regions. It should be noted that Scotland is at the level of the core regions when it comes to innovation, although it is regarded as peripheral in the Competitiveness Index.

4.5 CONCLUSIONS

The Regional Competitiveness Index and the Regional Innovation Scoreboard confirm the picture of basic geographical, economic and social factors: more centrally located and densely populated regions tend to have higher competitiveness and a better innovation environment. However, this picture is not explicitly applicable for innovation in water technology, it is an overview of strengths and weaknesses per region for innovation as a whole.

5. INNOVATION SYSTEMS FOR WATER TECHNOLOGY IN WTN-REGIONS

In this chapter we will focus on the determinants for innovation in water technology which we dealt with in Chapter 3. In doing this we arrived at the conceptual model below:



Social, economic and geographical factors have already been addressed in the previous chapter. In this chapter the other determinants are dealt with by region. We use the regional classification that best suits the economic policy of the regional authorities, because many of the determinants are determined by this policy (see section 2.3).

In the discussion of the determinants in this chapter we focus on water technology. The more we focus on individual economic sectors, the less quantitative data there is available. We have already seen this in the limitations of the Regional Innovation Scoreboard. The water technology sector is a very specific sector, which is not included in economic statistics as an independent sector. Even within water technology, the WTN regions place different significance on different determinants. Thus, there is little or no quantitative data available about the water technology sector. We will therefore focus on qualitative data about the determinants obtained from the surveys, interviews and desk research on the Internet.

In the last section we will make an attempt to compare the regional innovation systems for water technology of the WTN regions.

5.1 BADEN-WURTEMMBERG, GERMANY

5.1.1 Government

Germany is a federal state with a federal structure: the tasks of the state are divided between the federal government, the Länder and the municipalities. After reunification, the Federal Government, based in Berlin, is responsible for the framework legislation and national tasks of water management. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is responsible for water protection, the Federal Ministry of Economics and Technology for water supply and the water industry, the Federal Ministry of Education, Science, Research and Technology for the development of new technologies, and the Federal Ministry of Health for determining drinking water quality. International cooperation is the responsibility of the Federal Ministry for Economic Cooperation and Development. The ministries have specialised authorities such

as the Federal Environment Agency, the Federal Institute of Hydrology as well as private agencies such as the Project Management Agency for Water Technology and the Society for Technical Cooperation (BMU, 2001). Within the framework of federal legislation, the governments of the 16 Länder are responsible for regulating water supply and wastewater disposal in their territories. Water legislation in Germany is thus fragmentated between a lot of agencies. We have chosen to focus this report on new technologies in water treatment.

National Innovation Policy

At the national level, new technologies and therefore water technologies are embedded in the Research Agenda Green Economy developed by the Federal Ministry of Education, Science, Research and Technology (BMBF). Green Economy unites economics and ecology: an economy must be internationally competitive but must also be environmentally friendly and socially acceptable. A Green Economy enhances social welfare, combats poverty, and strives for social justice. The Agenda is focused on several priority areas:

Priority Areas in the Research Agenda Green Economy	
1. Production and Resources: Raw Materials, Water, and Land	2. Sustainability and Financial Services
3. Sustainable Consumption	4. Sustainable Supply and Use of Energy in the Economy
5. Sustainable Mobility Systems	6. Infrastructures and Intelligent Supply Systems for the City of the Future

Table 5.1 Priority areas in the German Research Agenda Green Economy. Water (technology) is involved in Production and Resources.

The BMBF is providing 350 million EUR of funding into research of green economy (BMBF, 2015). It is unknown how much of this budget is to be invested in water technology. The priority is broader and not expressly for the water sector, although the water sector is seen as one of the priority areas which can apply for this funding.

The other Ministry that is important for innovation is the Federal Ministry for Economic Affairs and Energy (BMWi). Its goal is to ensure both Germany's competitiveness and a high level of employment. The Ministry aims to help achieve this by using the legislative, administrative, and coordinating role it has in the fields of energy, industrial, innovation, competition, SME, and European policy.

Innovation policy Baden-Württemberg

The authority of the State (Land) Baden-Württemberg did not write a regional innovation strategy, however their innovation-related policies do feature in their operational programme. This programme is a comprehensive overview of the policies for the European Regional Development Fund (ERDF) (Baden-Württemberg, 2018).

The State of Baden-Württemberg focuses on two priority axes in its Operational Programme:

- Priority axis A: Research, technological development and innovation.
- Priority axis B: Reducing emissions of CO_2 in all branches of industry.

Baden-Württemberg is stimulating clusters and inclusive growth. Using these strategies, the government intends to build on the good facilities that are already available in the region. There are more than 100 colleges and universities and Baden-Württemberg has a central location in the global innovation network. To maintain this position, the state has continued its innovation strategy through intelligent specialisation based on the 2011 coalition agreement which focuses its economic and innovation policy on four future fields, existing innovative cores and nine key technologies. The four future fields are:

Baden-Württemberg main economic sectors for innovation	
1. Sustainable mobility	2. Environmental Technologies, Renewable Energies and Resource Efficiency
3. Health and Care	4. Information and Communication Technologies, Green IT and Intelligent Products

Table 5.2 The main innovative sectors in Baden-Württemberg. Water technology and the water sector are not included but the region does focus on Environmental technologies as a whole.

Intelligent specialisation provides the direction for the entire innovation system; from knowledge development, (especially between public research institutions, and companies, with the focus on SMEs), to the application and market launch of innovative products. Important components of the state's innovation system are the provision of public research and innovation infrastructure, knowledge development, knowledge and technology transfer, networking, start-ups and the development of the potential for technology leadership (Baden-Württemberg, 2013).

In addition to the State Baden-Württemberg there are other players among the regional authorities that play an important role in the regional innovation eco-system.

LUBW (Landesanstalt für Umwelt Baden-Württemberg) operates measurement networks for air, water, soil and radioactivity nationwide. Mapping of fauna and flora, which provides information on the condition of nature and landscape. They also monitor climate change. LUBW advises and supports the state government and the environmental and nature conservation administration in Baden-Württemberg. LUBW functions as an information and networking platform for municipalities, companies and institutions and provides support on the subject of sustainability.

With the BWPLUS funding programme (Baden-Württemberg Programme for Environmental Livelihoods and their Protection), the Ministry of the Environment, Climate and Energy supports application-oriented environmental research projects that are of particular relevance for Baden-Württemberg. The aim is to develop scientific and social science, technical and methodological benefits as well as instruments for solving problems in order to create an environment that is sustainable in the long term.

Water policy

Water is the basic prerequisite for all life on earth. It is an indispensable part of the natural balance. Running waters, stagnant waters and groundwater are an important part of the global water cycle. In Baden-Württemberg the total length of running waters is about 38,000 km. The natural and artificial lakes have a total surface area of 662 km², of which Lake Constance accounts for 535 km². The surface waters are currently represented in the Official Digital Water Management Network of Baden-Württemberg.

In Baden-Württemberg 75% of the drinking water comes from groundwater. The main objectives of water protection are the good ecological and chemical status of running waters and lakes as well as the good chemical and quantitative status of groundwater. These objectives are laid down in the European Water Framework Directive (EU WFD).

The monitoring of groundwater levels and spring discharges is the foundation for the timely detection of changes in quantitative status.

As with floods, water can also become a danger to humans. The flood prediction of the LUBW gives rescue forces important time to prepare for imminent flood events. By ensuring timely intervention by authorities, communities and citizens, great damages can be prevented. However, there is no absolute protection against floods. The identification of flood risks, as well as coordinated and joint action before, during and after a flood, is made mandatory by the European Flood Risk Management Directive (EU FRMD), which came into force in 2007.

In dry periods, the daily updated low water forecasts of LUBW are an important source for low water management. This information is of particular interest to water authorities, shipping, energy supply and agriculture.

5.1.2 Universities

An analysis on behalf of the Federal Ministry for Education and Research (BMBF) from 2010 to 2012 signalled a fragmentation of the water research community in Germany, and came to the conclusion that both universities and non-university research institutes possess a high research capacity, but lack the cross-institutional coordination of principles as well as long-term agreements and strategies between the federal and the regional level.

The Helmholtz Association reacted to the major challenges facing water research and to the abovementioned fragmentation, and procured funding accordingly (Joint Initiative for Research and Innovation, »portfolio funding«) from which the Helmholtz Water Network was developed.

The Helmholtz Water Network aims to promote synergies between universities and non-university research institutes to carry out collaborative projects, and to strengthen cooperation's with leading international partners and the business sector.

A study from the Helmholtz Water Network shows Baden-Württemberg is one of the centres for the water research community in Germany. Karlsruhe Institute of Technology (KIT) and the University of Stuttgart are regarded as major institutions for the German water sector (figure 5.1). In addition, Baden-Württemberg has several institutions in the water (technology) sector, such as: the University of Biberach and KomS (Kompetenzzentrum Spurenstoffe) (Helmholtz Water Network, 2015).

The Engler-Bunte-Institut is part of the Karlsruhe Institute of Technology and focuses on the education and training of students and experts, as well as on the research and development of effective processes, analysis and measurement methods and their underlying engineering fundamentals. The main activities are water treatment, drinking water supply, swimming pool water treatment, waste water disposal and water protection. These topics are very relevant for water technology according to the definition used in this report.

5.1.3 Industry

There is no statistical data available on the water technology sector in Baden-Württemberg. There are however a number of alternative sources. Companies in Baden-Württemberg can register for the Competence Atlas for Resource Efficiency and Environmental Technology of Umwelttechnik BW. Corrected for double counting, approximately 80 companies have registered for the Sustainable Water Management category. From the membership of Figawa - i.e. the national technical and scientific association of manufacturers and service providers of gas and water applications - 18% comes from the state of Baden-Württemberg. This means that the water and gas sector is somewhat overrepresented in Baden-Württemberg, as the contribution of Baden-Württemberg to the German GDP is 15%. We can thus identify about 80 water technology companies through these public sources. This is obviously an underestimate of the actual number, as not all water technology companies are members of the sector association or have registered with it.

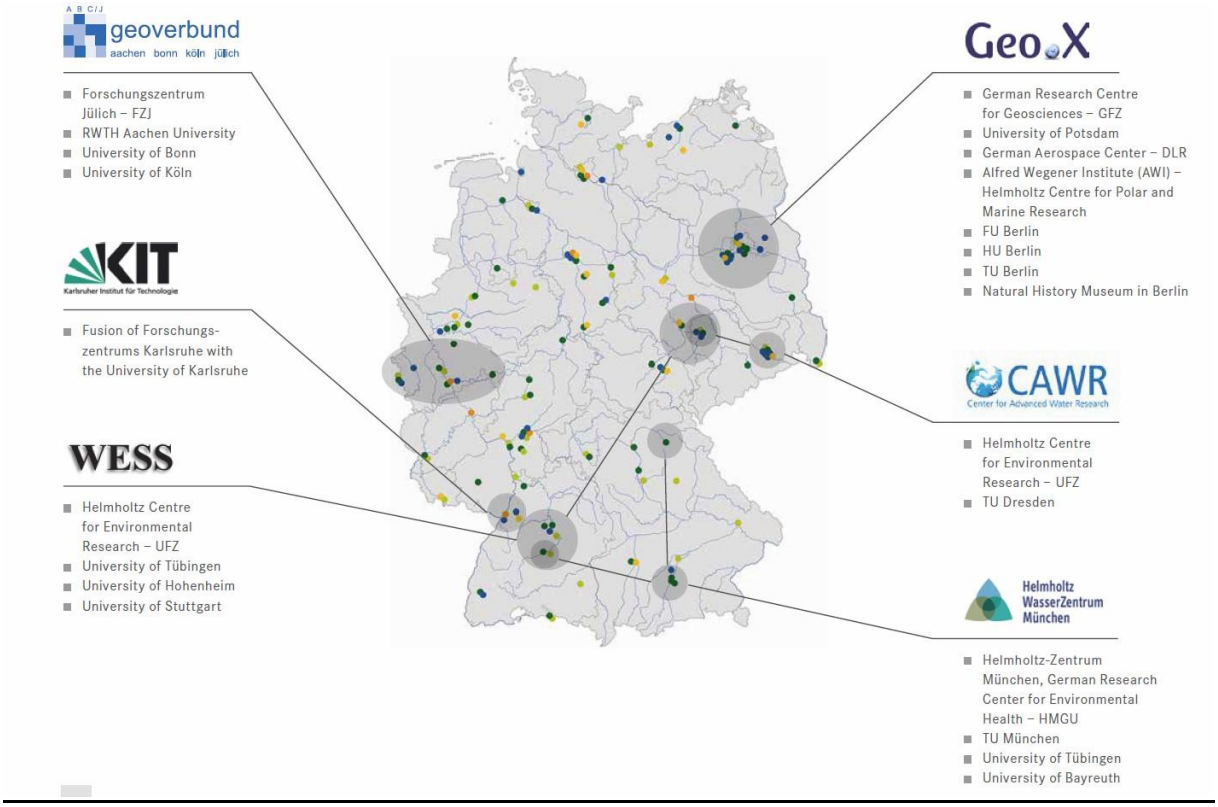


Figure 5.1: An overview of all publicly funded water research institutions in Germany

5.1.4 Networks

Within the region of Baden-Württemberg, the regional government stimulates cluster initiatives. The ministry of economic affairs and housing of Baden-Württemberg yearly presents the Cluster Atlas Baden-Württemberg. This atlas is an overview of cluster related networks and initiatives across Baden-Württemberg. For the Karlsruhe region (Mittlerer Oberrhein) several clusters are identified. These key industries are the automotive-, energy-, information and corporate software-, creative economy-, and the nanotechnology cluster. Many of these clusters work across state and national borders and are positioned towards the global market (Baden-Württemberg, 2019). In some other regions in Baden-Württemberg there are environmental technology clusters in operation: Heilbronn-Franken (waste and energy efficiency), Rhein-Neckar (mainly energy efficiency), südlicher Oberrhein (solar technology) and Lake Contance (environmental technology in general).

The water networks in Germany operate mainly on a national level, such as the SITW (Schutz & die Instandsetzung von Trinkwasserbehältern) and the VDDW (Verband der deutschen Wasser- und Wärmezähler Industrie). WTN partner TZW itself is part of the nationally operating DVGW (Deutsche Verein des Gas- und Wasserfaches). The German Water Partnership is a network supported by the federal government with the aim of strengthening the international competitive position of German players. The GWP is committed to stimulating innovation and business development by promoting cooperation between research, business and access to foreign markets and networks for German water companies.

However, there is no specific regional network for water technology that stimulates projects in the Triple Helix.

5.1.5 External partners

As mentioned above, the networks in Germany operate mainly on a national level, so that there is routinely a lot of contact with companies and institutes from outside the region. The universities in Baden-Württemberg participate in numerous international projects. TZW is a member of the German and European standards organisations DIN and CEN. TZW is also a member of the European Water Europe network. Parent organisation DVGW is a partner in the German Water Partnership. As already mentioned, the General Federal Ministries BMBF (Education and Research) and BMWi (Economy and Energy) are important players in the innovation field. For Water Test Network partner TZW, the universities in Hamburg and Duisburg-Essen are important external partners.

5.1.6 Education/learning lines

In Baden-Württemberg there are PhD, University and vocational education for water technology in place. At the Engler-Bunte-Institut, part of Karlsruhe Institute of Technology, education and training of students and experts is provided in relevant fields for water technology, according to the definition in this report.
There is no route for continuous learning for water technology in the region.

5.1.7 R&D infrastructure for the water sector

The universities in Karlsruhe, Stuttgart and Biberach have highly qualified laboratories for scientific research in the field of (water) technology. The fields on which the Engler-Bunte-Institut conducts research are especially relevant for water technology.
Apart from scientific research, innovative processes are tested and made ready for application together with water supply companies and swimming pool operators at the Department of Water Technology. At the DVGW Research Centre devices are tested, monitored and certified. This research centre underpins the application relevance of the research by the Engler-Bunte-Institut.

TZW, belonging to the DVGW, was in former times) part of the Engler Bunte Institut, and it performs applied research. The project WATERTRACE is presented in Annex A as an example of good practice of their innovation activities. TZW also offers its test facilities, mainly for drinking water, for use by the water sector and companies. The DVGW Water Technology Centre is the test site in the WTN-project. The regional authorities in Baden-Württemberg played no role in the development or (co)financing of this test site. Operational management is the responsibility of TZW.

There are no specific labs or test facilities at sites of launching costumers available in Baden-Württemberg for SMEs to test their applications on other types of water.

5.1.8 Specific policy programs

Water technology is not seen as a priority sector. Therefore, the regional government does not provide funding for water technology specifically but they do support innovation in environmental technologies.

Umwelttechnik BW is tasked with fostering environmental technology and resource efficiency in Baden-Württemberg. This organisation markets and advertises to local industries, thus making environmental technologies and resource efficiency from Baden-Württemberg more visible. The main target group are small and medium enterprises mainly in industry and construction. Umwelttechnik Baden-Württemberg is therefore operating as a business network but it is not specifically a business network for water technology.

The state-wide environmental technology network, Plattform Umwelttechnik, is a pool of companies, research institutions, organizations, and universities in Baden-Württemberg which promotes cooperation in the fields of research, development and production in the area of environmental and energy engineering and related services.

5.1.9 Innovation users

Public market: The standards for drinking and waste water are high in Germany. The main objectives of water protection are the good ecological and chemical status of running waters and lakes as well as the good chemical and quantitative status of groundwater. These objectives are laid down in the European Water Framework Directive (EU WFD). In Baden-Württemberg there do not seem to be any distinct problems in the field of water, which are a driving force for innovation. DVGW (TZW) deals with consulting, analysing and standardisation for the drinking water sector and does not promote specific water technologies.

Private market: Baden-Württemberg is an economically very strong region with a strong (manufacturing) industry. This provides good conditions for the sale of innovations in the water technology field as well as many potential partners for the construction of equipment.

5.1.10 Cluster organization for the water sector

There is no cluster organisation for water or water technology in Baden-Württemberg. Cluster-like organizations such as Plattform Umwelttechnik and Umwelttechnik BW are active in the field of environmental technology (see section 5.1.8 Specific policy programs).

5.1.11 Central Location/Hub

There is no central location or hub for water technology in Karlsruhe or Baden-Württemberg.

5.1.12 Overall impression

In Baden-Württemberg we cannot talk about a regional innovation system for water technology. Baden-Württemberg is an economically very strong region with an excellent innovation climate, but there is no focus on water technology. Knowledge about water technology is advanced. However, there are no programmes or facilities to develop this knowledge with companies into new products or services in the field of water technology and then market them. An organisation and laboratory such as TZW, which normally focuses on analysing and consulting in the field of drinking water and not on the development of new products, therefore could use support from other actors in the inflow and outflow of companies at their test site. Without this support it will be not easy to recruit many local SME-companies from Baden-Württemberg into their test site. Moreover, drinking water is only a sub-market in water technology, which also limits the number of potential companies.

5.2 CENTRE-VAL DE LOIRE, FRANCE

5.2.1 Government

National innovation policy

For water technology, the economic focus can be found in the French national cluster policy. Le Pôle de Compétitivité de la Filière de l'Eau (Competitiveness Cluster of the Water Sector certified by the State Cluster directory), by creating this national cluster, 3 existing structures will be joined work together under the name: France Water Team. This national cluster is a collaboration between Hydreos, Aqua Valley and DREAM cluster. The ambition of the Water Sector Competitiveness Cluster is to identify and develop solutions that meet the major water challenges of the future: resource resilience to climate change (including water re-use and controlled groundwater recharge) and management, infrastructure and ecosystem adaptation and responses and the fight against emerging pollution due to new analysis and treatment techniques (Pôle de Compétitivité de la Filière de l'Eau France Water Team, 2019). *Innovation policy Centre-Val De Loire*

Figure 5.2 The French National water cluster. A collaboration between 3 existing clusters.

The regional innovation strategy for Centre-Val de Loire identifies

regional strengths and areas of growth potential for economic development and employment in the region so that innovation actions and investments are better targeted. The region is focused on encouraging all types of innovation within companies by strengthening the territory's research and innovation capacities. Centre-Val de Loire is investing in human capital; to raise the skills and qualifications in the region. Also, the region is aiming to strengthen the financial capacity of SMEs. Investing in technology and innovation has a high level of risk. Therefore, Centre-Val de Loire is concentration on 5 themes and projects likely to have recognisable and quantified impacts on the regional territory (Centre-Val de Loire, 2013).

Centre-Val de Loire's main economic sectors for innovation	
1. Environmental engineering and metrology for activities heavily consuming natural resources	2. Biotechnology and health & cosmetics
3. Energy storage systems	4. Energy efficiency technologies
5. ICT services for heritage tourism	

Table 5.3 The main innovative sectors in Centre-Val de Loire. Water technology or the water sector is not specifically identified; however, there are links to the environment and biotechnology.

In addition to the Centre-Val de Loire region, there are a number of other public bodies that play an important role in the regional innovation eco-system.

DEV'UP is the regional agency for economic development in Centre-Val de Loire. DEV'UP manages the actual RIS3 strategy on behalf of the State and the region and is responsible for the design of the new RIS3.

DRRT (Délégation régionale à la recherche et à la technologie) is a State agency with a branch in Orléans. DRRT stimulates research and higher education in the Centre-Val de Loire region and supports partnerships between research and industry in the Centre-Val de Loire region (e.g. clusters). DRRT also finances industrial R&D in the Centre-Val de Loire region.

BPI France in Orléans helps stimulate Centre-Val de Loire business' growth by offering loans, providing guarantees and awarding buyer credit and supplier credit to encourage business abroad. BPI France invests in start-ups, SMEs and Mid-caps through direct investment and a fund for financing activity.

Agence de l'eau Loire-Bretagne is a water agency that provides financial and technical assistance for activities of common interest in the service of water and the environment.

Water policy

In France the Ministère de la Transition écologique et solidaire (Ministry of Ecological and Solidarity Transition) is responsible for water related issues. Most notably, they have the task to control the sanitation for wastewater and the treatment of sludge deriving from the wastewater. The French ministry describes sanitation and their treatments as follows: there are two main types of sanitation, collective sanitation (collection network and wastewater treatment plant) and non-collective (or individual or autonomous) sanitation. The choice between these two solutions is a matter for the municipality and depends the density of the habitat.

The ministry sets out the regulation for water quality and checks if all municipalities comply to the standards set out for France as a whole. However, the municipalities are free to decide how water is treated in their region (Ministère de la Transition écologique et solidaire , 2019).

At the national level, French water policy is also managed by the ministry of Ecology, Energy, Sustainable Development and the Sea. Where other institutions are responsible for wastewater treatment, this ministry is responsible for the management of water and aquatic environments. The ministry distinguishes qualitative issues such as water quality and quantitative issues such as extreme events like floods and drought. The aim of this policy is to restore water to good ecological quality for industrial, agricultural and public usage. The institutional organisation is divided among three main players; the state (ministry of Ecology, Water and Biodiversity Department), basin organisations who set out water policy, and local authorities who deliver water and sanitation services (Mignaux, 2011).

5.2.2 Universities

Centre-Val de Loire has two main universities (Orléans and Tours) who are affiliated with environmental technologies, but not specifically with water technologies. Furthermore Centre-Val de Loire houses branches of the national research institutes INRAE (National Research Institute for Agriculture, Food and Environment), CNRS (National Centre for Scientific Research) and the head office of BRGM (National Institute for Geological Research).

WTN-partner, BRGM, aims to meet key challenges for society; particularly climate change, energy transition and the development of the circular economy. One of the 6 major societal issues is groundwater management. BRGM's core topics in the area of water are: water resource management, preservation of hydro systems, mineral and thermal waters, new water resources, climate change impacts, pollution in aquifers and the socio-economics of groundwater.

5.2.3 Industry

No statistical data is available for the water technology sector for the Centre-Val de Loire. The membership of the cluster organisation DREAM is the only indicator we could find. The 100 members include 60 companies, 45 of which are SMEs and 15 are larger companies. Approximately 400 companies are affiliated to the national network, France Water Team, a cooperation of the water clusters DREAM, Hydrios and Aquavalley. The largest water companies in Centre-Val de Loire are offices of the multinationals Antea Group (mainly consulting activities, not only in water resources), Veolia and SUEZ EAU FRANCE.

5.2.4 Networks

In general the Triple Helix networks are well developed in Centre-Val de Loire. Chambre de commerce et d'industrie de Centre Val de Loire and the regional development agency DEV'UP are important players from the business side. DEV'UP manages the Network of business/economic developers in the Region (RDECVL). Within this network more than 380 members from economic development intermediaries and municipalities are in direct contact with regional companies. The CVL region has set up steering committees for each RIS3 priority with the aim to have regular joint meetings (2-3 per year) with all the stakeholders.

Water technology stakeholders are represented in the RIS3 priority dedicated to environmental metrology and engineering. Cluster organisation DREAM has been cultivating a strong network of partners in the Centre-Val de Loire region since its creation. In order to set up the best possible environment for networking and the development of innovative projects, DREAM has founded strong partnerships with other competitiveness clusters and regional clusters. In all regions, BRGM conducts activities to support policy development and expert studies as well as scientific research. Thanks to its comprehensive regional coverage, BRGM maintains close links with local and regional authorities, clusters, industries, universities and research establishments.

5.2.5 External partners

The national research institutes BRGM, INRAE and CNRS have their input through their branches in Centre-Val de Loire. BRGM teams are involved in projects in about 30 countries. Cluster organisation, DREAM, cooperates with environmental clusters in the regions Nouvelle Aquitaine, Ile-de-France and Brittany and the water clusters Hydrios and Aquavalley. In terms of European cooperation, DREAM is affiliated to Water EUROPE and

the European Enterprise Network (EEN). DREAM is also an associate member of Interreg Northwest Europe projects, Horizon 2020 and a partner in the INTERREG EUROPE project Bigdata4rivers. Together with the Centre-Val de Loire Region, DREAM is also part of the Water Smart Territories thematic platform.

Currently, the external partners are not identified in a systematic manner, but on a more ad hoc basis when the opportunity arises. The aim of involvement in EU projects is to detect commonalities and complementarities with other external partners in order to build long term partnerships.

5.2.6 Education/learning lines

There is no route for continuous learning for water technology in Centre-Val de Loire. The universities of Orléans and Tours have Bachelor's and Master's degrees in environmental technology. There aren't specific courses for water technology, although there are courses on larger topics such as:

- Sciences of earth and environment by the laboratory ISTO with Orléans University and OSUC
- BTSA management and control water by CFA of AFTEC in Orléans.

5.2.7 R&D infrastructure for the water sector

Figure 5.3 Test sites of the Pivots programme

The universities in Orléans and Tours have laboratories for their technical training, where environmental technological research can also be carried out. These are not dedicated water technology labs but are multiuse labs.

BRGM has a highly qualified laboratory in which research and tests can be carried out from TRL 1-9 on (ground) water, sediments, soil and rocks. To make this lab available for SMEs to test their applications is one of the key reasons why the PRIME platform, part of the PIVOTS project (see section 5.2.8) has been created. However, the management experiences extreme difficulties in convincing SMEs to conduct R&D with the tools and human resources available through PRIME.

There are no specific labs in Centre-Val de Loire that are available for SMEs to test their applications for other types of water.

In Centre-Val de Loire there are six PIVOTS test sites where innovative solutions can be tested for air, water and soil problems (see Figure 5.3). The test sites of the PRIME and DECAP platforms are located at the BRGM and the University of Orléans, respectively. They do not own/manage field sites but can easily gain (or provide) access to such facilities.

PRIME is the test site for the WTN-project. The Centre-Val de Loire region has played an active role in the development and financing of this site through the PIVOT programme and is also co-financer for the BRGM contribution to the WTN project. The operational management of the site is in the hands of BGRM.

5.2.8 Specific policy programs

Environmental engineering and metrology is one of the main innovative sectors in Centre-Val de Loire. Water technology is seen as a part of this spearhead sector, but there is no specific policy program for water technology. The research and interviews undertaken reveal a number of water technology projects, which are supported by the Centre-Val de Loire region:

- The Centre-Val de Loire Region is supporting the PIVOTS programme[6]. The regional council has created a funding call, ARD 2020 ("Ambition Recherche Développement"). The PIVOTS Programme has successfully applied to this call and has been awarded a regional grant of 10 million EUR from 2015 to 2020 and at least 4 million EUR out of FESI ERDF during the same period. The goal of the PIVOTS programme is to preserve natural resources (soils, subsoil, surface water, groundwater, air) at a time when they are under a double threat from both human activities and climate change (Plateformes PIVOTS, 2016). The aim is to integrate academic actors and companies to work together from basic research to the validation of products and services. This interaction between actors will support the emergence and development of an economic sector. Two of these platforms are dealing with water treatment. DECAP is a multiuse platform dedicated to the design of sensors for the environment and the development of processes for the removal of pollutants. The platform has the means to design and demonstrate new sensors suitable for different aqueous media. DECAP also focuses on the removal of pollutants from water by means of plasma processes or by electrochemical and ozonation processes incorporating carbonaceous materials.

Figure 5.4 Platforms of the Pivots programme to tackle environmental issues.

The other platform, PRIME, is taking part in the Interreg Water Test Network. This platform is managed by BRGM (partner of WTN). It offers groundwater circulation simulation to test new technologies e.g. sensors and passive samplers. There are also possibilities for development, tests, implementation or validation of other methods and equipment at TRL-levels 4 to 8. This PIVOTS programme is included as an example of best practice in Annex A.

[6] https://plateformes-pivots.eu/?lang=en.

The PIVOT- programme as a whole is a collaboration between the government of Centre-Val de Loire, BRGM, DREAM cluster and other relevant companies and research institutes.

- DREAM, the cluster organization for the water sector, gets financial support from Metropole Tours, Metropole Orléans and region Centre Val de Loire.

- Region Centre Val de Loire profiles itself as a water technology region under the co-leadership of the S3 thematic platform Water Smart Territories, a cooperation of 20 regions and clusters from all over Europe.

5.2.9 Innovation users

Public market: The Centre-Val de Loire region supports the PIVOTS programme, in which innovations are developed for, among other things, protecting the quality of groundwater and surface water. The WTN-project has a connection with this programme. Agence de l'eau Loire-Bretagne stimulates the use of innovations for the recovery and preservation of the quality of water and aquatic environments in the Loire-Brittany basin. These are positive indicators for the uptake of water technology innovations on the public market.

Private market: The signs for the private market are not bad either. Some of the priority sectors like *Biotechnology and health & cosmetics* identified by Centre-Val de Loire in the RIS strategy may be buyers of innovations in the field of water technology. In addition, large water companies such as Veolia and SUEZ EAU FRANCE keep a close eye on innovations and buy-out innovative smaller companies if necessary.

5.2.10 Cluster organization for water sector

DREAM is the cluster organisation for the water technology sector in the Region Centre -Val de Loire and also operates in the Pays de Loire and Brittany. It brings together key players in the fields of research and training, as well as economic stakeholders. DREAM helps companies to develop tailor-made, sustainable solutions, both technical and socio-economic. The cluster supports growth and competitiveness of its SMEs through innovation, a focus on research and technology transfer. Moreover, DREAM offers its members access to regional, national and international networks and support to reach targeted markets. At an international level DREAM operates in cooperation with the clusters Hydreos and Aquavalley under the name of France Water Team.

5.2.11 Central Location/Hub

There is not really a central location or hub for water technology in Centre-Val de Loire. However, the cluster organization DREAM, the research institute BGRM and the University of Orléans are located close to each other in Orléans, and DEV'UP is also based in Orléans. This close proximity has a positive influence on the cooperation between these organisations.

5.2.12 Overall impression

A regional innovation system for water technology is to a large extent present in Centre -Val de Loire. Various actors, such as the regional government, development company DEV'UP, BRGM and the cluster organisation DREAM, are in close proximity to each other and work well together. The cluster organisation facilitates companies in innovation projects and (international) profiling. The innovation system could be further strengthened with a specific learning direction. Research facilities for SMEs and more market-driven research both in a broader field than groundwater, the main field of BGRM activities in the water sector, would also be a valuable addition. The market potential is important to allow more companies to participate in research programmes, such as the PIVOTS program and its various platforms/test centres (PRIME, DECAP, O-ZNS, PESAt and PESAa) linked with the water sector.

5.3 FLANDERS, BELGIUM

5.3.1 Government

Both the quality and the availability of fresh water are under increasing pressure in Flanders. In Flanders, every inhabitant has around 1700 cubic meters of water, which is very little compared to other countries. Only three other countries in the Organisation for Economic Cooperation and Development (OECD) score worse: Italy, Korea and the Czech Republic (OECD, 2017). In this research Flanders is seen as the national and the regional government for legislation in water (technology). This is because of the non-hierarchical political system in Belgium, where legislation is divided between the federal government, regions (Gewesten) and communities (Gemeenschappen). However, it is unclear who is in charge for which subject since more governmental bodies are involved in the same themes. The water sector, an already fragmentated market, is therefore influenced by several agencies (Belgium.be, 2019).

Innovation policy of Flanders

The regional innovation strategy for the provinces of Flanders is created as a joint strategy for all Flemish provinces. With this, the Flemish government sets out the smart specialisation strategy to transform Flanders for a better allocation of investments for innovation. As the writers have previously reported, Flanders has several advantages but also disadvantages in the way it is set up. Firstly, their central geographical location in Europe offers scope for R&D and service-based activities for the global value chain. This location offers more opportunities to attract added value into the innovation system. Innovation is needed to transform the industry and to modernise education and training, to address the increasing pressure on maintaining a competive position, and the resulting acceleration of de-industrialisation (in electronics, automotive and several other branches). To tackle these issues Flanders have taken a targeted approach. A SWOT-analyses identified 10 themes that should be prioritised for further innovation investments.

Flanders main economic sectors for innovation	
1. Smart systems	2. Sustainable Chemistry
3. Specialised manufacturing	4. Sustainable living
5. Responsible entrepreneurship	6. Value-added logistics
7. Personalised cure and care	8. Agro-food
9. Industrial design and creative industries	10. Smart services

Table 5.4 The most important economic sectors in Flanders, water technology is not taken into account however the top 3 water consuming sectors are present.

The water sector or water technology is not mentioned in these themes. However, the manufacturing-, chemistry- and agro-food sectors are all dependent on water. For Flanders, water technology can therefore be regarded as an enabling sector.

Flanders is investing heavily in R&D&I (Flemish Reform Programme 2019). There are programmes for digitisation (artificial intelligence, cyber security), clusters (including budget for project financing), living labs, Industry 4.0, portfolios of strategic research centres and venture capital (Flanders Future Techfund).

Innovation policy of the province West-Flanders

The province of West-Flanders has set out their economic strategy in the 'West Deal'. In this paper, most consideration goes to entrepreneurship and SMEs; where West-Flanders should invest in sustainability, social economy and human capital. The development agency of West-Flanders (POM West-Flanders) has the responsibility to fulfil these tasks and therefore must focus on innovation, entrepreneurship, logistics and the labour market (Provincie West-Vlaanderen, 2013).

However, this strategy is very common, and most projects could be placed in one of the subjects above. Therefore, this way of working is a more general overview of how the province fosters the regional economy by

bringing several parties together. Policy interventions are not described in depth. The water sector or water technology is never specifically mentioned but it could be placed within several of the themes.

Water policy

The government of Flanders does understand that water is an important subject. In their Integral Water Policy they note that recent water scarcity and droughts have shown that fresh water resources in Flanders are scarce. Therefore, Flanders is investing in water purification. In their report, they state that a functional water management system is the basis for public health and the economy. Not only the government, but also industries should reuse water (CIW, 2017). These statements also feature in the Flemish Reform Programme of 2019 where the government commits to invest 260 million euros in wastewater treatment infrastructure. The largest water consumers are companies in the food, chemical, petrol and energy sectors (Flemish Government, 2019). The following intentions were recently formulated in the Flemish Coalition Agreement 2019 (Vlaamse regering 2019-2024: regeerakkoord, 2019): Flanders stimulates the use of rainwater and the reuse of waste water and, where necessary, eliminates barriers that make this use more difficult. Flanders stimulates therefore the recovery of raw materials and renewable energy from wastewater.

5.3.2 Universities

At the universities in Ghent, Leuven, Brussels and Antwerp and institute VITO/Vlakwa there are specific departments and professors with excellent knowledge in the field of water technology. There is no inter-university coherent multidisciplinary agenda for water challenges, but each university has its specific expertise. For the university of Ghent these are: wastewater modelling, biological treatment, physic-chemical treatment. At Campus Kortrijk, the Laboratory for industrial water and ecotechnology (LIWET) is situated, here research is conducted in the fields of industrial water treatment, algal technology and constructed wetlands. The university of Ghent is a participant of Wetsus, the European centre of excellence for sustainable water technology. The university of Leuven specializes in membranes, climate modelling and nanomaterials; the university of Antwerp specializes in ecosystems and ecotoxicity; and the university of Brussels specializes in groundwater modelling.

5.3.3 Industry

The determinant industry is difficult to identify due to a lack of recent statistical data. A study by Ghent University estimates that in 2004 about 350 Flemish companies were active in water technology. Nowadays the cluster organisation Watercircle.be has 75 member companies from Flanders. Most of these are SMEs. According to Director Mertens of WaterCircle.be, it is an innovative and growing sector. De Watergroep, participant in the WTN project, is probably the largest player. Innovation is an important factor in their business strategy, as evidenced by the more than 50, mainly international, innovation projects in which De Watergroep participates and the dedicated innovation department that was formed in 2019. Their innovation project DODC2C's is described in Annex A.

5.3.4 Networks.

Vlakwa operates according to the triple helix principles. They have governments, universities, water utilities and horizontal networks as partners. Vlakwa does not only focus on water technology but it's one of the core themes. In the water sector, there is a horizontal network for drinking water (Aquaflanders). Aquafin is the Flanders Waste Water Utility. Watercircle.be represents the water technology providers. The spearhead sectors in Flanders do have partnerships in the Triple Helix. The governments encourage expansion to quadruple helix networks. In West Flanders TUA-WEST brings together the strengths of the knowledge institutions in West Flanders. As an external agency of the Province of West Flanders, TUA West acts as a liaison between partners from various industries and civil society.

5.3.5 External partners.

All respondents to our interviews/surveys work together with many partners from outside the region. Flanders is their reference point rather than West Flanders. Ghent University, De Watergroep and Vlakwa/VITO participate in various Interreg and Horizon 2020 projects. De Watergroep is affiliated with KWR, the research institute of the Dutch drinking water companies. Vlakwa is member of Water Europe.

5.3.6 Education/learning lines

There is no route for continuous learning for water technology in Flanders. However, there are PhD projects at universities and companies, and a Masters in water technology. At the Flemish universities, there are components of 'water technology' in various graduate disciplines, but there is no coherent training except for the Advanced Masters in Water sustainability from Antwerp University. The objective of this Masters is to educate specialists in water technology and nature-based solutions with thorough understanding of integrated water management.

5.3.7 R&D infrastructure for the water sector

Flemish universities have high-quality laboratories for the priority areas. These can also be used for research in the field of water technology (not a priority subject). At Campus Kortrijk of the Ghent University, the Laboratory for industrial water and ecotechnology (LIWET) () is situated. The VEG-i-TEC test site of Ghent University for the food sector has become an important pillar for the water technology sector. With funds from the ERDF projects *Proeftuin Voeding en Water*, and *Construction of a research building* and the Interreg FWVl project *Pilot infrastructure* a mini food factory with modular pilot lines and an associated water treatment room has been set up to test innovative technologies. Within the framework of the Water Test Network project VEG-i-TEC has been equipped with extra water sources such as groundwater, surface water and rainwater. The VEG-i-TEC project is described in more detail in Annex A.

De Watergroep uses almost all available technologies for the extraction and treatment of drinking and industrial water. As a result, there are many test facilities at their installations. However, these are not open test sites. The use of the test sites must fit in with the company policy of De Watergroep.

The Flemish government has therefore played an active role in the development and financing of the VEG-i-TEC test site and is also co-financer of the WTN project. The operational management of the WTN test site is the responsibility of Ghent University and De Watergroep.

There are no lab facilities (like the Water Application Centre in Leeuwarden) available where SMEs can test their innovations for a trial period.

5.3.8 Specific policy programs

An important conclusion from the above, is that there is no specific policy for water technology in Flanders. Respondents also confirmed this during the interviews. West Flanders has, to a limited extent, a specific policy for water technology. The province supports the knowledge institute Vlakwa for demand-driven, innovative solutions for sustainable use and re-use of water, which contribute to the greening of the economy and socio-economic development. The province also gave a start-up subsidy to TNAV, the predecessor of the cluster organisation watercircle.be. Vlakwa is now part of VITO and works for the whole of Flanders. Both the province of Antwerp and West Flanders subsidize a 'open call' for water technology demonstration from Vlakwa.

The Flemish cluster policy distinguishes two types of clusters: the spearhead clusters and the innovative business networks (IBNs). The spearhead clusters correspond to important strategic domains for Flanders and are large-scale initiatives that receive funding for ten years to expand their operations. The IBNs are typically smaller initiatives that often originate bottom-up from companies that want to deploy in a specific domain that offers them opportunities to increase their competitiveness.

5.3.9 Innovation users

Public market: The government of Flanders note in their Integral Water Policy that recent water scarcity and droughts have shown that freshwater resources in Flanders are scarce. Therefore, Flanders is investing in water purification, reuse of waste water, the recovery of raw materials and renewable energy from wastewater. Innovation is an important element in the strategy of De Watergroep and they are interested in a broad range of technologies.

Private market: The conditions for the uptake of water technology innovations are very good in Flanders. The largest water consumers are companies in the food, chemical, petrol and energy sectors. Water is a relatively scarce resource. Therefore, efficient water use and water reuse are stimulated. Cluster organization, Flanders FOOD, supports water technology projects that benefit the food sector.

The WTN project includes test sites in Flanders for both the public and private markets.

5.3.10 Cluster organization for water sector

Watercircle.be is a cluster organisation for water technology. They have approx. 100 members including 75 companies. However, the organisation is very small (only 1 permanent fte) and they have not (and will not have) financial support of the government.

Vlakwa - Vlaams Kenniscentrum Water - unites and interlinks water stakeholders from government, industry and research. Vlakwa was established in 2010 as the result of an ERDF project. It initially received support from the Ministries of Economies and Innovation as well as from the province of West-Flanders. Vlakwa is an independent department within VITO (Flemish Institute for Technological Research) since 2016. Vlakwa is partially financed by the Flemish government (Ministry of Economy, Science and Innovation), the provinces Antwerp and West-Flanders and by means of projects.

5.3.11 Central Location/Hub

There is no physical location (hub) for water technology in Flanders. There is a certain concentration of organisations in Kortrijk. However, recent mergers (Vlakwa becomes part of VITO; mergers of regional drinking water companies into a large company like De Watergroep) reduce the chance of Kortrijk becoming a physical centre. Although, the new VEG-i-TEC test site in Kortrijk, , could be a first step towards a centralised hub.

5.3.12 Overall impression

In Flanders, many aspects are present for a regional innovation system for water technology. Moreover, of all WTN regions, Flanders has the best regional market to implement innovations due to water scarcity. However, there is no policy focus on the water technology sector in Flanders, resulting in a lack of coherence. A Flemish Water Hub, as an additional spearhead sector could make a major contribution in three areas: solutions to the shortage of water, innovations in sectors that consume a lot of water and strong growth of the water technology sector. Further development of cooperation between the water sector and the agri-food sector would be a good starting point. With the presence of Vlakwa, VEG-i-TEC and LIWET, Kortrijk is a potential physical innovation centre.

5.4 PROVINCE OF FRIESLAND, THE NETHERLANDS

The Netherlands have a lot of affiliation with water. A large part of their history has taken place on or near the water. On the one hand, water is seen as a blessing. Due to rivers and oceans the Dutch can travel globally which is where the Dutch maritime sector founds it origin. Through increased global trade the whole economy had a boost. It was due to water that the Dutch national economy found its prosperity. On the other hand, water is one of the biggest challenges for the Netherlands. As seen in Figure 5.5, 26% percent of the land surface is beneath NAP[7] (sea-level), more than half of the country, and almost the whole province of Friesland is vulnerable to water flooding.

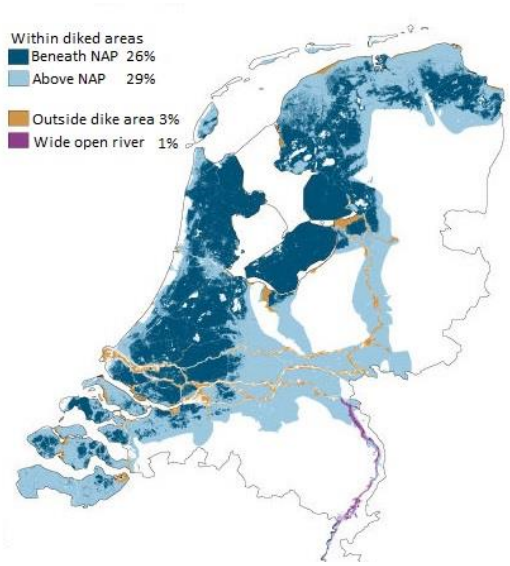


Figure 5.5: flood-sensitive areas in the Netherlands (Pieterse, Knoop, Nabielek, Pols, & Tennekes, 2009)

5.4.1 Government

National innovation Policy

The above overview of the Netherlands explains why delta technology is predominantly present in the Netherlands. Furthermore, the Dutch government recognises future water issues due to changing economy, industries and land use. Therefore, the water sector is one of the nine so called 'top sectors' of the Netherlands. The top sectors policy is a Dutch business policy to stimulate the knowledge-based economy. The nine sectors are areas in

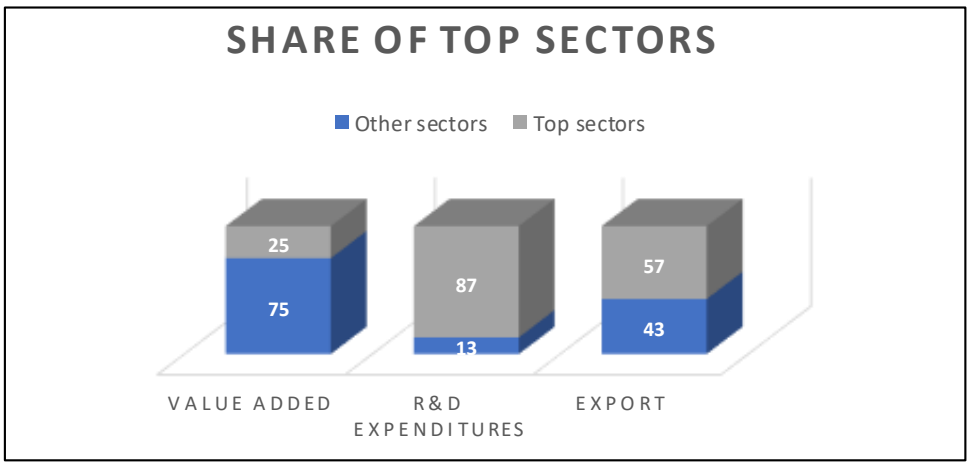


Figure 5.6 The top sectors in the Netherlands do have significant more influence than other sectors within the national economy. Measured after the crisis in 2012 (van der Wiel, 2016)

which Dutch industry and research centres worldwide excel. (Ministerie van Economische Zaken, 2017).

[7] Normaal Amsterdams Peil or Amsterdam Ordnance Datum, used as vertical datum in Europe which led to the European Vertical Reference System (EVRS).

These sectors are of economic importance in the aftermath of the economic crisis. As seen in Figure 5.6, top sectors do provide more exports and have a large amount of R&D expenditures.

The national government has established the top sector water policy. The water sector of the Netherlands is divided into 3 sectors: delta technology (1), maritime technology (2) and water technology (3). The water technology sector is responsible for the production of drinking and industrial water of the highest quality, while keeping the pressure on the living environment as low as possible. The sector also specialises in the purification and reuse of wastewater.

To establish goals and to support innovation, every sector has got its own Top Consortia for Knowledge and Innovation (TKI). In the TKIs, entrepreneurs and scientists from the nine top sectors work together to find ways to bring innovative products and services to the market. These TKIs stimulate public-private partnership projects, for example, by supplementing private R&D funding contribution from a company to a research organisation.

In addition, there is the Mkb-innovatiestimulering Regio en Topsectoren (MIT). MIT consists of different instruments where SMEs are supported to contact knowledge institutions, apply for network activities and collaborate in R&D cooperation projects (Rijksdienst voor Ondernemend Nederland, 2016). The goal is to double the added value and export by 2020 by working on several international challenges in the field of water safety, water scarcity, cleaner transport and energy scarcity. However, these policies are not explicitly for SMEs in the water technology sector. All companies within the 9 top sectors who match the prerequisites are able to apply for these instruments.

Innovation policy in the Northern Netherlands

The innovation policy is formulated in the Research and Innovation Strategy for Smart Specialization (RIS3) of the three northern provinces of the Netherlands: Friesland, Groningen and Drenthe as a Northern Netherlands Alliance (SNN). The main goals are both to contribute to the competitive strength of the Northern Netherlands as well as to solve major societal challenges.

In this RIS3-report at NUTS1-level, the key themes of the northern economy are clustered. SNN mapped the region's well-developed industries and industrial niches that demonstrate potential for further growth. The Northern Netherlands have their main focus on seven industry sectors which are highly active in the region (SNN, 2013).

Northern Netherlands main economic sectors	
1. Agri-food	2. Healthy Ageing
3. Energy	4. Water Technology
5. Sensor Systems	6. Chemistry
7. Tourism & Recreation	

Table 5.5 The main focus sectors in the North of the Netherlands. Water technology is concentrated in the province of Friesland.

The Northern Netherlands distinguished these seven sectors based upon three different criteria. The first criterion SNN examined was evidence based. Utilising the life cycle approach[8], combined with statistical evidence and qualitative information obtained from interviews and desk research. The second criterion was policy based and utilised the already existing initiatives within the industry sectors. The final criterion concerned the innovation potential of the industry sectors under

[8] implies that everyone in the whole chain of a product's life cycle, from cradle to grave, has a responsibility and a role to play, taking into account all the relevant impacts on the economy.

investigation, meaning the contribution the sectors or clusters could provide in order to tackle the major societal challenges.

Water technology is actively considered under the innovation strategy of the SNN since the sector has experienced strong growth over the last 10 years. Furthermore, the industry is deeply rooted in the province of Friesland. The sector is early in its life cycle, in terms of activity and potential, and has a very sizeable R&D investment and financial contributions to the Water Campus located in Leeuwarden, the capital of Friesland.

The RIS strategy has been further applied in the Northern Innovation Agenda (Taskforce RIS3 Noord-Nederland, 2015). An important trend reversal compared to the previous period is that there are no longer any instruments available to stimulate innovation in the lower TRLs. This is an important disadvantage for the innovation ecosystem around the Water Campus, which is based on the entire innovation cycle from idea to export.

History of water technology policy in Friesland
Before we describe the current regional innovation system for water technology in Friesland, we need to explain its development in more detail. This smart specialisation *avant la lettre* is a process that has been going on for more than 20 years. From the outset, there has been cooperation in the Triple Helix and synergy with regional, national and various European funds.

The choice to include water technology as a smart specialisation was made by the Province of Friesland on the basis of economic arguments, not because of major water problems in the region.

In the 1990s the Province of Friesland concluded in an economic analysis that knowledge and innovation would become important drivers for long-term regional economic development. In a region without a university, a connection was sought with the natural assets of the region, in which a lot of knowledge has been present since time immemorial: water.

The water authorities have a lot of knowledge because of the centuries of struggle for dry feet and good agricultural land. Dutch drinking water is among the best in the world. Companies are good at industrial water purification because the Netherlands was the first country in the world to introduce a pollution tax on dissolving industrial waste water. This created a new market in Friesland for the suppliers (machines and stainless steel tanks) of the strongly represented agro-industry. By purifying the waste water, the levy of the tax could be avoided. The higher and intermediate vocational schools in the region developed into knowledge institutes by training staff in the field of water technology.

Various market studies in the 1990s showed that the international market for drinking water, waste water and industrial water was very large and would continue to grow strongly. The Netherlands had and has a very strong knowledge position in these areas, but not a particularly large market share, with the exception of a few niches. Growth in the international market can be achieved by strengthening in four areas: combining the excellent but very fragmented knowledge present in the Netherlands, strengthening international relationships, entering foreign markets at an early stage and delivering reference projects. This process stagnated in practice at the national level due to an excessive number of players with conflicting interests.

The Province of Friesland therefore took the initiative in 2000 to be the first to apply these recommendations at the regional level. The most important companies, knowledge institutions, utilities and government bodies united in the Frisian Water Alliance. The main objective of this cooperation was: to strengthen the Frisian water (technology) sector through a cluster approach with

programme-oriented market development, knowledge development and the delivery of innovative pilot and reference projects. The most important project is the establishment in 2003 of the knowledge institute, Wetsus, in Leeuwarden with the financial help of ERDF, regional co-financing and funds provided by four companies. Wetsus combines the top expertise of the universities of Twente, Wageningen and Delft in the field of water treatment technology.

Attention to water is also reflected in the national government's innovation policy. In 2004, this policy was shaped around 'key areas,' in which water was one of them. In 2006, the Ministry of Economic Affairs identified the developments around Wetsus in Leeuwarden as an economic peak, the further development of which is important for the Dutch economy. Since 2007, Wetsus has been the national Top Technological Institute for Water Technology with national funding up to the end of 2013.

The three northern provinces have extended the national 'peak policy', the so-called Koers Noord policy (2007-2013) (Ministerie van Economische Zaken en het Samenwerkingsverband Noord-Nederland, 2007), which focuses on the transition to a knowledge economy. It is extended to focus on stimulating innovation and increasing the knowledge content of the economy. It concerns, among other things, the strengthening of the knowledge economy chain and the increase of spin-offs from knowledge institutions. The policy is aimed at strengthening five top sectors in particular: energy, sensor, healthy aging, agribusiness and water technology. This policy is supported by ERDF, national and regional funds.

The policy for water technology is not only aimed at creating a good innovation climate by stimulating innovation among SMEs, but also at strengthening the national and international position of the water technology sector with the aim of positioning the Netherlands as an European Water Technology hub with Water Campus Leeuwarden at its physical core. An eco-innovation system has been built with the aim of accelerating the innovation cycle from idea to export and/or the route from knowledge to revenue and export. This eco-innovation system includes top research, laboratories, a complete apprenticeship in water technology (from MBO to PhD), test sites for scaling up technology, showcase projects, business accommodation on the water campus, facilities for venture capital and the support of innovation projects, export and the development of entrepreneurship. Most elements will be discussed in more detail later in the description of the regional innovation system.

5.4.2 Universities

Wetsus, Centre of Excellence for sustainable water technology, ensures an exceptionally high level of knowledge in Friesland. The multidisciplinary collaboration between 109 companies and 22 universities and research institutes from all over Europe within Wetsus results in innovations that contribute significantly to the solution of global water problems. Wetsus' scientific research program is defined by the private and public water sector and is conducted by leading universities.

There are two universities of applied science in Leeuwarden (Van Hall Larenstein and NHL Stenden). They have a joint professorship in water technology: a knowledge centre that offers high-quality research opportunities and expertise within their education programmes.

In order to increase the number of science students and to promote cooperation between business and education, the Ministry of Education has assigned the national centres for applied research and innovative craftsmanship in the field of water technology both to Leeuwarden. These are CEW (Centre of Expertise Water Technology) and CIV Water (Centre for Innovative Craftsmanship Water Technology).

5.4.3 Industry

In Friesland there is no standard statistical data available on the size of the water technology sector. Specific research (BBO, 2018) (WaterCampus Monitor 2018) shows that in Friesland approximately 110 companies are active in the water technology sector with a turnover of approximately 470 million euros and approximately 2,300 employees. In Friesland, private water technology companies account for about 4% of total turnover in the industrial and specialist business services sectors. The water technology sector is strongly knowledge-based and has a high innovation and R&D content. It is a growing and international oriented sector (75% of the companies). The public companies for drinking water supply and wastewater treatment (Vitens and Wetterskip Fryslân) are the largest. The largest private company is Paques (biological water treatment), which also has branches in North and South America and Asia.

5.4.4 Networks

Cooperation in the Triple Helix has been at the basis of the development of water technology in Friesland. Wetsus, CEW, CIV Water and WAC are all organisations in which there is intensive cooperation between the business community and education and research. The board of the Water Alliance cluster organisation consists of representatives of government, research and businesses. The challenge is to scale up the collaboration to quadruple helix. The first quadruple project proposals have already been submitted to the EU.

5.4.5 External partners.

Involving external parties is an essential part of Leeuwarden Water Campus. The members of Water Alliance come from all over the Netherlands. The participants of Wetsus originate from all over the world. The total network of Water Campus Leeuwarden comprises 258 companies and 26 knowledge institutions. The stakeholders on the Water Campus participate in 128 international cooperation projects including Horizon 2020, Interreg and Erasmus plus projects. Together with the province of Friesland, Water Campus Leeuwarden is co-lead partner of the “Water Smart Territories” thematic platform. Water Alliance has a partnership with clusters from Europe, North America and Asia.

5.4.6 Education/learning lines

In Friesland, a specific route to continuous learning has been developed for water technology. This starts at primary schools (64) and then secondary schools (23) by offering projects to stimulate interest in the social impact of, and a career in, water technology. For vocational education, higher education and university education, specific courses with good future opportunities are offered. At Wetsus, students can do doctoral research. In addition, there are also various business courses for employees in water technology. In Friesland, lifelong learning in water technology is therefore possible.

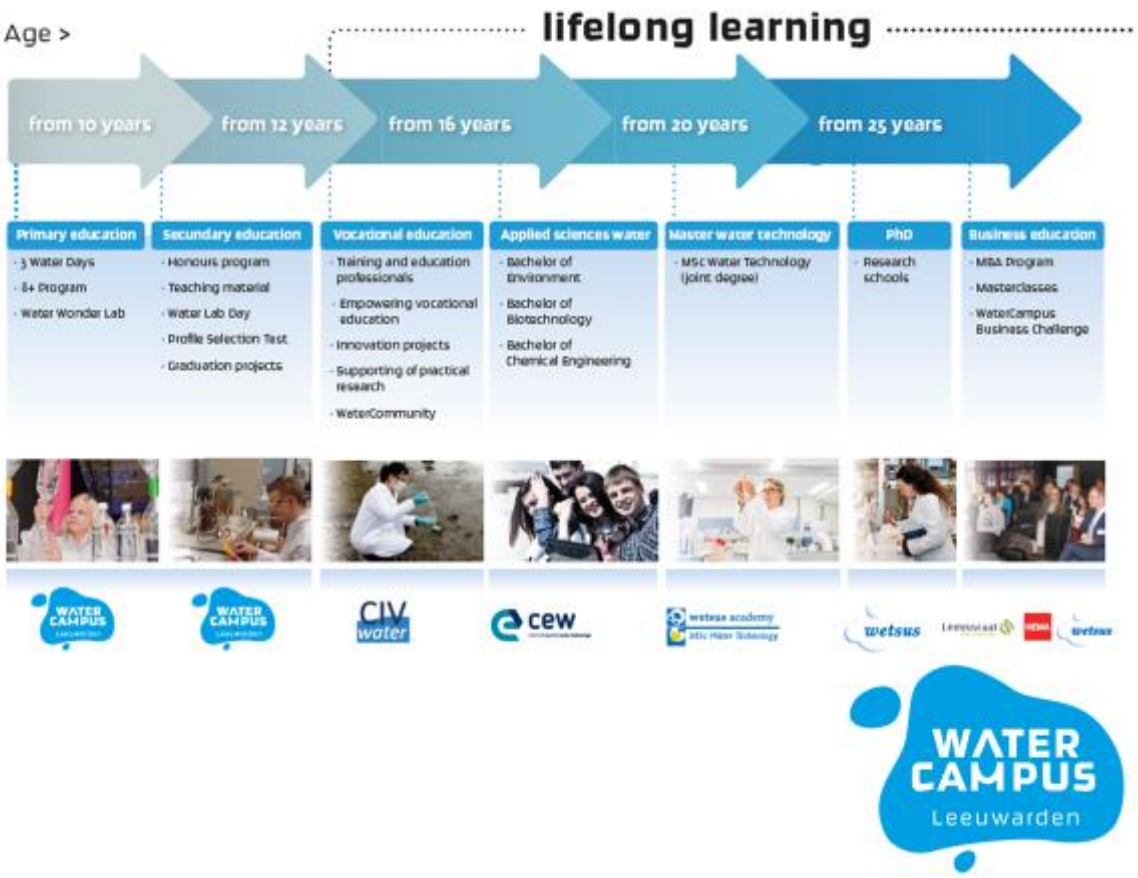


Figure 5.7 Lifelong learning lines for water technology in Friesland

5.4.7 R&D infrastructure for the water sector

The R&D infrastructure for water technology in Friesland is of an exceptionally high level. The laboratory of Wetsus has been specially built for water technology research with input from some 50 specific disciplines. Wetsus also has a budget for the purchase of highly specialised equipment.

The Water Application Centre (WAC) is a fully equipped centre in which companies, knowledge institutes and other organisations can carry out experiments in the field of water technology. SMEs can rent floor space for as long as they need it and have use of all the equipment. Students from Hall Larenstein University of Applied Sciences can assist the companies. The WAC is located on the Water Campus in Leeuwarden.

In the Northern Netherlands there are six demo sites for water technology: domestic wastewater, drinking water, salt water, hospital water, livestock water and a sensor test centre. The demo sites are all hosted by end users, allowing technology suppliers to test their innovations in real life conditions and show them to potential customers. They are plug & play demo sites with connections for different types of water, energy and internet as well as permits already in place. These test sites are used in the WTN project. The regional authorities played a major role in the development and (co)financing of these test sites in the period 2007-2014. The municipality of South-West Friesland is the owner of the test site for hospital water. The operational and marketing tasks associated with this are considered difficult by the municipality. The operational management of the other sites is in the hands of water companies and dedicated foundations. For the WTN project itself, no co-financing from the regional authorities has been made available.

In addition, various demonstration projects - pilot projects - have been set up in the northern Netherlands, such as DESAH and WaterSchoon in Sneek (decentralized water purification and reuse) and a Blue Energy (sustainable energy based on the potential difference between salt and fresh water) on the Afsluitdijk.

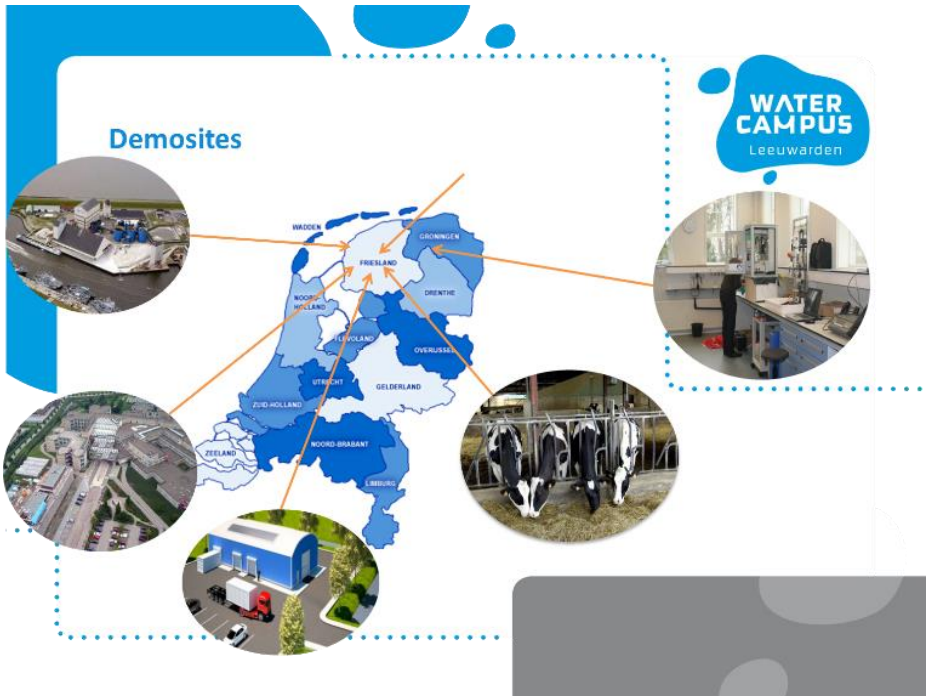


Figure 5.8 Test sites for six different water types in Friesland

5.5.8 Specific policy programs

For the period 2013-2020, the Northern Netherlands has a large fund at its disposal to improve its physical and knowledge infrastructure. This REP (Spatial Economic Package) finances two major programmes for the Frisian economic spearhead water technology. The first programme is Wetsus' R&D programme 2013-2020, for which a government contribution of 50% (4.5 million EUR per year) has been reserved.

The second programme is the Water Technology Implementation Framework (2013-2020). In this framework, 13 million EUR is available for the further expansion of the water technology sector in Friesland according to four lines of action:

Action Line 1. Technology: Research and Infrastructure

- European excellence in water technology research.
- Maintaining and/or expanding excellent research infrastructure.

Action Line 2. Talent: Education

- Maintaining, further developing and strengthening the continuous learning route in water technology in Leeuwarden.
- Developing, retaining, using and attracting talent.

Action line 3. Tolerance: Room for experiments, starters, projects and companies.

- Encourage and support techno-starters and innovative SMEs in the field of water technology.
- Delivery of demonstration projects, crossovers and large-scale exemplar projects/icon projects.
- Establishment of companies and institutions.

Action line 4. Transnational cooperation

- Developing commercial business cases abroad.
- Development of and participation in European projects.

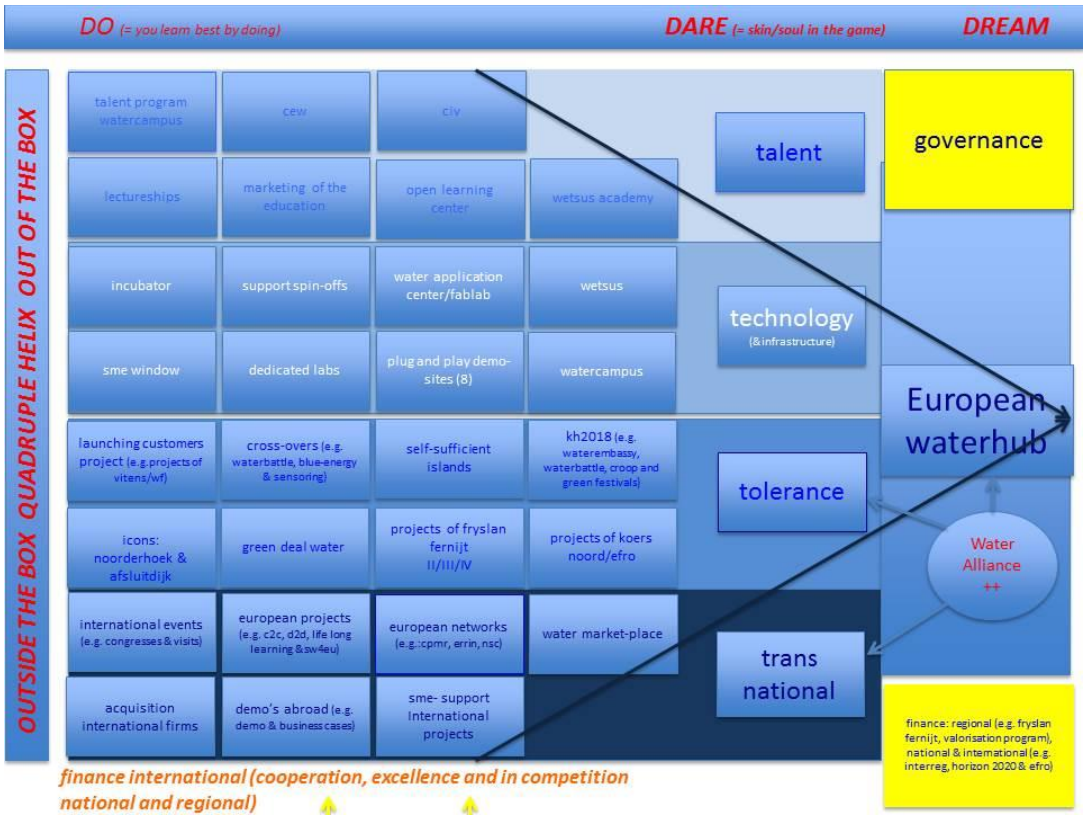


Figure 5.9: Implementation framework for water technology: coherence between objectives, action lines and possible projects

One of the larger projects being carried out within this framework is the Master Plan Water Campus Leeuwarden. This project is described in more detail in Annex A.

5.4.9 Innovation users

There are no specific problems with water scarcity or water quality in Friesland. The industry in the region does not have any major problems in the area of water either. As a result, there are few incentives for innovation from the regional public and private markets.

Among the participants in Wetsus' scientific research and CEW's clients for applied research are various companies that want to use the innovations that arise from it. These include not only water companies and water authorities, but also companies in the chemical, construction, dairy, mineral extraction and energy sectors. Cluster organisation, Water Alliance, regularly brings together suppliers and users of innovative technology. In this way, the innovation users are connected via the network of Water Campus Leeuwarden, but they do not have a specific regional focus.

5.4.10 Cluster organization for water sector

The *Friese Wateralliantie* started in the year 2000 as an informal cooperation of governments, (educational) institutes and companies in the field of water technology. It was the predecessor of the Water Alliance, that was founded in 2009 as the cluster organization for water technology companies in the Northern Netherlands. Today, the Water Alliance is the cluster and network organization for the whole of the Netherlands and is located at the Water Campus in Leeuwarden. Water Alliance has 115 members and is financially supported by local and regional governments in the Northern Netherlands.

5.4.11 Central Location/Hub

Water Campus Leeuwarden is not only the umbrella organisation under which various stakeholders work together, but also the physical location where they are located. Water Campus Leeuwarden was developed on a site adjacent to the Van Hall Larenstein University of Applied Sciences, which also houses the Water Application Centre. In the former Johannes de Doper church, a business centre for water companies was established, which also houses the cluster organisation Water Alliance . A little further on is the new building of Wetsus, with laboratory and offices. This also houses the Centre of Expertise for Water Technology (CEW) and the Centre for Innovative Expertise in Water Technology (CIV Water). Both centres have been financed with national funds and are located in Leeuwarden because of the concentration of activities in the water technology field.

5.4.12 Overall impression

The most complete regional innovation system for water technology in the WTN regions can be found in Friesland. Almost all determinants are present at a high level. Based on this and the six test sites present, we might expect that many companies in Friesland will carry out tests in the WTN project. Since the year 2000, the innovation eco-system has been built up with the support of companies and the regional authorities (and in latter years also the central government and the EU) and anchored in regional policy. It has now developed into a physical hub with national and international participation. One point for improvement is integration with the demand side, the water users. This includes citizens, public water companies as well as industrial water users.

5.5 PROVINCE OF GELDERLAND, THE NETHERLANDS

5.5.1 Government

National innovation Policy

The province of Gelderland, located in the east of the Netherlands has the same opportunities as the province of Friesland concerning national policies. All SMEs within Gelderland can apply for the 'top sector policy' which consists of a Public Private Partnership programme (PPP) and an MIT-arrangement. All water technology related SMEs are able to refer to these policy instruments which should help the level of innovation within the sector. Since the policy on a national level is equivalent to the province of Friesland the national policy will not be re-explained here. However, the province of Gelderland does have its differences. Gelderland is located in the east of the Netherlands and has therefore another RIS3 strategy with other economic focuses.

Innovation policy Eastern Netherlands

The Eastern Netherlands consists of two provinces, Gelderland and Overijssel. The regional governments of the two regions have written a regional innovation strategy based on a joint policy framework of the two regions. As seen in the Northern Netherlands (SNN), the eastern part of the country has its own managing authority (OPOost). A strong triple helix model between universities, government and companies is an important element in the strategy. The east of the Netherlands is the location of various large knowledge institutions. Technology, Health and Agro & Food, the focus of these knowledge institutions corresponds with the focus of the business community (OPOost, 2013).

Based on a SWOT-analysis[9] and the regional economic policy agendas, the Eastern Netherlands opts for smart specialisation in the following four sectors and their crossovers:

[9] planning technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning.

Eastern Netherlands main economic sectors	
1. Agro & Food	2. High Tech Systems and Materials (HTSM)
3. Health	4. Energy and environmental technology / bio-based economy

Table 5.6 The most important sectors of the Eastern Netherlands; water technology is not specifically featured but is embedded within the HTSM sector.

The region has chosen these four sectors as its priorities. Added value is created by the presence of regionally strong companies and industries, which have the potential to make use of the available knowledge from the priority sectors. The available innovation infrastructure that has been developed within the priority sectors can largely support this and thus accelerate development. The choices made by the East Netherlands are in line with the objectives set by the European Commission in its Europe2020 policy to contribute to smart, sustainable and inclusive growth. Furthermore, the four Eastern Netherlands sectors are in line with the priority sector policy of the Ministry of Economic Affairs in the Netherlands.

Within the regional innovation strategy of the Eastern Netherlands there is not explicit reference to water technology as a sector. In their report water technology is embedded within the High Tech Systems and Materials (HTSM) sector. The following technology fields of the HTSM sector are important for the East Netherlands:

Eastern Netherlands HTSM Technology fields	
1. Micro- and nanotechnology	2. Sensor technology
3. (Bio)medical technology	4. ICT Mechatronics/robotics
5. Materials science / Plastics	6. Bio-organic hybrid materials
7. Water technology	

Table 5.7 Water technology is one of the technology fields within the HTSM sector in Eastern Netherlands

The HTSM sector and therefore water technology is supported by the eastern region. SMEs have the opportunity to make use of subsidies and different network activities for the Eastern Netherlands region. Moreover, start-ups and other innovative companies can apply for an investment from the Participation Fund Oost NL, up to 5 million EUR. This makes Oost NL a shareholder in the company (Oost-NL, 2019).

5.5.2 Universities

Wageningen University & Research's fundamental research is carried out by the chair groups. The university consists of a faculty that is divided into five departments. The department of Agro Technology and Food Sciences and the department of Environmental Sciences have a clear link with water (technology). The university has close connections with, and is one of the founding scientific partners of, Wetsus.

5.5.3 Industry

There is no standard statistical data or special studies available for Gelderland in the field of water technology. By combining a number of public files and the database built up by the WTN partner, Water Authority Vallei & Veluwe, the only figure we can get is an estimation of the number of companies active in water technology in Gelderland. In the public sector, Gelderland has one drinking water company and three Water Authorities. In the private sector there are at least 40 companies in

Gelderland, about half of which are affiliated to one or more national clusters or parent organisations. Some of the larger companies are important suppliers of water treatment equipment to the food industry, particularly dairy products and meat processing.

5.5.4 Networks.

There is no specific triple-helix or quadruple helix in Gelderland for water technology. Cooperation in the Triple Helix is an important focus in Gelderland, but the focus is on the four aforementioned economic spearheads: HTSM, Health, Agro & Food and Energy and environmental technology / bio-based economy. The KIEMT network and the Cleantech Region are two networks in which Triple Helix collaborates on energy transition and circular economy. Water technology is of course part of the circular economy but does not play a prominent role in either network. As a result, potential users of the test site in Apeldoorn are for the most part from the network of the Water Authority Vallei & Veluwe or referrals from WTN partners in other countries.

WTN partner, Vallei & Veluwe, participates in two horizontal networks: the Union of Water Authorities and STOWA, the research organisation of the Water Authorities. Vallei & Veluwe is also a member of the Dutch network organization: Netherlands Water Partnership (NWP).

5.5.5 External partners.

In addition to the national networks mentioned above, Vallei & Veluwe collaborates in the field of innovation with KWR (research institute owned by drinking water companies), TU Delft and a number of large worldwide engineering firms. Furthermore, Vallei & Veluwe is lead partner of the Interreg NWE project WOW ! (resource recovery) project, in which 12 partners from 6 countries participate.

Consistent with their research priorities on water(technology), the universities in Wageningen and Nijmegen participate in international projects (H2020, Interreg etc.).

Circular, innovative and international are the key words in the economic policy of the province of Gelderland (Provincie Gelderland, 2016). The province stimulates and facilitates the participation of companies from Gelderland in European programmes through its participation in the Vanguard Network (network of industrial regions) and the Manunet fund. This is a generic policy and not specific to water technology.

5.5.6 Education/learning lines

The continuous lifelong learning route for water technology in the Netherlands is located in Friesland. Wageningen University & Research offers a joint Masters programme on water technology with the University of Twente and University of Groningen. Students study in Leeuwarden at Wetsus, the European centre of excellence for sustainable water technology. In addition, there are also Masters programmes at Wageningen University with an important water technology component, such as: biotechnology, and food and water management. The Radboud University in Nijmegen has no specific water technology programme but offers Masters in Water and Environment and Cities, and Water and Climate change. The universities of applied science in Gelderland do not have specific water technology programmes. However, Van Hall Larenstein in Velp and the HAN in Arnhem/Nijmegen do offer water management training.

5.5.7 R&D infrastructure for the water sector

Wageningen University has laboratories where water technology research can be carried out for the sustainable water management research programme and where its intersects with the food and drink sector. There are no laboratories available where SMEs can do their water technology research. In Gelderland there is one test site for companies to test and show their innovative equipment at the

waste water treatment plant of Water Authority Vallei & Veluwe in Apeldoorn. The provincial and municipal authorities in Gelderland played no role in the development or (co)financing of this test site. Operational management is the responsibility of Water Authority Vallei & Veluwe. Recently this WTN test site has been used as an example of good practice in an inspirational book for circular economics in the Netherlands (HaskoningDHV, 2020).

5.5.8 Specific policy programs

The economic policy paper of the province of Gelderland from 2016 is generic, i.e. no priority sectors are identified (Provincie Gelderland, 2016). The document contains three key words: circular, innovative and international. The focus of economic policy in Gelderland is primarily on further developing the potential of the driving sectors. The province focuses specifically on SMEs in these sectors. This is a broadening of the target group from the previous period: the (Gelderland) top sectors. So, in Gelderland there is no specific policy for stimulating the water technology sector. The importance that Gelderland attaches to the development of the circular economy is, however, a positive factor as a lot of water technology innovations have circular aspects.

5.5.9 Innovation users

Public market: There are no major water quality problems in the region that function as a direct driver for innovations. However, WTN-partner, Water Authority Vallei en Veluwe has an interest in innovative developments. Apart from their WTN-test site in Apeldoorn, they run test installations in Ede (extraction of cellulose), Wilp (extraction of all possible raw materials and process them into usable raw materials) and in Harderwijk (central manure fermentation).

Private market: As an enabling technology, water technology is important as it crosses into important sectors for Gelderland. This includes the cross-over between Agrifood and Cleantech & Renewable Energy and the cross-over between Life Science/Health and Cleantech & Renewable Energy (Ontwikkelingsmaatschappij Oost Nederland, 2015). These sectors can therefore be important buyers of innovations from water technology companies.
WTN-sub partner Cleantech Region can be the link into innovation users.

5.5.10 Cluster organization for water sector

In Gelderland there is not a cluster organisation in place for the water sector. Among the 110 members of the cluster organization, Water Alliance, in Friesland; 13 companies are based in Gelderland. The KIEMT network and the Cleantech Region are two networks in which Triple Helix collaborates on energy transition and circular economy (see section Networks).

5.5.11 Central Location/Hub

There is no physical location (hub) for water technology in Gelderland, nor any clear geographical concentration of organisations.

5.5.12 Overall impression

In Gelderland a lot of attention is paid to circular economy, but water technology is not a focal point within this. A regional innovation system for water technology is therefore not really present. Nor would it be logical and feasible in a small country like the Netherlands to organize complete innovation systems for a small sector like water technology in two regions. Partly for this reason, Wageningen University and various companies from Gelderland are participating in the innovation system in Friesland. One area of improvement could be for the Water Authority Vallei & Veluwe to use support from a water technology network to recruit companies for projects to its test site.

5.6 SCOTLAND, UNITED KINGDOM

For the examination of the regional innovation system for water technology in Scotland we must define which region we are talking about. In terms of administrative areas, Scotland can be seen as an exception. It is a nation of people living in an internal division of the United Kingdom of Great Britain. Yet, Scotland does have its own government, legal system, health service, education system and interior affairs department. Therefore, this study recognises the policy from the Scottish Government as a national policy. Additionally, the Scottish regions involved in WTN do collaborate for their RIS3 strategy and the policy on water technology (Scotland The Hydro Nation) on this same (Scottish national) level. For the purposes of this study we look at Scotland as the region.

5.6.1 Government

For this section we examined two policy interventions: the national economic strategy and the Scotland Can Do RIS3 strategy.

Economic strategy Scotland

The economic strategy builds on the vision and framework set out in Scotland Can Do, which is co-created with public, private and third sector partners, to make Scotland a world-leading entrepreneurial and innovative nation (The Scottish Government, 2015). In their strategy, which is based on 4 pillars, the government sets out their vision.

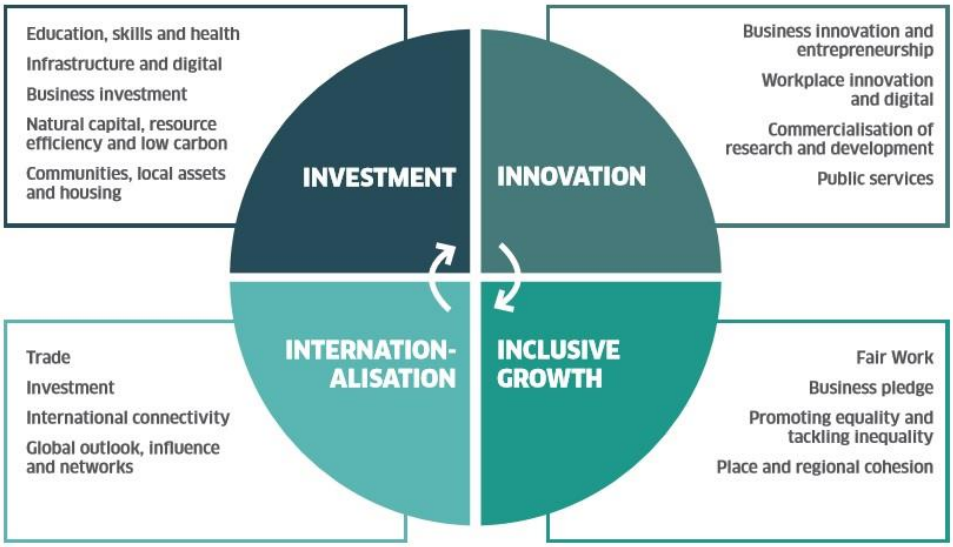


Figure 5.10 The Scottish economic strategy divided into 4 pillars (The Scottish Government, 2015).

Investment needs to stimulate sustainable growth in people, infrastructure and other assets. Similarly, innovation is seen as important. The Scottish economy must be open to new ideas and doing things differently. The whole of Scotland needs to benefit. Inclusive growth needs to be about the whole of society creating opportunity through a fair and inclusive jobs market and regional cohesion to provide economic opportunities across all of Scotland. Furthermore, internationalisation is seen as relevant. Scotland must have an open outlook on new ideas, be open for trade and collaboration and migration (Figure 5.10). This strategy is comprehensive since all economic aspects are divided into these 4 pillars. Although, at the same time it does lack some depth.

RIS3 strategy Scotland Can Do

The implementation of the economic strategy is embodied in the Scotland Can Do report, which can be seen as the regional innovation strategy of Scotland. In this report, another perspective is being used; where innovation is seen as the key to development. According to their RIS-strategy the Scottish economy has 8 main economic sectors for innovation:

Scotland's main economic sectors	
1. Food & beverages	2. Tourism
3. Energy	4. Life Science
5. Universities	6. Creative Industries
7. Marine Energy	8. Financial & Business service

Table 5.8 The most innovative sectors of Scotland. Marine Energy is present, but water technology is not featured in their regional innovation strategy.

Their innovation strategy is more of an overview on how innovative businesses and start-ups from key sectors could scale up their investments in R&D. With a comprehensive action plan where public and private parties from all kinds of sectors are working together. The Scottish Government focuses on 4 issues to help the Scottish economy to foster innovation:

Firstly, the Scottish Government wants to directly encourage more business innovation by increasing the number of companies and to scale up existing high growth potential start-ups through a collaborative scale-up programme. Where more companies are receiving innovation support due to streamlining partnerships across all relevant agencies.
Secondly, the Scottish Government's Procurement Team should act as a catalyst for business innovation, by using the public sector needs to stimulate innovation. To do so, the government wants to start a public challenge fund. This will allow the public to bring their own innovative ideas to solve issues with help from this fund.
Thirdly, enhance innovation across sectors and places all over Scotland through investments in manufacturing, product design and supply chains to create high-value and highly skilled jobs.
Fourthly, make best use of university knowledge and talent to drive growth. To increase the conversion of academic research and knowledge into business.
With these steps the Scottish Government tries to foster innovation and inclusive growth all over Scotland. These measures are not sector specific but more of a wide-ranging plan to tackle issues identified in the Scottish economic strategy (Scotland Can Do, 2017).

Water in Scotland

The landscape of Scotland has many lochs and lochans, making Scotland one of the world's most fresh water containing areas. Many individuals, companies and communities rely on groundwater for drinking water, agriculture and industry. Groundwater also feeds wetlands and river flows during dry spells and is vital to the maintenance of Scotland's rich ecology and biodiversity (Scotland's environment, 2016). Furthermore, water is essential for the economy as well. Water is used by industry (e.g., distilling whisky and supporting fisheries), for producing energy (hydropower), and for recreational activities such as bird-watching, angling and water sports.

5.6.2 Universities

There are several universities and institutes in Scotland with expertise in water technology including: Glasgow, Edinburgh, Strathclyde, Heriot Watt, Dundee and the James Hutton Institute.

http://www.crew.ac.uk/Scotland's Centre of Expertise for Water (CREW) has been established and services the public sector. It is managed by WTN partner, James Hutton Institute, and is drawing upon its Scotland-wide network of experts from water policy, industry and academia. Two kinds of activities are carried out:
a) quick research/desk research
b) longer term research

The Institute also manages the Hydro Nation Scholars Programme; a PhD program with highly qualified international PhD-students.
The programme is financed by the Scottish Government and the content is steered by a group of public bodies (economic and environmental regulators, Scottish Water) and universities.

5.6.3 Industry

Scottish Enterprise examined the market size of the water sector in Scotland in 2019 (Scottish Enterprise, 2019). The water sector in Scotland encompasses 412 companies, provides 16,600 direct jobs and has a turnover of £3.7 billion. The water sector is growing more rapidly than the overall Scottish industry. However, these figures are not comparable with research in other countries because of differences in definition of the water sector.

The study makes clear that Scottish Water is the dominant player in the sector with roughly 50% of the turnover and 40% of the jobs. The water utilities are also the most important client of the water sector companies (over 40% of the sales). 15 % of the companies also report sales to the oil and gas and/or beverage sector. These are mostly domestic sales because the overall export outside the UK is only 7%.

5.6.4 Networks

The Hydro Nation Forum is a specific network for all aspects of the water sector including water technology. It has been established as a high-level group of water experts from industry, academia and public sector who advise Scottish Ministers on the overall direction and focus of the Hydro Nation agenda. Chaired by the Cabinet Secretary for Environment, Climate Change and Land Reform, the Forum provides guidance and tracks progress of the strategy at biannual meetings.

The Forum continually reviews the overarching Hydro Nation strategy on the four key and interlinking themes of National, Innovation, International, and Knowledge to ensure that the Hydro Nation programme is fit for purpose and is working to support the sector's needs. A significant review of the strategy will be completed by the end of 2020.

5.6.5 External partners

The Hydro Nation strategy outlines the intent to grasp the potential of Scotland's knowledge and innovation in a global context. Hydro Nation Research International (HNRI) was established to coordinate and harness a range of international water-related activities across Scottish public bodies, universities and non-Governmental organisations that contribute not only to the Hydro Nation agenda but also to the United Nation's Sustainable Development Goals. Hydro Nation International Services (HNIS) is, or has recently been active, in India, Malawi, Cyprus and Romania.

Scottish Water, James Hutton Institute and Scottish Enterprise have a lot of different external partners. Besides the cooperation in the Water Test Network they operate in several European projects as well. Scottish Water is a platform member of Wetsus, the European Centre of excellence for sustainable water technology. The Scottish Government Hydro Nation is a member of the "Water Smart Territories" thematic platform.

5.6.6 Education/learning lines

There is no route to continuous learning for water technology in Scotland. Most learning routes are focused on higher education. At several universities water(technology) subjects are in their programme but there is not yet a specific learning route for water technology. However, the Hydro Nation agenda facilitates the Hydro Nations scholars programme: a PhD programme with high qualified international PhD-students and supports the UNESCO Category 2 Centre for Water Law, Policy and Science at the University of Dundee. Within the Erasmus +-project PoVE a study route on water technology is under development at a vocational level (Glasgow Clyde College) (Pilot Platform of Vocational Excellence Water, 2020).

5.6.7 R&D infrastructure for the water sector

The James Hutton Institute and several universities have qualified labs for high TRL research.

In its Aberdeen based laboratories, James Hutton Limited offers testing and verification of technologies for the chemical and microbiological treatment of water and water resource management. Scottish Water Horizons runs two facilities for testing innovative water technologies that are part of the WTN-project. The Waste Water Development Centre at Bo'ness is a testing site at a working waste water plant. The Water Development Centre is a test site at a former drinking water station in Gorthleck. The Scottish Government has invested £2.1 million in these Development Centres which has been matched by Scottish Water in staff and assets. There is no EU funding involved. The Scottish government has played a very active role in the development and financing of the Scottish Water test sites through the Hydro Nation programme. For the WTN project itself, no co-financing from the Scottish Government has been made available.

The operational management of the WTN test sites is in the hands of Scottish Water Horizons and the James Hutton Institute. Scottish Enterprise is an associated partner of the Water Test Network.

There are no dedicated lab facilities available for SMEs to test their innovative water technology products and equipment though labs are available at the Scottish Water Development Centres and a central register of all facilities can be used to identify other suitable locations if needed.

5.6.8 Specific policy programme for water technology

In spite of not being mentioned as one of the main economic sectors, Scotland has been stimulating the water (technology) sector since 2012, when the Hydro Nation agenda came into operation. This policy is based on the Water Resources Act (2013) which puts the duty on Scottish Ministers '*to take such reasonable steps as they consider appropriate for the purpose of ensuring the development of the value of Scotland's water resources.*' It aims not only to develop sustainable and responsible water policies, especially with climate change in mind, but also to develop the value of the water sector and the water resources.

A restructuring of the Scottish water sector offered new possibilities. Three water operators (North Water, West Water and South-Eastern Water) were successfully merged into Scottish Water. Scottish Water delivered excellent achievements and standards in the fields of water supply and water treatment. The ambition of the ruling First Minister was to use this business as an engine for economic growth. Politically it is attractive to add positive economic effects to a policy field in which problems with flooding, droughts and water pollution can appear on the political agenda.

We can consider the Hydro Nation agenda as the specific Scottish policy on water technology (see also Annex A for more on this agenda). The Scottish Government plays a very direct role as initiator and financer of the Hydro Nation agenda. Moreover, the Hydro Nation organisation is run by officials of the Scottish Government and the Cabinet Secretary is chair of the high-level Hydro Nation Forum.

Because the Scottish Government is owner of Scottish Water it can influence the policy of this most dominant player in the Scottish water sector. The drawback of this governmental drive is maybe the focus on the public water market and less attention to industrial water. That said, the Hydro Nation Water Innovation Service (see below) was specifically established to support private sector SMEs in the water sector.

The Hydro Nation agenda consists of several policy instruments. Some of these are mentioned under the other determinants.

Research
Scotland's Centre of Expertise for Waters (CREW) (see universities)

Innovation services
Hydro Nation Water Innovation Services (HNWIS) provides support and opportunities for innovative businesses in Scotland to create and grow sustainable solutions for the global water and wastewater sector. Established by the Scottish Government through Scottish Enterprise and Highlands and Islands Enterprise, HNWIS works with innovative Scottish companies, specifically SMEs, and supports them along the innovation path to commercialisation. The support for the companies consists of (free) advices from specialized consultants given at three stages:
A) Initial analyses about product readiness of their innovation
B) Technical advice to prepare testing
C) Technical support during testing.

Apart from managing HNWIS, Scottish Enterprise (SE) gives special attention to the water sector. SE has appointed a dedicated specialist to promote economic opportunities relating to the water sector and water technology in particular.

Test sites
Scottish Water Horizons runs two facilities for testing innovative water technologies (see R&D infrastructure)

International programme
Scotland is maximizing the value of their water resources by sharing knowledge and collaborating with other countries to grow the international water economy. This includes:

- helping the domestic water sector to identify and respond to international opportunities
- raising international awareness of Scotland's capacity and reputation for academic and research excellence
- exporting Scotland's expertise in water governance and management
- delivering projects with partners in key international territories (Malawi and India) to address water challenges, contribute to policy development and identify opportunities.

5.6.9 Innovation users

The Scottish domestic market offers good opportunities for uptake of water technology innovations.

Public market: Scotland is one of the world's most fresh water containing areas. There are no water quality problems, but there is the obligation to preserve the quality for drinking water, agriculture, industry and ecology (Scottish Enterprise, 2019). Additionally, it is government policy to develop the value of the water sector and the water resources. Through the Hydro Nation agenda the government stimulates Scottish Water, the largest player in the Scottish water market to have a

positive attitude to innovations. Acting as lead partner of WTN, owning and managing the two WTN-test sites and the number of companies that already make use of the Scottish Water test sites underline this positive attitude towards innovation.

Private market: Important economic sectors, such as food and beverage and energy (oil, gas, hydro power) are large water users. Scottish Enterprise's market research also identifies these sectors as market outlets for the water technology sector. However, this private market receives little or no attention in the Hydro Nation agenda and there are no representatives of these sectors in the Hydro Nation Forum. This seems to be an opportunity for Scotland to further strengthen its water technology sector.

5.6.10 Cluster organization for the water sector

There is not a real cluster organisation in place. However, the Hydro Nation agenda is run by officials of the Scottish Government and has a High-Level Steering Group in which stakeholders are represented. In Friesland a similar situation was the predecessor of the cluster organization, Water Alliance.

5.6.11 Central location/Hub

There is not yet a central location for water technology. The elements of the innovation cycle are not physically concentrated. In and around Edinburgh are the Hydro Nation Department of the Government and the Waste Water Development Centre (test site). The Water Development Centre is in the Highlands. The lab of the James Hutton Institute and the Centre of Expertise for Waters (CREW) are located in Aberdeen. The James Hutton institute reports that the Hydro Nation International Centre is under construction and will also be based in Aberdeen. This centre could be a start of a hub, but as an initiative of the James Hutton Institute currently receives no direct financial support from the Hydro Nation agenda.

5.6.12 Overall impression

In Scotland, the regional innovation system is largely in place. The Scottish Government is inspired by the innovation system built up in Friesland and acts as the driving force with its Hydro Nation agenda. Scottish Water is also a powerful driver with a lot of practical knowledge from which innovative SMEs can benefit. Expansion into the industrial water market (food & beverages, oil & gas) could significantly increase the impact of the policy programme on the Scottish water technology sector. The Hydro Nation Agenda could be further strengthened with a continuous learning route, lab facilities for SMEs and a cluster organisation implemented under the Hydro Nation Forum.

5.7 COMPARISON OF REGIONAL INNOVATION SYSTEMS

Now that we have gathered as much information as possible about the determinants of the various regional innovation systems for water technology, the challenge is now to compare the WTN regions. Due to the lack of directly comparable data, this is actually an impossible mission, but we shall still make an attempt.

For each determinant, we have drawn up a working definition that matches the information that we have been able to collect. We then linked a classification system to it based on a five-point scale. Because the available information was very diverse, each determinant has a specific five-point scale. This makes it possible to classify the WTN regions for each determinant and makes it clear on what grounds this was done. The underlying reasoing for the score per region can be found in the sections on each of the regions in this chapter.

The five-point scales are open to discussion. A disadvantage of specific scales is that the scores of the determinants are not comparable. So this is not a scientifically refutable method, but it provides a picture of the regional innovation systems for water technology.

The purpose of this exercise is to provide stakeholders, in particular regional authorities, with some guidance if they want to improve the innovation system for water technology in their region. For each determinant, they can see what steps they could take to reach a higher level.

Determinant	Operational definition	Rating	Legend
Social economical and geographical factors (1)	Position in the EU Regional Competitive Index (RCI)	*****	Top-50
		****	Position 51-100
		***	Position 101-150
		**	Position 151-200
		*	Position 201-268
Social economical and geographical factors (2)	Category EU Regional Innovation Scoreboard (RIS)	*****	Category Leader
		****	Category Strong +
		***	Category Strong –
		**	Category Moderate
		*	Category Modest
Specific policy programs	Degree to which there is a specific policy programme for water technology in the region	*****	Explicit water technology policy programme (complete)
		****	Explicit water technology policy programme (under construction)
		***	Elements / building stones for water technology programme
		**	Potential for water technology programme
		*	No water technology programme
Government	The importance that the government attaches to water (technology) in its innovation policy (RIS3).	*****	Water (technology) is mentioned as a spearhead sector
		****	Water (technology) is listed as a sub-sector
		***	Circular economy or environmental technology is mentioned as a spearhead sector
		**	Spearhead sectors for which water technology is an important enabling technology
		*	Generic RIS or no relationships of water technology with spearhead sectors
Universities	Degree of scientific specialisation in water technology	*****	Full range scientific water technology institute
		****	Scientific expertise centre water technology or water technology institute
		***	Technology institute with water technology research (limited areas)
		**	University departments with clear link to water technology
		*	No water technology on academic level
Industry	Relative size of the water technology sector in the region	***	Several water technology companies and organisations based in the region For the determinant industry, only the rating *** is included, as no comparison between regions is possible due to lack of data.
Networks	Degree of specialisation (water technology) of regional (triple helix) networks	*****	Regional Triple Helix Network water technology
		****	Regional Triple Helix Network environmental technology or circular economy
		***	Regional Triple Helix Network other spearhead sectors
		**	Only one-dimensional networks
		*	No networks
External partners	Degree of connection with water technology partners from outside the region	*****	Clear strategy and involved in specific (international) networks for water technology
		****	Involved in specific (international) networks for water technology
		***	National networks mainly; WTN-partners also international (very) active.
		**	Connections with national partners; no or few international connections
		*	No or few connections with partners from outside the region
Learning lines	Degree to which a continuous learning line water technology is available in the region	*****	Continuous learning line for water technology in place
		****	3 or 4 levels study tracks water technology
		***	PhD's and university study tracks for water technology
		**	Study tracks in programs of related subjects (environmental tech, water management)
		*	No study tracks or education for water technology or related subjects
R&D infrastructure	Extent to which R&D infrastructure facilities (dedicated labs, labs for sme's, test sites) are available in the region	*****	Full range (3 out of 3) of research infrastructure facilities
		****	2 out of 3 research infrastructure facilities
		***	1 out of 3 research infrastructure facilities
		**	Not used
		*	No research infrastructure facilities
Innovation users	Extent to which potential innovation users (launching customers) are present in the region (and in the WTN project)	*****	Innovation users on public **and** private market in the region (and both in WTN- project)
		****	Innovation users on public **and** private market in the region (one of them in WTN-project)
		***	Innovation users on public or private market in the region
		**	Connections from the region to innovation users
		*	No clear innovation users in the region or network
Cluster organisation	Degree to which a mature cluster organisation for water technology is present in the region	*****	Cluster organization for water technology with company members and regional funding
		****	Cluster organization for water technology with company members
		***	Stakeholder organization for water technology with company representatives
		**	Cluster-like organisation for environmental technology/circular economy
		*	No cluster organization
Central location or hub	Extent to which a central location or hub for water technology is located in the region.	*****	Designated hub with clear concentration of stakeholders and facilities
		****	Hub or central location under construction
		***	Certain concentration of stakeholders or facilities (potential hub)
		**	Minor concentration of stakeholders or facilities
		*	No central location or concentration of stakeholders or facilities

Table 5.9 Operational definitions and legend for the determinants of regional innovation systems for water technology

In Table 5.10 the ratings of the WTN-regions on all determinants are displayed. At the top we have highlighted the two determinants for the overall geographical, economic and social strength of the region (EU Regional Competitive Index and Regional innovation Scoreboard). For comparison, we have put the determinant 'specific policy programs' underneath. In our view, the 'specific policy programs' is the most dominant of the determinants for the regional innovation system for water technology. A specific policy brings coherence between a number of determinants and is the overarching structure for specific financial instruments.

	Baden-Württemberg	Centre-Val-de Loire	Flanders	Friesland	Gelderland	Scotland
Determinants						
Overall economy						
EU Regional Competitive Index	*****	***	****	****	*****	****
Regional Innovation Scoreboard	*****	***	****	**	****	****
Water technology						
Specific policy programs	*	***	**	*****	*	****
Government	***	****	**	*****	****	*
Universities	****	***	***	*****	**	****
Industry	***	***	***	***	***	***
Networks	****	*****	*****	*****	****	*****
External partners	***	****	***	*****	***	****
Education / Learning lines	****	**	***	*****	**	****
R&D infrastructure	****	****	****	*****	****	****
Innovation users	***	****	*****	**	****	****
Cluster organisation	**	*****	****	*****	**	***
Central location or hub	*	***	***	*****	*	***

Table 5.10 Ratings of the determinants of regional innovation systems for water technology

The table shows that the stronger the overall economy of a region is, the less specific water technology policy it has. With the exception of Scotland, this applies to all WTN regions. The strongest regions Baden-Württemberg and Gelderland score the lowest on specific policy programmes for water technology. The weakest region (Friesland) in terms of innovation in their total economy, has the most comprehensive policy for water technology. This connection is not illogical. Strong regions generally have several strong sectors and good conditions for innovative businesses, which means that incentives for small sectors are not really necessary.

Table 5.10 illustrates that a specific policy for water technology leads to high scores on the other determinants of the regional innovation system. The leading region on specific water policy, Friesland, has 8 five-star scores. Scotland and Centre-Val de Loire (numbers 2 and 3 in terms of specific policy) each have 6 five- or four-star scores on the other determinants. Both score five stars on *networks* and Centre-Val de Loire also on *cluster organisation*. Scotland scores remarkably low on the determinant *government*. The UK doesn't formally pursue a RIS3 approach in the terms envisaged by the EU and therefore the policy is formulated very generically in the Scottish documents. Also, no reference is made anywhere to the Hydro Nation Strategy.

In Baden-Württemberg and Gelderland there is no *specific policy programme*, *cluster organisation* or *central location* that ensures coherence between the determinants. It also emerged from the interviews that the owners of the WTN test sites have no direct contacts with regional government in the field of innovation. The WTN project, will reveal whether these matters affect the number of innovative projects that can be delivered.

Flanders has good market conditions for the development of an innovative water technology sector due to water scarcity and the great importance of water for the food industry. They score five stars on the determinant *innovation users*. However, current government policy is less attentive to the opportunities this offers than in the past, because the province of West Flanders, where the water issues play the most, has been given less power and resources.

R&D infrastructure for water technology is well established in all WTN regions. All regions score four or five stars on this determinant. There is in all regions a university or research institute with a highly qualified lab and, of course, one or more WTN test sites.

This brings us to the test sites, of themselves, only a small part of the regional innovation system, but the central subject of the WTN project. This chapter has also discussed the role of the regional authorities in the development, financing and management of the test sites. This is summarised in Table 5.11.

Region	Development	Financing	Operation
Baden-Württemberg	No	No	No
Centre-Val de Loire	Yes	Yes	No
Flanders	Yes	Yes	No
Friesland	Yes	Yes	Incidental
Gelderland	No	No	No
Scotland	Yes	Yes	No

Table 5.11 Active role of the regional government regarding WTN test sites

In four of the six regions, regional authorities have played an active role in both the development and financing of the test sites. These four authorities have incorporated test sites, or other similar facilities, in their policy programs. They have also provided grants for the build/operation of the sites and sometimes even grants for projects undertaken by users of the sites. This is not the case in Baden-Württemberg and Gelderland. This confirms the picture that in the economically strong regions, present in WTN, the regional authorities do not play a role in stimulating innovation in water technology.

It appears that among the actors in the Triple Helix, it is the regional government that determines the strength and coherence of the regional innovation system for water technology. They do this through their policy programs that facilitate various determinants that strengthen the innovation system. This is because public authorities, more than universities and businesses, have an interest in the overall system and the role they play in creating the conditions for the regional innovation system. Moreover, governments are responsible for the region. Financial instruments also focus almost entirely on **regional** businesses and infrastructure. Businesses and universities are not tied to regional borders. Market, content, quality of partners, and price are more important factors than location. Regional presence is an advantage in an innovation process when testing in a lab, at a test site or with a pilot customer, but not a necessity.

. FINANCIAL INSTRUMENTS

6.1 INTRODUCTION

In this chapter we try to give an overview of the financial policy instruments of WTN regions, which can contribute to the development and/or expansion of regional innovation systems in the field of water technology. The information comes partly from internet research and partly from the surveys and interviews conducted. In practice, it proved difficult to obtain detailed financial information. Most of our respondents were not directly involved in the implementation of the subsidy programmes and databases with data at project level are not always (publicly) available. We therefore start with a qualitative overview of the availability of the subsidy instruments. Next, we look at the opportunities in the regions through their ERDF programmes. Finally, we look at additional possibilities for financial support, which have been put forward in the surveys and interviews with the (sub)partners.

6.2 AVAILIBILITY OF FINANCIAL INSTRUMENTS

In the questionnaires and during the interviews we asked which policy instruments are available in each region. The replies were supplemented by information from the ERDF programmes, in which the regions were involved.

The WTN-project will help SMEs to test their innovative water technologies at operational scale (or lower TRL, albeit not below 4) demonstrator sites. Its main aim is to speed up market uptake of innovative water technologies. These test sites are just one stage in the innovation cycle from idea to successful export of products as is shown in the innovation eco-system for water technology in the province of Friesland (Figure 6.1).

Figure 6.1. Innovation cycle for water technology of Water Campus Leeuwarden (Friesland).

This innovation eco-system is not a scientific model. It is rather, an example of best practice consisting of a combination of a number of instruments at the different stages of the innovation cycle. We will use it as a reference to map the support for water technology innovations in each region. We have broken down the innovation eco-system into a number of policy instruments. Respondents were asked to indicate whether the specific policy instrument exists in their region or not. If yes, we asked them additional questions about the funding source and the scope, i.e is the instrument available only for water technology or broader.

We have already seen in the previous chapter that water technology is not a specific priority in most regions. In Table 6.1 this is confirmed; only in Friesland and Scotland are there instruments specifically intended for the stimulation of water technology (the blue boxes). This does not take away from the fact that generic innovation policy or policy aimed at, for example, environmental technology provides financial instruments that can be used for elements of a regional innovation system for water

technology. Of course, the competition for the companies and organisations in water technology is then much bigger to obtain these subsidies. Certainly, water technology organisations will be at a disadvantage as there will be a preference for companies and organisations which belong to the priority sectors of regions.

In general, one can say that in all regions most of the instruments in the innovation cycle are present (there are few red boxes). At the least, they are available separately, this means that there is not yet a sector-specific innovation system. Programs are needed to develop this.

Interreg North-West Europe Water Test Network	Baden-Württemberg	Centre-Val-de Loire	Flanders	Friesland	Gelderland	Scotland
Instruments innovation cycle						
Scientific R&D	x	x	x	x		x
Applied R&D	x	x	x	x	x	x
Research infrastructure (labs and equipment)	x	x	x	x	x	x
Innovation projects SME	x	x	x	x	x	x
Demonstration projects / pilot projects (limited scale)	x	x	x	x	x	x
Launching customer projects (full scale)	x		x	x	x	x
Incubator facilities (e.g. offices for start ups)	x	x	x	x	x	x
Networking activities / clusters	x	x	x	x	x	x
Venture capital	x	x	x	x	x	x
Education (e.g. study tracks etc)	x	x	x	x		x
Export preparation (e.g. trade fairs)	x	x	x	x	x	x
Export (grants or garanties)		x				x
Housing / real estate	x			x		x
Cofunding EU-projects (ERDF, Interreg, other ….)	x	x	x	x	x	x
Specific support demo sites						
Support investment		x	x	x	x	x
Support of operation and maintenance (exploitation)				x		x
Support of users (direct of indirect via site owner)		x	x	x	x	x
	Policy instrument is available for:					
	Water technology specific					
	Environmental technology					
	Other sectors or general					
	Not available					

Table 6.1. Availability of regional policy instruments.

6.3 EUROPEAN REGIONAL DEVELOPMENT FUND

All European regions[10] are eligible for contributions from the European Regional Development Fund (ERDF). For the ERDF 2014-2020, regions had to submit operational plans[11] based on their Regional Innovation Strategy (RIS) and to indicate to which of 11 EU defined thematic objectives[12] and 37 investment priorities they wished to benefit. Table 6.2 shows the thematic objectives chosen by the WTN regions.

Thematic objectives applying to ERDF programmes	Baden-Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland
(1) strengthening research, technological development and innovation	x	x	x	x	x	x
(2) enhancing access to, and use and quality of, ICT		x				x
(3) enhancing the competitiveness of SMEs		x	x			x
(4) supporting the shift towards a low-carbon economy in all sectors	x	x	x	x	x	x
(5) promoting climate change adaptation, risk prevention and management			x			
(6) preserving and protecting the environment and promoting resource efficiency		x	x			x
(7) promoting sustainable transport and removing bottlenecks in key network infrastructures						
(8) promoting sustainable and quality employment and supporting labour mobility						
(9) promoting social inclusion, combating poverty and any discrimination			x			
(10) investing in education, training and vocational training						
(11) enhancing institutional capacity of public authorities and stakeholders						

Table 6.2 Thematic objectives in ERDF programmes of WTN regions.

[10] The operational programmes ERDF for Friesland and Gelderland Friesland and Gelderland have been drawn up for the Northern and Eastern Netherlands regions respectively. For the sake of readability, we will talk about Friesland and Gelderland in this section.

[11] (Baden-Württemberg, 2018), (Programme Opérationnel FEDER-FSE Centre 2014-2020, version 5.2, 2019), (Operational Programme United Kingdom - ERDF Scotland, version 3.2, 2018), (OPERATIONEEL PROGRAMMA "INVESTEREN IN GROEI EN WERKGELEGENHEID" VLAANDEREN 2014 – 2020, Ontwerp OP EFRO 2014-2020, 2014), (Operationeel Programma EFRO 2014 – 2020 Oost-Nederland Versie voor SFC, 2014) (Operationeel Programma EFRO 2014-2020 NoordNederland, versie 1.2, 2014)

[12] https://ec.europa.eu/regional_policy/en/policy/what/glossary/t/thematic-objectives

Thematic objectives number 1 (R&D and innovation) and number 4 (low-carbon economy) are part of the programmes of all the 6 regions. Baden-Württemberg, Friesland and Gelderland are the most selective: numbers 1 and 4 are the only thematic objectives in their operational programmes. Centre-Val de Loire, Flanders and Scotland have chosen five or six thematic objectives. In total, 7 of the 11 objectives appear in the operational programmes of the WTN regions.

These investment priorities allow the regions to indicate how they wish to give support to the thematic objectives they have chosen. In total, the WTN regions have chosen 21 investment priorities to which they allocate money. All regions have included investment priority 1b concerning R&D and innovation[13] in their programme. The rest of the investment priorities differ significantly from region to region. The complete overview can be found in Annex D.

For further differentiation and comparability of the region's programmes, the EU has developed a nomenclature for 123 categories of intervention[14]. The WTN-regions all together use 29 intervention fields (Annex E). These are therefore the types of policy instruments which are allocated budgets that the regions want to use for their regional development. From these 29 fields there are 20 interventions, which could in principle be used to support a regional innovation system for water technology. These interventions can be aimed at innovation (*Research and development and innovation*) or at strengthening water technology companies (*Productive investment* and *Business development*) or at increasing the sales market (*Environmental infrastructure*). Of the other 9 intervention categories we do not expect an incentive for the water technology sector.

INTERVENTION CATEGORIES (x mln €)	Baden-Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland	All regions
Productive investment	0	17	0	0	0	104	121
Environmental infrastructure	0	0	0	0	0	0	0
Research and development and innovation	163	49	70	96	88	177	643
Business development	33	17	40	3	9	89	191
Total of relevant interventions for water technology	196	83	110	99	96	369	953
Other interventions	34	67	34	0	0	2	137
Total ERDF-budget (excluding technical assistance)	229	151	145	99	96	372	1.092

Table 6.3 ERDF budgets of WTN-regions per intervention category

We then inventoried the operational programmes of the WTN regions to which budgets have been allocated within these intervention categories (see Table 6.3). The budgets available vary considerably

[13] promoting business investment in R&I, developing links and synergies between enterprises, research and development centres and the higher education sector, in particular promoting investment in product and service development, technology transfer, social innovation, eco-innovation, public service applications, demand stimulation, networking, clusters and open innovation through smart specialisation, and supporting technological and applied research, pilot lines, early product validation actions, advanced manufacturing capabilities and first production, in particular in key enabling technologies and diffusion of general purpose technologies;

[14] EU215/2014 - IA - Methodologies for climate change support, the performance framework and the nomenclature of categories of intervention for the ERDF, the ESF and the Cohesion Fund under the IGJ goal

from region to region as they depend, among other things, on the size of the regions and socio-economic indicators. The budget for Scotland is almost four times as high as that for Friesland or Gelderland. Scotland (EUR 369 million) and Baden-Württemberg (EUR 196 million) therefore have much larger budgets available for water technology relevant interventions than the other regions, which are all around EUR 100 million.

In order to increase comparability, we have shown the expenditure by category of intervention as a percentage of the total ERDF budget (excluding technical assistance) (see Table 6.4). In total, the WTN regions allocated 87% of the ERDF budget to relevant water technology interventions. Research and development and innovation is the most important category with 56%. None of the regions spent ERDF funds on environmental infrastructure. There is therefore no ERDF incentive on the demand side. Of course, there are differences between regions. Scotland, Friesland and Gelderland have allocated (almost) 100% of their ERDF budget to interventions relevant to water technology. Baden-Württemberg (15%) and Flanders (24%) spend a portion, and Centre-Val de Loire (44%) a considerable portion, on other interventions.

INTERVENTION CATEGORIES (in % of total budget)	Baden-Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland	All regions
Productive investment	0%	12%	0%	0%	0%	28%	11%
Environmental infrastructure	0%	0%	0%	0%	0%	0%	0%
Research and development and innovation	71%	33%	48%	97%	91%	48%	59%
Business development	14%	11%	28%	3%	9%	24%	18%
Total of relevant interventions for water technology	85%	56%	76%	100%	100%	99%	87%
Other interventions	15%	44%	24%	0%	0%	1%	13%
Total ERDF-budget (excluding technical assistance)	100%	100%	100%	100%	100%	100%	100%

Table 6.4 Relative allocation of ERDF-budgets of WTN-regions.

Table 6.5 provides an overview of the top 5 interventions of all WTN regions together. Intervention 058 *(Research and innovation infrastructure - public)* is the most popular with 15% of the total budget. Between the regions we see many differences in the ranking of the intervention categories. Almost every region has a different favourite. Only Baden-Württemberg and Flanders have the WTN's most popular Intervention 058 as their favourite. The top 5 intervention categories of all WTN regions can be found in Annex E.

Intervention category	% of ERDF budget
058 *Research and innovation infrastructure - public*	15%
062 *Technology transfer and university-enterprise cooperation primarily benefiting SMEs*	12%
065 *Research and innovation infrastructure, processes, technology transfer and cooperation in enterprises focusing on the low carbon economy and on resilience to climate change*	11%
001 *Generic productive investment in small and medium – sized enterprises*	10%
066 *Advanced support services for SMEs and groups of SMEs (including management, marketing and design services*	8%

Table 6.5 Top-5 of interventions in WTN-regions over all with percentage of ERDF-budget.

It is interesting to see to what extent the ERDF intervention categories support the full innovation cycle from idea to successful (export) product or service. Table 6.6 shows for the policy instruments from the Friesland innovation eco-system the ERDF interventions with which a match can be found.

Instruments innovation cycle	**ERDF Intervention categories**				
Scientific R&D	060	061			
Applied R&D	002	060	061	062	065
Research infrastructure (labs and equipment)	056	057	058	059	065
Innovation projects SME	062	064	065	069	
Demonstration projects / pilot projects (limited scale)	062	064	065	068	
Launching customer projects (full scale)					
Incubator facilities (e.g. offices for start ups)	067				
Networking activities / clusters	063				
Venture capital					
Education (e.g. study tracks etc)					
Export preparation (e.g. trade fairs)	001	063	066		
Export (grants or garanties)					
Housing / real estate	072				
Cofunding EU-projects (ERDF, Interreg, other ….)					
Specific support for test sites					
Support investment	056	057	058	059	
Support of operation and maintenance (exploitation)					
Support of users (direct of indirect via site owner)	062	064	065		

Table 6.6. Matches of policy instruments for water technology and ERDF-intervention categories (listed in Annex E)

For the most part, especially in the early stages of the innovation cycle, there are ERDF interventions that can provide support. For training (future staff), close-to-the-market instruments such as launching customer projects, venture capital and export grants; there is no support from ERDF. Looking at support for test sites; ERDF support is possible for the investments in infrastructure and innovation projects on the test site, but does not apply to the operational costs.

6.4 ERDF FUNDING FOR WATER TECHNOLOGY

The ERDF certainly offers opportunities to support (innovation in) water technology companies and organisations. But does this happen in practice? To get an idea of this, we have searched in the available databases[15] on ERDF grants awarded for projects in the field of water technology.

Region	Generic support	Specific support
Baden-Württemberg	OP EFRE 2014-2020 Several innovation instruments executed by *Industrie und Handelskammers* and cities.	 No information available at project level
Centre-Val de Loire	OP FEDER-FSE-IEJ Diffusion de l'innovation - Programme d'actions 2015,2016,2017,2018 Executed by DEV'UP	PIVOTS Programme ERDF: 4 million EUR (2016-2020) No information available at project level
Flanders	OP EFRO Vlaanderen	Full project list available: - Proeftuin Voeding-Water - Onderzoeksgebouw VEG-i-TEC ERDF: 3.320.000 EUR
Friesland	OP Noord-Nederland Subsidy instruments: VIA 2017, 2018, 2019	Project list partly available - 4 SME projects ERDF: 1.251.000 EUR. No information available at project level
Gelderland	Programma OP Oost	Full project list available: - 6 SME projects ERDF: 677.000 EUR
Scotland	OP ESF and ERDF Several innovation instruments executed by: - Scottish Government - Local Governments - Scottish Enterprise - Islands and Highlands Enterprise	 No information available at project level

Table 6.7 Generic and specific support for water technology out of ERDF-budgets.

[15] https://www.gov.scot/policies/european-structural-funds/; https://www.op-oost.eu/Overzicht-beschikte-projecten; https://www.europe-en-france.gouv.fr/fr/ressources/liste-des-operations-feder-fse-iej-2014-2020; https://efre-bw.de/downloadcenter/; https://www.europaomdehoek.nl/; https://www.efro-projecten.be/

It is not possible to derive a complete picture from the available databases of projects or companies in the field of water technology that have received support from ERDF. The main reason for this is that most regions pay grant schemes or intermediary organisations from the ERDF, which then support companies or projects. For these secondary layers we could not find public reports, so it cannot be ascertained whether water technology companies have made use of these - mostly generic - instruments or projects. In some regions, however, we have been able to find a number of related projects supported by the ERDF (see the overview in Table 6.7).

The total aid out of ERDF budgets during the period 2014-2019 for water technology seems to be limited to a number of occasional projects and companies and nowhere exceeds 3.5 million EUR. There is no support for systematic water technology programmes, although the available interventions can support the vast majority of the innovation cycle. This requires a clear political choice for water technology as a focal sector in the RIS, which has not been made in any region for the period 2014-2020. In the period 2007-2013, however, this has been done in Friesland. In that period, the ERDF co-financed a large part of the innovation eco-system, including subsidy schemes specifically aimed at water technology companies.

6.4 REGIONAL FUNDING FOR WATER TECHNOLOGY

In the previous chapter we looked at specific policy programs, because that is the most dominant determinant in our model of a regional innovation system for water technology. It is interesting to see to what extent a specific policy programme is actually accompanied by regional budgets for the implementation of that policy and how these relate to the ERDF budgets for water technology. The information comes partly from internet research and partly from the surveys and interviews conducted. In practice, it proved difficult to obtain detailed financial information. We therefore limit ourselves to the main points. Table 6.8 provides an overview.

Friesland and Scotland are the only WTN regions with an explicit policy programme for water technology. This also translates into budgets being available to stimulate the sector. In Friesland, this is almost 6 million EUR per year. In Scotland, 4 million GBP a year is available and, in addition, Scottish Government has contributed 2.1 million GBP to the construction of the Scottish test sites. In both regions, water technology programmes are funded almost exclusively from regional funds. There is hardly any ERDF co-funding, although that would be possible under the objectives of the ERDF.

Centre-Val de Loire does not have an explicit coherent policy in the field of water technology, but (co)-finances a number of building blocks for such a programme, such as the cluster organisation DREAM and the PIVOTS programme. For PIVOTS, Centre-Val de Loire will have made 2 million EUR a year available during the 5-year duration of the programme.

Flanders supports Vlakwa (Flanders Water Knowledge Centre) with an annual contribution for its intermediary activities. In addition, there is regional co-financing for a number of water projects.

Gelderland and Baden-Württemberg do not have regional water technology programmes. It is known from the database of approved ERDF projects that Gelderland co-finances six water technology projects.

These findings confirm the negative link between the economic strength of a region and the specific focus on water technology in policy: the stronger a region, the less there is a specific policy on water technology.

Region	Policy programmes	Financial support
Baden-Württemberg	There is no specific policy program for water technology	No projects or instruments found.
Centre-Val de Loire	- There is no comprehensive policy program for water technology, though there are some elements: - The PIVOTs programme has two platforms that support water technology topics from R&D to validation: PRIME (water, mainly groundwater, monitoring and remediation) and DECAP (sensors). - The water technology cluster gets financial support of Metropole Tours, Metropole Orléans and region Centre-Val de Loire. - Region Centre-Val de Loire is co-leader of the S3 thematic platform, Water Smart Territories.	10 M€ regional grant from 2015 to 2020 (ARD 2020-funding)
Flanders	There are no specific policy programmes for water technology in (Western) Flanders	Vkakwa receives 750.000 EUR/year from the Flemish Ministry of Economy and Innovation. Vlakwa receives 200.000 EUR/year of provinces for Open Call West Flanders and Open Call Antwerp Regional cofunding ERDF for water technology projects (15%): 498.000 EUR Regional co-funding WTN-project (15%): 144.000 EUR
Friesland	Two specific programmes for water technology: 1) Wetsus' R&D programme 2013-2020 2) Water Technology Implementation Framework 2013-2020	1) 36 M EUR (RijksREP) 2) 13 M EUR (RegioREP) 3) Regional cofunding ERDF for water technology projects: EUR 540.000
Gelderland	In Gelderland there is no specific policy for stimulating the water technology sector.	Regional cofunding ERDF for water technology projects: 174.000 EUR
Scotland	Specific policy programme: Hydro Nation Agenda - Scotland's Centre of Expertise for Waters (CREW) - Hydro Nation Water Innovation Services (HNWIS) - Scottish Enterprise's special focus on water sector - Scottish Water Horizons manages two test sites - International collaboration programme	Hydro Nation Agenda: 4 M GBP/year. 2.1 M GBP for test sites

Table 6.8 Regional policy programmes and financial support for water technology.

Although it is difficult to get the exact figures, it is clear that the top three regions with special policy programmes (Friesland, Scotland and Centre-Val de Loire) provide regional funding for these policies. Over approximately the 2014-2020 ERDF period, the budget in Friesland will amount to almost 50 million EUR. In Scotland the budget is about 20 million EUR and Centre-Val de Loire makes about 10 million EUR available. The funding of innovation projects and infrastructure in the field of water technology from regional funds is much higher than from ERDF.

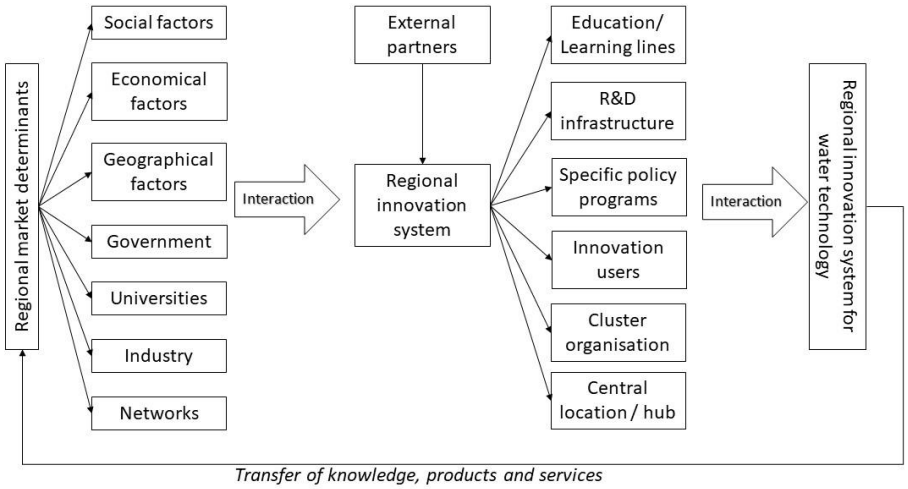
7. SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The Water Test Network (WTN) project has been set up to help SMEs to bring products to market for the water sector. This will be achieved by creating a transnational network of operational scale demonstrator sites, which will offer a range of water types. One of the long-term objectives of the WTN project is to develop a robust business model for the test sites. The test sites are part of the innovation cycle from idea to marketable product. Therefore, it is important to gain insight into models and support mechanisms that regions use to realize the innovation systems for water technology. That is why this report on regional innovation systems for water is included as a deliverable in the approved project proposal.

Conceptual model

For this study a conceptual model for regional innovation systems in water technology[16] has been constructed. It is based on academic research of innovation and its driving factors in European regions.



On the left side of the model (Regional market determinants) we have incorporated, based on literature research: regional geographic, economic and social factors and the workings of the Triple Helix. On the right side of the model (Regional Innovation System determinants) the theories about clusters and the determinants in regional innovation systems find their place.

[16] *Water technology includes*:
- Drinking water, process- and industrial water, waste water treatment, reuse of water (for instance recovery of energy or nutrients) and sensor technology.
- All activities that treat or process water in one way or another with use of technology.
- All technologies and technics that are being developed and used for treatment of water based on the use of R&D from knowledge institutions .

Innovation systems for water technology in the WTN regions

In order to gain insight into the innovation systems for water technology, we have described all determinants from the conceptual model for each region, using information from statistical sources, internet research and the interviews and surveys conducted. This led to the following overall impressions.

In Baden-Württemberg we cannot talk about a regional innovation system for water technology. Baden-Württemberg is an economically very strong region with an excellent innovation climate, but there is no focus on water technology. Knowledge about water technology is at a high level. However, there are no programmes or facilities to develop this knowledge with companies into new products or services in the field of water technology and then market them. An organisation and laboratory such as TZW, which normally focuses on analysing and consulting in the field of drinking water and not on the development of new products, therefore could use support from other actors in the inflow and outflow of companies at their test site.

A regional innovation system for water technology is to a large extent present in Centre-Val de Loire. Various actors, such as the regional government, development company DEV'UP, BRGM and the cluster organisation DREAM, are in close proximity to each other and work well together. The cluster organisation facilitates companies in innovation projects and (international) profiling. The innovation system could be further strengthened with a specific route to learning. Research facilities for SMEs and more market-driven research in a broader field than groundwater, the main field of BGRM activities in the water sector, would also be a valuable addition. The market potential is important to allow more companies to participate in research programmes such as the PIVOTS program and its various platforms/test centres (PRIME, DECAP, O-ZNS, PESAt and PESAa) linked with the water sector.

In Flanders, many aspects are present for a regional innovation system for water technology. Moreover, of all WTN regions, Flanders has the best regional market to implement innovations due to water scarcity. However, there is no policy focus on the water technology sector in Flanders, resulting in a lack of coherence. A Flemish Water Hub, as an additional priority sector could make a major contribution in three areas: solutions to the shortage of water, innovations in sectors that consume a lot of water and strong growth of the water technology sector. Further development of cooperation between the water sector and the agri-food sector would be a good starting point. With the presence of Vlakwa, VEG-i-TEC and LIWET, Kortrijk is a potential physical centre.

The most complete regional innovation system for water technology in the WTN regions can be found in Friesland. Almost all determinants are present at a high level. Since the year 2000, the innovation eco-system has been built up with the support of companies and the regional authorities (and later also by the central government and the EU) and anchored in regional policy. It has now developed into a physical hub with national and international participation. One point for improvement is integration with the demand side, the water users. This concerns citizens, public water companies as well as industrial water users.

In Gelderland a lot of attention is paid to circular economy, but water technology is not a priority within this. A regional innovation system for water technology is therefore not really present. Nor would it be logical and feasible in a small country like the Netherlands to organize complete innovation systems for a small sector like water technology in two separate regions.

In Scotland, the regional innovation system is largely in place. The Scottish Government is inspired by the innovation system built up in Friesland and is the driving force behind its Hydro Nation Agenda. Scottish Water is also a powerful driver with a lot of practical knowledge from which innovative SMEs can benefit. Expansion into the industrial water market (food & beverages, oil & gas) could significantly increase the impact of the policy programme on the Scottish water technology sector. The Hydro Nation Agenda could be further strengthened with a route to continuous learning, lab facilities for SMEs and a cluster organisation implemented under the Hydro Nation Forum.

To compare the WTN regions on the determinants of their regional innovation systems for water technology we designed our own system due to a lack of quantitative data. We have drawn up working definitions that match the information that we have been able to collect. We then linked a classification system to the determinants based on five-point scales and scored the regions. The underlying information for the score per region can be found in chapters 4 and 5. A number of examples of best practice are set out in Annex A. The purpose of this exercise is to provide stakeholders, and in particular regional authorities, with some guidance if they want to improve the innovation system for water technology in their region. For each determinant, they can see what steps they can take to reach a higher level.

In the table below, the WTN regions are ranked on all determinants. At the top we see the two determinants for the overall economic strength of the regions and the most dominant factor/determinant for the water technology innovation system, “specific policy programs”.

	Baden-Württemberg	Centre-Val-de Loire	Flanders	Friesland	Gelderland	Scotland
Determinants						
Overall economy						
EU Regional Competitive Index	*****	***	****	****	*****	****
Regional Innovation Scoreboard	*****	***	****	**	****	****
Water technology						
Specific policy programs	*	***	**	*****	*	****
Government	***	****	**	*****	****	*
Universities	****	***	***	*****	**	****
Industry	***	***	***	***	***	***
Networks	****	*****	*****	*****	****	*****
External partners	***	****	***	*****	***	****
Education / Learning lines	****	**	***	*****	**	****
R&D infrastructure	****	****	****	*****	****	****
Innovation users	***	****	*****	**	****	****
Cluster organisation	**	*****	****	*****	**	***
Central location or hub	*	***	***	*****	*	***

It appears that the stronger the overall economy of a region is, the less specific water technology policy it has. With the exception of Scotland, this applies to all WTN regions. The strongest regions Baden-Württemberg and Gelderland score the lowest on specific policy programmes for water technology. The weakest region, in terms of innovation, Friesland; has the most comprehensive policy for water technology. This connection is not illogical. Strong regions generally have several

strong sectors and good conditions for innovative businesses, which means that incentives for small sectors are not really necessary.

A specific policy is the overarching structure for specific financial instruments for investments to strengthen and connect the determinants of the regional innovation system. The table illustrates that a specific policy leads to high scores on the other determinants of the regional innovation system. The leading region on specific water policy, Friesland, has 8 five-star scores. Scotland and Centre-Val de Loire (numbers 2 and 3 in terms of specific policy) each have 6 five- or four-star scores on the other determinants. Both score five stars on *networks* and Centre-Val de Loire also on *cluster organisation*. In Baden-Württemberg and Gelderland there is no *specific policy programme, cluster organisation* or *central location* that ensures coherence between the determinants. Flanders has good market conditions for the development of an innovative water technology sector due to water scarcity and the great importance of water for the food industry. They score five stars on the determinant *innovation users*.

R&D infrastructure for water technology is well established in all WTN regions. All regions score four or five stars on this determinant. In all regions, there is a university or research institute with a highly qualified lab and in all regions there are, of course, one or more WTN test sites.

In Friesland, Flanders, Scotland and Centre-Val de Loire regional authorities have played an active role in both the development and financing of the test sites. This is not the case in Baden-Württemberg and Gelderland. This confirms the picture that in the economically strong regions the regional authorities do not play a role in stimulating innovation in water technology.

Financial instruments

In general one can say that in all regions most of the instruments in the innovation cycle are present (in the table below there are few red boxes). But only in Friesland and Scotland are there instruments specifically intended for the stimulation of water technology (the blue boxes).

Interreg North-West Europe Water Test Network	Baden-Württemberg	Centre-Val-de Loire	Flanders	Friesland	Gelderland	Scotland
Instruments innovation cycle						
Scientific R&D	x	x	x	x		x
Applied R&D	x	x	x	x	x	x
Research infrastructure (labs and equipment)	x	x	x	x	x	
Innovation projects SME	x	x	x	x	x	x
Demonstration projects / pilot projects (limited scale)	x	x	x	x	x	x
Launching customer projects (full scale)	x		x	x	x	x
Incubator facilities (e.g. offices for start ups)	x	x	x	x	x	x
Networking activities / clusters	x	x	x	x	x	x
Venture capital	x	x	x	x	x	x
Education (e.g. study tracks etc)	x	x	x	x		
Export preparation (e.g. trade fairs)	x	x	x	x	x	x
Export (grants or garanties)		x				x
Housing / real estate	x			x		x
Cofunding EU-projects (ERDF, Interreg, other ….)	x	x	x	x	x	x
Specific support demo sites						
Support investment		x	x	x	x	x
Support of operation and maintenance (exploitation)				x		x
Support of users (direct of indirect via site owner)			x	x	x	x
	Policy instrument is available for:					
	Water technology specific					
	Environmental technology					
	Other sectors or general					
	Not available					

In other regions, companies and organisations in water technology can apply for generic or environmental technology funds, but the competition to obtain these subsidies is then much bigger.

The total aid from ERDF budgets for water technology during the period 2014-2019 seems to be limited to a number of occasional projects and companies and nowhere does it exceed 3.5 million EUR. There is no support for systematic water technology programmes, although the available interventions can support the vast majority of the innovation cycle. This requires a clear political choice for water technology as a priority sector in the RIS, which has not been made in any region for the period 2014-2020.

In the top three regions with special policy programmes (Friesland, Scotland and Centre-Val de Loire) the funding of innovation projects and infrastructure in the field of water technology from regional funds is much higher than from the ERDF. Over approximately the 2014-2020 ERDF period, the budget in Friesland will amount to almost 50 million euros. In Scotland the budget is about 20 million euros and Centre-Val de Loire makes about 10 million euros available.

7.2 CONCLUSIONS

- The EU-indexes for competitiveness and innovation confirm the picture of basic geographical, economic and social factors of the WTN-regions: more centrally located and densely populated regions tend to have higher competitiveness and a better innovation environment.
- The stronger the overall economy of a WTN-region is, the less specific water technology policy it has.
- Among the actors in the Triple Helix, it is the regional government that determines the strength and coherence of the regional innovation system for water technology. This is because public authorities, more than universities and businesses, have an interest in the overall system and the role they play in creating the conditions for it.
- In Friesland, Flanders, Scotland and Centre-Val de Loire regional authorities have played an active role in both the development and financing of the test sites. This is not the case in Baden-Württemberg and Gelderland.
- There is little difference between the WTN-regions in the policy instruments available to businesses and knowledge institutions. The difference lies mainly in the focus on the sectors. The more focus on water technology, the less competition there is to obtain the available subsidies.
- For the most parts (especially in the early stages) of the innovation cycle there are opportunties for ERDF support. Even the regions that have water technology as a priority make little or no use of it.
- In the top three regions with special policy programmes (Friesland, Scotland and Centre-Val de Loire) the funding of innovation projects and infrastructure in the field of water technology from regional funds is much higher than from the ERDF.

Hypothesis

- As the regional innovation systems in some regions are further developed then in other regions, one can expect that more tests as part of the WTN project will take place in the former regions. It will be interesting to verify this hypothesis at the end of the project.

Content

In this Annex we make use of a good practice template from the Interreg Europe programme to help regions to improve their policies.

1. Watertrace (Baden-Württemberg)

General information	
Title of the practice	***WATERTRACE*** ***Innovative sensor system as an online tool for monitoring organic micropollutants in water***
Does this practice come from an Interreg Project	*No*

Specific objective	*Two research projects on the sensor system are currently in progress:* ***Project: SenSOS*** *Topic: Online sensor technology for organic trace substances in the field of drinking water production. Location: Rastatt.* *(Funding: Baden-Württemberg, BWplus)* ***Project: OnSpur*** *Topic: Online sensors in the field of waste water treatment. Monitoring of the fourth treatment stage using activated carbon powder. Location: Mannheim.* *(Funding: Deutsche Bundesstifung Umwelt, DBU)* *In both projects, the applicability of the online sensor system in the practice of drinking water treatment and waste water treatment is to be tested. In the work prior to the projects, laboratory tests were carried out. Therefore, both projects aim at determining the performance and the maintenance effort in practical use.*	
Main institutions involved	*Project: SenSOS* - *UNISENSOR Sensorsysteme GmbH (Karlsruhe)* - *Stadtwerke Rastatt* - *TZW* *Project: OnSpur* - *UNISENSOR Sensorsysteme GmbH (Karlsruhe)* - *Stadtentwässerung Mannheim* - *TZW*	
Location of the practice	Country	*Germany*
	NUTS 1	*Baden-Württemberg*

Detailed description	
Detailed information on the practice *Please provide information on the practice itself. In particular:* - *What is the problem addressed and the context which triggered the introduction of the practice?* - *How does the practice reach its objectives and how it is implemented?* - *Who are the main stakeholders and beneficiaries of the practice?* - *Precise target group and objectives of the good practise* - *Market potential* - *Description of the unique elements of the good practice*	***SenSOS*** *- What is the problem addressed and the context which triggered the introduction of the practice?* *The analytical online monitoring in the waterworks is to be improved. This creates a higher level of safety. Furthermore, it will be checked whether the system can be used as a supplement or replacement for an online SAK measurement. The loading of activated carbon filters (GAC) is to be included in the monitoring. As it is an ongoing research project, it is not yet possible to make conclusive statements on all points.* *- How does the practice reach its objectives and how it is implemented?* *The system has now been running in practice for several months. The feasibility is shown. However, details are still being improved in an ongoing process.* *- Who are the main stakeholders and beneficiaries of the practice?* *If the system is successfully established, the water supplier gains more analytical certainty about its water. This can be used internally for optimization processes. However, it can also be used positively for external customer communication.* *- Precise target group and objectives of the good practise* *The system is to be used in this configuration in the field of drinking water production and treatment. However, there are also other areas of application (control of surface water, industrial waste water, etc.).* *- Market potential* *The research project is still ongoing. It is to be hoped that the expectations of the system will be confirmed. In this case, a good market potential can be predicted. The first customers will be larger water suppliers.* *-Description of the unique elements of the good practice* *Instruments that can measure organic compounds online in the trace range from drinking water matrix are hardly available on the market. There are about 3 commercially available systems that go in the direction of the system we have developed.* *Of course, the system cannot measure all organic trace substances. The analytes must have certain properties. However, many experiments have shown that an acceptable part of the trace substances are compatible with the system. The method is based on automated distillation at the sample preparation stage and subsequent spectral determination in the UV range. This combination has been patented by UNISENSOR.* ***OnSpur*** *- What is the problem addressed and the context which triggered the introduction of the practice?* *The online system in the field of waste water treatment is to control the activated carbon dosage in the fourth treatment stage. For this purpose, the total signal produced by the system is evaluated (similar to a SAK value). In addition, a substance-specific quantification in the water matrix is to be carried out on the basis of indicator substances. Currently, an attempt is being made to specifically determine the substances benzotriazole and diclofenac from the waste water matrix. Their removal capacity can then be used to draw conclusions about coal adsorption.* *- How does the practice reach its objectives and how it is implemented?* *The system has been installed in the sewage treatment plant next to the activated carbon stage for several months. A lot of experience has already been gained in the current project. However, improvements are still being made to the sensor process. Final statements are not yet possible.* *- Who are the main stakeholders and beneficiaries of the practice?* *The sewage treatment plant has a high temporal resolution control over the adsorption process. Furthermore, atypical situations in the water could already be detected by the system in a few cases. The response of the SAK measurement or other parameters (e.g. ammonium values) was not so clear here. Through subsequent analysis of retained*

	samples, laboratory analysis (non-target screening) was used to identify, for example, an industrial chemical that would otherwise have remained undiscovered. The system therefore has the potential to detect unauthorized entries or accidents promptly. *- Precise target group and objectives of the good practise* *The system can be used in municipal and industrial waste water treatment plants. It leads to greater and immediate control over the quality of the water or the technical process. In industrial parks, for example, it could be used to monitor the discharges of various companies.* *- Market potential* *Advanced waste water treatment with powdered activated carbon or ozone has recently become more and more common. If the system provides robust information on treatment quality, it will be of interest for various waste water treatment plants.* *If, in addition, coal dosing can no longer be controlled by volume but by the trace substance concentrations contained in the water after treatment, a savings potential for coal or ozone can be assumed. This means that this purchase can also be amortized again.* *-Description of the unique elements of the good practice* *The system has already given a warning message in a few cases, whereas the effect could not yet be detected in the classic SAK value. It turns out that unauthorized discharges, for example, can be better detected via the system. If the detection of a few individual trace substances can also be established robustly in the project, it is unique on the market in this form.*
Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* *- How long have you been working with the practise?* *- Why do you think the practice is useful and necessary?* *- What are the success factors of the practice?* *- Are there special regional factors for the practice to be successful (means that transferability into another region might be difficult)*	*- How long have you been working with the practise?* *In both cases approx. 6 months in the treatment plants* *- Why do you think the practice is useful and necessary?* *Yes. It will improve the analytical tools in online-monitoring organic substances.* *- What are the success factors of the practice?* *Low maintenance, low limits of quantification, robust in several environments, tolerant to different matrices, and at the end a benefit for the company* *- Are there special regional factors for the practice to be successful (means that transferability into another region might be difficult* *No*
Resources needed	*The system needs a normal power connection and a network connection for data transmission and remote control*
Timescale (start/end date)	*Project: SenSOS* *06/2018 to 06/2020* *Project: OnSpur* *07/2018 to 12/2019*
Evidence of success (results achieved)	
Difficulties encountered/ lessons learned	
Potential for learning or transfer	

Further information	*https://tzw.de/en/projects/project-details/detail/konzeption-eines-sensor-systems-zur-online-erfassung-von-organischen-spurenstoffen-sensos*
Contact details	
Name	*Dr. Oliver Happel*
Organisation	*TZW: DVGW-Technologiezentrum Wasser*
Email	*oliver.happel@gmx.de*

2. Platformes ARD Pivots (Centre-Val de Loire)

General information	
Title of the practice	***Plateformes ARD PIVOTS***
Does this practice come from an Interreg Project	*No, it doesn't*

Specific objective	*Set up Research infrastructures on environmental engineering open to academic research and market players*	
Main institutions involved	*BRGM, ANTEA Group, Cluster DREAM, INRAE, Université d'Orléans, CNRS*	
Location of the practice	Country	*France*
	NUTS 1	*Région Centre Val de Loire*

Detailed description	
Detailed information on the practice *Please provide information on the practice itself. In particular:* - *What is the problem addressed and the context which triggered the introduction of the practice?* - *How does the practice reach its objectives and how it is implemented?* - *Who are the main stakeholders and beneficiaries of the practice?* - *Precise target group and objectives of the good practise* - *Market potential* - *Description of the unique elements of the good practice*	***Research and learning academic platforms are mainly focused*** *on both experimental research and higher education.* ***They look for a good business model to become public & commercial platforms.*** ***Local and regional institutions that develop incentive actions but not are efficient enough:*** *The grant program "Ambition Recherche Développement" that has an annual budget of M€ 10 since 2014.* *It aims at promoting a partnership dynamic to reach:* • *International visibility* • *Economic development on the sectors of the regional specialization* ***What result of the good practice do we expect?*** ➢ *Regarding to the Public-private Partnership:* *Gather feedback from the platforms:* • *Legal set-up proposed* • *Ranges of services (types, prices) sold* • *Business model (free/subsidized price/fair market price)* • *Activity model: what share between research and commercial activities?* ***Main stakeholders and beneficiaries of the practice*** *are the main institutions involved (read above) + SMEs.* ***Market potential:*** *environmental engineering; advisory consulting, monitoring, data storage, …* *Open* ***public & commercial*** *experimental Platform with profitable business model*
Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* - *How long have you been working with the practise?* - *Why do you think the practice is useful and necessary?* - *What are the success factors of the practice?* - *Are there special regional factors for the practice to be successful (means that transferability into another region might be difficult)*	*2 years* *To develop links and relationship between academic research laboratories and companies – To develop technology transfers – To improve profitability of the platforms.* *The head office of the BRGM is in Orléans.*
Resources needed	*Too expensive*
Timescale (start/end date)	*Not long enough*
Evidence of success (results	*Defining the theoretical business model*

achieved)	
Difficulties encountered/ lessons learned	*The French academic accounting model is too rigid.*
Potential for learning or transfer	*The theoretical business model*
Further information	*https://plateformes-pivots.eu/*
Contact details	
Name	***Christophe MOUVET***
Organisation	*BRGM*
Email	*c.mouvet@Brgm.fr*

3. VEG-i-TEC (Flanders)

General information	
Title of the practice	***VEG-i-TEC***
Does this practice come from an Interreg Project	*Yes (FWVI Interreg VEG-i-TEC), in the meantime more projects are coupled.*

Specific objective	*VEG-i-TEC is a living lab for applied research, training and demonstrations in order to innovate and optimize. VEG-i-TEC wants to facilitate the implementation of technological innovations for the industry, which are often (too) large or complex to handle themselves. The focus is also on new technologies, water (including disinfection) and energy management, by-products, food safety and (organoleptic) quality, hygienic design and the economic, ecologic and/or social impact.*	
Main institutions involved	*UGent, INRAe, Howest, Adrianor*	
Location of the practice	Country	*Belgium (new research facility), France*
	NUTS 1	

1. Detailed description	
Detailed information on the practice *Please provide information on the practice itself. In particular:* - *What is the problem addressed and the context which triggered the introduction of the practice?* - *How does the practice reach its objectives and how it is implemented?* - *Who are the main stakeholders and beneficiaries of the practice?* - *Precise target group and objectives of the good practise* - *Market potential* - *Description of the unique elements of the good practice*	*Processing of harvested crops, i.e. production of fresh cut and frozen vegetables or processed potatoes, consists of a sequence of steps such as cutting, trimming, washing, (blanching), dehydrating, heating and packaging. Both from a food quality and food safety perspective, these processing steps are interconnected, that is, the performance of one process step affects the performance of the following steps. Current practice in research is to isolate a certain step of this entire processing line and study it as an independent process. Different research laboratories have, from their own expertise, focused on the different steps of the vegetable processing line research conducted from a different angle. This one situation does not lead to coherent and representative data, for various reasons. Most research is conducted on a laboratory scale. Although this is the logical (and necessary) first step in research and because this is the best way to control the process parameters, upscaling similar to industrial equipment, is necessary to produce representative data and validate a technological improvement. Unfortunately, upscaling to extend lab-scale experiments is rarely performed. In addition, since the process steps are linked, it is not possible to estimate the impact of certain choices or solutions on the entire process line.* *The partners of VEG-i-TEC have already experienced that the development of new technologies or knowledge / solutions gained / found during the research projects get stuck in the research phase and find it difficult to find their way to the target group, being the companies. The step of the research phase into implementation is sometimes too large because certain socio-economic factors have not been charged or known. In this way, the companies stick to the existing (sometimes obsolete (or incomplete) knowledge and switching from traditional technologies to alternative technologies appears to be a complicated process. More support is needed for applied research, in particular for collaboration between science and industry.* *VEG-i-TEC is a flexible and dynamic space that can be used: for testing of apparatus with applied research; for training and demonstration: in an industrial or academic/education of students context; for internal use or towards machine builders, technology suppliers, and the vegetable and potato processing industry;* *VEG-i-TEC presents itself as an accelerator and unique platform for the creation of (new) technology and innovations.* *The step from the research phase to the implementation of technological innovations is often (too) large or complex for companies. This creates a gap between research and eventual market penetration.* *VEG-i-TEC responds by setting up a testing facility for food companies, in order to stimulate, to realise and to implement innovation.* *VEG-i-TEC provides pilot installations for applied research, training and demonstrations (Living lab). This contributes to new technological developments and brings together the expertise of various knowledge and research institutions.* *VEG-i-TEC translates its knowledge into the programmes of (engineering) students or into workshops for companies.*

Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* - *How long have you been working with the practise?* - *Why do you think the practice is useful and necessary?* - *What are the success factors of the practice?* - *Are there special regional factors for the practice to be successful (means that transferability into another region might be difficult)*	*We have been working now for 2 years. It is useful as we see now that there are collaborations between different sectors: e.g. food companies, water technology suppliers, machine builders, researchers, educational departments, … There is also a more active approach between different actors in defining research projects, tackling problems, communication, … Since last year different projects have been written and started. A network has been developed around the processing of vegetables and potatoes. It acts as a real communication platform. There is also a strong interaction with the different regions involved.*
Resources needed	*Yes, in new technologies.*
Timescale (start/end date)	*April 2018 (4 years, but we will continue afterwards)*
Evidence of success (results achieved)	*The network, communication platform (advisory boards with companies), new projects started, ….*
Difficulties encountered/ lessons learned	*Too soon to define*
Potential for learning or transfer	
Further information	*http://www.veg-i-tec.eu/*
Contact details	
Name	*Imca Sampers*
Organisation	*UGent*
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4. DOC2C's (Flanders)

General information	
Title of the practice	***DOC2C's: Innovative technologies for DOC removal in drinking water treatment***
Does this practice come from an Interreg Project	*Yes*

Specific objective	*SO 1.2 Increase the delivery of innovation in smart specialisation sectors*	
Main institutions involved	*PWN Technologies, South West Water, De Watergroep, Lille 1 Univeristy, Delft University of Technology*	
Location of the practice	Country	*Belgium*
	NUTS 1	*BE2*
	NUTS 2	*BE25*
	NUTS 3	*BE252*

Detailed description	

Detailed information on the practice
Please provide information on the practice itself. In particular:
- *What is the problem addressed and the context which triggered the introduction of the practice?*
- *How does the practice reach its objectives and how it is implemented?*
- *Who are the main stakeholders and beneficiaries of the practice?*
- *Precise target group and objectives of the good practise*
- *Market potential*
- *Description of the unique elements of the good practice*
	- *High levels of dissolved organic carbon (DOC's) are occurring in the raw water of the drinking Water Production Centres (WPC's). These are occurring due to high agricultural activity in the region as well as the availability of nutrients in the water, that cause bacterial and algal growth. High levels of DOC cause reduction in efficiency of water treatment steps and jeopardises drinking water quality by the production of disinfection by-products and lower network bio-stability.*
	- *New removal technologies are piloted (4 pilots) and intense collaboration of partners is set-up to exchange results and good practices.*
	Pilot 1: NL, Pilot2: BE, Pilot3: UK, Pilot4: FR
	- *Stakeholders: Utilities (13 observers) learn new technologies (8) and their performances, citizens benefit in the long-term by access to high quality, stable drinking water. Contractors, technology and service providers (7) profit from preparation of the pilot sites and R&D centra (8) experience with the innovations. Regulators (3) observe new technologies and possibilities and sector organisations (3) address their members.*
	Technologies involved: Ceramic membranes, (suspended) IEX, biological denitrification, polymeric nanofiltration, electrodialysis, testing recovered DOC's use (e.g. agriculture) and salt separation technologies (dynamic vapour recompression), coagulation and flocculation, advanced oxidation
	- *Good practice: piloting innovative treatments prior to large scale investments and exchanging data and results*
	- *Several WPC's and in the broader sense utilities are confronted with DOC's, so there is a multiplication effect*
	- *Unique elements:*
	  ○ *Extensive preparation (physically organising meetings)*
	  ○ *Organising a joint research programme with a joint database of innovative approaches*
	  ▪ *Inventory of local knowledge*
	  ▪ *Inventory of local strategies and needs*
	  ▪ *Writing a joint R&D strategy*
	  ▪ *Exchange of water samples, data and results*
	  ○ *Open up facilities for SMEs and technology providers*
	This will allow utilities to make informed choices and eliminates the need for duplication of experiments

Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* - *How long have you been working with the practise?* - *Why do you think the practice is useful and necessary?* - *What are the success factors of the practice?* - *Are there special regional factors for the practice to be successful (means that transferability into another region might be difficult)*	*De Watergroep has been looking at alternative ways to remove DOC from surface water for two decades now. Within the DOC2Cs project, a combination of ion exchange and coagulation/flotation for DOC removal has been piloted from 2016 – now.* *The piloting enabled De Watergroep to make some important decisions with respect to the design of new treatment plants for two of its largest surface water treatment sites. At the Blankaart site, where the DOC2Cs piloting was done, ion exchange was found to be less effective than expected to remove DOC from the raw surface water. This is due to high levels of competing anions present in the raw water. Implementing ion exchange will not result in an improved overall DOC removal efficiency and neither will it decrease the chemicals demand of the overall treatment. At another site, Kluizen, where the concentrations of competing anions are lower, including ion exchange in the treatment process will result in an improved overall DOC removal efficiency and at the same time lower the chemicals demand and sludge production of the overall treatment process.* *The results from the DOC2Cs project are valuable for all drinking water companies relying on surface water sources, but caution has to be applied in transferring the results due to the fact that each water source is different and needs a specific approach.*
Resources needed	*?*
Timescale (start/end date)	*01/01/2016 – 31/12/2019*
Evidence of success (results achieved)	*A lot of additional knowledge was gained on removing DOC from surface water by combining ion exchange and enhanced coagulation/flotation. At De Watergroep, the decision was made to build a full scale ion exchange – coagulation/flotation plant at the Kluizen site in the near future. At the Blankaart, additional research will address improvement of the DOC removal efficiency.*
Difficulties encountered/ lessons learned	*It is important to realise that each water source is different and that a universal optimal treatment train for treating surface water does not exist. Piloting is a powerful tool to make the right choices with respect to the selection of the optimal treatment technology for a specific water source.*
Potential for learning or transfer	*Working together with two other drinking water companies facing the same challenges and two universities with knowledge on the subject was very beneficial to the research. There was a very open communication between the partners.* *The workshops organized within the project were attended by a large number of people, mostly from other drinking water companies, research organizations and technology providers, resulting in direct knowledge transfer and interesting discussions on the subject of DOC removal. They also provided an excellent opportunity for networking with people interested in surface water treatment.*
Further information	
Contact details	
Name	*Klaas Schoutteten*
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Email	*Klaas.schoutteten@dewatergroep.be*

5. Masterplan WaterCampus Leeuwarden (Friesland)

General information	
Title of the practice	***Masterplan Water Campus Leeuwarden***
Does this practice come from an Interreg Project	*No*

Specific objective	*To increase the regional impact and the international position of Water Campus Leeuwarden*	
Main institution involved	*Water Campus Leeuwarden*	
Location of the practice	Country	*Netherlands*
	NUTS 1	*Noord-Nederland*

Detailed description	
Detailed information on the practice *Please provide information on the practice itself. In particular:* - *What is the problem addressed and the context which triggered the introduction of the practice?* - *How does the practice reach its objectives and how it is implemented?* - *Who are the main stakeholders and beneficiaries of the practice?* - *Precise target group and objectives of the good practise* - *Market potential* - *Description of the unique elements of the good practice*	*- The problem* *In the 1990s the Province of Friesland concluded in an economic analysis that knowledge and innovation would become important drivers for long-term regional economic development. In a region without a university, a connection was sought with the natural qualities of the region, in which a lot of knowledge has been present since time immemorial: water. The water sector had to become an important factor in the transition to a knowledge-based economy. The ambitious goal was that by 2020, 2,000 knowledge workers would be active in the Frisian water sector.* *- Reaching the objectives* *The Master Plan Water Campus (2017-2020) serves here as an example of how stakeholders in the province are working towards the aforementioned objective by means of integrated programmes. The Master Plan includes the following actions:* *Action 1.1 Monitoring programme* *Action 2.1 Increase Critical Mass Water Campus* *(acquisition of foreign companies; spin-offs and techno start-ups; water-SME contact point (national SME counter)* *Action 2.2 Marketing Water Campus as a water technology hub* *Action 2.3 Economic programme* *(pilot development, launching customer projects, demonstration sites)* *Action 2.4 National water technology cluster* *(Inbound/outbound international missions and fairs; stimulate exports)* *Action 3.1 Strengthen continuous learning + talent programme* *Action 3.2 Marketing for attracting students* *Action 3.3 Applied research* *Action 4.1 Internationalisation within Europe* *Action 4.2 Internationalisation outside Europe* *- Main stakeholders and beneficiaries:* *1) Stichting Water Alliance, 2) Stichting Center of Expertise Water Projectpartners* Technology, 3) Stichting Wetsus, European centre of excellence for sustainable water technology* *- Precise target group:* *Water technology companies (SMEs) in Friesland* *- Market potential:* *Growth of the water sector in Friesland from 2014 until 2030:* *Turnover: from 365 to 700 million EUR/year* *Employment: from 1800 tol 3500 highly qualified jobs* *Companies: from 80 to 120 companies* *- Unique elements:* *WaterCampus organises cooperation between (inter)national companies, knowledge institutions and public authorities in the water technology sector, in order to create synergies for innovation, education and entrepreneurship at world level and thereby strengthen the position of European water technology.* *In addition to this cooperation function, Water Campus offers a unique research infrastructure (including advanced laboratories, an application centre and unique*

	demonstration sites) and is therefore a meeting place of scientists and companies from all over Europe. *The international cooperation, which is organised and stimulated from Water Campus Leeuwarden, leads to knowledge, talent and entrepreneurship that contributes to solving world water problems.*
Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* - *How long have you been working with the practise?* - *Why do you think the practice is useful and necessary?* - *What are the success factors of the practice?* - *Are there special regional factors for the ipraxctice to be successful (means that transferability into another region might be difficult)*	*- Time frame* *The master plan Water Campus Leeuwarden (2017-2020) is part of a long-term strategy, which was started as early as the year 2000. The target of the strategy was originally 2020,but has now shifted to 2030.* *- Usefulness and necessity* *The further development of the water sector requires an integrated approach in which the Water Campus parties work closely with regional authorities, but also with national and EU authorities, with companies and knowledge institutions in the water sector and with various others actors. For these reasons, generic instruments are generally not sufficiently appropriate and this project proposes a package of specific measures to implement the strategy.* *- Success factors* *(see lessons learned)* *- Specific regional factors:* *No university (as driver for innovation) in the region.* *Water is in the DNA of Friesland*
Resources needed	*Masterplan Water Campus (2017-2020): € 7.420.000*
Timescale (start/end date)	*01-01-2017 / 31-12-2020*
Evidence of success (results achieved)	*To give an indication of the impact of the campus. In 2018 there were 129 research projects, 128 international cooperation projects, the network had 284 unique participants (knowledge institutions and companies), the 100th PhD student got his degree and the 634th scientific article was published.* *The impact of the water sector on the Frisian economy is considerable. In the year 2018 (latest Figures) it accounts for some 2,200 FTEs, more than half of whom are higher educated. It comprises around one hundred private companies, ten sectoral (knowledge) institutions and two public water companies. The turnover of the Frisian sector in 2017 was between € 450 and € 480 million. In the same year, the number of jobs grew by twenty percent compared to 2012.* *(results achieved during the long term development programme)*
Difficulties encountered/ lessons learned	*Lessons learned during the long term development programme:* *1. Dare to dream big and think big, in quadruple collaboration.* *2. Define a mission and a vision.* *3. Assume present qualities, no copycat behaviour.* *4. Make use of unconscious knowledge (tacit knowledge).* *5. Work programmatically, with the programme defining the frameworks.* *6. Develop innovative projects within the programme:* *- along three lines: talent, experiment and technology;* *7. Monitor continuously and make timely adjustments.* *8. Cooperate on an equal basis, as partners.* *9. Dare as a government to invest in dreams, the imagination in power, and look far beyond an administrative period.* *10. Take administrators and civil servants to international meetings and working visits, so that they can get away from their daily worries and get a broader perspective.* *11. Recognize that as a government you facilitate and have different roles.* *12. A thirst for efficiency and working towards 'expected results' leads to disappointment and is a killer for innovation.*
Potential for learning or transfer	*See lessons learned.* *Within the framework of Interreg Europe the project iWatermap has started in 2018 with partners out of 7 European countries.* *The iWATERMAP project focuses on supporting the innovation policies in water technology sector, helping to increase the critical mass of innovation ecosystems in partner regions in this sector. The critical mass in the innovation ecosystem approach*

	means that all the necessary elements for innovation ecosystem are identified and put in place stage by stage, such as academia and business cooperation, cross-cluster fertilization, interregional networks and cooperation, science and education, thus ensuring stable and sustainable development of the system.
Further information	*https://www.watercampus.nl/*
Contact details"	
Name	*Stefan Bergsma*
Organisation	*Water Alliance*
Email	*info@watercampus.nl*

6. Hydro Nation Water Innovation Services (Scotland)

General information		
Title of the practice	Hydro Nation Water Innovation Service	
Does this practice come from an Interreg Project	No	

Specific objective	The aim is to help accelerate the route to market for companies developing innovative water technologies.	
Main institution involved	Scottish Enterprise / Scottish Government	
Location of the practice	Country	United Kingdom
	NUTS 1	*Scotland*

Detailed description	
Detailed information on the practice *Please provide information on the practice itself. In particular:* - *What is the problem addressed and the context which triggered the introduction of the practice?* - *How does the practice reach its objectives and how it is implemented?* - *Who are the main stakeholders and beneficiaries of the practice?* - *Precise target group and objectives of the good practise* - *Market potential* - *Description of the unique elements of the good practice*	Hydro Nation Water Innovation Service (HNWIS) was established – in collaboration with Scottish Enterprise – to assist in the identification and exploitation of key opportunities for Scotland to bring new technologies forward that can reduce costs and raise standards. The service is a partnership of the Scottish Government, Scottish Enterprise, HIE, SEPA and Scottish Water Horizons. The aim is to help accelerate the route to market for companies developing innovative water technologies. Companies will be able to apply to HNWIS, be assessed for their market readiness, and, if suitable, be referred to the most relevant support from across these public sector agencies. The core of this support is to help companies to take their new products to test and demonstration facilities by supporting trials and providing an independent report on the results of such trials. Successful demonstration of new technologies is an essential part of the commercialisation process for domestic and international markets.
Experience with the good practice and transferability *Please provide information on the practice itself. In particular:* - *How long have you been working with the practise?* - *Why do you think the practice is useful and necessary?* - *What are the success factors of the practice?* - *Are there special regional factors for the ipraxctice to be successful (means that transferability into another region might be difficult)*	The 3-year Hydro Nation Water Innovation Service project phase 1 ended in May 2018. The service successfully supported 17 companies with a range of technical advice around developing products for the water and wastewater markets. Nine of those companies successfully completed testing at a variety of test centres. A number of case studies of the support provided, and outcomes of the projects can be found on the HNWIS website. Also available are six Market Intelligence Reports that were well received by companies. These outline the challenges and economic opportunities from the water sector. The new Hydro Nation Water Innovation Service commenced in November 2018. HNWIS was targeted at a specific gap in the market for Scotland so if the model was used in another region it may need to be adapted as necessary to take account of local circumstances and needs.
Resources needed	The Scottish Government has provided funding of £330k so far to support the Innovation Service who also receive funding from the Enterprise Agencies. [Separately, but linked to innovation support, the Scottish Government has provided funding of £2.1 million to Scottish Water to establish two Development Centres within treatment works where companies can test new equipment, products and processes for potential rollout in the water industry].
Timescale (start/end date)	2015 – ongoing
Evidence of success (results achieved)	The service has, so far, successfully supported 17 companies with a range of technical advice around developing products for the water and wastewater markets. Nine of those companies successfully completed testing at a variety of test centres.

Difficulties encountered/ lessons learned	Costs of trialling/testing are often beyond the reach of SME companies
Potential for learning or transfer	HNWIS was established to meet demand given an identified gap in the market in Scotland. A proposed transfer to another region would need careful consideration on whether there is already support for this and/or whether it should be targeted at a different level.
Further information	*https://www.hnwis.scot/*
Contact details"	
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ANNEX B. PARTICIPANTS IN THE SURVEYS AND THE INTERVIEWS

Name	Organisation
Francis Bertrand	DREAM
Natassia Daumas	Region Centre-Val de Loire
Marie Lavayssière	Region Centre-Val de Loire
Alban Marché	Region Centre-Val de Loire
Héloïse Peschard	DEV'UP
Christophe Mouvet	BRGM
Neil Kitching	Scottish Enterprise
Barry Greig	Scottish Government
Jon Rathjen	Scottish Government
Rodger McGovern	James Hutton Limited
Edwin de Buijzer	Water Authority Vallei en Veluwe
Peter-Jan van Oene	Water Authority Vallei en Veluwe
Marcel van der Maal	Clean Tech Regio
Charlotte Boeckaert	VITO/Vlakwa
Imca Sampers	Universiteit Gent
Matthias Mertens	Watercircle.be
Dirk Van der Stede	POM West-Vlaanderen
Han Vervaeren	De Watergroep
Stefan Bergsma	Water Alliance
Jordi Moreno	Centre of Expertise Watertechnologie (CEW)
Gerard Jonker	Provincie Fryslân
Beate Hambsch	TZW: DVGW-Technologiezentrum Wasser
Josef Klinger	TZW: DVGW-Technologiezentrum Wasser
Dr. Oliver Happel	TZW: DVGW-Technologiezentrum Wasser

ANNEX C. GEOGRAPHICAL, ECONOMICAL AND SOCIAL DATA

Eurostat data of the regions: retrieved at 10-07-19.

REGION	FRIESLAND	GELDERLAND	KARLSRUHE	WEST-FLANDERS	CENTRE-VAL DE LOIRE	HIGHLANDS AND ISLANDS	NORTH EASTERN SCOTLAND	EAST SCOTLAND
AREA KM2 (2015)	5.749	5.136	6.919	3.144	39.150,9	41.974	6.544	18.296
POPULATION (2018)	647.268	2.060.103	2.795.783	1.192.254	2.571.632	470.743	494.624	1.988.307
POPULATION DENSITY INHABITANTS/KM2 (2017)	190,5	410,8	406,3	307,9	65,6	11,6	75,9	150,0
REGIONAL COMPETITIVE INDEX (2019)	0,37 (86)	0,72 (20)	0,77 (15)	0,45 (63)	0,10 (125)	0,08 (147)	0,41 (73)	0,48 (52)
GDP PER CAPITA (2017)	25.900	31.300	39.900	33.700	25.100	26.800	42.000 (including revenues from oil and gas)	29.800
EMPLOYMENT RATIO (2017)	44%	47%	51%	43%	37%	48%	53%	48%
UNEMPLOYMENT RATE (2017)	5.6%	4.5%	3.3%	3.2%	8.6%	2.6%	4.2%	3.9%
WORKING AGE (25-64) WITH TERTIARY EDUCATIONAL ATTAINMENT	29%	34.3%	31.4%	37.4%	30.2%	46.3%	46.6%	51.4%
PERCENTAGE OF GDP SPEND ON R&D (2016)	0,83%	2,18%	4,56%	1,12%	1,63%	1,55% (Scotland is measured as one identity)	‘’	‘’

ANNEX D. ERDF THEMATIC OBJECTIVES AND INVESTMENT PRIORITIES OF WTN-REGIONS

List of thematic objectives (numbers between brackets) and investment priorities (letters between brackets) applied to ERDF programmes	Baden-Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland
(1) strengthening research, technological development and innovation by:	x	x	x	x	x	x
(a) enhancing research and innovation (R&I) infrastructure and capacities to develop R&I excellence, and promoting centres of competence, in particular those of European interest;	x		x			
(b) promoting business investment in R&I, developing links and synergies between enterprises, research and development centres and the higher education sector, in particular promoting investment in product and service development, technology transfer, social innovation, eco-innovation, public service applications, demand stimulation, networking, clusters and open innovation through smart specialisation, and supporting technological and applied research, pilot lines, early product validation actions, advanced manufacturing capabilities and first production, in particular in key enabling technologies and diffusion of general purpose technologies;	x	x	x	x	x	x
(2) enhancing access to, use and quality of ICT by:		x				x
(a) extending broadband deployment and the roll-out of high-speed networks and supporting the adoption of emerging technologies and networks for the digital economy;						x
(c) strengthening ICT applications for e-government, e- learning, e-inclusion, e-culture and e-health;		x				
(3) enhancing the competitiveness of SMEs by:			x			x
(a) promoting entrepreneurship, in particular by facilitating the economic exploitation of new ideas and fostering the creation of new firms, including through business incubators;			x			
(b) developing and implementing new business models for SMEs, in particular regard to internationalisation;			x			
(d) supporting the capacity of SMEs to grow in regional, national and international markets, and to engage in innovation processes;		x	x			x
(4) supporting the shift towards a low-carbon economy in all sectors by:	x		x	x	x	
(a) promoting the production and distribution of energy derived from renewable sources;			x			
(b) promoting energy efficiency and renewable energy use in enterprises;	x		x			
(c) supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector;			x			

List of thematic objectives (numbers between brackets) and investment priorities (letters between brackets) applied to ERDF programmes	Baden-Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland
(e) promoting low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility and mitigation-relevant adaptation measures;	x		x			
(f) promoting research and innovation in, and adoption of, low-carbon technologies;		x		x	x	x
(5) promoting climate change adaptation, risk prevention and management by:			x			
(a) supporting investment for adaptation to climate change, including ecosystem-based approaches;			x			
(b) promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems;						
(6) preserving and protecting the environment and promoting resource efficiency by:			x			
(c) conserving, protecting, promoting and developing natural and cultural heritage;						
(d) protecting and restoring biodiversity and soil and promoting ecosystem services, including through Natura 2000, and green infrastructure;						
(e) taking action to improve the urban environment, to revitalise cities, regenerate and decontaminate brownfield sites (including conversion areas), reduce air pollution and promote noise-reduction measures;			x			
(f) promoting innovative technologies to improve environmental protection and resource efficiency in the waste sector, water sector and with regard to soil, or to reduce air pollution;		x				
(g) supporting industrial transition towards a resource-efficient economy, promoting green growth, eco-innovation and environmental performance management in the public and private sectors;						x
(9) promoting social inclusion, combating poverty and any discrimination, by:			x			
(b) providing support for physical, economic and social regeneration of deprived communities in urban and rural areas;			x			

ANNEX E. ERDF INTERVENTION FIELDS USED BY WTN-REGIONS

INTERVENTION FIELD
Productive investment
001 Generic productive investment in small and medium – sized enterprises ('SMEs')
002 Research and innovation processes in large enterprises
Environmental infrastructure
020 Provision of water for human consumption (extraction, treatment, storage and distribution infrastructure)
021 Water management and drinking water conservation (including river basin management, water supply, specific climate change adaptation measures, district and consumer metering, charging systems and leak reduction)
022 Waste water treatment
Research and development and innovation
056 Investment in infrastructure, capacities and equipment in SMEs directly linked to research and innovation activities
057 Investment in infrastructure, capacities and equipment in large companies directly linked to research and innovation activities
058 Research and innovation infrastructure (public)
059 Research and innovation infrastructure (private, including science parks)
060 Research and innovation activities in public research centres and centres of competence including networking
061 Research and innovation activities in private research centres including networking
062 Technology transfer and university-enterprise cooperation primarily benefiting SMEs
063 Cluster support and business networks primarily benefiting SMEs
064 Research and innovation processes in SMEs (including voucher schemes, process, design, service and social innovation)
065 Research and innovation infrastructure, processes, technology transfer and cooperation in enterprises focusing on the low carbon economy and on resilience to climate change
Business development
066 Advanced support services for SMEs and groups of SMEs (including management, marketing and design services)
067 SME business development, support to entrepreneurship and incubation (including support to spin offs and spin outs)
068 Energie-efficiëntie en demonstratieprojecten in kmo's en ondersteunende maatregelen
069 Support to environmentally-friendly production processes and resource efficiency in SMEs
072 Business infrastructure for SMEs (including industrial parks and sites)
Other interventions
009 Renewable energy: wind
010 Renewable energy: solar
011 Renewable energy: biomass
012 Other renewable energy (including hydroelectric, geothermal and marine energy) and renewable energy integration (including storage, power to gas and renewable hydrogen infrastructure)
013 Energy efficiency renovation of public infrastructure, demonstration projects and supporting measures
014 Energy efficiency renovation of existing housing stock, demonstration projects and supporting measures
046 ICT: High-speed broadband network (access/local loop; >/= 30 Mbps)
087 Adaptation to climate change measures and prevention and management of climate related risks e.g. erosion, fires, flooding, storms and drought, including awareness raising, civil protection and disaster management systems and infrastructures
089 Rehabilitation of industrial sites and contaminated land

Top-5 of interventions in WTN-regions with percentage of ERDF-budget (blue:relevant interventenions for water technology; green: other interventions)

Overall	Baden Württemberg	Centre-Val de Loire	Flanders	Friesland	Gelderland	Scotland
058-15%	058-40%	060-15%	058-16%	064-27%	065-32%	001-28%
062-12%	013-13%	046-12%	066-11%	065-25%	064-18%	062-20%
065-11%	068-10%	061-11%	062-10%	062-22%	062-10%	066-18%
001-10%	060-8%	014-11%	063-10%	063-8%	061-9%	058-13%
066-8%	056-7%	013-9%	014-10%	056-7%	063-7%	065-10%

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