Drivers and Barriers for Water-Smart Solutions across 6 Cases: Policy and Governance

Deliverable 5.3

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Summary

The present report corresponds to Deliverable 5.3 of B-WaterSmart – Preliminary Report on Policy and Governance: Drivers and Barriers across 6 European Cases. It offers a preliminary overview of the main drivers and barriers related to the policy and governance dimensions across the six Living Labs of B-WaterSmart: Alicante (Spain), Bodø (Norway), East Frisia (Germany), Flanders (Belgium), Lisbon (Portugal) and Venice (Italy).

It starts by providing an overview of the policy framework with implications for water management in the European Union, including the main plans and strategies related to adaptation to climate change and implementation of a circular economy, along the nexus water-energy-resources-waste. Furthermore, we added a section that describes succinctly the main models of water governance in Europe.

At this preliminary stage, the sources for information were mostly bilateral meetings with LL owners and mentors, as well as workshops carried out in October 2020 and January 2022, plus a review of key literature and policy documents.

The contents and conclusions of D5.3 will inform further work of WP5 – Society, Governance and Policy, namely Task 5.2 on Drivers and Barriers for the Implementation of B-WaterSmart Solutions, as well as Task 5.4 – Guidelines and recommendations for policy & regulation for water-smart systems, which has started in February 2022, at the time of submission of this deliverable, and goes until the end of the project in August 2024. This report will also inform further work on proposals for innovative models of governance, in parallel with the Communities of Practice (CoP) of each LL (D5.5).

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Lead beneficiary	**Deliverable author(s)**
Institute of Social Sciences University of Lisbon (ICS-UL)	Carla Gomes (ICS-UL) Rosário Oliveira (ICS-UL) Luísa Schmidt (ICS-UL) Marcella Melo (ICS-UL) Sigrid Damman (SINTEF) Sofía Tirado Sarti (UNED)

Alicante: Ignacio Casals (AMAEM); Laura Flores; Mario Ruiz (CETAQUA)
Bodø: Marit Elveos, Silje Ulriksen Lyngstad (Bodø Municipality)
Flanders: Han Vervaren (De Watergroep); Joris de Nies (Proefstation voor de Groenteteelt); Simon de Paepe (Vlakwa); Birte Raes (Aquafin) Geertje Pronk (KWR)
Lisbon: Alexandra Henriques, Ana Cristina Lourenço (CML); Margarida Rebelo, Rita Ribeiro, Maria João Rosa (LNEC)
East Frisia: Julia Oberdörffer, Kerstin Krömer (OOWV); Alexandra Schmuck, Kristina Wencki (IWW)
Venice: Patrizia Ragazzo, Giulia Moretto (VERITAS); Rita Ugarelli (SINTEF)

Quality assurance	
ICS-UL LNEC KWR	Ana Delicado Adriana Cardoso Stefania Munaretto
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List of Acronyms and Abbreviations

CE	Circular Economy
CML	Câmara Municipal de Lisboa
CoP	Community of Practice
D	Deliverable of B-WaterSmart
DWD	Drinking Water Directive
EC	European Commission
EU	European Union
LL	Living Lab
M	Month
MS	Milestone Report of B-WaterSmart
NBS	Nature-based solutions
RO	Reverse Osmosis
SO	Strategic Objective
T	Task
WFD	Water Framework Directive
WP	Work Package
WWTP	Wastewater Treatment Plant

Executive summary

The present report corresponds to **Deliverable 5.3 of B-WaterSmart – Preliminary Report on Policy and Governance: Drivers and Barriers across 6 European Cases**. Its main objective is to provide an overview of the issues that may hinder or foster the application of water-smart solutions across the six Living Labs of the project, over its duration and beyond.

It starts by providing an overview of the policy framework with implications for water management in the European Union, including the main plans and strategies related to adaptation to climate change and implementation of a circular economy, along the nexus waste-energy-resources-waste. Furthermore, we added a section that describes succinctly the main models of water governance in Europe.

This introductory section aims at helping to interpret the chapters dedicated to the six Living Labs (LLs) of B-WaterSmart: Alicante (Spain), Bodø (Norway), East Frisia (Germany), Flanders (Belgium), Lisbon (Portugal) and Venice (Italy). Each of these LLs has a different technical focus depending on the policy priorities identified for that city or region, as well as the transformation of the environmental, social and economic context over the last few decades.

In some cases, water scarcity is undoubtedly the key challenge to manage, and thus the 34 water-smart solutions under development will concern, for instance, to reusing treated water from Wastewater Treatment Plants (WWTP), including reuse of sludge, a by-product from wastewater treatment. In other cases, nutrient material and energy recovery in industry or agriculture plays a more central role. It is certainly a challenge to address all the policy and governance implications of such different solutions. Therefore, this report is a preliminary overview centred on those drivers and barriers that have been identified by LL owners and mentors as most critical for the application of their technical solutions.

At this preliminary stage, the sources for information were mostly bilateral meetings with LL owners and mentors, as well as workshops carried out in October 2020 and January 2022, plus a preliminary collection and review of the literature (including policy reviews) and policy documents.

The contents and conclusions of D5.3 will inform further work of WP5 – Society, Governance and Policy, namely Task 5.2 on Drivers and Barriers for the Implementation of B-WaterSmart Solutions, as well as Task 5.4 – Guidelines and recommendations for policy & regulation for water-smart systems, which is starting in February 2022 and goes until the end of the project in August 2024. This report consists in a first preliminary version of the policy and governance analysis that will be carried out throughout the Project, especially within Task 5.4. – Guidelines and Recommendations for Policy and Regulation, which started in February 2022 and goes until the end of the Project in August 2024. The analysis of governance models will also proceed, in articulation with the process of stakeholder engagement through the Communities of Practice (CoP) of each LL. This will result in proposals for innovative models of governance at Month 36 (D5.5).

1 EU policy for sustainable water management

Before focusing on the policy context of each Living Lab of B-WaterSmart, this section provides an overview of the key policy strategies driving a smart-water society in Europe. They policy areas to consider are climate action and the circular economy, in line with the **United Nations Agenda for 2030**, the **Sustainable Development Goals** (SDGs) and the **Paris Agreement**. This preliminary review highlights the main points of convergence between adaptation and circular economy policy, as well as water-related EU directives, key European policy strategies that have been updated over the last few years.

Climate change and increasing water consumption are currently the main drivers of water stress in Europe. More prolonged and intense droughts are exacerbating water scarcity, in parallel with a continuous increase in water abstraction and consumption (households, tourism, industry and agriculture). It is estimated that 30% of the European population is already affected by water scarcity (EEA, 2021). Agriculture alone is responsible for around one quarter of water abstraction in Europe. In order to reduce freshwater demand of this sector, the EU recently issued legislation on water reuse in agriculture, which aims to standardise the practise of and minimise the risks related to water reuse across European countries. Conversely, in some regions heavy rains and floods are also occurring more frequently and with increased intensity, which calls for a more integrated and effective management of stormwater and river basins, including across national boundaries.

Water is undoubtedly a key and pressing concern for EU policy at the moment, in line with its **Strategy on Adaptation to Climate Change**, the **Green Deal**, the **Territorial Agenda 2030** and the **'Farm to Fork' Strategy** (aiming to promote more sustainable, fair and more resilient food systems in the EU, while protecting biodiversity). Water is also a critical sector for investment under **New Generation EU** and the national **Recovery and Resilience Plans**, which also respond to the social and economic impacts of the COVID-19 pandemics.

1.1 Water policy: key directives

Regarding water policy more specifically, the key policy instrument is the **EU Water Framework Directive** (2000/60/EC), which establishes a legal framework to protect and restore clean water in the EU and to ensure its long-term sustainable use, ensuring the protection of inland surface waters, transitional waters, coastal waters and groundwater. The implementation of the WFD is supported by 'daughter' directives, i.e. the Groundwater Directive, the Drinking Water Directive and the Bathing Water Directive, the Nitrates Directive, the Urban Waste Water Treatment Directive, the Environmental Quality Standards Directive and the Floods Directive (European Commission, 2022).

The **Groundwater Directive** against pollution and deterioration provides specific criteria for the assessment of good chemical status, while threshold values for pollutants (with the exception of nitrates and pesticides) are set by the Member States.

The **Urban WasteWater Treatment Directive** aims to protect the environment from the adverse effects of urban wastewater discharges and discharges from industry. The directive sets minimum standards and timetables for the collection, treatment and discharge of urban wastewater, introduces controls on the disposal of sewage sludge, and requires the dumping of sewage sludge at sea to be phased out. The revision of this directive was exected in the first quarter of 2022, with an aim to respond to water scarcity by facilitating the reuse of treated wastewater for agricultural irrigation.

The **Nitrates Directive** aims to protect waters from nitrates from agricultural sources, safeguarding drinking water and preventing damage from eutrophication. In its latest implementation report, the EC (2018) stressed that, while water pollution caused by agriculture nitrates has been reduced across Europe over the last 20 years, some areas show persisting pollution and require action.

The **EU Floods Directive** aims to reduce and manage the risks posed by floods to human health, the environment, infrastructure and property. It requires Member States to prepare flood risk maps and management plans focused on prevention, protection and preparedness.

The following sections outline the key current trends in EU and European policy with regards to water policy and governance. We will then discuss how these reflect on the B-WaterSmart Living Labs, in six dedicated chapters.

1.2 Ensuring water availability and quality

In 2012, the Commission launched the **Blueprint to Safeguard Europe's Water Resources**, a long-term strategy that aims to ensure the availability of a sufficient level of quality water for all legitimate uses by better implementing current EU water policy, integrating water policy objectives into other policy areas. It envisages the establishment by the Member States of water accounts and water efficiency targets, as well as the development of EU standards for water reuse, such as the EU regulation (May 2020) establishing minimum requirements for water reuse in agricultural irrigation (which follows the ISO standards 16075 series)[1].

The revised **Drinking Water Directive of 2020**, which replaces the previous directive of 1998, has its origins in the citizens' initiative 'Right2Water' and defines essential quality standards for water intended for human consumption. The revised Directive was adopted by the European Parliament on 15 December 2020, entered in force on 12 January 2021, and the Member States have two years to transpose it into their national legislation, until early 2023. It requires Member States to regularly monitor the quality of water intended for human consumption, as well as reduce plastic waste. Member States can include additional requirements specific to their territory but only if this leads to setting higher standards. Other key focus of the directive are transparency and equity: it requires the provision of regular information to consumers, as well as improving access to drinking water in public spaces and introducing mechanisms for risk assessment.

[1] Standards issued by the International Organization for Standardization (ISO), for instance for quality management, health and safety or environmental management.

While welcoming the advancements of the new revised directive, the European Economic and Social Committee has pointed out some aspects where they believe EU policy has to go beyond, in improving access to drinking water for consumers – in accordance with the WHO guidelines (EESC, 2018):

- ***safety**: the tolerance values must be observed;*
- ***acceptance** with regard to colour, smell and taste of water;*
- ***accessibility**: water and sanitation facilities should be in close proximity to the home, school, workplace or health institution;*
- ***water costs** should not exceed 3% of household income (United Nations Development Programme - UNDP). The Committee calls on Member States and the Commission to monitor price developments and price transparency;*
- *citizens should also be **motivated to drink tap water**, and for this it is important to guarantee its safety and raise awareness with clear and easily understandable information.*

Regarding water scarcity, the **EU Climate Adaptation Strategy (2021)** acknowledges that this is one of the critical areas where the adaptation gap has been widening. Besides more frequent and prolonged droughts, climate change is also expected to increase the risk of contamination and pollution of freshwater, due to low river flows, increased water temperatures, flooding and forest loss. Therefore, it will be crucial to include climate impacts in the risk analyses of (drinking) water management plans, develop water-monitoring technologies, and ensure minimum river flow.

Integrated management of water flows has other complementary advantages in terms of adapting to warmer temperatures and increased resilience to heatwaves, such as solutions for local water retention, green roofs and walls that reduce the urban heat island effect (European Commission, 2021a). The Green Deal and the national Plans for Recovery and Resilience (2021) have highlighted Nature-Based Solutions (NBS) as particularly well suited for improving resilience of water resources.

Furthermore, climate change emphasizes the challenge of sharing water resources, and certainly will require a stronger cooperation between adaptation action and water management authorities, including transboundary cooperation.

The **European Climate Law** entered into force on 29 July 2021 and writes into law the goal set out in the European Green Deal “for Europe’s economy and society to become climate-neutral by 2050” (European Commission, 2021b), setting the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030 (in relation to 1990). The law aims to ensure policy integration across sectors towards this goal, while providing a stable legislative framework for investors and other economic actors and developing a system for monitoring progress and taking further action as needed. It will also inform the 2023 Global Stocktake of the Paris Agreement and the UN Convention for Climate Change (UNFCCC).

The new Drinking Water Directive supports the provision of more transparent information on consumption and tariffs, raising awareness of the impact of different household practices throughout the year and the real value of water as a resource, including the costs of treatment. This will be typically undertaken through digital applications and the so-called ‘smart-meters’.

Smart metering is a touchstone of sustainable water policies and is therefore one of the key tools for the solutions demonstrated by the B-WaterSmart LLs. It provides detailed and transparent information on water consumption from different economic sectors, as well as households, supporting changes in consumption behaviour and the management of competing demands in scenarios of water scarcity.

1.3 Implementing circularity

In line with more recent tendencies in environmental policy, the EU has also launched a new Action Plan for Circular Economy ("For a cleaner and more competitive Europe") (EC, 2020a), in support of the European Green Deal, which is especially relevant for promoting wastewater reuse and recovery of nutrients from wastewater treatment, as well as the EU Taxonomy (EC2020b), a classification system establishing a list of environmentally sustainable economic activities. In this context, there is an alignment between the objectives of the EU taxonomy (climate change mitigation and adaptation; sustainable use and protection of water and marine resources; transition to a circular economy; pollution prevention and restoration of biodiversity and ecosystems), towards a water-smart society.

While the paradigm of the circular economy is fairly recent, as an explicit political strategy across Europe, the integration of the water sector in these policies is even more recent. Fidelis *et al.* (2021) reviewed the circular economy action plans of nine European countries (including Germany, Italy, Spain and Portugal) to conclude that concerns with water (and land) were still not well integrated into CE policy, both at the EU and national levels. Wastewater treatment for water reuse is frequently mentioned in the southern national action plans (Spain, Portugal, Italy, and Greece), where there has been pressure from water scarcity since longer and is already practised for agricultural irrigation in some countries (e.g., Malta).

The focus of circularity policy has been on solid waste management, and even in the most recent **Action Plan for Circular Economy (2020)** the references to water management are still scarce. Yet, the plan highlights the key strategic policies to foster water reuse across the EU over the coming years: the new **Water Reuse Regulation**, which "will facilitate water reuse and efficiency, including in industrial processes" and the future **Integrated Nutrient Management Plan**, "with a view to ensuring more sustainable application of nutrients and stimulating the markets for recovered nutrients". Furthermore, the European Commission envisages to "consider reviewing directives on wastewater treatment and sewage sludge, as well as assess natural means of nutrient removal" (e.g., algae).

Another front where water and waste management are expected to converge is the monitoring and support to the requirements of the Drinking Water Directive to make drinkable tap water accessible in public places, which will then reduce dependence on bottled water and prevent packaging waste (European Commission, 2020).

1.3.1 Water reuse

Water reuse is one measure to combat water scarcity on a global level. According to the United Nations Global Assessment Report on Disaster Risk Reduction (GAR) on droughts, water scarcity is a global and complex threat that will require new approaches of governance to adapt, prevent and mitigate droughts (UNDRR 2021). Water recycling is identified as one measure that can help to alleviate the risk of droughts. Water recycling and water reuse are further mentioned under sustainable development goal (SDG) 6 target 6.3 (Water quality and wastewater) and are linked to target 6.4 (water use and scarcity). Water reuse and recycling are identified as complementary measures to the reduction of freshwater withdrawals and the improvement of water use efficiency (UN Water 2017).

Water reuse is commonly and successfully practiced in, for example, Israel, California, Australia, and Singapore, but it is so far deployed below its potential in the EU. Limited awareness of potential benefits among stakeholders and the public, as well as lack of a supportive and coherent legislative framework, have been identified as two major barriers preventing a wider spreading of this practice in the EU. In the 2015 Communication 'Closing the loop – An EU action plan for the Circular Economy' (COM/2015/614), agricultural irrigation and aquifer recharge were identified as main potential sources of demand for reclaimed water, with the greatest potential for higher uptake, scarcity alleviation and relevance in the EU (JCR, 2017). Water reuse is already practiced in some EU member states: Malta reuses 60% of their wastewater, while Spain and Italy reuse around 5-12 % of their effluents (DG Environment, 2022). Prior to the EU regulation on water reuse, there was however no overarching regulatory framework directly addressing water reuse.

In 2018, the Commission proposed a regulation to boost water reuse when it is cost-efficient and safe for health and the environment. In 2020 the **regulation on minimum requirements for water reuse** (REGULATION (EU) 2020/741) entered into force and will apply from June 2023. The regulation is limited to the reuse of treated urban wastewater and agricultural irrigation. It establishes minimum requirements for water quality and monitoring, as well as provisions on risk management for the safe use of reclaimed water in agricultural irrigation. Up until then, already practised water reuse was governed by national regulations, which may have differed in terms of water quality requirements, monitoring standards and risk management approaches. By harmonising water reuse across the Member-States, the EU establishes homogenised market conditions for agricultural products, while increasing public and environmental safety. Although current regulation is limited to urban wastewater and agricultural irrigation, the Circular Economic Action Plan highlights the intentions of the EC to facilitate water reuse also in other sectors, such as industrial processes.

All in all, with the new regulation the EU has responded to the global trend that identifies water reuse as one alternative and reliable source of water supply, having provided a framework for national regulations such as to ensure environmental and human protection.

1.3.2 Recovery of nutrients: agriculture and industry

The **Circular Economy Action Plan** (EC, 2020a) promotes the reuse, recycling, and recovery of waste. In this framework, Directive 2018/851/EC provided a waste hierarchy that shall apply as a priority order in waste prevention and management legislation and policy: prevention (e.g., minimization techniques), preparing for reuse (e.g., chemical or biological stabilization), recycling (e.g., matter recovery), other recovery (e.g., energy recovery), and disposal (e.g., landfilling) (Collivignarelli, 2019).

In this context, WWTPs can play an important role in circular sustainability due to the integration of resource and energy recovery. For example, sewage sludge from WWTPs can be treated to produce biosolids for its application on agricultural land. Co-digestion of sewage sludge with other biodegradable waste is another option which provides a range of economic and environmental benefits (Neczaj & Grosser, 2019).

Making the most of circular synergies will be key for nurturing the soils. One of the main objectives of the EU Farm-to-Fork Strategy (COM (2020)381, 20th May 2020) is to manage soil nutrients more sustainably, particularly nitrogen and phosphorus. The strategy aims at reducing nutrient losses by at least 50%, while ensuring that there is no deterioration in soil fertility. This will reduce the use of fertilisers by at least 20% by 2030. The EC is working on an Integrated Nutrient Management Plan (nutrient recovery, renewable fertilisers), as well as promoting more sustainable practices for agriculture and livestock. Member States should include these principles in their CAP Strategic Plans[2], through tools such as the Farm Sustainability Tool for nutrient management.

Implementing a water circular economy will certainly require considerable investment and financial support, especially in the wake of the COVID-19 pandemics. A recent report states that not all EU countries have taken the opportunity of the national recovery and resilience plans (NRRP) approved within Next Generation EU to maximise synergies and invest in smart-water solutions (Water Europe, 2021). Direct investment in water innovation represents only 6 to 7% of the total funding available for each country (though water-related measures may be 'hidden' in cross-cutting investments).

Nevertheless, the report highlights Belgium and Italy as good examples of resilience plans that consider the value of water across various sectors, including the industrial one. The potential for water reuse has also been considered in the Spanish and Portuguese plans, which are also highlighted as a good example of transboundary cooperation (water and biodiversity protection), which is generally underestimated in the national plans reviewed. Other area that should receive more financial support in these plans is the development of digital solutions for water management, according to the same report.

[2] National plans for the implementation of the Common Agricultural Policy (CAP), which address the specific needs of each EU country while delivering tangible results in relation to EU-level objectives and contributing towards the European Green Deal.

1.4 Water governance in Europe

Although water is a public good, meaning that access to it is in principle free, in practice its management involves complex technical operations and sophisticated infrastructures provided by the private sector, which implies significant costs and structures of management. The governance of water resources and services, including supply of fresh water, distribution and treatment, differ from country to country due to history, cultural heritage and national or local traditions, which result in specific regulatory frameworks.

There is a diversity of management models, organisational structures, tasks and responsibilities of the players involved at the different levels of governance (EU, national, regional or local). Over the last two decades, water management evolved from a model that was mostly public in nature, to the emergence and development of a private sector (EurEau, 2020).

The supply of drinking water and the collection and treatment of wastewater go under the definition of 'water services' in all European countries. In a few countries, flood protection and reclaimed water provision is also carried out by water service providers.

Four main management models may be distinguished across Europe (EurEau, 2020):

- ***Direct public management:*** *under this system, the responsible public entity is entirely in charge of service provision and their management. In the past, this system was predominant in Europe.*

- ***Delegated public management:*** *under this system, a management entity is appointed by the responsible public entity to carry out the management tasks. Management entities usually retain owned by the public sector, although in the EU, in some cases, there is the possibility of a minor private shareholding.*

- ***Delegated private management:*** *under this system the responsible public entity (usually a local government) appoints a private company to manage tasks, on the basis of a time-bound contract in the form of lease or concession contract. In the countries where this type of management is common, municipalities subcontract their duties to private companies. The ownership of the infrastructure remains under the public domain.*

- ***Direct private management:*** *under this system all management tasks, responsibilities and ownership of water services are placed in the hands of private operators, while public entities limit their activities to control and regulation. There are two options. One is that the responsible public entity designates a private company to manage the tasks under a lease or concession agreement but maintains public ownership of the infrastructure. The other is that all management tasks, responsibilities and ownership of water services, including infrastructure, are in the hands of private operators. This system is in place in very few European countries (England, Wales, and the Czech Republic).*

According to the EurEau report 'The governance of water services in Europe', the public management model is the most common in Europe. Considering the countries involved in B-WaterSmart: in Belgium, water services (including wastewater treatment) are a public responsibility, but in Flanders there is private involvement in wastewater treatment. In some countries where public management is also the predominant model, private companies participate in water services through a mixed model or delegation in private management (this is the case of Germany). In Italy, about half of the population receives services through a delegated public management model, and the other half through a mixed model. In Portugal about one fourth of the population receives services through public-private partnerships. In this regard, we should note that direct private management of the water services is not contemplated in the Portuguese legislation. Norway follows the public model.

The monitoring of the quality of drinking water is generally a responsibility of health authorities (Ministry of Health and their respective regional/local bodies). The protection of water resources and the setting of environmental standards are usually the competence of the Ministry of the Environment and/or River Basin authorities and/or regional authorities as well as national environmental agencies (EurEau, 2020).

An independent regulator ensures compliance with legislation for water quality. Depending on the country and on how services are organised, customers also have access to fora where they can file a complaint: the water utilities customers' service, the municipalities, consumers' boards, national regulators, ombudsmen, arbitrations and courts.

In terms of bottom-up engagement of the civil society in water governance, the European Citizens' Initiative (ECI) 'Right2Water' is certainly a good and recent example. The Europe-wide movement originated in 2013 and prompted the revision of the EU Drinking Water Initiative, becoming the first ever successful ECI, with 1.9 million signatures collected. In its essence, it is opposed to water privatisation and has sought to push for Europe's legal enforcement of the Human Right to Water and Sanitation (HRWS). The European Commission subscribes that 'water is a public good, not a commodity', however this is a contentious matter of governance that will drive much of the policy debate and the society involvement in water policy over the next few years (van der Berge et al., 2021), and especially as new standards of water quality and circularity require sigificant investment and an ever-stronger involvement from technology providers.

Inequalities in water access by the most vulnerable groups in society have been dealt with, as the private sector gains influence in the sector, through corrective policies such as social tariffs. The EU revised Drinking Water Directive includes provisions to improve free water access in public spaces, restaurants and canteens, as much as possible. It also considers the situation of particular social groups, such as cultural minorities. The European Parliament, in its resolution of 8 September 2015 on the follow-up to the European citizens' initiative Right2Water, requested that Member States pay special attention to the needs of vulnerable groups in society, such as refugees, nomadic communities, homeless people and minority cultures such as Roma and Travellers. The resolution urged Member States to take measures to improve water access for vulnerable social groups, but Member States retain the right to define who they are in their territories. The solutions can, for instance, include providing alternative supply systems, such as individual treatment devices, providing water on wheels through the use of tankers, such as trucks and cisterns, and ensuring the necessary infrastructure for camps.

2 Alicante

2.1 Key challenges and features of this Living Lab

Table 1 - Key features of LL Alicante

Key challenge & objectives	***Boost sustainability and circular economy around water, through water reuse and resource recovery*** • Turn a **wastewater treatment plant** into a **biofactory**: recovering minerals, nutrients & salts, and saving energy; • Demonstrate a **smart water allocation & negotiation tool** to boost water reuse at the municipality level; • Identify key actions and investments to boost **water reuse**, involving stakeholders in the process.
Technologies & tools	• Ammonia evaporation CEVAP (#9) • Oil and fat co-digestion (#10) • Microturbines for energy recovery (#13) • Re-Actor allocation & negotiation tool for water reuse (#18)
Key legislation applicable to the LL water-smart solutions	• Ley das Aguas, 1985 • Royal Legislative Decree 2001 (revised Water Act)
Regulatory instruments	• Art. 272 of the RDPH (Reglamento del Dominio Público Hidráulico) is the main regulation applicable to water reuse

In Alicante, which relies mostly on distant groundwater sources for drinking water supply, reclaimed water is essential to manage the impacts of droughts in the region (García, 2018). In the case of reclaimed water, salinity and seasonality can be technical barriers for a greater utilisation. Seasonality is an important challenge. In winter there is insufficient demand to cover supply, whilst in summer part of the demand for agricultural and other uses cannot be covered (Ricart et al., 2019). AMAEM's (municipalised waters of Alicante) responsibility must be to ensure that no reclaimed water is wasted, rather than providing reclaimed water to everyone.

Projects such as B-Water Smart and **'Alicante Agua Circular'** ("Alicante Circular Water") have been developed to achieve the goals proposed by the official documents to combat water scarcity in the territory and decrease the dependence on water from distant sources. From a first preliminary study, some potential circularities have been detected in the water-energy-resources-waste nexus. Those

circularities are related to reclaimed water production, energy production from sludge and water treatment and raw materials recovery from wastewater treatment.

A key objective of "Alicante Circular Water" is to improve the quality of the bay's water by eliminating discharges, which will benefit tourism and encourage water reuse. For this, technical and infrastructure improvements must be made to intensify the use of the existing water, thus guaranteeing a second life for available water resources. The goal is to achieve 100% of reuse of Alicante's treated water and zero dumping in the coastal area. In addition, the plan aims to provide the agricultural sector with new quality flows at an affordable price, which will involve the construction of a solar plant.

2.2 Policy framework

At national level, the two key strategies with relevance to smart-water innovation are the Nacional Plan of Adaptation to Climate Change (Plan Nacional de Adaptación al Cambio Climático 2021-2030) (Gobierno de España, 2021), which aims at making cities and regions more resilient to various socio-environmental challenges in the face of climate change. Besides this plan, there is the Spanish Circular Economy Strategy, which aims to develop instruments to produce an economy where cycles are integrated, complement each other, and facilitate a more efficient management of resources (Ministerio para la Transición Ecológica y el Reto Demográfico, 2021).

The **National Climate Change Adaptation Plan 2021-2030** assesses the ecological, social, and economic impacts and risks derived from the effects of climate change on water resources and associated aquatic ecosystems. It intends to deepen the integration of climate change into hydrological planning and management of the integral water cycle, prioritizing the management of extreme events (droughts and floods). It also seeks to reduce risk, promoting sustainable adaptation practices aimed at multiple objectives, in terms of water use and management, as well as extreme events. And finally, it aims to strengthen the collection of key parameters to monitor the impacts of climate change on the hydrological cycle, water use and extreme events.

The **Spanish Circular Economy Strategy** aims to improve water use efficiency by 10%. The strategy plans to improve the efficiency of water use cycles through water policy instruments, such as hydrological planning and sustainable management of water resources. Much of the circularity in water is achieved through improvements in effluent treatment, which simultaneously allows the recovery of materials in the form of nutrients such as nitrogen, phosphorus, and magnesium in the dewatering processes of digested sludge from the Wastewater Treatment Plants (WWTP), for its possible subsequent use as fertilizer.

2.2.1 Legislation applicable to 'water-smart' solutions in this LL

Specifically, regarding water, in **2001, the Royal Legislative Decree** approved the revised text of the Water Act (Ley de Aguas, 1985) (Ministerio del Ambiente, 2001). It is the main legislative document providing a framework for the laws regarding water management and governance at national level. The water law also deals with the protection of water bodies, coastal areas, and transition areas. Complementing this document, there are policies that range from concessions and authorizations regarding the private use and wastewater, the status and quality of water in the Spanish territory, the evaluation of water resources, the delimitation and restoration of the public hydraulic domain, flood risk management, dams and reservoir safety, to hydrological planning and the creation of national observatories.

The **Water Act** sets the definition of the public hydraulic domain and goes on to point out the general principles of the public administration of the resource. An important part addressed are the objectives and criteria for hydrological planning to achieve a good status and adequate protection of the public hydraulic domain, the satisfaction of water demands, the balance and harmonisation of regional and sectorial development, for a greater availability of the resource, protecting its quality, economizing, and rationalizing its uses in harmony with the environment and natural resources. The document includes regulations for authorisations and concessions of use. Population supply stands out as the prior goal of water use, followed by irrigation and industrial uses.

Table 2 - Key policy instruments (Alicante)

Policy documents	Source
España Circular 2030 - Estrategia Española de Economía Circular	Ministerio para la Transición Ecológica y el Reto Demográfico: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/economia-circular/espanacircular2030_def1_tcm30-509532.PDF
Plan Nacional de Adaptación al Cambio Climático 2021-2030	Ministerio para la Transición Ecológica y el Reto Demográfico: : https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico
Real Decreto Legislativo 1 / 2001, de 20 de julio , por el que se aprueba el texto refundido de la Ley de Aguas.	Boletín Oficial Del Estado, 1–60. www.boe.es/buscar/pdf/2011/BOE-A-2011-17887-consolidado.pdf
Reglamento del servicio Municipal de Alcantarillado, (2009)	Reglamento_Alicante_Prestacao servico.pdf. (n.d.).

2.2.2 Regulatory issues

With the entry into force of the **Royal Decree 1620/2007**, a series of measures were introduced to establish the legal regime for the reuse of treated water in Spain. The aim is to increase the availability of water resources by allowing the use of treated wastewater as an alternative resource in certain sectors, and thus achieve a 35% increase in the use of reuse water in the coming years.

Any action or use in the public water domain, except for the use of surface water while it flows through its natural channels for drinking, bathing and other domestic uses, as well as for watering livestock, is subject to a system of administrative concession, authorization or responsible declaration regulated by specific regulations, the processing of which generally corresponds, in the intercommunity basins, to the hydrographic confederations, more specifically to the Water Commissions.

An Authorization is also needed for wastewater discharges. All wastewater discharges must have the corresponding permission, the purpose of which is to achieve the established environmental objectives. Wastewater is subjected to a purification process prior to discharge to ensure the least possible impact on the receiving body of water (Reglamento Del Servicio Municipal de Alcantarillado, 2009).

Art. 272 of the **RDPH** (Reglamento del Dominio Público Hidráulico) in its section 2 and following, defines the concept of reuse of treated water. In all cases of direct reuse of sewage, a report from the health authorities, which will be binding, will be collected by the basin authority. The concession titles may incorporate the conditions of protection and rights of both users. Art. 273 of the RDPH determines the conditions and procedures for the concession of water reuse, depending on whether this reuse is done by the first user or by a third party.

2.2.3 Funding available for water innovation

Regarding financial support for investing in water innovation, a review from Water Europe (2021) noted that water-related components account for around 7% of the funding in Spain. On the other hand, the Spanish plan has been complimented for giving emphasis to ecosystem conservation/restoration and supporting joint projects with Portugal for the management of transborder water courses.

2.3 Governance model

Spain's water management system brings together the common efforts of Public Administrations and private enterprises, and it has been and continues to be a source of inspiration for other countries, in the Mediterranean region as well as in other areas that face similar water management challenges

(Gobierno de España, 2014). Water-resource planning based on river basin districts was formally instituted in the Water Act of 1985 (Ley de Aguas de 1985), with the European Union adopting it for Europe as a whole with the establishment of the Water Framework Directive.

The Spanish state determines national laws, but autonomous communities are responsible for the management of water basins in their territory. The state can intervene in the case of basins that cross territorial borders (regional or national). The management of the basin is the responsibility of the local authorities, together with the group of users and water utilities. The National Water Council plays the role of a consultation and participation body.

The Basin bodies are those directly involved in water management. They are independent and are formed by the president and the boards of government, which are basically made up of representatives of five different ministries and users, as well as representatives of some autonomous communities (Article 27 of the Water Act). The organisation in groups (Juntas) is very present in the Spanish management model. When a basin is in more than one autonomous community, representatives from the different regions make up the group, thus creating a relationship and sharing the management of the resource. They are responsible for the creation of the basin's hydrological plan, the administration and control of the public hydraulic domain, and the projects developed in the region. In this way, conflicts over the use of water cease since their representatives are working together (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020).

The Spanish government has released a catalogue with four different areas on which its governance principles are based: water resource planning, sustainable management, service efficiency, and security for citizens - four groups that describe a system of good governance, with a high level of technology and innovation, built on modern infrastructure systems.

The Spanish Water Management System seeks to guarantee adequate sustainable management of water, based on what has come to be referred to as “GIRH”, *gestión integrada de recursos hídricos* or integrated management of water resources. The management of water in Spain is based on a single hydrological cycle and in the key principle that all continental waters, regardless of their origin, have the same legal consideration (Gobierno de España, 2014).

Water is considered a public resource, whose ownership is always exercised by the Public Administration. The idea is to guarantee service effectiveness in some different front such as collection and regulation of water (surface and groundwater), drinking water treatment, desalination, water transport, sewerage and wastewater treatment, regeneration and reutilization of treated water, power generation from water, integrated management and modernisation of irrigated farmland, systems for integrated cycle management and citizen services.

Water utilities, as managers of the integral water cycle, are responsible for the quality of the water up to the point of supply (deposit or irrigation ponds in the case of agriculture). There is a close collaboration with the business sector. For the Alicante LL, the public organism in charge of providing water reuse permits and monitor effluent and water body qualities is the regional basin Cuenca Hidrográfica del Jucar (CHJ). EPSAR (Entidad Pública de Saneamiento de Aguas Residuales de la Comunidad Valenciana) is the regulator body in charge of the wastewater treatment of the region.

In order to involve the main users and the community at the local level, the Spanish Water Act establishes the obligation to constitute user communities (Chapter IV, Art 81 Water Act, 1985). The

statutes or ordinances is drawn up and approved by the users themselves and must be submitted for administrative approval.

Finally, Spain's water management system seeks to provide water security, which means the security that the infrastructure in place is sufficient to guarantee adequate water in terms of quantity and quality for each use in all parts of the country. These infrastructures are also able to respond to extreme weather phenomena, such as floods and droughts, which is another dimension of security that Spain's Water Management System must provide.

2.4 Summing up: key drivers and barriers for this LL

While public policies have been providing increasing support for circular economy and adaptation, in the country and in the province, some regulatory barriers are acknowledged from the start. These will have to be overcome, to make the most of the synergies and resources available for circularity. Regulation has been more focused on water quality, and when it comes to getting permission for water reuse it becomes quite complex (Jodar-Abellan *et al.*, 2019). Reuse of sludge is another solution that Alicante aims to implement in the local community, but at an initial phase there are also regulatory barriers to its valorisation, which may imply increased costs for treatment (Hidalgo *et al.*, 2017).

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3 Bodø

3.1 Key challenges and features of this Living Lab

Table 3 - Key features of LL Bodo

Key challenge & objectives	**Challenge**: become a low-mission society and a sustainable city and developed the city's resilience to climate change • decrease leaks from the drinking water network • decrease infiltration on the wastewater network • boost efficiency of potential water use • increase energy recovery • reuse excess heat • increase resilience to climate change
Technologies & tools	• Small-scale biogas production at small WWTPs or other alternative ways of generating energy from wastewater (#12) • Smart water meters for leak detection (#15)
Key legislation applicable to the LL water-smart solutions	• Drinking water regulations: https://lovdata.no/dokument/SF/forskrift/2016-12-22-1868 the water directive: https://www.vannportalen.no/
Regulatory instruments	• Regulation on the limitation of pollution (Pollution Regulation), FOR-2004-06-01-931, Department of Climate and Environment • GDPR (data protection), with implication to data collection from smart meters

Norway has abundant sources of good quality drinking water, which only require minimal treatment, and there is generally a low involvement of citizens in issues related to water management. However, a general focus on sustainable use of resources also affects watermanagement. Southern Norway has had periods of drought, which can also affect the northern areas of the country. An increasing focus has been placed on water capacity and water quality.

The Bodø LL in B-WaterSmart envisages to support a new, more participatory, paradigm of integrated water resource management, by developing blue-green solutions and green infrastructures with no non-potable use of drinking water. This involves mapping water needs against the available amount of surface water in the area of the old airport, which is to be relocated. One of

the objectives is to calculate the available amount of surface water in Bodø throughout one year, through a water balance model, in order to have information on the available volume at any given time. Another one is to develop a plan for the new district, based on blue-green infrastructures.

Bodø's main water source is located 26 km from the city centre, surrounded by mountain landscapes. It is a clean and good source located in an area with little human activity. Most of the distribution is automatic due to height difference. However, within the city water is distributed via pumps. In order to save energy in water supply, Bodø LL envisages to reduce water usage as well as leakages.

The maintenance of water distribution networks has been one of the key issues requiring attention in LL Bodø. Additional measures are required to prevent contamination (e.g., Ecoli), as well as raising consumer's knowledge about water and sewage. There are several cases of both leaks and sealing of drainpipes due to lack of knowledge on the part of the user.

3.2 Policy framework

Although Norway is not a EU Member-State, national strategies and directives are well aligned with the priorities of EU policy in terms of climate adaptation, water management and circular economy. The activities of LL Bodø in B-WaterSmart will support existing legislations, platforms and initiatives (e.g., reduction in carbon emissions (**National Climate Plan** (Meld. St. 13 (2020-2021), recovery of energy (national energy policy (Meld.St. 36 (2020-2021), as well as national stormwater regulations and the strategies for water, runoff and wastewater management recommended by the Norwegian Environment Agency). Some changes would be needed to mandate the use of the tools developed in the project, but there are current and near future activities, regionally and nationally, that follow up on these activities.

Regarding circular economy policies, the Government's ambition (stated in the **National Strategy for the Circular Economy (2021)**), is that Norway can play a pioneering role in the development of a green, circular economy that makes better, more efficient use of resources, by further developing circular policies both nationally and in cooperation with the EU. This includes specific action for the sectors that have been identified as having the greatest potential for circularity and green competitiveness in Norway: the bio-based sectors; the process industries; construction and buildings; and service industries, including retail and wholesale trade.

The "Circularity Gap Report" estimates at 2.4 % Norway's circularity rate, below the global average (8.6 %), but could see a 20-fold increase in its circularity by restructuring the country's business and industry (Circle Economy, 2020). Norway consumes 235 million tonnes of materials - metals, fossil fuels, biomass and minerals - each year. 97.6 % of these materials are never cycled back into the economy. The Bodø LL will also invest in creating circular synergies, for instance by using sludge for energy production, and therefore prevent disposal of this by-product from wastewater treatment.

The investment in nature-based solutions across green and blue infrastructures has been highlighted in key strategies and plans for sustainable development in Europe. In Norway, a **national planning**

guideline (SPR) for climate and energy planning and adaptation, of 2018, states that Nature-Based Solutions (NBS) always shall be considered, and where not selected proper justification must be provided. There are however some gaps in policy and regulation that have to be overcome, in order to facilitate investment in NBS. There is a need to develop standards for operation and maintenance of such infrastructures, and also create financial opportunities to incentivise these investments. Other aspect that is relevant for the Bodø case is land ownership, as most areas with potential for green-blue infrastructures are not owned by the municipality.

The municipality has a **master plan for sewage (2019-2026)** and a **masterplan for drinking water (2016-2019)** that are revised every four years. A new **plan for stormwater (2022 – 2026)** is under public consultation and is expected to be adopted in June 2022. The purpose of the stormwater plan is to clarify local issues and provide examples of possible solutions according to the principles of local management, as well as to ensure solid an environmentally solution.

Bodø is a partner in the centre for research-based innovation project ZEN (Zero emission neighbourhoods) https://fmezen.no (2015-2023), where energy efficient and smart sustainable resource utilization are in focus. Bodø is also a partner in the research CIRCULUS and City Loops. Both projects aim to reuse masses, both concrete from existing facilities at the military airport and general mass handling in a circular economy. The aim is that new buildings in the former airport district will be sustainable.

Within B-WaterSmart, the Bodø LL aims at preventing leakages and controlling water consumption through the installation of smart meters. The leak detection coupled with smart water meter technology will be partly installed on infrastructure owned by the city, and partly in private residences.

3.2.1 Legislation applicable to 'water-smart' solutions in this LL

A number of national directives have been laid down for the purpose of protecting water bodies. The national **Water Framework Directive** forms a superstructure for all these directives. The directive covers all freshwater, groundwater and coastal water up to one nautical mile outside the baseline. The Directive shall contribute to the preservation, protection and improvement of water bodies and the aquatic environment and ensure the sustainable use of water resources. The Water Framework Directive is implemented in Norway through the **National Water Regulation** (Vannforskriften), since 2008. The legal basis for this Regulation includes the **Norwegian Water Resources Act**, the **Planning and Building Act**, the **Pollution Control Act** and the **Biodiversity Act**. In 2019, the government issued a set of national conditions to ensure that the effort to follow up regional water plans is increased so that the targets of the Water Framework Directive can be reached.

Table 4 - Key policy instruments (Bodø)

Legislation	Source
National water directive	https://www.vannportalen.no/
Water Resources Act (2000)	https://www.regjeringen.no/globalassets/upload/oed/vedlegg/lover-og-reglement/act_no_82_of_24_november_2000.pdf
Drinking water regulations	https://lovdata.no/dokument/SF/forskrift/2016-12-22-1868
Pollution regulations:	https://lovdata.no/dokument/SF/forskrift/2004-06-01-931
GDPR (data protection)	https://www.datatilsynet.no/regelverk-og-verktoy/lover-og-regler/

3.2.2 Regulatory issues

At this stage regulatory issues for the Bodø solutions are not fully explored. The legislation for data protection might eventually constitute a barrier to smart meter use.

For the development of green-blue nature-based solutions (NBS), land ownership will be a crucial issue, that may operate as a barrier if not adequately addressed. NBS require large tracts of land and will involve e.g., water courses that are not under the municipality control. But it is fundamental to make the blue-green infrastructure an integral part of the wastewater system, so that maintenance can be financed with laid-down costs (*selvkost*) like the rest of the infrastructure.

3.2.3 Funding available for water innovation

Klimasats is a national support scheme dedicated to climate measures in municipalities and counties, providing cofunding for projects that reduce climate gas emissions and contribute to transition to a low-emission society. Support is provided both for implementation, planning, networking and experience-sharing, and assessment of measures.

For climate and energy related innovations, funding may also be sought from Enova, a state enterprise aiming to reduce climate gas emissions and stimulate development of energy and climate technology. Furthermore, water innovation projects may be supported by Innovation Norway's grants for environmental technology (Miljøteknologiordningen), whereby the State assumes part of the risk for companies developing, building and testing environmental technology.

Water innovation can also be supported through innovation, research and competence projects under the Research Council of Norway, which has a strong focus on climate and sustainability transition. However, there is no funding programme specifically targeting water challenges. Although not a Member-State, Norway is part of the European Economic Area (EEA) and therefore eligible for innovation and research funding through programmes such as Horizon 2020 and JPI Water.

3.3 Governance

Figure 1 shows how water governance is organised in Norway. The Ministry for Climate and Environment has the main responsibility at ministerial level, while Norwegian Environment Agency follows up in relation to 11 water regional authorities (VRMs) and 105 local water areas, which are defined according to catchments and therefore in most cases intermunicipal. The water areas aim to ensure coordination and collaboration across sectors, scales and levels.

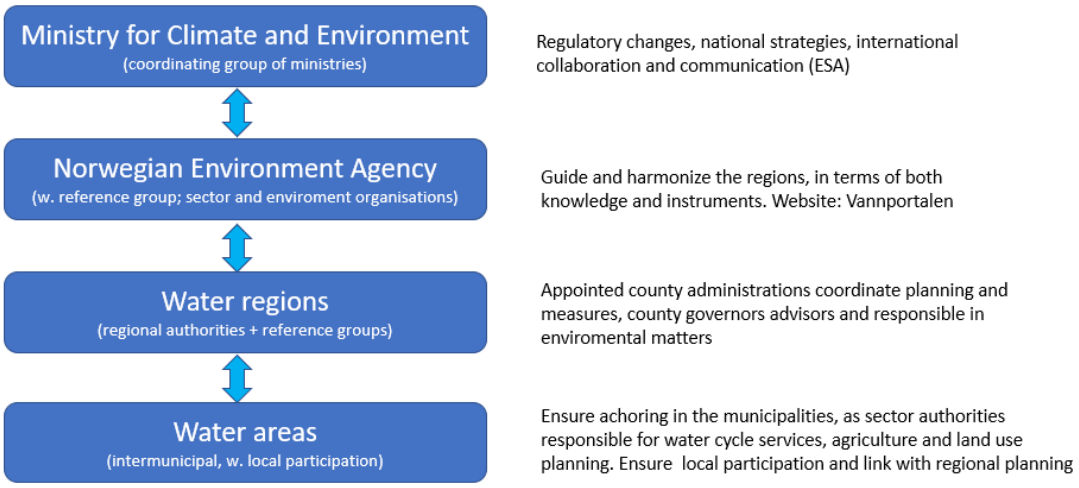

Figure 1: Water governance in Norway

(Adapted from www.vannportalen.no)

The provision of water cycle services is under the responsibility of the municipalities, which also mostly own the infrastructure and facilities. Some municipalities have organised their water and wastewater management in co-owned intermunicipal companies, but in many cases the utility is an integral part of the municipality.

About 2,500 municipal wastewater treatment plants have been built in Norway, 400 of which have discharge permits from the County Governors. The municipalities are responsible authorities for the rest, that is to say for populated areas of fewer than 2,000 person equivalents in the case of

discharge to fresh water and fjord outlets, and of fewer than 10,000 for discharge into fjords and coastal waters. There are also about 350,000 treatment plants for approximately 800,000 people who either live in sparsely populated areas or have cabins. For these too, the municipality is the pollution control authority. Most wastewater treatment plants in Norway were built during the period 1970 to 1985.

In Bodø, the municipality owns and operates the water network. The Norwegian Food Safety Authority is the supervisory authority for the water network, while the county governor is the supervisory authority for the sewage network.

The Norwegian Food Safety Authority supervises the drinking water, and is responsible for approval, inspection, and emergency preparedness. Iris, the intermunicipal waste company in the region, treats the sludge from WWTPs.

The owner of the WWTP is responsible for complying with the drinking water regulations. Most of the plants in Norway are owned by the municipalities, as well as the infrastructure for drinking water supply.

A matter that will require further policy refinement and institutional coordination over the next few years is stormwater management. As extreme climate events increase in frequency and intensity, namely flood events, there will be a need for a more integrated management and a clarification of responsibilities over stormwater flows.

3.4 Summing up: key drivers and barriers for Bodø

The key goals for Bodø are to find local-based solutions towards a low-emission society and sustainable, as well as develop the city's resilience to climate change. In the water and wastewater field there is potential for energy savings and energy recovery. It is also a possibility to adapt to climate change by using nature-based solutions, which is both environmental and economically sustainable.

Barriers for Bodø include challenges in finding solutions that are cost-efficient in a town of 50.000 inhabitants, and for instance several geographically spread-out plants for treating wastewater. Areas fit for the use of NBS for treating surface water are often not owned by the municipality. There is a need to challenge current thinking in the area of handling surface water, so that nature-based solutions can be considered in development projects from an early stage.

There is also little involvement in water-related issues by the public. A higher engagement would help put these issues on the policy agenda.

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4 East Frisia

4.1 Key challenges and features of this Living Lab

Table 5 - Key features of LL East Frisia

Key challenge & objectives	***Improve efficiency of water use in industry and agriculture, reducing groundwater extraction*** • Demonstrate reuse of treated process water as replacement of drinking water in dairy & food industry • Improve substance flow in crop production • Improve water demand forecast via grid monitoring and rainwater usage
Technologies & tools	• Combined treatment of vapour condensate & milk/whey permeate for reuse in dairy industry (#6) • Extended UWOT urban water cycle (#22) • Regional demand-supply matching GIS tool (#23) • Short-term demand forecasting tool (#28)
Key legislation applicable to the LL water-smart solutions	• **Federal Water Act** (Wasserhaushaltsgesetz, WHG) • **Drinking water Ordinance (**Trinkwasserverordnung, TrinkwV**)** • **Food hygiene Ordinance (**Lebensmittelhygiene Verordnung, LmhV) • **Metering Point Operation and Data Communication in Intelligent Energy Networks Act** (Gesetz für den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen, MsbG) • **Law on the Federal Office for Information Security** (German: Gesetz über das Bundesamt für Sicherheit in der Informationstechnik, BSIG) • **IT Security Act** (German: IT-Sicherheitsgesetz, IT-SiG)
Regulatory issues	• There is still a gap in policy and regulation for reuse of municipal wastewater in the industrial sector • The topic is new at national level and most technical solutions remain on pilot-scale • So far only drinking water can be used in the food processing industry (TrinkwV, LmhV) • Digitalisation is a major but still emerging topic and a diverse set of regulations apply for digital solutions in the water sector, e.g. data protection, data security

The key focus of the East Frisia LL is to explore alternative sources of water, as a means to compensate for increasing demand of different socioeconomic sectors.

OOWV, the East Frisia LL owner of B-WaterSmart, is one of the main water utilities in the state of Lower Saxony. The OOWV has around 1 million customers, which are divided in public, commercial and industrial customers such as households, farms and industrial enterprises. In the summer of 2019, water consumption was the highest ever reported in the OOWV's existence of more than seven decades, forcing the organisation to reduce water pressure and ask customers to reduce consumption (DW, 2019). Likewise, the pressure on fresh water supply within the OOWV area has been rising, for example in areas requiring external drinking water supply (region Wesermarsch), and over the tourist peak season (four islands in the Northern part of the state). At some OOWV locations, water abstraction rights are already exploited to a high degree. The technical equipment for the treatment and pumping of drinking water and the piping system are at times working to capacity, while the public asks for resilient and sustainable solutions for water supply. In conclusion, the water demand is increasing while the availability of freshwater resources are limited – also because of changing conditions due to climate change.

Despite the changing framework conditions, the OOWV must be able to provide water for all, at the present and in the future, since this is the inherent responsibility of a public water utility. For this purpose, the OOWV has been working on identifying untapped water resources, as well as increase the reuse of process water and treated wastewater in water-demanding key industries. In the case of B-WaterSmart the pilot technology focuses on an improved treatment of vapour condensate and whey permeate, through a combined biology-UF-RO treatment of vapour condensate & milk/whey permeate for the reuse of ‘cow water’ in the dairy industry.

Complementing the water efficiency improvement of industrial processes, new digital solutions for monitoring are under development in this LL, namely a Regional Demand-Supply Matching GIS Tool to identify water requirements and match these with water resources available at the regional level. Finally, the forecasting of domestic water demand will be improved, by installing a grid monitoring within the OOWV supply area.

4.2 Policy framework

This section provides a brief outline of the policy framework which applies to water smart innovation in Germany. Highlighted are the key topics of adaptation to climate change, water reuse, circular economy, and digitalisation.

On a federal level the goal is to develop the waste and circular economy into a sustainable resource efficient material cycle economy (BMUV 2021a). The **Circular Economy Act** (German: Kreislaufwirtschaftsgesetz, KrWG) is the main legal basis for this goal, and the circular economy policy in Germany. One central aspect of this Act is waste avoidance through product responsibility. According to this principle, the producer is responsible to design the product in a way to reduce waste occurrence, and to facilitate environmentally friendly recovery and disposal. The Circular Economy Act was amended in 2020, following the advances in the EU Waste Framework Directive. The goal of the new Circular Economy Act is to strengthen the idea of a circular economy through avoidance and recycling of waste. Additional measures are the inclusion of the duty of care, which

dictates the preservation of the usability of products, allows their disposal only as a last resort, and ensures a legally enforceable transparency obligation (BMUV 2021a). Overall, strengthening circular economy in Germany has the additional benefit to further the nation's climate action goals through the reduction of greenhouse gases from the waste sector, e.g., through the increase in energy efficiency through energy recovery, and by using biowaste for energy generation.

The main legal document in Germany regarding climate change is the **Climate Action Plan 2050** (German: Klimaschutzplan 2050), which was adopted in 2016 and contains the strategy on how to implement the Paris Agreement (BMU 2021a). Germany wants to reach greenhouse gas neutrality by 2050. This shall be achieved by measures related to the different sectors, e.g., energy, industry and agriculture. Examples of such measures are the expansion of renewable energies, the use of waste heat potential, and the reduction of nitrous oxide emissions, respectively. Within the water sector, it is anticipated that there will be emission reductions in the wastewater treatment process through the use of biogas and the reduction of methane emissions (BMU, 2016).

Adaptation to climate change impacts is organised on communal, state and federal level in Germany. On federal level the key strategy is the **German Strategy for Adaptation to Climate Change** (German: Deutsche Anpassungsstrategie, DAS), which was adopted in 2008 and has since been updated twice. The **Action Plan Adaptation** (German: Aktionsplan Anpassung, APA III) was published in 2020, together with the second update of the DAS. APA III is divided in six clusters (water, infrastructure, land, health, economy, spatial planning and civil protection) and overarching measures. It contains a total of 180 identified measures to enhance Germany's adaptability to climate change.

Although water reuse is not a focus topic in neither of the above, it is briefly mentioned as one measure identified within the APA III report of the Cluster Water. Water reuse is identified as one measure to enhance groundwater availability. Potential measures, for instance, may be the reuse of water for agricultural irrigation, and, potentially, also for urban irrigation. Another measure identifies the use of water of inferior quality, such as grey water or rainwater, as substitute for drinking water in some urban areas, e.g., for irrigation of green areas, sport areas, recreational areas (Fritzsch et al., 2021). Water reuse is currently under discussion on a national level to determine the transposition of the EU regulation (EU) 2020/741 on water reuse for agricultural irrigation into national law. The discussion focuses also on specific implications that will arise from this new law for the German case. Relevant organisations involved in this discussion are the German Working Group on water issues of the Federal States and the Federal Government represented by the Federal Environment Ministry (LAWA), and the Federal/State Working Group on Soil Protection (LABO) (UBA 2021).

Digitalisation is a major political topic within Germany. In January 2021, the German government adopted its **data strategy** with around 240 measures. This strategy is based on a broad participation process, including an online survey with more than 1200 participants. It addresses five fields of actions, innovation being one of them. Topics and actions within these fields range across a broad spectrum, relevant for B-WaterSmart are, amongst others, measures related to environment, climate and resources, critical infrastructures, and sustainability. Digitalisation is also identified as a major topic and a driver of innovation in the water sector. The DWA – German Association for Water, Wastewater and Waste – and the DVGW - the German Technical and Scientific Association for Gas and Water – both identify digitalisation as focus topics for the water sector in Germany with potential uses such as smart meters, augmented virtual reality, or building information management.

4.2.1 Legislation applicable to 'water-smart' solutions in this LL

Water management in Germany is regulated on national and state levels, which in turn are influenced by decisions made in the European and International policy arena. In the following sub-sections, the focus is primarily on the national level with indications to relevant European legislations. Table 6 shows the transposition of EU Directives focusing on water management into German law.

Fundamental for water protection in Germany is the Water Framework Directive (WFD). The main objective of the WFD is to achieve a good status for all waters by 2027 (formerly 2015). To this end, management plans must be drawn up. To coordinate this process, river basin communities have been established among the German States sharing joint responsibility for the catchment areas of large rivers (Water Europe, 2021). Due to the overarching nature of the WFD, it has implications for nearly all other water protection rules and regulations, such as the Federal Water Act (table 6 & 7).

Table 6 - Overview of relevant policies for LL East Frisia

(Own illustration based BMU & UBA, 2018)

<table>
<tr><th>Level</th><th colspan="5">Regulations</th></tr>
<tr><td rowspan="3">EU</td><td>Water Framework Directive (WFD)</td><td rowspan="2">Urban Wastewater Treatment Directive</td><td rowspan="3">Drinking Water Directive (DWD)</td><td rowspan="3">Nitrate Directive</td><td rowspan="3">Flood Risk Management Directive</td></tr>
<tr><td>Groundwater Directive (GWD)</td></tr>
<tr><td>Environmental Quality Standards Directive (EQSD)</td><td>Industrial Emissions Directive (IED)</td></tr>
<tr><td rowspan="4">National</td><td>Federal Water Act (WHG)</td><td>Federal Water Act (WHG)</td><td rowspan="4">Drinking Water Ordinance (TrinkwV)</td><td rowspan="2">Fertilizer Act (DüngG)</td><td rowspan="4">Federal Water Act (WHG)</td></tr>
<tr><td>Groundwater Ordinance (GrwV)</td><td rowspan="2">Waste Water Charges Act (AbwAG)</td></tr>
<tr><td>Surface Waters Ordinance (OGewV)</td><td rowspan="2">Waste Water Ordinance (AbwV)</td><td rowspan="2">Fertilizer Ordinance (DüV)</td></tr>
<tr><td>Ordinance on Installations for Handling Substances Hazardous to Water</td></tr>
<tr><td>States</td><td colspan="5">Federal states' legislation (laws/ordinances, licences, notices, monitoring)</td></tr>
</table>

The most important law on national level is the **Federal Water Act** (German: Wasserhaushaltsgesetz, WHG) adopted in 2009 and last amended in 2017. The WHG is under the full legislative competence of the federal government. German states can deviate from the regulations if it does not concern plant-related or substance related matters. On state level this implies that water-related rules and regulations may contain specifications and additions to the WHG such as administrative procedures, the division of responsibilities amongst state authorities, and more specifically also rules and regulations concerning the use of water, water distribution, wastewater systems, and flood management – all of course within the overarching EU framework. On the federal level, the WHG allows to implement binding European requirements uniformly across Germany such as the **Surface Water Ordinance** (German: Oberflächengewässerverordnung, OGewV) and the **Groundwater Ordinance** (German: Grundwasserverordnung, GrwV). To secure the public water supply, water protection areas may be established under the WHG.

The (water) environment is further protected through specific regulations on minimum discharge requirements of wastewater into receiving water bodies. The minimum requirements are based on current state-of-the-art technologies. Since 2004 this is governed by the Wastewater Ordinance (German: Abwasserverordnung, AbwV), which contains regulations and emissions limits, and a total of 57 annexes dedicated to specific sectors and industries.

Drinking water is governed by the Drinking Water Ordinance (German: Trinkwasserverordnung, TrinkwV), which, together with the Infection Control Act (German: Infektionsschutzgesetz, IfSG), translates the EU Drinking Water Directive into German Law. Water supply is a basic public service, which falls in the area of competence of cities and municipalities and is regulated through state constitutions or state law. The Drinking Water Ordinance manages the quality of water, the treatment of water, the obligations of the water supplier, and monitoring requirements according to the EU Directive, but, at times, with more stringent specifications. The Ordinance includes national and international standards for the extraction, treatment and distribution of drinking water to ensure compliance with its requirements.

Table 7 gives an overview of the above introduced key policy instruments specific to the B-WaterSmart products developed in the LL East Frisia.

Table 7 - Key policy instruments (East Frisia)

Legislation	Source	Description
Abwasserverordnung, AbwV	https://www.gesetze-im-internet.de/abwv/index.html	The Wastewater Ordinance regulates the minimum requirements to be set for permits to discharge wastewater into waterbodies. Numerous annexes contain regulations for specific areas. It also specifies the analysis and measurement procedure.
Grundwasserverordnung, GrwV	https://www.gesetze-im-internet.de/grwv_2010/index.html	The ordinance establishes criteria for the characterization, assessment, classification and monitoring of groundwater status and transposes trend reversal into German law.
Lebensmittelhygiene Verordnung, LmhV	https://www.gesetze-im-internet.de/lmhv_2007/index.html	The LMHV implements food hygiene regulations of the EC and EU and serves their implementation.
Oberflächengewässer-verordnung, OGewV	https://www.gesetze-im-internet.de/ogewv_2016/index.html	This ordinance regulates the detailed aspects of surface water protection on a nationwide basis and contains provisions for the categorization, typification and delimitation of surface water bodies in accordance with the requirements of the WFD.
Trinkwasserverordnung, TrinkwV	https://www.gesetze-im-internet.de/trinkwv_2001/index.html	The purpose of the Ordinance is to protect human health from the adverse effects resulting from the contamination of water intended for human consumption by ensuring sufficient water quality and water quantity.
Wasserhaushaltsgesetz, WHG	https://www.gesetze-im-internet.de/whg_2009/index.html	The Water Resources Act (WHG) forms the main body of German water law. The WHG contains provisions on the protection and use of surface waters and groundwater, as well as regulations on the development of water bodies, water management planning and flood protection.

4.2.1.1 Legislation applicable to digital solutions in East Frisia

The digital solutions developed in the LL East Frisia are governed by a complex and broad set of regulations and rules with one of the main issues of concern being data security. Data security applies on the one hand to costumer data protection. This entails the protection of data against misuse by external parties, but also to the aspect of ensuring that the data will only be used in the prior agreed terms. These concerns will play a key aspect in the development of the Short-Term demand Forecast Tool. Relevant regulations are regulations concerning the handling of personal data of residential customers, the General Data Protection Regulation (2016/679), and regulations concerning smart metering in water supply or utility industries in general, such as the Act on Metering Point Operation and Data Communication in Intelligent Energy Networks (German: Gesetz für den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen, MsbG). Any intelligent measuring system must be according to the technical standards defined by the MsbG in form of protection profiles (PP) and technical rules (TR). The MsbG aims to ensure data protection, data security, and interoperability. Still, smart measuring systems are not widely applied in the water sector yet, and there may be issues of acceptance and security concerns by involved stakeholders.

Furthermore, data security applies to systems protection. As a critical infrastructure the OOWV falls under certain obligation also with regards to cyber security. These obligations are legally defined under the **Law on the Federal Office for Information Security** (German: Gesetz über das Bundesamt für Sicherheit in der Informationstechnik, BSIG), and are supported by the National Strategy to Protect Critical Infrastructure (German: Nationale Strategy zum Schutz Kritscher Infrastrukturen, KRITIS Strategy). The IT Security Act (German: IT-Sicherheitsgesetz, IT-SiG) further ensures that critical infrastructures can ensure their provision of services – amongst others through the protection of information. Cyber security is also always about the protection of the information processing systems. In practice, it means that if there are interfaces to the water supplier's network, the measuring devices or the software used must of course be "secure" in the sense that they do not pose a risk to the information-processing systems of the water supplier. Overall, it is important to ensure that sensitive data are handled with care and in a way to prevent security risks from leaked data. One example of such a risk would be the threat of cyber or physical attacks due to unwanted publication of key site locations. This has several implications such as the need for agreements with contractors/suppliers (i.e., manufacturers of equipment and software) regarding information security, and privacy agreements on a bilateral basis between the OOWV and industrial customers.

4.2.1.2 Legislation applicable to East Frisia pilot plant

The main legislations that are applicable for the LL East Frisia pilot plant are the **Drinking Water Ordinance** and the **Food Hygiene Ordinance**. The Drinking Water Ordinance states that "*all water used in a food establishment for the manufacture, treatment, preservation or placing on the market of products or substances intended for human consumption"* (translated from German, TrinkwV, §3, 1b) must be drinking water, which is confirmed by the Food Hygiene Ordinance (LmhV, §3a). The substitution of drinking water through process water is currently prohibited in Germany. Amongst the main concerns is the perceived risk to public safety through the potential consumption of products

that may have been exposed to water of inferior quality. Therefore, a key goal for LL East Frisia within B-WaterSmart is to prove the safety, in terms of public and environmental health, of cow water as a substitute for drinking water in the dairy industry in order to discuss/coordinate the regulatory conditions for a full-scale plant, and to contribute to the reduction of freshwater consumption in this water-intensive industry.

4.2.2 Regulatory issues

In industrial processes, cascade use of water and in-plant recycling are state of the art. In the food industry, too, water is used several times to a large extent. However, in order to be able to achieve a further increase in water efficiency, the "Reuse water" must meet the qualitative and formal requirements for drinking water. B-WaterSmart products may influence policies in this direction by the successful demonstration of process water reuse in the dairy industry.

The topic of reuse of treated wastewater is new in the country and has not been reflected in relevant national plans to date. Water reuse in terms of reusing treated wastewater for agricultural irrigation will come into effect by June 2023 and is already part of several national and EU funded research projects. Using alternative water resources fit-for-purpose is further strengthened through the increasing numbers of conflicts surrounding groundwater abstraction, water rights allocation, and increasing water scarcity.

Although it is widely acknowledged that alternative sources of water will have to be explored in the near term, there is still a gap in policy and regulation for water reuse and the use of water from alternative sources. Regarding the industrial sector, there are several wastewater streams. In addition to real wastewater streams, industrial processes, especially in the food industry, may generate water streams of very high quality, such as cow water. Cow water is extracted from the milk and is a water of very high quality, and, once treated accordingly, could be used as a drinking water substitute in the dairy industry, thereby reducing freshwater consumption of this water intensive industry. At the time of publication of this report (February 2022), it was however prohibited to reuse cow water for this purpose, since drinking water must be used in the food processing industry according to the **Drinking Water Ordinance** (TrinkwV). That said, within the food processing industry, the reuse of water of certain qualities is standard. Depending on the quality, the cow water is used for various suitable applications without direct product contact. As a substitute for drinking water, however, much more cow water can be reused, and fresh water substituted at the same time.

Especially with increasing water scarcity issues, the use of alternative resources is a promising option to ensure water for all while conserving the environment. However, so far policies concerning the use of alternative water resources are lagging behind the technical possibilities, resulting in discrepancies in the adoption of eco-innovations in the water supply and treatment systems, which in most cases remain on a pilot scale. One aim of the East Frisia LL is to find a way to implement the pilot-scale into a full-scale application, which will require the creation of favourable policy conditions.

4.2.3 Funding available for water innovation

There are several funding mechanisms available for water innovation in Germany. Water abstraction charges may be applied by German states. These charges have to be paid for the abstraction of water from groundwater and surface water sources. The charges were introduced to steer the precautionary resource protection, i.e. the charges refinance the maintenance and improvement of water bodies from which the water is abstracted, and to comply with the principle cost recovery according to the WFD. The levies can contribute to water innovation related to the introduction of measures to achieve good status of water bodies as defined under the WFD (Geidel et al. 2021).

Another earmarked funding method are wastewater levies. These levies are paid according to the volume of discharged wastewater into a receiving water body. Wastewater levies can be offset against investments in wastewater treatment. The levy fee is coupled with the pollution load, hence the lower the pollution load the lower the levy. Thus, the aim of the levy is to create an incentive to improve the performance of wastewater treatment and stormwater treatment, and to introduce production processes with no or little wastewater discharge. The revenues are earmarked for measures that serve to maintain or improve the water quality of the receiving water bodies.

Other funding opportunities, especially for research, may be through the DVGW, the German Technical and Scientific Association for Gas and Water, which includes a special scheme for small-scale R&D projects, the Federal Ministry of Education and Research (German: Bundesministerium für Bildung und Forschung, BMBF), and on a European level through INTERREG or Horizon projects. Water management measures in agriculture may be financed through the European agricultural fund for rural development. Several funds exist on national and European level for measures to improve water ecosystems under the WFD, which, however, mostly include a self-funding share (Geidel et al. 2021).

Digital Water (data policy, microelectronics) is one the key investments included in the National Resilience Plan for Germany, accounting for 7-8% of the total amounts. Part of the funding for the climate-friendly building and renovation component will also be used for implementing nature-based solutions (NBS) (Water Europe, 2021).

4.3 Governance

According to the distribution of competences under Germany's Basic Law, the German federal government has concurrent legislative competence in the area of water protection. The Federal States can deviate from federal provisions, with the exception of substance-specific, installation-specific and EU regulations. To coordinate water management policy, the Federal States and the federal government have formed the German Working Group on water issues of the Federal States and the Federal Government (Bund/Länderarbeitsgemeinschaft Wasser, LAWA, in German).

The German water industry is composed of a few large companies and a large number of small and medium-sized supply and disposal companies. Water supply and wastewater disposal are under the responsibility of the municipalities (municipal self-administration), which therefore make the decisions on their structure and forms of organisation. Wastewater disposal is provided as a public service, water supply is sometimes privatised to an extent.

Charges (contributions, prices and fees) are levied to cover the costs of these services. According to the federal **Wastewater Charges Act** (Abwasserabgabengesetz, AbwAG) and supplementary provisions on a state level, charges must be paid for the discharge of wastewater containing certain

contaminants into water bodies. These charges provide an economic incentive for reducing the introduction of pollutants to a minimum. The majority of the Federal States also levy charges for groundwater abstraction, some also for abstraction from surface water bodies. The objective is to encourage the conservation of scarce water resources.

Water abstraction is managed by the allocation of water rights, which in Germany are issued for a time horizon of 30 years. Approval periods for re-application of existing water rights, or the application of new water rights are potentially very long (~ 10 years), and there is no guarantee that existing water rights will be renewed. In fact, there have been reductions in water rights within the OOWV supply area. This has a direct effect on planning security especially in combination with worsening water scarcity driven by, among other factors, climate change.

The need to adapt to climate change to secure water resources in the future is one of the drivers for new water supply governance. Traditionally, the management of water supplies falls under the responsibility of cities and communities. Rural communities may form regional entities, such as the OOWV, to facilitate the provision of services in the areas and to its members. Currently, the OOWV is participating in the development of the **"water supply concept of Lower Saxony"** (Wasserversorgungskonzept des Landes Niedersachsen). The underlying principle of the concept is to establish a common data basis (status quo of water supply in Lower Saxony), anticipate change over time (mid-term and long-term perspectives), and derive required actions and courses of actions.

On a national level, the Federal Ministry for the Environment has recently presented the draft **National Water Strategy** (German: Nationale Wasserstrategie des Bundesumweltministeriums) (June 2021) (BMU, 2021b). The National Water Strategy focuses on the topic of water supply security in terms of water quantity and quality in the year 2050. It is a blueprint for the process of transitioning to sustainable water management in Germany. It deals with 10 strategic themes such as conserving global water resources, connecting water-energy-and material cycles, developing novel water infrastructures, and increasing the public awareness on water issues. Additionally, it describes an action programme with measures to be implemented by 2030. The implementation of these measures is already starting. The next step is to produce an agreed version of the National Water Strategy of the Federal Government based on the draft version.

The draft of the National Water Strategy was presented together with the citizens' advice, which complements the draft strategy. The citizen's advice contains the input from German citizens, which was organised by the BMUV through the National Citizens Dialogue Water (German: Nationaler Bürgerinnen und Bürger Dialog Wasser). For this purpose, four workshops in different cities were organised and randomly selected citizens were invited to join the workshops. During the workshops the participants were asked to discuss how to ensure the sustainability of water resources, and to come up with proposals (BMUV 2021b). Within the OOWV supply area, public participation is encouraged for instance through round tables with relevant stakeholders. Additionally, the OOWV has dedicated regional managers, who are the face of the company in their respective region, thereby facilitating contact between communities and the company management.

4.4 Summing up: key drivers and barriers for East Frisia

Regarding digital solutions in B-WaterSmart the key drivers identified for the East Frisian LL are the current political ambitions to enhance the level of digitalisation in Germany, and the parallel ambitions within the water sector to increase the use of digital solutions in the industry. Relevant barriers are the diverse set of regulations governing digital solutions in general, such as data security concerns and data protection issues. For critical infrastructures, there are additional issues such as system site protection. Privacy agreements will be needed on a bilateral basis between supplier and costumer when installing and using digital solutions, which requires a sufficient level of trust and acceptability of the involved stakeholders. Also, the water industry is traditionally a more conservative sector, which may possibly hamper innovation.

From a financial perspective, there are sufficient funding options for research and innovation available. However, most innovation remains on pilot-scale. The transposition from pilot to full-scale plant has been identified as a barrier mostly due to economic reasons. Implementing a full-scale plant is costly and for this type of investment funding options are scarcer.

Water reuse and the use of water from alternative sources such as process water are not part of national policies and plans yet. The topic is new and ongoing and not sufficiently covered on a national level. The advances of the topic on EU level is a driver for national policy development. In the food industry in particular all water in contact with food must have drinking water quality according to the TrinkwV, which is the main barrier in relation to the substitution of drinking water by cow water in the dairy industry. In order to overcome this barrier, policy developments are needed. Relevant governance drivers for such a change are that the relevant approval authorities have been involved actively in the B-WaterSmart project since the beginning, and that the public asks for resilient and sustainable solutions for water supply.

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5 Flanders

5.1 Key challenges and features of this Living Lab

Table 8 - Key features of LL Flanders

Key challenge & objectives	***Develop of a regional concept for improving and monitoring water-smartness and a more robust water system*** • Establish regional circularity in the water system • Include alternative water resources in water supply • Secure irrigation by integration with urban reuse cycle • Improve performance of drinking water systems
Technologies & tools	• Effluent reuse for drinking water production (#3) • Urban stormwater reuse for agriculture (#5) • Stormwater reuse management system (#21) • Extended UWOT model urban water cycle (#22) • QMRA+ for water reuse and agriculture (#26)
Key legislation applicable to the LL water-smart solutions	• Regulation for drinking water: Drinkwaterwetgeving (EMIS Navigator (vito.be)) • Regulation concerning e.g., concentrate discharge to surface water: VLAREM II • Permits for building and exploitation of combined infrastructure in the urban environment Omgevingsvergunningsdecreet (EMIS Navigator (vito.be)), milieuluik • EU regulation on minimum requirements for water reuse for agricultural irrigation
Regulatory issues	• The work required to obtain a permit is quite extensive, even for small pilots and demonstration of technologies at a very small scale • Discharge permits for industrial brines, regulations about fertilizers and pesticide usage, need for international agreements on water flow across borders • Currently no specific regulation for (direct) reuse of effluent

The focus of the Flanders LL is the development of a regional concept for improving and monitoring water-smartness and a more robust water system, with an emphasis on safe water reuse. It aims at assessing the regional water system and its potential for incorporation of water-smart solutions, close water cycles, increasing resilience and integrating the existing natural water system as a nature-based solution, while ensuring safe reuse. Water availability and demand including potential alternative water sources will be modelled using UWOT as Urban Water Optioneering Tool to develop a regional strategy to increase water system robustness. The QMRA+ tool will be developed to assess water reuse safety. Practical implementation of water reuse and production will be demonstrated for two sites. One focusing on a comparison between improvement of the existing drinking water production by multi-stage RO, and effluent reuse for drinking water (Diksmuide – De Blankaart). The other is about urban stormwater reuse for irrigation (Mechelen). Both practical implementations have high transferability potential for the region.

In relation to the impacts of climate change, the key challenges for Belgium, and in particular Flanders, are due to changes in precipitation patterns, which are increasing the risk of floods over the winter, as well as raising threats of water scarcity and prolonged droughts in the Summer. Coupled with population growth, coastal vulnerability and the increasing competing demands over extraction of freshwater, these stressors have been addressed by adaptation plans at the national and regional levels. In general, policies and guidelines for new water concepts are moving towards an integrated approach to risk management.

Since 2017, Flanders faced water scarcity on an unprecedented scale, making it increasingly challenging to meet the demands of multiple sectors on water availability and quality. During the Summer of 2020, water flow was at minimum levels, so farmers were forbidden of extracting water from the river systems. Aquafin opened their water supply to farmers as an emergency response, which is actually better for the farmers because water is standardised quality. In Flanders, agriculture represented 10% of total water abstractions in 2018 (Flemish government, 2020a). Within the agricultural sector, specialised livestock farming accounts for 41% of water consumption (Flemish Government, 2020b).

5.2 Policy framework

The Flemish Decree on Integrated Water Policy was approved in July 2003, in implementation of the EU Water Framework Directive and the Floods Directive. However, the environmental situation in the country has evolved rapidly, and the last dry Summers since 2017 made it evident that the country will need to step up policies, technical solutions and the governance of its water resources in order to face worsening scarcity and droughts.

A range of measures have already been taken: as early as 2010, Belgium adopted a **National Adaptation Strategy**, which envisaged the elaboration of a **National Adaptation Plan**. This plan was adopted by the National Climate Commission in 2017 to strengthen cooperation and develop synergies between different entities. To this end, the adaptation policies already implemented by the different entities were mapped and new national measures were identified in order to strengthen Belgium's resilience against the expected effects of climate change.

The **Flemish Climate Policy Plan (VKP)** 2013-2020 consists of an overall framework and two separate but closely related sections: the Flemish Mitigation Plan (VMP) and the Flemish Adaptation Plan (VAP). The purpose of the VMP is to reduce emissions of greenhouse gasses in Flanders between 2013 and 2020 as a means of combatting climate change. The purpose of the VAP is to understand the Flemish vulnerability to climate change and then improve its ability to defend against its effects, up to 2050.

A key plan in the fight against water scarcity and drought is the **Blue Deal**, approved in the summer of 2020, which contains over 70 actions and six focus areas:

- Public administrations leading by example and ensuring appropriate regulations
- Circular water use becoming the rule (including agriculture and industry)
- Agriculture and nature as part of the solution (large-scale infiltration and buffer basins)
- Raising awareness amongst citizens
- Increase security of water supply
- Investing in innovation to make the water system smarter, more robust and more sustainable

Within the Blue Deal, 75 million euros will be invested to fight the impacts of droughts in Flanders and make the region more resilient. For companies, a water scan/audit will be part of the admissibility conditions for applications for financial support and permits from the Flemish government from 2022 onwards. Large consumers and companies with a large impervious pavement will be subject to a water audit (CEOs 4 Climate, 2022).

In addition, the Blue Deal states that from 2024 a municipality will only have access to water-related subsidies if it has a sufficiently ambitious stormwater and drought plan. The new river basin management plans for Flanders were concluded in 2021, and already integrate the principles of the Blue Deal (CIW, 2022).

A cornerstone of adaptation and water policy in Flanders will undoubtedly be management of stormwater as a resource, rather than just as a threat. Until now, it was ensured that stormwater was drained as fast as possible in order to prevent floods. However, both floods and droughts are becoming more frequent and intense, which requires a new circular model of management.

5.2.1 Legislation applicable to ‘water-smart’ solutions in this LL

Flanders will implement legislation concerning EU regulation on minimum requirements for water reuse (reclaimed water), but there are still aspects that will need to be further refined in policies at the national and regional level to make this new paradigm of water management possible. Further work on regulations and protocols for treatment is necessary, requiring an interdisciplinary involvement of experts and stakeholders (Dingemans et al., 2020). While stormwater is not considered ‘reclaimed water’, there will be a need to better define how it should be managed at regional level. A treatment before infiltration may be necessary. It is still to be determined who should carry the cost for such improved solutions, as there are mutual benefits and trade-offs.

The activities of LL Flanders in B-WaterSmart support existing legislations, platforms and initiatives (e.g., Blue Deal, CIW). Several initiatives have started recently in which water utilities and other stakeholders work towards a regional strategy for 2050. The Flemish Environment Agency (VMM), De Vlaamse Waterweg, De Watergroep, Aquafin and VITO - Vlakwa have launched the initiative **H2050.be**, a 'transition arena' that proposes solutions for systemic innovation towards robust water systems in Flanders.

A focus group on Strengthening Agriculture-Water Policy within the Coordination Committee on Integrated Water Policy (CIW) has drawn up a work program that will give concrete form to the agricultural-oriented actions in the river basin management plans, where possible already in the final design plan or later via the water implementation program; will detect synergies and linkage opportunities between processes for the agricultural sector and the river basin management plans; will test the proposals in a number of representative agricultural areas for their contribution to achieving good ecological status. Flanders has also decided to apply the measures of the EU Nitrates Action Programme to its whole territory, adding targeted measures for areas where the water quality is particularly low.

In 2021, the CIW approved the amendments to the draft **River Basin Management Plans 2022-2027** for Scheldt and Maas. Following public consultation, there were some adjustments to the original plans, including: prioritization to local water bodies that do not drain to a Flemish water body but to a water body outside Flanders; the inclusion of several additional actions, including for facilitating and supporting the development of municipal sanitation infrastructure and for a structural approach to water scarcity and drought (CIW, 2022).

Table 9 - Key policy instruments (Flanders)

Legislation
• EU regulation on minimum requirements for water reuse for agricultural irrigation
• Regulation for drinking water: Drinkwaterwetgeving (EMIS Navigator (vito.be))
• Regulation concerning e.g. concentrate discharge to surface water: VLAREM II
• Permits for building and exploitation of combined infrastructure in the urban environment Omgevingsvergunningsdecreet (EMIS Navigator (vito.be)), milieuluik

5.2.2 Regulatory issues

With regards to water availability, there is a need for international agreements on water flow across borders, particularly for the Southwest region, where inflow of surface water is important. There are agreements in place with the Netherlands regarding the Scheldt and Meuse River.

With regards to implementing water smart solutions, the work required to obtain a permit is quite extensive, even for small pilots and demonstration of technologies at a very small scale. Discharge permits for industrial brines, regulations about fertilizers and pesticide usage are also important.

Currently there is no clear regulation in place for effluent reuse. Work on this is currently under development, among other things based on the experiences with the EU guideline for water reuse for agricultural irrigation. But there is a need to expand this to water reuse in other sectors. Infiltration of water is also subject to strict regulations, but guidelines on how and when these regulations apply to circular water solutions need to be further developed.

5.2.3 Funding available for water innovation

In reviewing the water-related investments included in the National Plan for Recovery and Resilience of Belgium (6-7% of total investment), Water Europe (2021) complimented the focus on circularity, NBS and Digital Water, highlighting the importance of the recently approved Blue Deal in promoting a sustainable water use. However, the organisation considers that it would have been important to also take this opportunity to “strengthen intraregional synergies”.

5.3 Governance

Belgium is a federal state in which decision-making is shared between the federal administration, three regions (Walloon, Flemish and Brussels-Capital) and three Communities (Flemish, French and German-speaking). Regarding climate policy, the regions hold important responsibilities in areas such as rational use of energy, promotion of renewable energy sources, public transport, transport infrastructure, urban and rural planning, agriculture and waste management.

In Flanders, water services are entirely under the delegated public management model. The drinking water price is subject to agreement by the Water Regulator, hosted at the Flemish Environment Agency (VMM). Drinking water supply is operated by public (municipality owned) companies, such as De Watergroep (also B-WaterSmart partner). Wastewater treatment is carried out by municipal companies at local level, and by Aquafin, a public-private owned company, at the regional level.

The water price structure is fixed by law and is the same for a) drinking water; b) sanitation; and c) wastewater treatment. Each operator must introduce a six-year forecast (‘Tariff Path’) based on a

‘Tariff Plan’ with the specific (yearly) prices for household consumption (basic tariff and comfort tariff) and non-household tariffs (EurEau, 2020).

VMM is the Environment Agency of the region and is responsible for regulation and permitting of environmental issues including (waste) water; measures and controls the quantity and the quality of surface water, groundwater and sediments; manages the large unnavigable Flemish waterways and strives for their ecological recovery. The agency is also developing flood forecasts, in order to mitigate the impact of recurring floods in the territory (Flemish Environment Agency, 2022).

The minister who is responsible for integrated water policy is assisted by the Coordination Committee on Integrated Water Policy (CIW), established in 2004. This commission is responsible for the coordination of the integrated water policy on the level of the Flemish Region and integrates the administrative entities of the Flemish region involved in water management, the representatives of the authorities of the water management at the local level and a representative of the water companies. The B-WaterSmart Community of Practice of LL Flanders is organised in collaboration with CIW to ensure a connection to their agenda.

For the organisation and planning of the integrated water management, the decree on Integrated Water Policy distinguishes 3 levels: the River Basin District (Scheldt and Meuse) with the river basin management plans; the Flemish region (river basins Scheldt, Meuse, IJzer, Polders of Bruges) with the Water Policy Note; the sub-basin (11) with the river catchment management plans, that are part of the river basin management plans. Consultation and planning of the water management in the river basin districts takes place within international river commissions.

Although water management is under delegated public management in Flanders, waste services and energy production are private markets, industrial wastewater treatment and process water production is a private market, where many private companies are active, but also (subsidiaries of) the public companies such as De Watergroep and Aquafin. There is, as in most cases, a need for stronger integration across sectors and between circular activities in the region, which at the moment are mostly stand-alone initiatives.

In the Mechelen a new governance structure will be set up for the reuse of stormwater, through cooperation between the municipality and farmers, also with the involvement of Pidpa, the local wastewater company in Mechelen who has experience in treatment and reuse.

5.4 Summing up: key drivers and barriers for Flanders

There is a strong drive to improve water security for Flanders in the future, and several regional and national intiatives have been started to work towards a more robust and circular water system. Regulations on effluent reuse are needed for the succesful implementation of circular solutions. Furthermore, governance and business models for shared solutions are required, involving multiple stakeholders across sectors.

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6 Lisbon

6.1 Key challenges and features of this Living Lab

Table 10 - Key features of LL Lisbon

Key challenge & objectives	***Improve Lisbon climate readiness, in particular for water scarcity*** Development of tools & processes to: • smart allocation of the water quality (fit-for-purpose) and quantity (water efficiency) for non-potable uses • facilitate safe water reuse in non-potable uses • improve water-energy-phosphorous balance • contribute to build trust on reuse in food-grade water production • certification mechanisms for households (Climate Readiness)
Technologies & tools	• Water reclamation protocol for potable water reuse in beverage industry (#1) • Urban water cycle observatory (#20) • Reclaimed water distribution network quality model (#24) • Water-energy-phosphorous balance planning module (#25) • Risk assessment for urban water reuse module (#27) • Climate-readiness certification toolkit (#33)
Key legislation applicable to the LL water-smart solutions	• Water Act (Lei da Água, 58/2005) • Decree-Law 119/2019 establishes the legal framework for producing water for reuse, obtained from the treatment of wastewater, as well as its use, in order to promote its correct use and avoid harmful effects on health and the environment • Decree-law 16/2021 defines the production of water for reuse is part of the public wastewater treatment, which, together with the collection and disposal of wastewater, is an activity entrusted to multi-municipal wastewater systems
Regulatory issues	• There is only one water supply entity (EPAL) licensed in Lisbon, current legal framework does not allow other entities in the water supply system; the Municipality of Lisbon is not authorised to sell reused water to third parties; • Lack of national regulation for non-potable water reuse (e.g., grey waters) in buildings • Lack of regulation and establishment of national water reuse market as a new economical concept

Lisbon LL ambitions are to deliver algorithms and software for a smart allocation of the water quality (fit-for-purpose) and quantity (water efficiency) for non-potable uses in the city. Furthermore, a protocol for food-grade water production from treated wastewater by ozone/reverse osmosis (O3/RO) for artisanal beer production is to be demonstrated and a climate-readiness index and the subsequent auditing/certification mechanism for Climate Readiness of households, buildings and neighbourhoods is to be developed. Lisbon LL also aims to build trust on water reuse, and to deliver innovative governance model(s) towards a well-informed society, willing and ready to use the water-smart products developed.

6.2 Policy framework

In Lisbon, the estimated increase in the resident population and a growing economy depends on distant freshwater resources with increasing climate challenges (e.g., droughts and floods). This demand must be balanced with the need to increase urban green areas to ensure the quality of life of citizens and the sustainability of urban life. The key focus of the Lisbon LL is to reduce freshwater dependency for non-potable uses and introduce standards for buildings, and, on the long run, look at other possible uses and quality standards, such as potable reuse at least at an industrial level.

In line with the **National Strategy for Climate Adaptation** (ENEAC 2020) and the **Action Plan for Circular Economy** (2017), the protection of water resources and drought prevention are key principles of sustainability policy in Portugal. Lisbon, European Green Capital 2020, is a pioneer municipality in designing and implementing adaptation plans at the local level. The **Municipal Adaptation to Climate Change Strategy (EMAAC)**, developed in the scope of the project ClimAdaPT.local, focuses on identifying adaptation options and actions that aim to mitigate the impacts of climate change. The EMAAC is operationalised through SECAP|Covenant of Mayors and also through the actions defined in the framework of the C40 Cities network.

The Action Plan for a Circular Economy in Portugal was approved in 2017, following the first version of the EU plan (2015) and explicitly supports water reuse, as well as the implementation of sustainable agricultural practices to save water resources. It states that in Portugal only an estimated 65% of abstracted fresh water is effectively used, which also brings water losses' prevention and consumption monitoring to the forefront of investment priorities. Another relevant policy document in this context is the **National Programme for the Efficient Use of Water** (Agência Portuguesa do Ambiente, 2012), which has set limits to water losses in each economic sector in the country.

6.2.1 Legislation applicable to 'water-smart' solutions in this LL

According to the Portuguese legislation, water services include: the abstraction, treatment, transport, storage and distribution of drinking water; the collection, drainage, elevation, treatment and discharge of urban wastewater as well as the collection, transport and final disposal of sludge from septic tanks. Urban wastewater is defined as domestic wastewater or a mixture of domestic

wastewater and rainwater or industrial wastewater. Recently, Decree-law 16/2021 included water reclamation for water reuse in the mission of the multi-municipal wastewater systems, next to the wastewater collection and treatment.

In Portugal, the transposition of the Water Framework Directive (Directive 2000/60/EC) was ensured by the **Water Act** (Lei da Água, 58/2005), whose objectives are: to prevent further degradation and protect and improve the state of ecosystems, promote sustainable water use based on long-term protection of available water resources, achieve enhanced protection and improvement of the aquatic environment, ensure the gradual reduction of groundwater pollution and prevent further pollution of groundwater, mitigate the effects of floods and droughts, ensure sufficient supplies of good quality surface water and groundwater, protect marine waters, including territorial waters, and ensure the achievement of the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment.

The Document presents guidelines that govern the management of water in the territory with the principle of the social value of water, the principle of the environmental dimension of water, the economic value, the integrated management, the precaution, the preservation, the correction, the cooperation and the reasonable and equitable use of shared basins and highlights the hydrographic region as the main unit of planning and management of water.

Management is based on the **National Water Plan**, which provides an overview of the situation at the country level, and on the River Basin Management Plans. The Document also presents the water management structure throughout the territory. The public administration, at national and local level, is responsible for guaranteeing the application of this law, while the hydrographic regions manage, license and inspect water at a local level. Ten regions have been defined in Portugal. In the case of Lisbon, the Tagus hydrographic region is responsible for managing the area. Although the Tagus basin straddles the border with Spain, the administration of the hydrographic region (ARH) of the Tagus is responsible for the part of the basin in Portuguese territory.

The use of public and private water resources that may have a significant impact on water status requires a licence that allows such use, issued under the terms and conditions set out in the Water Act and in the Water Resources Use Regime. This title is attributed by the territorially competent APA Hydrographic Region Administration Departments, depending on the characteristics and dimension of the use, and may take the form of an "authorization", "licence", or "concession"

Table 11 - Key policy instruments (Lisbon)

Legislation	Source	Description
Water Act (Lei da Água, 58/2005)	https://apambiente.pt/agua/lei-da-agua	Transposition of the Water Framework Directive (Directive 2000/60/EC)
Decreto-Lei N.º 226-A, 105, 24–49	https://dre.pt/dre/detalhe/decreto-lei/226-a-2007-340237	
PO SEUR – Programa Operacional Sustentabilidade e Eficiência no Uso de Recursos	https://poseur.portugal2020.pt/	PO SEUR - Operational Programme for Sustainability and Efficient Use of Resources is one of the 16 programmes created for the operationalization of Portugal 2020 Strategy (a partnership agreement established between Portugal and the European Commission) in which the programming principles are laid down and mark the economic, social and territorial development policy.
P-3AC – Programa de Ação para a Adaptação às Alterações Climáticas	Resolution of the Council of Ministers 130/2019 (https://dre.pt/dre/detalhe/resolucao-conselho-ministros/130-2019-123666112)	The Programme of Action for Adaptation to Climate Change (P-3AC) complements and systematises the work carried out in the context of the National Strategy for Adaptation to Climate Change (ENAAC 2020), with a view to its second objective, that of implementing adaptation measures.
PENSAAR 2020 - Plano Estratégico de Abastecimento de Água e Saneamento de Águas Residuais	https://apambiente.pt/agua/plano-estrategico-de-abastecimento-de-agua-e-saneamento-de-aguas-residuais-2020	The Strategic Plan for Water Supply and Wastewater Sanitation 2020 (PENSAAR 2020) defines the strategy for the water supply and wastewater sanitation sector. This strategy is focused on efficient management of resources, seeking to respond to current challenges.

The Water Act provides that by virtue of the use title, a Water Resources fee must be paid for certain uses of water. This financial instrument aims to compensate the benefit that results from the private use of the public water domain, the environmental cost inherent to activities that may cause a significant impact on water resources, as well as the administrative costs inherent to planning, management, supervision and ensuring the quantity and quality of water.

One of the solutions that Lisbon aims to implement to avoid water shortages that may occur in the territory in the near future is the use of reclaimed water provided by the three WWTPs of AdTA (Águas do Tejo Atlântico), in line with EU and national strategies for climate adaptation and circular economy.

For the most part, water reuse in Lisbon is for urban irrigation and street washing (74% of municipal consumption), which will contribute to further reducing potable water consumption.

Decree-Law 119/2019, of 21 August, is a key instrument in promoting water reuse at the national level, through the establishment of a legal regime for the production of water for reuse (*ApR - água para reutilização*) and regulation of quality standards for obtaining reuse licenses. DL L119/2019 is consistent with EU regulation but has a broader applicability (not limited to agricultural irrigation).

Whereas the cost for water reclamation to the quality fit for the intended use cannot be included in the wastewater tariff and has therefore to be paid by the use, i.e. the Lisbon municipality, to the reclaimed water producer (AdTA). In Portugal there is only an established market for drinking water and only one utility (EPAL) is licensed to supply water in the Lisbon area. The licensing of other supply companies could bring about a faster development of water production alternatives. However, this requires legislation changes, to allow other entities into the water supply system. At the moment, water for reuse in Lisbon is only to be used by the municipality itself, as it is not allowed to supply third parties. The demonstration activities of water reuse (risk assessment and water quality network modelling) are the most complex issues until now.

Lisbon's Strategic Plan for Water Reuse will allow the municipality to save 3 million m3 of drinking water by 2025 (about 75% of current consumption). The plan implies the creation of a reclaimed water distribution network, which will come out of the three Lisbon water treatment plants and will be 55km long. The first phase involves Alcântara, Frente Ribeirinha and Parque das Nações. This water is not potable, but it is safe for irrigation, washing streets, creating lakes or in the cooling systems of industries (class A – highest quality level).

Another point to be highlighted is the implementation of water and energy efficiency standards in municipal buildings, through the issuance of Climate-Ready Certificates, a solution proposed within the B-Water-Smart Lisbon LL. At the moment, no auditing/certification mechanism is in place for water, therefore the Lisbon pilots should have a significant impact on policy design.

While the Portuguese National Resilience Plan, one key financial programme approved in 2021, emphasizes the need to improve water management efficiency in various sectors, as well as the importance of water reuse and developing the water-energy nexus, it only attributes 2,3% of the total investment to the water management component, or up to 5-6%, if taking into account indirect investment in projects of green innovation and bioeconomy (Water Europe, 2021).

One aspect highlighted in the Portuguese Resilience Plan is the priority attributed to transboundary cooperation with Spain. International cooperation is essential to ensure the protection and sustainable use of transboundary water resources, enabling coordination of efforts to improve knowledge and management of waters. The main international convention on water is the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention). In Portugal, and as a large part of its water resources are shared with Spain, cooperation in water management is a key issue in bilateral relations. At the bilateral Portugal-Spain level, the main instrument for cooperation is the Cooperation Convention for the Protection and Sustainable Use of Water from Luso-Spanish Hydrographic Basins, known as the Albufeira Convention.

6.3 Governance

In Portugal, three management models for water services coexist: a) direct public management, b) delegated public management and c) delegated private management. 'Direct private management' is not considered in Portuguese legislation. The public management model (a) is predominant, allowing distinctive subtypes: a1) direct municipal management; a2) specialised and autonomous water services of a municipality or group of municipalities (mostly in large or medium-sized municipalities); a3) in the case of the biggest, state-owned, water company in Portugal (EPAL, in Lisbon).

The delegated public management model (b1) can have a municipal or regional (covering several municipalities) basis. Besides the delegation, appointed directly by a municipality or a group of municipalities, a specific model with a wide territorial extent, named 'multi-municipal systems' (b2) is implemented, differing from the straight delegated public management model appointed solely by a municipality or group of municipalities (Costa, 2018).

Those multi-municipal systems are regional service systems jointly owned by a Portuguese state-owned company (Águas de Portugal) and several municipalities. Their scope of operation, at the regional level, includes the abstraction, treatment and main regional piping of drinking water (but not its distribution, which remains at municipal level); the collection, elevation and transport in the final wastewater drainage pipes, its treatment and discharge (but not its domestic collection; that remains at municipal level). This model is structural in the Portuguese water services organisation, but it has no direct links with the consumers, providing its services to the municipalities that maintain – directly or through their delegated public or private services - responsibilities for the domestic water supply and drainage systems (EurEau, 2020).

APA, the Portuguese Environment Agency, holds the role, as the National Water Authority, to propose, develop and monitor public policies that ensure the application of the principles proposed by the Water Act. ERSAR, the Portuguese authority for Water and Waste Services Regulation, regulates the supply public services including the regulation of drinking water supply, urban wastewater management and municipal waste management quality.

In order to ensure sustainable water management and protection of water resources, APA develops a wide range of activities that include the definition and implementation of national policy on water resources, the planning and management of these resources and the associated territory, the licensing of their use and respective supervision, the promotion of the efficient use of water, the implementation of monitoring programs and the application of the water resources fee. The management of the hydrographic regions is carrier out on the ground through services from the Hydrographic Region Administrations of the North, Center, Tagus and West, Alentejo and Algarve.

The main hydrographic basin that supplies and flows into the city of Lisbon is the Tagus hydrographic region. The Tagus hydrographic region is an international hydrographic region, among the eight that are present in Portuguese territory, shared between Portugal and Spain. The ARHs are currently integrated in APA. The municipalities are responsible for managing or are shareholders of the water utilities managing the urban water services (drinking water supply and wastewater management). Often the bulk water supply and wastewater collection and treatment are ensured by public companies or delegated to private companies. It is in this context that the recycled water reuse policies are included.

At the local level, the municipality of Lisbon and the local agency Lisboa E-Nova will develop actions for water and waste reuse and the implementation and support of intelligent water management solutions. Lisboa E-Nova is a private non-profit agency that supports projects in the environmental area, having as main pillars energy, water, and climate change. This entity will support projects in the area of environment in the municipality and also running the observatories in order to provide knowledge about water.

In terms of controlling the health risks of water contaminants, the National Health Authority (DGS) plan and program the national policy for quality in the health system, as well as the regional health entity from Lisboa e Vale do Tejo (Administração Regional de Saúde) in the case of Lisbon.

In Lisbon the water supply and distribution of potable water is managed by EPAL, – Empresa Portuguesa das Águas Livres, S.A. a company belonging to the state corporate sector, 100% held by AdP – Águas de Portugal, SGPS, S.A.

6.4 Summing up: key drivers and barriers for Lisbon

There is only one water supply entity (EPAL) licensed in Lisbon, and the current legal framework does not allow other entities in the water supply system. With current legislation, the Municipality of Lisbon can reuse water from Lisbon WWTPs directly but is not authorised to sell reused water to third parties. There is still a lack of national regulation for non-potable water reuse (e.g., grey waters) in buildings, which can have a great potential in light of solutions such as the Climate-Ready Certificates (energy and water efficiency).

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7 Venice

7.1 Key challenges and features of this Living Lab

Table 12 - Key features of LL Venice

Key challenge & objectives	Beyond the identification of innovative techniques for extracting value from water, the real challenge is to act in exact sequence on the priorities that prevent the transformation of the value into a usable (and saleable) product, i.e.: i) addressing certain issues related to wastewater process management which in fact have so far prevented or slowed the resource enhancement goals resources associated to wastewater (nutrient and sludge); ii) a shared (and updatable) knowledge on risks linked to each specific reuse to objectively establish the related opportunities; iii) a participatory governance model including all strategic interest groups/stakeholders connected to water chain; iv) decision support systems (DSS) evaluation tools, to identify the state of the art and the most sustainable and suitable opportunities of reuse/valorization (for water and sludge), guaranteeing an objective and repeatable process. Contributing to complete the reuse goals envisaged by a funded regional project (the Integrated Fusina Project PIF) is another challenge, which, alongside other important reclamation goals for industrial area, provides for the reuse of the effluent of the WWTP Fusina for "non-drinking" purposes, from which derives the pilot plant that will be installed at Fusina WWTP to demonstrate the convenience of using the effluent for industrial reuse.
Technologies & tools	• Compact combinatory treatment for industrial water reuse (#4) • Ammonia recovery from concentrated WWTP streams (#11) • Water Reuse Strategic Platform (#16) • Sludge management platform (#19) • Digital Enabler integrated support system to enable RR and CE (#32)
Key legislation applicable to the LL water-smart solutions	• **Legislative Decree N. 152/2006** disciplines the protection of surface, marine and groundwater against pollution • **Ministerial Decree N. 185/2003** lays down technical standards for wastewater recycling directed to specific uses • **Article 184 ter of the Legislative Decree N. 152/2006** establishes that new products from resource recovery processes must comply with the End of Waste criteria (in Waste Framework Directive, 2008/98/EC) • **Legislative Decree N. 99/92** sets the limits for sludge application in agriculture; then **Legislative Decree N. 109/2018** corrected in part some limits to be respected for sludge application in agriculture • **Legislative Decree N. 75/2010** disciplines the activities of matter recovery from sludge to produce fertilizers and soil amendments

Regulatory issues	• For water, no regulatory issues are foreseen for industrial reuse. For agricultural reuse, the new EU Regulation 2020/741 is going to enter in force in June 2023, so the situation is changing and implications deriving from the new EU Directive should be evaluated • For nutrients recovery (including ammonium sulphate produced with the stripping technologies), the National regulation refers to the End of Waste criteria in the EU Waste Framework Directive (2008/98/EC), whose are generic and not specified for individual substances. If the recovered product does not fit into these criteria (or if there are doubts) the Ministry (MiTE) is in charge of proceeding with a “case by case” evaluation, creating delays and uncertainties for the producers • For sludge, Legislative Decree N. 99/92 is old and unclear in some parts. Legislative Decree N. 109/2018 in part corrected the old regulation, but there is still a gap between the intention to pursue the most sustainable and natural valorization pathway (sludge in agriculture) and the actions undertaken in the last years. This regulatory uncertainty, caused also by a lack of transparent and shared knowledge on the quality and opportunities connected to the reuse itself and by an overevaluation of risks, led to a low social acceptance that further complicates the pursuit of virtuous actions connected to sludge reuse

7.2 Policy framework

At national level, current policies regulating water services are the result of important evolutions at legislative and governance level over the last thirty years. The main purpose was to organise and modernise the management of water services into more homogeneous areas (optimal territorial areas, namely ATOs), while providing instruments (economic and regulatory) to align the infrastructures and management to EU standards along principles of safeguarding, sustainability, and recovery of water resources. The current policies are also the result of the regulatory transposition of the Water and Wastewater Directives (2000/60/EC and 91/271/EEC respectively) and starting from 2012, of the introduction of articulated tariff methods which, through several evolutions (MTT, MTI-1 MTI-2 and MTI-3) progressively recovered and covered the full costs of investments, operations and effectiveness, efficiency and environmental impacts related to water management and incurred by managers.

Several factors, however, determined the delay between the intentions and actions undertaken or that should be undertaken when focusing on resource recovery and circular economy directly and indirectly connected to water services. Among them, the lack of sufficient integration and coordination among the several policies and regulations disciplining the different compartments intercepted by or connected to water (such as material and nutrient recoverable from water), probably mediated by a lack of knowledge and transparency on the risks connected to recovery and reuse, and the consequent lack of reforming the related governance and market play a key role. To briefly summarize policy developments, a quick overview of the main laws/regulations and related

innovations in the sector is provided below, about the organization and sustainability of the water services management targeted at a rational and efficient use of water.

The **Galli Law** in 1994 (L.36/94), trying to overcome the fragmentation of water management, reorganized the water service by identifying the so-called ATOs, in which the services (to be entrusted to a private or public company or to a mixed ownership) for water and waste management could be organized by its own authority (AATOs) and homogeneously managed (Guerrini et al., 2020). This law also defined the integrated water service as the whole services from the withdrawal of water up to the final discharge in the environment; and stated main principles such as equity in the use of water, the need of safeguarding, saving and water renewal, and the priority use for human consumption (with other uses allowed only in case of plenty of resources). Water was valued as a resource, since “the use of water is directed to saving and restoration, in order not to compromise the water heritage, ecosystems, agriculture, aquatic flora and fauna, geomorphological processes and hydrological equilibrium”. Though many progresses were obtained in the water sector, the law’s purpose has not yet been completely achieved. In 2000, in the Water Framework Directive (WFD, 2000/60/EC), wise and rational use of water resources were clearly stated, defining the concepts of prevention and pollution upstream control and of responsibility, and introducing two economic principles ("end-user" called to pay for the full cost of water received and "member state" called to use economic analysis to assess water resources, costs effectiveness etc.."; Guerrini et al., 2014) with the intentions of laying the foundations for the subsequent regulation.

The **Legislative Decree n. 152/2006**, still now in force and updated several times, implemented the WFD and incorporated the Galli law (as well as all other laws previously issued in this field) and contains all the disciplines concerning the environment, including water safeguard and management as one of the most important sections. Beyond the pollution prevention and recovery of polluted water bodies, its focus is declined on the principles on which the mitigation and prevention of climate change impacts are declined: improvement of water quality and safeguard of water resources for specific and sustainable uses; safeguard of natural water bodies purification capacity and mitigation of the effects of flooding and droughts; safeguard and improve ecosystems health. Among them, the reduction of water withdrawal (surface and underground) and the increase of water reuse is another important target declared to be reached. The decree improves the organization and control of water services by individuating more precisely targets, tasks, activities of the various institutional actors involved in the water industries. Under this law, the AATOs are now defined uniformly across the country (Guerrini et al., 2014).

To focus on some actions answering to EU directives and guidelines for climate change (GHGs emission reduction, fostering resource recovery and circular economy), the Ministry of Environment (now Ministry of Ecological Transition, MiTE) drafted the **National Adaptation Strategy** (NAS; Directorial Decree n. 86 of 16th June 2015), which provides a national vision to address future risks of climate change, underlining the need to manage water resources in an integrated and participatory way through a model of multilevel governance (MiTE, 2015). To implement the first EU Circular Economy Action Plan (COM/2015/0614), Italy approved its own Plan for Circular Economy in 2017, clearly referring to the “reuse of treated wastewater, in conditions that are safe and cost-effective”, as well as to “the recovery of energy and substances through an efficient increase of wastewater treatment” (MiTE, MiSE, 2017).

However, the plan acknowledges that there is still work to do to prepare a regulatory framework that facilitates the development of the circular paradigm across the nexus water-energy-waste in the country.

In this complex context, the Italian Regulatory Authority for Energy, Networks and Environment (ARERA) is acting with an important role in supporting these intentions, since it regulates water services with a tariff method that applies a series of mechanisms to incentivize for investments and improvements in the direction of resource recovery and environmental sustainability.

In 2020 the independent research organisation supporting companies and regulatory institutions in the knowledge and decision-making processes (REF Ricerche), reported that Italy is among the countries in EU with the higher water exploitation index (~ 16%). Pistocchi et al. (2017) reports a total volume of withdrawal of approximately 33 billion m^3, of which 43% for agriculture, 25% for SII, 18% for hydroelectric energy production, 12% for the manufacturing industry. The same study investigated the potential for reuse of effluents from WWTPs considering the relative costs, report Italy as one of the countries with the highest potential: a potential that could cover up to 45% of the demand irrigation (with approximately 5 billion m^3 out of the 9.8 total available, usable in conditions of proximity to WWTPs). Based on ARERA data for the period 2018-2019, against an available potential of 20%, only 4% of the effluent volume produced by WWTPs was reused mainly for agricultural purposes.

7.2.1 Legislation applicable to 'water-smart' solutions in this Living Lab

At the regional level, laws are connected to the national regulation either by applying it as it is or by translating it into regulation with some modified standards (more restrictive with respect to the national ones). In the Veneto Region, the **Water Safeguard Plan** ("Piano di Tutela Acque"; Deliberation of the Regional Council n. 107 of 5th November 2009) is the transposition of the Legislative Decree n. 152/2006. Even if in the Veneto Region the water sources are abundant, the impacts of climate change became exponentially evident in the last years. Additionally, this territory is characterized by flourishing commercial activities, among which, some of them contribute strongly to add pressures to ecosystems.

The Veneto region contributes for around 7% to the national water withdrawal for the integrated water service (roughly corresponding to 9 billion m^3), 43% of which is carried out by the northeastern territory of Italy. The highest withdrawal interest groundwater (67%), followed by springs (23%) and surface water (10%) (ARPAV, 2021). In the area of the Venice basin, the uptake distribution is the same, but surface water is withdrawn from three rivers (Adige, Sile, and Livenza) and treated by four different treatment plants. After being used (~ 103 Mm^3 in 2019), the wastewater is collected and treated by 38 WWTPs located in the Veritas service area (Veritas, 2020). Most of the effluent derived from the treatment is discharged into nearby rivers, contributing to water indirect reuse for all subsequent uses (mainly agricultural, in some cases industrial and recreational).

A **Regional Plan for the lagoon protection** from which came the Integrated Fusina Project (PIF) allowed the adoption of several treatments, including nature-based solutions (NBS), to reach reuse goals of treated municipal wastewater for non-potable uses. Several factors, such as the industrial

recession and some barriers mainly connected to a lack of knowledge on actual risks connected to reuse and coordination of competences, however, slowed down its full implementation.

The pursuing of water reuse objectives for agricultural, urban, and industrial purposes, is disciplined by the National Ministerial Decree n. 185/2003, which refers to both law n. 36/1994 and Legislative Decree n. 152/1999 (now n. 152/2006, the transposition of Directive 91/271/EEC for urban wastewater and of Directive 91/676/EEC for protection of water by nitrates from agricultural sources) for specific requirements, to tackle structurally permanent situations of water resource scarcity. For agricultural reuse in particular, the situation is going to evolve soon due to the introduction of the new EU Regulation (2020/741), which is going to become effective from the 26th of June 2023 in EU member states. The implications of its application will be evaluated during the project development.

Nutrient recovery and related processes are regulated by the **End of Waste regulation** at EU level (Directive 2008/98/EC), implemented at National level by Legislative Decree n. 152/2006 Article 184 ter. To cease the waste status after a recovery process, materials/substances produced must respect the criteria/requirements indicated in the EU Directive. If the criteria are not defined or not met, the decree n. 152/2006 (and subsequent modifications and integrations) imposes that the MiTE act with “case by case” Decrees to cease the waste status of products. At regional level, a similar procedure is followed by the authorities responsible for the authorization release (the provincial administrations and the Metropolitan City of Venice). With **Regional Decree n. 120/2018**, the Region promulgated some more specific technical requirements for the “case by case” evaluation procedure, with the intention of simplifying the bureaucracy.

Sludge derived from urban wastewater treatment can be valued as an important resource since they are rich in organic carbon and other substances essential for soil restoration. Currently, sludge reuse is slowed down rather than fostered, even if within the same regulatory framework is stated that soils need the complex organic substances and nutrients contained in the sludge. The National regulation in force for sludge limits related to agricultural reuse is the **Legislative Decree n. 99/1992**, which implemented EU Directive 86/278/EEC. There have been several attempts to update it until 2018 when, after an intervention by the jurisprudence which forced sludge for agricultural applications to respect the same limits imposed for land reclamation, the Legislative Decree (n. 109/2018) was emitted to update in some parts the limits contained in the previous decree, contributing to solve the paralysis arisen. In Veneto, as well as in other regions, regional decrees integrated the national regulations in some parts and requirements, extending quality assurance of sludge finalized to agricultural application (DGRV n. 2241/2005 and DGRV n. 1407/2006).

Relevant for both nutrient recovery and sludge, the National Decree n. 75/2010 disciplines the field of fertilizers and soil amendments, establishing the criteria to be respected for a product to be classified as fertilizer and what substances can be introduced in the market.

7.2.2 Regulatory issues

For water reuse, the issues are dependent on the type of application targeted. If the potential reclaimed effluent is addressed to industrial reuse, beyond the direct quality needs of each specific industrial end-user, the issues are strictly connected with the requirements asked to be respected at

discharge. This is even more important for industries connected to the Marghera site (industrial area near Venice), which must comply with the very restrictive limits introduced by the Ministerial Decree of 30th July 1999 (from "Ronchi-Costa" Decree) for the quality protection of the Venice lagoon. The limited reuse of water for agricultural purposes has up to now been very connected to the regulatory dimension, partly due to the lack of a common standard capable of identifying standards and related measures to prevent risks for human health and environment, liberalizing circulation of the products on the market, and partly to a deeply rooted tendency in the country to restrictively implement EU directives (this happened for some parameters of Decree n. 185/2003, especially the microbiological ones) which, rather than favoring reuse, amplifies the economic-operational convenience gap between reuse and conventional use/withdrawal of resources. Though it seems not to imply additional more stringent requirements with respect of the current national regulation, potential issues for agricultural reuse could derive from the criteria and standard required by the new EU Regulation 2020/741 (entering in force for the Member States in June 2023).

For other potential resources connected to water, applying the principles of circular economy means, from a regulatory point of view, intertwining the legislation on water management with the one on waste management. In some cases, the possibility of finding clear classifications to enhance the products and direct them to sustainable reuses is lacking. It is the case, for example, of nutrients and specifically of nitrogen recovered under the form of new products (such as ammonium sulphate salt), and sludge.

In the field of nitrogen recovery, the fact that the national legislation (Decree n. 152/2006 Article 184 ter) delegates the End of Waste classification to the "case by case" decrees (MiTE and regional authorities), implies an arbitrary process of decision-making which exposes "the virtuous operator" at the risk of incurring penalties, with the result of discouraging rather than encouraging valorization and circular economy paths. In general, this regulatory uncertainty creates several difficulties in the application of virtuous cycles in this sector. On one hand the investment risk on processes and infrastructures for resource recovery in WWTPs can be very high, on the other hand, to avoid potential penalties, the virtuous producers are “forced” to adopt the most precautionary approach and classify the recovered resource as waste.

In relation to sludge valorization, the framework is even more complex and, although governance sees favorably the valorization of sludge in agriculture, the main obstacles for pursuing sludge agricultural reuse up to date have mainly been regulatory; thus allowing the rooting of widespread prejudices. For that reason, they are often perceived as a problem rather than as a resource to be treasured for its nutrient and organic carbon.

This is certainly linked at least to two factors: the lack of a stable, transparent and shared knowledge on the state of the art of quality, opportunities and risks linked with their reuse and a weak coordination and integration among the several regulations which discipline the different compartments connected to sludge (production, management and use). All these factors make in general difficult the identification of the most suitable and sustainable management path, preventing an objective and open vision and hindering their physiological destination to the environment and to the soil.

7.2.3 Funding available for water innovation

One of the most recent and biggest funding programs on the national territory is surely the National Recovery and Resilience Plan (PNRR), deriving from the program Next Generation EU. In Italy it is structured around 6 Missions (M): i) Digitalisation, innovation, competitiveness, culture, and tourism; ii) Green revolution and ecological transition; iii) Infrastructures for sustainable mobility; iv) Education and research; v) Cohesion and inclusion; vi) Health. A considerable amount of funding has been assigned to the second Mission, to foster ecological transition (40% of the total funding, corresponding to 59.47 billion €). Each M is structured into 16 components (C) and M2 include four components financed respectively for sustainable agriculture and circular economy (C1); energy transition and sustainable mobility (C1); energy efficiency and buildings upgrading (C3); territory and water resource safeguard (C4). In detail, for M2C4 concerning water resources, a total of 15.37 billion € have been allocated. This new financing instrument will foster “initiatives to contrast hydrogeological instability, to safeguard and promote biodiversity in the territory, and to guarantee a safe supply and an efficient and sustainable management of water resources” (PNRR, 2021).

Other funding opportunities derive directly by the European Union, with the possibility to apply for research programmes such as the new LIFE programme 2021-2027 and Horizon Europe.

Among the EU funding from the structural and investments funds (SIE funds), one of the most relevant is the FESR fund (acronym for “European Funds for Regional Development”). These funds are active for 7 years, previously from 2014 to 2020 and now from 2021 to 2027. Specifically, for the Veneto Region, the overall funding for the regional programme FESR 2021-2027 is equal to ~ 1 billion €. The programme proposal has been approved by the Regional Council, and is currently under approval by the EC. The priorities set with the FESR programme are five: i) a more intelligent and competitive region in relation to industry and tourism; ii) a more resilient, green, and lower emission region; iii) a more connected region through sustainable urban mobility; iv) a more social and inclusive region; v) a region closer to citizens. Over the 86% of the total resources have been assigned to the first two priorities, confirming the high attention posed to environment.

Moreover, the city of Venice (Municipality) is also taking steps towards climate change mitigation and resilience, especially because the city is known worldwide for its delicate balance and coexistence with water. Due to tourism and intensive human activities, the environmental equilibrium of the Venice lagoon is requiring continuous and intensive efforts to be maintained and improved. To counterbalance negative impacts, in 2012 Venice joined C40 Cities, an international initiative for the development/implementation of policies and programs towards greenhouse gases emission reduction and climate change mitigation (C40 Cities, 2022). These kinds of initiatives could also foster the attraction of funds or specific programmes.

Finally, it is worth to underline that in addition to specific action plans, the objectives related to the reuse and recovery of resources, energy-saving and sustainability of the service are also left to the voluntary initiatives of the local government and/or the operators of the integrated water service. In this sense, a key role is played by ARERA, which in the new tariff method MTI-3 (2021-2023), introduces incentives to promote rationalization interventions and efficiency in the use of the resources (for ecosystem services), by providing for a "sharing" factor (economic recovery for the manager) higher for activities linked to energy and environmental sustainability objectives, other than those included in the integrated water services (such as the reuse of effluent for irrigation and industrial purposes, energy efficiency, recovery of material from sludge).

7.3 Governance

When dealing with water governance it is worth considering firstly the basic level of administrative partition in which the country is divided: the Regions, with some politics and administrative autonomy; Provinces and Metropolitan Cities, which are intermediate local authorities between municipality and region; and Municipalities, representing the smallest scale of institutional public management of the territory.

On national level, the authority responsible for environmental policies, including the implementation of EU Directives, is the Ministry of the Ecological Transition (MiTE). It defines general objectives of water quality, develops ways to encourage its conservation, water use efficiency, and wastewater reuse. The regulation and control of water services at national level is entrusted to the Italian Regulatory Authority of Energy, Networks and the Environment (ARERA), an independent authority regulating water services with the aim of assuring the quality and uniformity of services throughout the country, by fostering efficiency and assuring the economic sustainability and financial stability of the management and protecting the rights of users. For this reason, ARERA defines the most suitable tariff method to cover full costs incurred by the manager of services, including environmental and resource-related costs.

The local authority responsible for transferring the targets established at national level (by the central government, translated and interpreted by the regional authority if the case, and by the regulator) into an Action Plan of water services in the territory of its competence, is the Basin Council or EGATO (Government Body of the optimal territorial area ATO; former AATO). It is a form of cooperation between the municipalities for the planning and organization of the integrated water service in Optimal Territorial Areas (ATOs). The Basin Council identifies and plans the structural and organizational changes necessary for the management of water resources and services, by matching it with the Business Plan of the manager of services, and with the aim of ensuring efficient and economic management in compliance with the principles of environmental protection and safeguard. Water services can be entrusted to: i) a private company (chosen by a public competitive tender); ii) mixed ownership (in which the private component is chosen by the same manner); iii) a public company, with an “in house” provision of services.

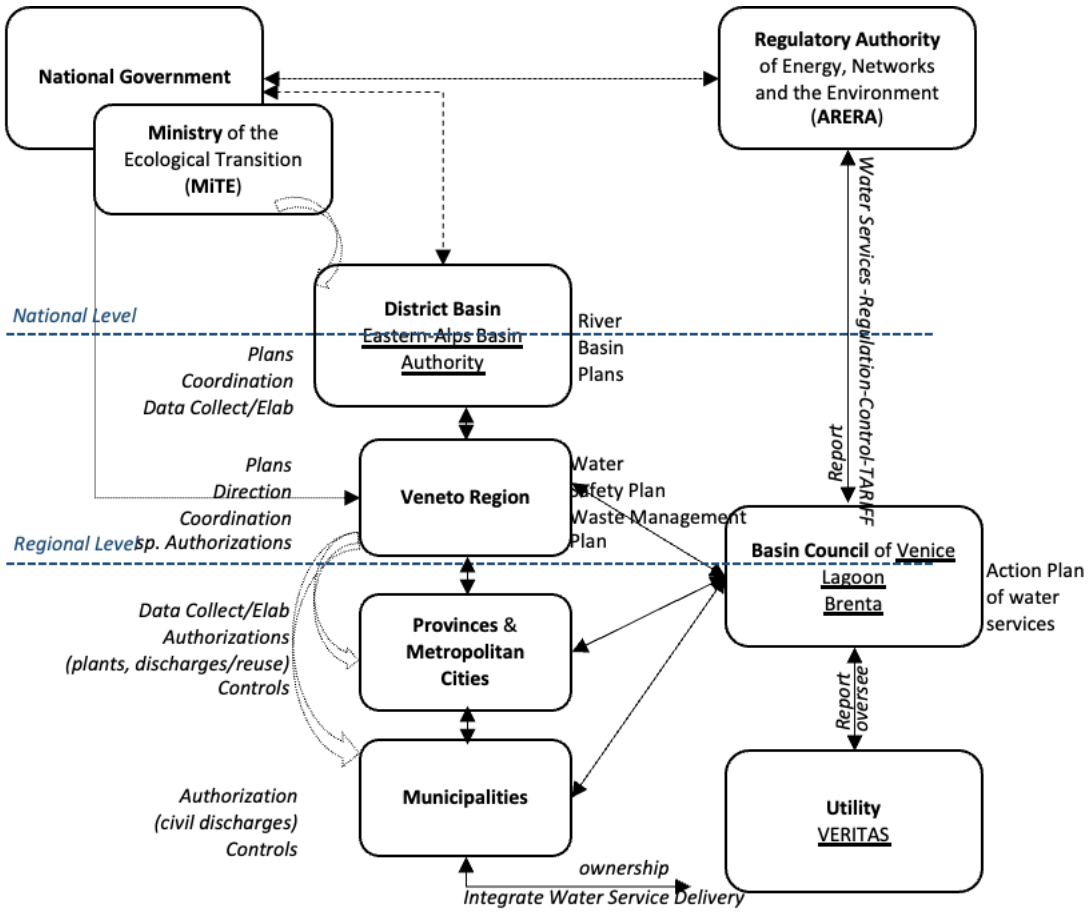

Figure 2. Representation of the main governance actors of the water sector

In the same way, from the hydrographic point of view, the national territory is divided into Districts and related District Basin Authorities, to which "uniform regional and interregional river basins" belong, with the goal of ensuring effective actions aimed at the protection, defence and enhancement of existing resources. The main District Basin Authority operating in the Veneto region is the Eastern-Alps Basin Authority, which operates also in basins belonging to the Friuli Venezia Giulia region, as well as in some cross-border basins bordering with Switzerland, Austria and Slovenia, for a total territorial managed area of 40.000 km2 and ~7 million population.

In the Veneto region there are nine Basin Councils, among these the Venice Lagoon Basin Council, managing a territorial basin extended over two provinces (Venice and Treviso) and 36 municipalities, for an extension of about 2.000 km2 and a catchment area of about 800.000 inhabitants. On this territory, the water services have been entrusted to the multiutility Veritas S.p.A. Moreover, the Viveracqua Consortium represents most of the utilities with the main goal to scale-up the economy of some common processes (i.e. energy and other products) to pursue the efficiency and sustainability of services.

To pursue resources sustainability, all the competences need to integrate and coordinate their knowledge to overcome the institutional fragmentation that undermines the possibility of unified and integrated planning, towards climate change impacts mitigation.

7.4 Summing up: key drivers and barriers for Venice

Adhering to the EU guidelines on climate change and circular economy to face common challenges associated with water scarcity, and more generally with territorial imbalances in resources availability, is surely a common driver for all the objectives of Venice LL. Though resource recovery and reuse are widely accredited concepts, the reality is that we still need to face several barriers for pursuing these goals, especially in the water sector. Hence, the opportunity of building alliances in the EU and realizing synergies is fundamental to obtain concrete results. The willingness of solving certain issues related to wastewater process management, which in fact are slowing down the pursuit of resource enhancement goals (water from WWTP or other potential resources associated, such as nutrient and sludge, is a significant driver.

Summarizing drivers and barriers in key concepts, the main drivers connected to the project are to: i) build consistency with the principles of the circular economy and climate change policies; ii) create awareness and objective knowledge on opportunities to support rational long-term planning; iii) create a habit of competencies sharing for decision-making processes; iv) develop decision support systems (DSS) evaluation tools, to identify the state of the art and the most sustainable and suitable opportunities of reuse/valorization (for water and sludge), guaranteeing an objective and repeatable process.

The main barriers to tackle can be mainly identified in: i) the complexity of the regulatory system and the variety of subjects involved, which should coordinate among each other; ii) the lack of transparency and access to knowledge on the actual risk associated with valorization and reuse, especially for some resources (such as sludge); iii) long-term planning and immediate needs; iv) the economical convenience (in a broad sense and for several factors, such as the low costs of conventional water use).

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8 Conclusions: drivers and barriers for water-smart solutions

This report consists of a preliminary assessment of the main drivers and barriers pertaining to aspects of policy and governance across the six Living Labs of B-WaterSmart – Alicante, Bodø, East Frisia, Flanders, Lisbon and Venice – and therefore reflect on the most recent tendencies of EU policy and national policy in their respective countries, all of them EU Member-States, with the exception of Norway (Bodø).

First of all, D5.3 should be read as an overview of policies at national, regional and local level that are relevant and have implications for the implementation the solutions being developed in the project LLs. In regards to the governance models in operation in each of the six regions/cities, this also a preliminary overview. The Communities of Practice (CoPs), the key node of stakeholder engagement in the project, are just starting to be mobilised (first meetings between late 2021 and early 2022), which means that many issues regarding policy and regulation are still to be discussed with the relevant institutions and will be fully addressed in future reports of B-WaterSmart (D5.5. – Drivers and Barriers: Proposal for a New Governance Model).

Many of the barriers identified derived from the fact that the B-WaterSmart LLs are in the frontline of innovation in water services and circular economy, and some possibilities are still at an early discussion and will require a stronger inter-sectoral collaboration. Solutions such as water and sludge reuse are still underdeveloped and need to be further considered in policy and regulation, at the national, regional and local level.

For an integrated management of nutrients, as it is envisaged in the EU Action Plan for Circular Economy, requirements for sludge will have to be aligned with the needs from the agricultural sector and depleted soils. There is an enormous potential to identify synergies within industry but also between WWTP operation and the agricultural sector, for instance.

Waste and inefficiency in the use of water resources continues to hinder the industry and agricultural sectors. The pressure of climate change and population growth is revealing a growing tension between overlapping water demands from sectors such as tourism and agriculture, which is most evident in the case of Bodø and Flanders. A cross-cutting concern that affects most LLs is that national regulations have been slow to adapt to the new priorities of EU strategies for adaptation and the circular management of resources. It is notably the case of sludge reuse in Venice, as well as wastewater reuse in Lisbon, which is at an early stage of its implementation in Portugal.

There are still gaps in national regulations, which requires frontrunners to rely mostly on EU regulation. In some cases, as in Lisbon, the monitoring plan required to obtain permits for water reuse from national institutions results in high costs that may hinder further investment in multiple purposes (e.g., expanding covered green spaces or investment in agriculture irrigation). The same eventually happens in Flanders, where the scale of the reuse pilots is still small, making the onus of investing as a frontrunner more difficult to carry (e.g. permits and technology required to meet the requirements). Investments in water reuse are still much regarded as standalone experiences and yet to be fully integrated as part of a long-term strategy for the water sector.

Concerning the implementation of circular businesses, which is a fairly recent experience in the water management sector across Europe, the representatives from the Venice LL have also

highlighted a remaining lack of integration between the institutions in charge of relevant sectors, such as waste and water management, as well as in the policies under implementation in Italy.

In creating circular business models for water-smartness, it is also fundamental to keep in mind reasonability of costs. Quality requirements for water treatment may require such high costs that some sectors will be unwilling to invest. The same barriers are present in relation to wastewater reuse in agriculture, for instance, as often long-distance transportation from WWTPs to end-users is required, as happens in Alicante.

In addition, to achieve a more efficient consumption of water, more investment in smart metering devices is required. In East Frisia, for instance, precise consumption data will be the basis to set water tariffs and water abstraction rights. In a context of scarcity, we will increasingly be confronted with tensions between viewing water as a public good and internalising its environmental and economic value.

Therefore, B-WaterSmart and its LLs is expected to significantly contribute to policymaking, especially in aspects regarding wastewater reuse in different sectors (drinking water, industry and agricultural irrigation), as well as nutrient recovery and risk assessments to ensure water quality standards according to EU directives.

The momentum created by EU plans and strategies, such as the Green Deal and the Action Plan for Circular Economy, the new EU Strategy for Adaptation to Climate Change (2021) and Next Generation EU (2021) – which are being implemented by State-Members and other countries, including Norway – are certainly key drivers for promoting a more sustainable and integrated management of water resources across Europe, and beyond. Recent policy strategies are certainly regarded as strong drivers, provided there will be the necessary funding for investing in innovation.

At the national level, drivers are usually associated with the awareness of the public and decision-makers, which facilitates implementation of solutions such as water reuse. However, there is much work ahead to develop models of governance that are more inclusive, fair and sustainable, especially in the face of worsening water scarcity. The proposal of new models of governance is a key objective for B-WaterSmart, for which this preliminary report is a crucial step, and which will be further developed in D5.5.

The results from this report will also be useful to inform the work of the Communities of Practice (CoPs), the key nodes of engagement with stakeholders and institutions in the B-WaterSmart Living Labs. The identification of drivers and barriers can help inform the creation of dedicated workgroups to overcome regulatory and economic barriers, raising the impact of the project on a circular economy for the water-energy-resources-waste nexus in Europe.

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