Guidelines & recommendations for regulation and policy instruments

Deliverable 5.6

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Guidelines & recommendations for regulation and policy instruments

D5.6: Guidelines & recommendations for regulation and policy instruments
Deliverable 5.6

Summary
Within the scope of WP5 – Society, governance, policy, the aim of this deliverable D5.6 is to provide guidelines and recommendations for future policy and regulation instruments, according to the reality of each of the six Living Labs of B-WaterSmart: Alicante (Spain), Bodø (Norway), East Frisia (Germany), Flanders (Belgium), Lisbon (Portugal) and Venice (Italy). This document describes (i) the role of the policy and regulation instruments to accelerate transition to a water-smarter society, (ii) the scope of the recommendations, topics grounded on the resources addressed by the project Living Labs, (iii) the approach followed to produce the recommendations, including contributions from other project activities (within WP1, WP2, WP4, WP5, WP6), and two dedicated sessions on policy and regulation, (iv) the policy and regulation instruments, addressing water-related circularity at European, national, and LL levels, (v) analysis of the major issues, and (vi) the recommendations for policy and regulation for water-smart systems, related to the topics addressed, namely – Digitalisation & IoT, Drinking water, Energy, Nutrients, biosolids and others, Reclaimed water, and Stormwater. The recommendations are expected to be applicable to other EU State-Members and to support the production of a set of four policy briefs, targeted for improved policy frameworks at local, national and EU levels.

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adelphi : Adelphi research gemeinnützige

ARERA : L'Autorità di Regolazione per Energia Reti e Ambiente

B3S : Information Technology security standard water/wastewater

BDSG : Federal Data Protection Act (Esta-Frisia)

BWS AF : Water-Smartness Assessment Framework

C40 Cities : Global network of mayors of the world's leading cities united in action to confront the climate crisis

CBM : Circular business models

CBMI : Circular business models innovation

CE : Circular Economy

CEAP : Circular Economy Action Plan

CETAQUA : Centro Tecnológico del Agua

Cl2 : Clorine

COM : Communication

CoP : Community of Practice

DPR : Direct potable reuse

DWD : Drinking Water Directive

Dx.y : Deliverable x.y

E-coli : Escherichia coli

EC : European Commission

EC-ECCE : European Commission, Energy, Climate change, Environment

EC-SP : European Commission strategy and policy

EC-Water : European Commission, Energy, Climate change, Environment. Topic water

ECI : European Critical Infrastructure

EDR : Electrodialysis reversal

EEA : European Environment Agency

ELP	: Long-Term Decarbonization Strategy
ENISA	: European Union Agency for Cybersecurity
ERSAR	: Entidade Reguladora dos Serviços de Águas e Resíduos (Portuguese Water and Waste Services Regulation Authority)
ETC	: European Topic Centre
EU	: European Union
EurEau	: European Federation of National Water Services Associations
GDPR	: General Data Protection Regulation
GIS	: Geographic Information System
HWDP	: Rainwater and Drought Plan (Flanders)
IAM	: Infrastructure asset management
ICS-UL	: Instituto de Ciências Sociais da Universidade de Lisboa
IDN	: Instituto da Defesa Nacional
InAll	: Innovation Alliance
IoT	: Internet of Things
IPR	: Indirect potable reuse
IRAR	: Instituto Regulador de Águas e Resíduos
ISO	: International Organisation for Standardisation
IT	: Information technology
IWA	: International Water Association
IWW	: IWW Rheinisch-Westfälisches Institut für Wasserforschung gGmbH
KRITIS	: Critical infrastructure
KWR	: Water Research Institute
LL	: Living Lab
LL_i	: Living Lab problem-owner
LMHV	: Food Hygiene Regulation (East Frisia)
LNEC	: Laboratório Nacional de Engenharia Civil

NAS : National Adaptation Strategy

NIS2 : Directive (EU) 2022/2555

OECD : Organisation for Economic Co-operation and Development

P : Phosphorus

PENSAARP2030: Portuguese strategic plan for the decade, for water, wastewater, and stormwater services

PER : Renewable Energy Plan

PERAL : Lisbon water reuse strategic plan

PESTLE : Political, Economic, Social, Technological, Legal, Environmental

PNA : National Water Plan

PNIEC : National Integrated Energy and Climate Plan

PNRR : National Recovery and Resilience Plan

PNUEA : National Plan for Efficient Water Use

P&R : Policy and regulation

QMRA : Quantitative Microbial Risk Assessment

RA : Risk Assessment

R&D : Research and development

RR : Resource Recovery

RWO : Rainwater Ordinance

SDG : Sustainable Development Goal

SWOT : Strengths, Weaknesses, Opportunities and Threats

Tech. : Technological

Tx.y : Task x.y

UN : United Nations

UNED : Universidad Nacional de Educación a Distancia

UWC : Urban Water Cycle

UWOT	: Model for simulation of the urban water cycle from source-to-treatment-to-tap, supporting planning and assessment of distributed interventions
UWWTD	: Urban Wastewater Treatment
VAP	: Flemish Adaptation Plan
VITO	: VITO nv
VKP	: Flemish Climate Policy Plan
Vlakwa	: Vlaams Kenniscentrum Water
VMP	: Flemish Mitigation Plan
W-E-P	: Water-Energy-Phosphorus
WAREG	: European Association of Public Authorities
WFD	: Water Framework Directive
WISE	: Water Information System for Europe
WoLL	: Water-Oriented Living Labs
WP	: Work Package
WRRF	: Water Resource Recovery Facility
WWTP	: Wastewater treatment plant

Executive summary

Within the scope of WP5 – Society, governance, policy, the aim of this deliverable D5.6 is to provide guidelines and recommendations for future policy and regulation (P&R) instruments, according to the reality of each of the six Living Labs of B-WaterSmart: Alicante (Spain), Bodø (Norway), East Frisia (Germany), Flanders (Belgium), Lisbon (Portugal), and Venice (Italy). This includes targeted policy recommendations aimed at creating an enabling environment for wide application of water-smart solutions, at local, national and EU levels, concerning Digitalisation & IoT, Drinking water supply, Energy, Recovery of nutrients, biosolids and others, Water reuse, and Stormwater for agricultural irrigation and other uses.

The guidelines consider contributions from the work developed in other activities of the project, particularly (i) the drivers, barriers and socio-economic factors identified (WP5); (ii) the SWOT analysis in the scope of the strategic planning process developed within the Innovation Alliance (InAll) (WP1); (iii) the WaterSmartness Assessment Framework developed (WP6); and (iv) the legal issues identified in T4.4 (WP4). Specific regulation and economic aspects, as economic incentive mechanism and instruments, as well as regulatory risk-related aspects of water reuse in agriculture were also addressed. In addition to the original plan, the results also include contribution collected from two P&R dedicated meetings: an interactive discussion (T5.4), held in Alicante (September 2023), with about 70 project participants and a Lisbon LL meeting (January 2024) on water reuse (T2.4), with 18 participants (50% external P&R experts).

This document presents (i) the relevance of the P&R instruments to accelerate transition to a water-smarter society, (ii) the scope of the recommendations, according to the topics grounded on the abovementioned resources addressed by the project Living Labs, (iii) the approach followed to produce the recommendations, including contributions from other activities in the project and two dedicated meetings, (iv) the P&R instruments addressing water-related circularity at European and LL levels, seeking to identify changes that can be expected and identifying the main issues and strengths to attend for achieving water-related circularity, providing a brief insight into the main challenges water reuse for drinking water purposes still faces and refering to current processes of indirect reuse, (v) the analysis of the major issues, and (vi) recommendations for policy and regulation on the water-related topics addressed.

Cross-cutting and topic-specific recommendations to policy-makers, at European, national and regional levels were drawn. Cross-cutting recommendations are to: ensure coherence among sectors (water, energy, waste, food, health) and across levels (EU, national, local); promote a problem-driven research and innovation environment, as well as stakeholders' engagement and co-work, data-based decision-making, strategic planning and resource allocation; develop coherent EU-national-local strategic plans on water and related resources, supported by a clear, quantitative, and objective-driven assessment; create incentives to train and capacitate human resources regarding the adequate knowledge and competences to implement the strategic plans; to promote the SDGs' monitoring and international benchmark; create/empower national, regional and local water governance boards with representatives from government and regulation agencies, the water sector (public and private), water users, civil society, and academia; promote co-work among these stakeholders for decision-making and periodic update of regulations with the best available knowledge; promote the mindset and semantics' shifting from "wastewater

treatment" to "resource recovery" and valuing the water quality rather than its 'history', i.e., privileging 'water' over 'wastewater', which would contribute to a generational change towards an increased market acceptance of recovered water, nutrients and biosolids.

On digitalisation and IoT, recommendations are to: promote mechanisms for the continuous update and monitoring of IT threats and solutions against unauthorized access; produce guidelines or standards of fit-for-purpose data specification, comprehensively demonstrating the value, both from the economic and the innovation points of view, of the shared data; clarify the boundaries between confidential and open data, promoting the safe availability of sound anonymous shared data, and to transpose the above to national and/or regional levels, when and if applicable.

On drinking water, recommendations are to: regulate or provide incentives for the development of strategic asset management of water supply systems for the prioritization of the most cost-effective investments on the long term, towards network renewal and smart monitoring, assessing the progress through quantity and quality indicators; minimise the discharge of microcontaminants in the water sources; promote point source control (including of contaminants of emerging concern); promote research on simpler and cost-effective monitoring of proxy indicators; monitor and regulate, particularly in water-scarce regions, the non-potable uses of drinking water.

Regarding energy, recommendations are to: promote and provide the means for energy efficiency in water systems and self-sufficiency in WWTPs towards energy neutrality; regarding the energy production and use by water utilities, facilitate the management between the water systems and the energy distribution grid, in order to minimise the need for energy storage while ensuring the quality of electricity on the distribution grid; provide incentives for the adoption of water-energy efficiency certificates for households, buildings, and neighbourhoods; better harmonise the water, energy, and waste policies at national, regional or local levels.

Concerning recovery of nutrients, biosolids and others, recommendations are to: co-produce an EU roadmap for biosolids/sludge management; revise the EU directive concerning biosolids/sludge beneficial use in agriculture and the required characteristics/standards, defining a clearer allocation of responsibility along the biosolids value chain and excluding biosolids/sludge from waste legislation to overcome the existing barriers to circular economy; deliver a comprehensive EU regulation concerning the organic fertilizers obtained from the urban wastewater treatment, including the required characteristics/standards, to promote their recovery and market acceptance; promote monitoring of phosphorus (P) as a critical raw material in Europe and accordingly update the regulation targets of phosphorus recovery; promote research and the use of technologies that recover nutrients (nitrogen, phosphorus, and potassium) from wastewater and sludge streams in a concentrated form, increasing the options for reuse with reduced pathogen risk and improved ease of transportation; promote research on the impacts on soil, vegetation, animals, and humans resulting from the use of biosolids/sludge in agriculture; better harmonise the water, energy, and waste policies at national, regional or local levels, namely to ensure coherence of policy and targets between biosolids recovery/beneficial use and biogas production.

Concerning water reuse, recommendations are to: develop an EU strategic agenda on water reuse covering all uses, non-potable, and potable, indirect and direct; monitor and increase the safety of the current indirect reuse and to agree on a uniform position across the EU countries on

if and how to account for indirect water reuse – clarifying the boundaries between treated wastewater discharge and (indirect) water reuse; encourage the Member States to integrate water reuse in the local/regional water balance and define context-specific priorities for reclaimed water uses; to reflect the best site-specific water resource management in the cost coverage of the additional treatment (if needed); account for environmental uses as direct or indirect water reuse; ditto for managed aquifer recharge and to deliver clear instructions for a sound assessment of its environmental impact and for risk assessment and management. Furthermore, a future revision of the Regulation (EU) 2020/741 should (i) establish minimum requirements for industrial and urban uses, maintaining the fit-for-purpose principle used for agriculture uses, (ii) provide clearer instructions on the risk assessment process, and (iii) reflect in the monitoring the knowledge about the system and its reliability. It is also recommended to: promote research and provide guidance on how to upgrade the current urban WWTPs to cope with the new requirements of the UWWTD recast and enable water reuse account for the beneficial use or recovery of phosporus through the irrigation with reclaimed water; promote EU policies for public engagement, awareness, and communication to overcome the perception of worse water quality and high risk; develop guidelines for a Europewide coherent water reuse licensing and service provision; promote research & innovation and subsequently develop policy and regulation on water reuse business models, funding mechanisms, and pricing, valuing opportunity costs and considering multiple users to improve economic feasibility of water reuse; promote research and pilot demonstration projects of direct potable reuse to develop sound guidelines of water quality and treatment process operation and redundancy needed to anticipate a solution for aggravated water scarcity, localised needs, emergency situations, as well as to build the trust of the society in water reuse safety.

Regarding stormwater for agricultural irrigation and other uses, recommendations cover governance and technical aspects, namely: provision of adequate international agreements on transboundary water flow, particularly where surface water inflow is important; promotion of stakeholders' involvement in rain/stormwater management as a shared challenge with a clear definition of roles, responsibility and ownership, including who and how to pay for an unstable source as stormwater; promotion of storage and use of rainwater/stormwater in rural and urban (including households) spaces; promotion of the use of nature-based solutions to manage stormwater quantity and quality; promotion of smart monitoring and control of the water quality for the safety of the fit-for-purpose stormwater use with the appropriate treatment.

The recommendations are expected to be applicable to other EU State-Members and to support the production of a set of four policy briefs, targeted for improved policy frameworks at local, national and EU levels.

1 Introduction

1.1. Objectives and scope

Within the scope of the B-WaterSmart WP5 – Society, Governance, and Policy, the objective of this document is to provide guidelines and recommendations for future policy and regulation instruments, according to the reality of each living lab, considering the drivers, barriers and socio-economic factors identified (Task 5.2 – analysis of drivers and barriers for implementation and acceptance of solutions), and the socioeconomic metrics developed for the water-smartness assessment framework (Task 6.2 – development of the water-smartness assessment framework). This includes policy recommendations aimed at creating an enabling environment for wide application of water-smart solutions, at local, national and EU levels. The guidelines consider contributions from the work developed in other activities of the project, particularly the referred drivers, barriers and socio-economic factors identified in Gomes et al. (2022) and Schmidt et al. (2023); from the strategic planning process developed within the B-WaterSmart Innovation Alliance (InAll) presented in Cardoso et al. (2022) (Task 1.4 – implementing the B-WaterSmart innovation alliance InAll); the socioeconomic metrics developed in the B-WaterSmart Assessment Framework (Silva et al., 2023); the legal issues identified (Task 4.4 – supporting the circular transition: financing CE projects), including those hindering stormwater use in irrigation. Specific regulation and economic aspects, as economic incentive mechanism and instruments, as well as regulatory risk-related aspects of water reuse in agriculture were also addressed. In addition to the original plan, the results of an interactive discussion held in Alicante (September 2023), and of the Lisbon LL meeting dedicated to Policy & Regulation (January 2024) focused on water reuse and related issues are also included.

Drawing from the reality of representative case studies in the B-WaterSmart Living Labs (LLs) (Alicante|Spain, Bodo|Norway, East Frisia|Germany, Flanders|Belgium, Lisbon|Portugal, and Venice|Italy), the recommendations are expected to be applicable to other EU Members States and to support the production of a set of four policy briefs on regulation and policy instruments, targeted for improved policy frameworks at local, national and EU levels.

1.2. Structure

Following this introduction, Chapter 2 highlights the role of the policy and regulation instruments to accelerate transition to a water-smarter society, Chapter 3 identifies the scope of the recommendations, grounded on the B-WaterSmart resources addressed by the project LLs, and Chapter 4 describes the approach followed to produce the recommendations. This includes contributions from other project activities, as well as from an interactive session on policy and regulation (held in Alicante, ca. 70 project participants), and a dedicated Lisbon LL meeting (18 participants).

Chapter 5 maps the policy and regulation instruments, addressing water-related circularity, relevant for recommendations and with focus on B-WaterSmart resources, at European and LL levels, and addresses the different European directives and frameworks that currently govern water reuse. Where possible, it seeks to identify changes that can be expected. Additionally, it identifies the main issues and strengths to be addressed to achieve water-related circularity. It also provides a brief insight into the main challenges still facing water reuse for drinking water purposes and refers to current processes of reuse (e.g. via discharge in and abstraction from groundwater or surface water

bodies), technological possibilities, and quality standards. Chapter 6 analyses the major common and specific issues concerning policy and regulation. Chapter 7 presents the recommendations for policy and regulation.

2 Role of policy and regulation instruments to accelerate transition to a water-smarter society

2.1 Overview of key challenges in the transition to a water-smarter society

Relevant aspects in the transition to a water-smarter society are analysed in the literature (Damman et al. (2023) and an overview is presented in Cardoso et al. (2023). Together with the efficient use of resources (e.g. water and energy efficiency, control of water losses), the circular economy in water services intends to address issues of global, regional, and local sustainability, and is an issue of great relevance with an outstanding role in the sector's policies and strategic plans, both nationally and internationally. Internationally, there are several initiatives by funding agencies, regulators, and associations in the water sector. The initiative of the World Bank "Wastewater: From Waste to Resource" (World Bank, 2020) recognises the wastewater potential to create value and promotes shift in the paradigm in wastewater systems, replacing traditional wastewater treatment plants (WWTPs) by resource recovery facilities, particularly for resources such as water, biosolids, energy, and fertiliser. The circular economy is highlighted on the Finnish Institute of the Environment research and development page (Syke, 2021), indicating to the four main areas of action that have been identified as key to sustainable water use: reducing inefficiencies in water use, reducing water losses, materials and energy recovery, and water recycling and reuse. To support management bodies, regulators, funding agencies, consultants, industry and researchers, the International Water Association (IWA) published, in 2016, a guide for circular economy in the urban water cycle, which is summarised in three interrelated resources, namely water, materials and energy (IWA, 2016). This association suggests that the urban water cycle should be considered and managed as a closed (circular) system, with cascading water quality options defined and differentiated for each use. It states that efficient reuse and transport systems are critical, to success, and that resource recovery should be competitive in a market driven by consumption. According to the IWA, the main challenge is to find markets willing to work with recovered products as alternatives to traditional (manufactured or extracted) products. Scale of production/recovery and acceptance by the consumer are identified as key problems. For the IWA, the energy portfolio should seek to increase renewable energy production and consumption, reducing fossil energy consumption, and contributing to zero carbon cities (IWA, 2016).

European Federation of National Water Services Associations has identified ten key challenges for the water sector for the next decade. One of these challenges is "Giving water its value in the circular economy". Wastewater and its by-products (e.g. sludge) contain valuable resources, such as energy and phosphorus, which can be recovered and reused, thus contributing to the conservation of scarce or depleted resources (and their associated negative impacts). Additionally, they may support job creation and economic growth, as jobs and incentives should be created to bring the recovered resources to the market in a sustainable way (EurEau, 2021). The new proposal for the EU urban wastewater treatment directive COM(2022)541 will require water utilities to systematically consider water reuse, reflecting the progress that has been made. In terms of energy, it proposes energy neutrality for urban wastewater treatment. In the context of the circular economy, WWTPs should be viewed as resource recovery facilities for water, energy, and materials (e.g. phosphorus), and managed accordingly.

In terms of stormwater management, there is a general dispersion of responsibilities in the stormwater sector worldwide. Clarification of financial models, greater articulation between agencies, and concern for environmental control are critical. International literature highlights the benefits of the green/blue approach, which should be implemented adaptively and progressively, taking advantage of investment opportunities to expand or rehabilitate systems (Ashley et al., 2020; Bertrand-Krajewski, 2020; Bichai and Ashbolt, 2017; EEA, 2017; Graham, 2016; Kapetas and Fenner, 2020; Zhou, 2014). The clear definition of stormwater systems boundaries is a relevant question for the allocation of responsibilities, for the definition of financing mechanisms, and for controlling services provision. Internationally, stormwater systems are generally regulated by environmental authorities, with a greater focus on flood protection, water bodies protection from pollution discharges, or increasing the resilience of cities to climate variability and uncertainty. All these aspects tend to focus on the downstream boundary. The European Directive 91/271/EEC on urban wastewater treatment (EU, 1991a) is currently under revision. The new proposal COM(2022)541 recommends to reduce pollution from stormwater in large agglomerations, requiring the implementation of integrated urban water management plans, where nature-based solutions are considered as good means to treat overflows (Zammar and Scholefield, 2021; Ashley et al. 2020; Bertrand-Krajewski, 2020; Bichai and Ashbolt, 2017; EEA, 2017; Graham, 2016; Kapetas and Fenner, 2020; Zhou, 2014).

An additional concern is the asset management of urban water systems, considered as an organisation coordinated activity to recognise and create value from its assets (ISO 55000:2014). Urban water systems belong to a significant portfolio of physical and other assets, which include the infrastructure that provides the service. Despite asset management is wider in terms of the issues it covers, infrastructure asset management (IAM) applied to urban water systems goes beyond the management of infrastructures as assets in themselves. It examines the specificities of the infrastructures, such as their interdependencies and the cause-effect relationship of their behaviour (Cardoso et al., 2023). IAM also intends to ensure the sustainability of these assets in the long term, guaranteeing compliance of the objectives and targets of the service over a longer time horizon and considering all dimensions of sustainability: social, environmental, and economic. It is also a powerful tool to address the integrated planning and management of all water services (the traditional water supply and wastewater management, as well as stormwater and water reuse). It should always be based on a sound strategic planning process, as exercised within the B-WaterSmart Innovation Alliance (Task 1.4).

Regarding the digitalisation of water services, it is essential to recognise that there is an increasing number of actors with potential connections and possible motivations for intrusion, what may create concerns related to cybersecurity and security against intrusion. These motivations can be political, financial, economic, criminal or terrorist, among others (IDN, 2017). In this regard, it is already recommended within the framework of water security plans (IRAR, 2005) the existence of security systems against intrusion, particularly to avoid clandestine activities in reservoirs and catchment areas. The European Directive 2008/114/EC (ECI Directive) requires each Member State to identify potential critical infrastructures. These are infrastructures essential for the maintenance of functions vital to society, health, security, safety, or social well-being or economic and which disruption or destruction would have a major impact on a Member State. The transport and energy sectors are identified, but others may be included if considered appropriate. This Directive, which sets out obligations for the identification and designation of European Critical Infrastructures, has recently been revised and published, introducing additional measures for the protection of critical infrastructures (EU, 2022a).

2.2 Role of policy and regulation instruments to accelerate the transition

The water sector requires a multi-level governance as water connects across sectors, places, and people, as well as geographic and temporal scales, as referred in OECD (2015). Additionally, it is also argued that freshwater management (surface and groundwater) needs to be considered both at global and local scales, given that hydrological boundaries and administrative limits do not necessarily coincide, involving diverse stakeholders (public, private and non-profit) in the decision-making, policy, and project cycles. Coordination is essential in the water sector, given it is highly a natural monopoly, capital-intensive with important market shortcomings (Hirano and Latorre, 2020; Lima et al., 2021; Cardoso et al., 2023). Water policy is inherently complex and strongly linked to critical domains, including health, environment, agriculture, energy, spatial planning, regional development, and poverty alleviation. Countries have allocated increasingly complex and resource-intensive responsibilities to sub-national governments, resulting in interdependencies across levels of government that require co-ordination to mitigate fragmentation OECD (2015).

The water circular economy creates new challenges in water governance by adding water loops with various purposes and qualities, demanding robust institutional arrangements based on well-designed water policy frameworks and regulations, cooperative governance, the acknowledgement of risks and a fair distribution of benefits, costs, and risks (Riazi et al., 2023). The development of regulatory frameworks for water reuse may help to address safety concerns and support its adoption (Mukherjee and Jensen, 2020).

According to OECD (2015), it is fundamental to know “what to do”, “who does what”, “why”, “at which level of government” and “how” to handle forthcoming water challenges. To be feasible, policy responses require coherence, appropriate stakeholders’ engagement (e.g., public participation in regulation; Hirano and Latorre, 2020), implementation of well-designed regulatory frameworks (WAREG, 2021; Cardoso et al., 2023), existence of adequate and accessible information, as well as of sufficient capacity, integrity, and transparency. Key to the transition to more inclusive and sustainable practices is the capacity of institutions to adapt to changing circumstances, political will, and policy continuity. Coping with current and future challenges requires robust public policies, targeting measurable objectives in pre-determined timeframes at the appropriate scale. These policies rely on a clear assignment of duties across responsible authorities and subject to regular monitoring and evaluation (OECD, 2015).

The Principles on Water Governance (OECD, 2015) aim at enhancing water governance systems that help to manage “water in a sustainable, integrated and inclusive way, at an acceptable cost, and in a reasonable timeframe”, recognising that governance is highly contextual, that water policies need to be tailored to different water resources and places, and that governance responses must adapt to changing circumstances.

To guarantee environmental sustainability, there is an urgency for action, given the accelerated rate of biodiversity loss, the aggravating impacts of climate change and the overutilization of natural resources (OECD, 2023). The most used instrument for environmental policy in OECD countries is regulation (WAREG, 2021), including prescriptive “command and control” regulation and performance standards, that should be balanced with other forms of regulatory interventions as market-based instruments (e.g., taxes and permits), and other measures (e.g., incentives, co- and self-regulation). The regulatory environment is key, both in creating incentives for companies to

invest in innovation for the environment and in discouraging the kind of innovation that can help economies and societies become more resilient and environmentally sustainable.

The development of agile, technology-neutral, and adaptive regulation promotes innovation and contributes to mitigate innovation-related risks, including for climate and the environment (Mukherjee and Jensen, 2020; OECD, 2021a; Riazi et al., 2023). When there is significant risk, rules are required addressing the factors that can lead to harm, and permitting requirements, inspections and enforcement must depend on the level of risk of a given product, issue, and business (OECD, 2021b). Additionally, precautionary measures as environmental licensing or prohibition need to be balanced with the societal benefits of environmental action and innovations. Permitting, or licensing, is a regulatory tool for public administrations to regulate the registration and/or operation of a business unit by prior approval. It includes all requirements needed by the operator to start their activity (approvals, permits, licenses, certifications, professional requirements, authorisations of all types). In the case of environmental policy, improving licensing and permitting procedures can promote green innovation by enabling businesses to carry out environmentally friendly activities (OECD, 2021b).

Governments have to face significant challenges, posed by climate change and advancing climate-relevant technologies. Therefore, it is essential to consider measures that ensure that regulations remain fit-for-purpose, encourage investment in innovation and continue to promote environmental objectives.

At the European level, the development and implementation of EU policies include the European Commission laws' proposals to the European Parliament and Council of the EU, helping Member States implementing EU legislation, managing the EU's budget, and allocating funding, ensuring that EU law is complied with. EU policies are designed to bring benefits to citizens, businesses, and other stakeholders in the EU. Commission initiatives for new policies must be agreed on internally, according to a set procedure. Better regulation tools ensure that each new policy is based on evidence and best available practice (EC-SP, 2023). The Better Regulation agenda (COM (2015)215) ensures that EU policymaking is evidence-based, leading to simpler and better EU laws, while avoiding unnecessary burdens. It involves citizens, businesses, and stakeholders in the decision-making process.

The European Commission (EC) recognises clean water as the driving force of life and an essential resource for (EC-ECCE, 2023): i) food security, as climate change and overuse of water can affect the availability and price of food; ii) energy security, as less water is used for renewable energy sources than fossil fuels, while challenges remain; iii) health, as clean, safe, and affordable water is essential for people's health; iv) peace, since transboundary water cooperation can be a catalyst for peace, rather than conflict; v) nature, because thriving healthy ecosystems require clean water and can help mitigate the effects of climate change.

Water has been facing many pressures, involving pollution from industrial chemicals, pesticides, nutrients, pharmaceuticals, and climate change. Water stress is increasing worldwide. It is driven by overdemand, mismanagement and the impacts of the triple crisis of climate change, biodiversity loss and pollution. If not enough action is taken now, almost half of the world's population will suffer acute water stress by 2030 (EC-ECCE, 2023).

The main water-related objective of the EU is to ensure access to good quality and sufficient water to all Europeans, as well as to ensure the good status of all water bodies across Europe using the River Basin Management Plans and Programmes of Measures to protect and restore water bodies in order to reach good status (both chemical and ecological), and to prevent deterioration (WAREG,2023). To achieve this objective, EU defined rules aiming at ensuring a sustainable water management in the long-term, reduction of water pollution, and protection of aquatic ecosystems (EC-SP, 2023). In the EU almost 85% of bathing water sites are of excellent quality and over 90% of urban wastewater is managed in line with EU standards. However, only 40% of surface water bodies achieve good ecological status. According to the European Drought Observatory, about 42% of continental Europe is in a state of warning and about 8% in a state of alert, with a particularly worrying scenario in the EU's south, plagued by severe and prolonged droughts.

In the world, 40% of the world's people are affected by water scarcity, 80% of the world's wastewater is discharged untreated into the environment and 90% of disasters are water related.

EU water policy is one of the foundations of environmental protection in the EU, with the rules to protect water resources, fresh and saltwater ecosystems, and ensure drinking and bathing water are clean. In the context of the European Green Deal, the Water Framework Directive (EU, 2000) provides the main framework and the objectives for water policy in Europe.

In alignment, specific EU policies are addressed to: i) drinking water, in order to improving access to drinking water for all; ii) flood management, through measures to manage flood risk, including risks to human health and the environment; iii) groundwater, ensuring its good quantity and quality; iv) nitrates, protecting waters against pollution caused by nitrates from agricultural sources; v) urban wastewater, to ensure that it is properly managed; vi) water reuse, ensuring water resources are managed more efficiently and facilitating water reuse in the EU; vii) water scarcity and droughts, preventing and mitigating water scarcity and droughts in the EU; viii) surface water, protecting them from chemical pollution; ix) bathing water to ensure it is clean and its high-quality across Europe; x) marine waters to protect Europe's coasts, seas and oceans; xi) EU efforts on the global water agenda, as it is fundamental to sustain the political momentum of the UN 2023 Water Conference, to accelerate actions for clean water and sanitation for all by 2030 (EC-Water, 2023).

Gomes et al. (2022) mention the water as a current pressing concern for EU policy, 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.

An overview of the key policy strategies driving a smart-water society in Europe is presented in Gomes et al. (2022), focusing on the areas of climate action and circular economy, in line with the United Nations Agenda for 2030, the Sustainable Development Goals (SDGs) and the Paris Agreement. They highlight 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.

Overall, the EU commitments to the Water Action Agenda aim to achieve (EC-ECCE, 2023): i) water security for all, global resilience to water stress; ii) the human right to safe drinking water and

sanitation, without compromising the rights of future generations; iii) protected and restored aquatic ecosystems; and iv) a fair balance between water supply and demand.

Regarding priorities, the EU considers (EC-ECCE, 2023): i) access to safe drinking water and sanitation as a human right; ii) protecting and restoring aquatic ecosystems for sustainable development, climate mitigation and adaptation; iii) promoting a more integrated approach to the management of water resources across sectors; iv) promoting circularity in the use of water for industry, energy, and agriculture by increasing water efficiency and water reuse; v) developing transboundary water cooperation, as a catalyst for peace and security; and vi) mobilising public and private finance, research and innovation, and knowledge sharing.

Considering the priorities referred to, with relevance to the water sector, the new EU Circular Economy Action Plan (CEAP) will facilitate water reuse and efficiency (including in industrial processes) and announces the review of directives on wastewater treatment and sewage sludge, and the development of an Integrated Nutrient Management Plan to ensure more sustainable application of nutrients and stimulate the markets for recovered nutrients. Among the CEAP priorities is the new Water Reuse Regulation to encourage circular approaches to water reuse in agriculture.

The circular economy (CE) challenges bring together several policy and regulatory regimes with potential gaps and overlaps. This may restrict the feasibility of circular water solutions. As the CE requires a shift from waste management and disposal towards the value creation within and between sectors, it is fundamental that pressures between different regulatory frameworks are overcome.

The European Commission adopted a new EU strategy on climate change adaptation (EC, 2021). This new policy explicitly seeks to accelerate the development and roll-out of solutions to safeguard the availability of freshwater. It recognises the need for action to ensure the availability and sustainable use of freshwater resources and calls for protecting water quality in the face of climate change to guarantee a stable and secure supply of drinking water. The strategy was conceived in the belief that climate change impacts will affect all economic sectors and all social groups, and so policy mainstreaming and systemic change are prominently featured. It emphasises the need for climate-informed and future-proofed investment and policy decisions, for improved collection of and access to climate-related risk and loss data, for fostering efficient water use in the domestic, agricultural, and industrial realms, for promoting drought management planning, and for setting water prices that adequately reflect the value of the resource (EEA, 2021).

Recently, general considerations on water stress have been integrated into the European Green Deal, the biodiversity strategy for 2030, the farm to fork strategy, the 2030 climate and energy framework, the new circular economy action plan, and the 2050 long-term strategy. Elements of water security and insurance are also embedded in the EU's sustainable finance taxonomy (EEA, 2021). Developing comprehensive and incentive regulatory frameworks and incentive pricing mechanisms is as important for facilitating the uptake of new technologies as developing the technical solutions themselves (EEA, 2021). Within the scope of B-WaterSmart, these instruments play an important role to accelerate transition to a water-smarter society.

2.3 Impact of regulation on business model innovation

With respect to impact of regulation on business model innovation, regulatory factors will have a substantial impact on the innovation of business models, a trend expected to intensify as future

business model innovation becomes increasingly influenced by technological advancements, data-driven strategies, and ecosystem-based movements. Regulation tends to impede innovation efficiency, particularly in highly uncertain markets (Nielsen, 2023, Aghion et al. ,2021) indicating a correlation between regulation and lower innovation intensity. However, there are positive instances where direct environmental regulation creates new markets for innovative solutions, driven by increased demand for clean energy technologies, and intellectual property laws incentivize firms to invest in research and development. Indirect forms of regulation, such as those preventing established companies from stifling competition, can create opportunities for new entrants with innovative business models. Nevertheless, challenges may arise if regulations hinder firms from experimenting with new models or diminish incentives for risk-taking. Additionally, the speed of legislative adaptation to new technologies and the influence of indirect regulation on social norms impacting consumer behaviour are identified as critical factors shaping future business model innovation (Nielsen, 2023).

In highly regulated contexts, such as the water sector, the establishment of Water-Oriented Living Labs (WoLLs) creates very effective environments for collaborative innovation among public authorities, water companies, technological and solution providers, and research institutes. These environments enable the analysis and assessment of the impacts of current policies and regulations on the development of circular solutions, facilitating adjustments and modifications to foster the adoption of technologies that promote circular solutions and the consequent development of circular business models.

LLs have the capacity to experiment, innovate, and explore, yet they require support systems to ensure sustained success and longevity. The shift towards a circular economy necessitates not only heightened business, technological, and social innovation but also collaboration and strategies involving governments, companies, and citizens collectively. These crucial collaborative efforts and strategies can be termed as enablers for the circular economy (ETC, 2021).

In this line, efficient circular economy policies can encourage the uptake of suitable business models, technical innovations, and social changes by offering the needed stimuli to unleash their potential for the transition. In this context, policy encompasses actions taken or suggested by legislative and executive bodies to facilitate and hasten circular initiatives (ETC, 2021). The following policy tools are considered: Legislative measures, regulations, and information requirements (e.g. EU Ecodesign Directive, restrictions on the use of hazardous substances), support for research and innovation, economic incentive mechanisms (environmental taxation), voluntary tools and guidelines (EU Ecolabel or the EU green public procurement criteria).

Clear policies, including specific targets and proper enforcement, can aid, prioritise, and encourage strong action towards the transition to the circular economy.

3 Water-related resources addressed in B-WaterSmart

For definition of the scope for the policy and regulation recommendations, the resources addressed by the B-WaterSmart Living Labs (LLs) – Alicante, Bodø, East Frisia, Flanders, Lisbon, and Venice – were considered the most relevant within the project focus. Based on the LL strategic agendas agreed by the Communities of Practice (CoPs) (Schmuck et al., 2021; Glotzbach et al., 2023), the identification of the resources addressed by LLs in the project is presented in Table 1. CoPs are communities formed by people who voluntarily share common interest, interact regularly, exchange information and knowledge, and seek to sustain the community and share learning (Rebelo et al., 2021).

Table 1. Resources addressed in the B-WaterSmart LLs

Type of resource /circularity	Living Labs addressing the resource in B-WaterSmart		# related B-WaterSmart product or tool (Annex 1)
Digitalisation & IoT	All LLs		Digital tools
Drinking water	Bodø:	Urban water losses management	#14, #15, #29, #30
	East Frisia:	Regional water demand-supply matching tool, Short-term demand forecasting tool, UWOT tool	#22, #23, #28
Energy	Alicante:	Biogas production and microturbines for energy self-sufficiency	#10, #13
	Bodø:	Small-scale biogas production	#12
	Lisbon:	W-E-P balance, climate readiness certification	#17, #24, #25, #33
	Venice:	Biogas production and energy saving	#4, #11
Nutrients, biosolids and others	Alicante:	Ammonia recovery, biosolids beneficial use, Cl2 production	#7, #8, #9
	Venice:	Ammonia recovery, Biosolids beneficial use	#11, #19
Reclaimed water	Alicante:	Reclaimed water production for urban uses and industry	#18
	East Frisia:	Water reuse in dairy industry through combined treatment of vapour condensate	#6
	Flanders:	Regional analysis, agricultural reuse Direct potable reuse	#2, #3, #5, #22, #26, #31
	Lisbon:	Reclaimed water for non-potable urban uses Direct potable reuse for beer production	#1, #17, #20, #24, #25, #27
	Venice:	Reclaimed water for industrial and agricultural reuse	#4, #16, #32
Stormwater	Flanders:	Agricultural use (Proef Station)	#21, #22, #26
Cross-cutting	All LLs:	Water-smartness assessment framework and tool	#34

4 Approach

4.1 Overview

The approach adopted (Figure 1) includes contributions from the work developed in other activities of the project, namely (i) drivers, barriers and socio-economic factors identified in Gomes et al. (2022) and Schmidt et al. (2023), (ii) the SWOT analyses from the strategic planning process developed within the B-WaterSmart Innovation Alliance (InAll) (Cardoso et al., 2022); (iii) the socioeconomic metrics developed in the B-WaterSmart Assessment Framework (Silva et al., 2023); (iv) the legal issues identified in Task 4.4, including stormwater use for irrigation. Specific regulation and economic aspects, as economic incentive mechanism and instruments, as well as regulatory risk-related aspects of water reuse in agriculture were also envisaged. In addition to the original plan, the approach also includes the results of an interactive discussion held in Alicante, during the project meeting on the 19th of September 2023, and of the Lisbon LL meeting on Policy & Regulation focused on water reuse and related issues, that took place on the 12th of January 2024.

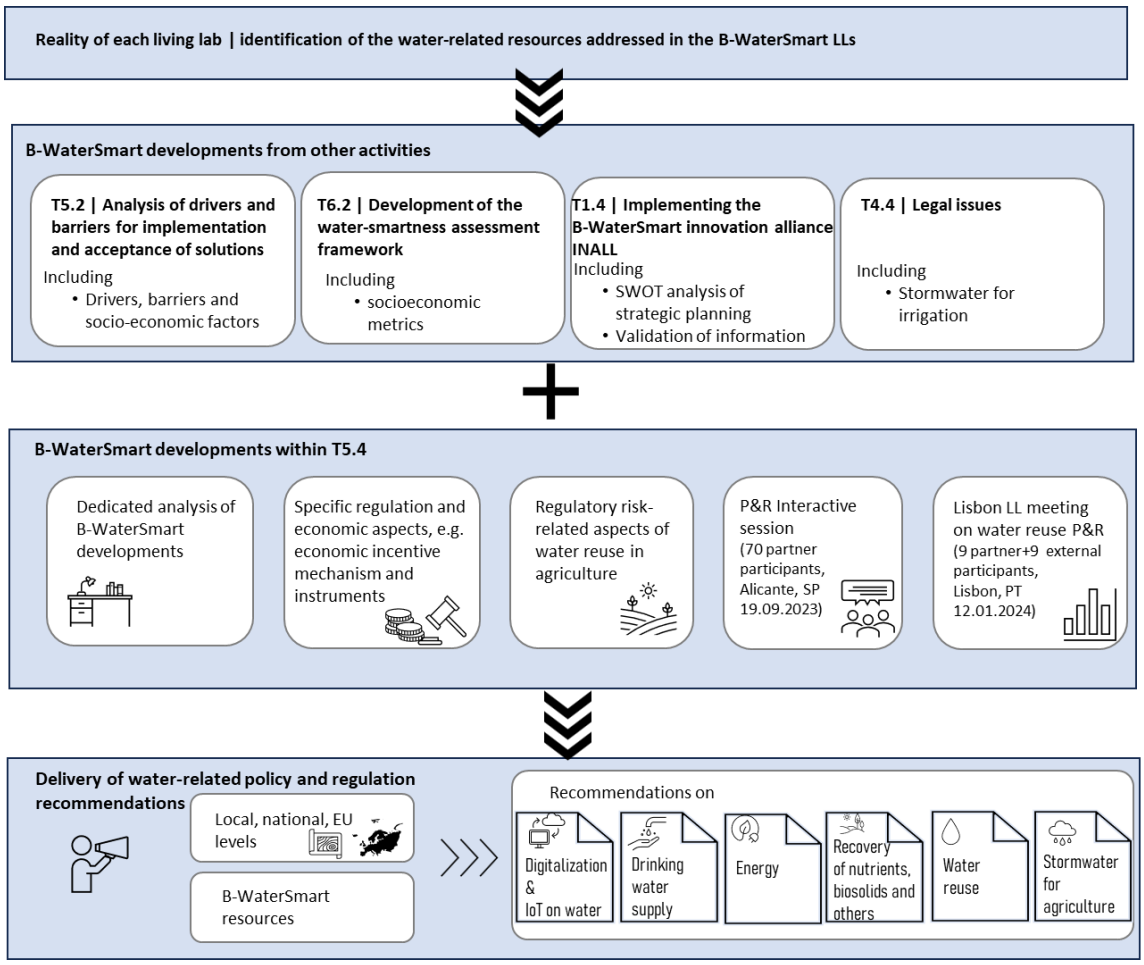


Figure 1. Approach adopted to develop the recommendations.

4.2 Contributions from B-WaterSmart developments

4.2.1 Contributions from WP4, WP5 and WP6

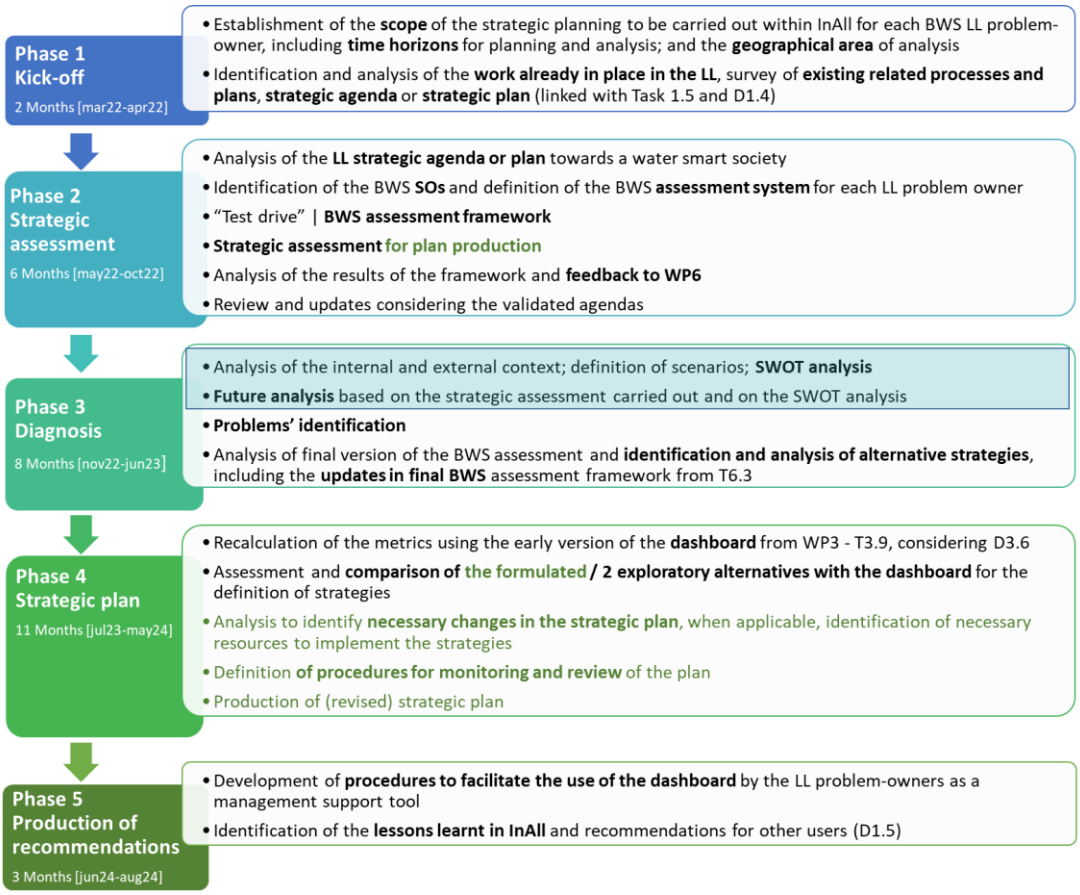
The work carried out includes the analysis of information from other project developments and deliverables (Gomes et al., 2022; Schmidt et al., 2023 and Silva et al., 2023), as well as new information to complement this analysis. The set of questions in Table 2 was proposed to support the gathering of information needed to produce the P&R recommendations and the subsequent policy briefs, guiding the analysis of the deliverables, and encouraging further contributions. The contributions are integrated in the mapping of policy and regulation instruments (section 5.3).

Table 2. Questions proposed to guide the gathering of information.

Remark: please consider information regarding EU, national, and local reports; relevant LL legislation, governmental plans, or central actions; Best Management Practices, guidelines, other relevant instruments (for EU, national and local levels). Key-aspects to address are land use, water use/reuse including stormwater, energy production, pricing, market, multilevel actors, contracts' mechanisms, agreements or memoranda of understanding, allocation of responsibilities.
Regulations and Policy Practices addressing water circularity in LL X (Country X) (Analysis per LL)
1. Are there national policy frameworks or instruments supporting the implementation of the B-WaterSmart solutions for this country? (Identify them linking to the solutions addressed)
2. Are there national legislative frameworks supporting the implementation of the B-WaterSmart solutions for this country? (Identify them linking to the solutions addressed)
3. Are there local/sub-national legislation and policies supporting the implementation of the B-WaterSmart solutions for this LL? (Identify them linking to the solutions addressed)
4. Considering national and local legislation in this country/LL, are there gaps or inconsistencies between EU regulation and national or local legislation? (Identify them linking to the solutions addressed)
5. Can you outline and B-WaterSmart the most significant legal and policy barriers that hinder the implementation of the BWS solutions, differentiating between the B-WaterSmart solutions for this country/LL?
6. Can you identify the political level(s) at which legal and policy barriers may be most severe (EU/International, national, federal, and local)?
7. Does the legal and policy situation support or impair interventions for exploiting the B-WaterSmart solutions for this country/LL? If so, what barriers apply?
8. What legal and policy barriers impede successful business models for the B-WaterSmart solutions in this country/LL?
Policy and legal drivers and approaches to overcome barriers in LL X (Country X) (Analysis per LL)
9. Can you outline and describe the most significant legal and policy drivers, factors that support water circularity, differentiating between the B-WaterSmart solutions for this country/LL?
10. Which requirements or needs do you consider most critical for improving the legal and policy framework creating an enabling environment for water circularity and implementation of the B-WaterSmart solution for this country/LL?
11. What governmental or private sector actors do you consider most critical for improving the legal and policy framework for water circularity and implementation of B-WaterSmart solutions for this country/LL?
12. Are there actor-based instruments (such as a central agency to coordinate interventions, a quality of service or environmental regulator, or specific funding or educational programmes) established that promote water circularity and support the implementation of B-WaterSmart solutions for this country/LL? If yes, please specify.
13. Are there legal and policy interventions that are currently being planned, revised or already under way to overcome the main barriers you mentioned above (e.g., a revision of quality-of-service assessment system?)

4.2.2 Contributions from WP1 InAll partners | strategic planning

One of the objectives of the Innovation Alliance (Task 1.4) was to build the capacity of the LL problem-owners' organizations on developing a strategic planning process towards water smartness, while promoting sharing and cross-fertilisation among the InAll partners (Rebelo et al., 2021). The process follows a 5-phased schedule program (Figure 2; Cardoso et al., 2022). In Phase 3 – Diagnosis, a SWOT analysis was carried out by the problem-owners (highlighted in blue in Figure 2), where the main Strengths, Weaknesses, Opportunities and Threats were identified. The policy and regulation aspects identified in each LL were used as an input for the recommendations.



[text in green] plan related tasks, (steps not to be carried out by those LLs producing a strategic agenda rather than a strategic plan)

Figure 2: The InAll process | 5-phased schedule program (Cardoso et al., 2022)

4.3 Interactive session on Policy & Regulation

4.3.1 General overview

The Policy & Regulation (P&R) interactive session took place on the 19th of September 2023, as part of the project PSB meeting in Alicante (Spain). It aimed to contribute to identify relevant recommendations for policy and regulation, resource-oriented and addressing different scales, i.e., EU/national/regional/local. It was planned to share the work carried out within B-WaterSmart, with contribution of the Living Labs regarding the P&R instruments and issues identified for the following

types of resources addressed in the B-WaterSmart LLs: 1. Digitalisation and IoT; 2. Drinking water; 3. Energy; 4. Nutrients, biosolids, and others; 5. Reclaimed water; and 6. Stormwater.

4.3.2 Working tables organization

The work session was organized into these six working tables, each one addressing a different topic or type of resource, to focus the 50-min discussion on the main needs and requirements to support the recommendations. Seventy participants attended this session (sixty partners and ten members of the advisory board). Each participant selected a table according to his/her main interests, ensuring the participation from the LLs and other partners, and distributing elements from the same organization among different tables. As there were not enough participants for the Energy table, the worktables were organized as presented in Table 3. The session was supported by LNEC's and ICS-UL's teams, and by Maria Salvetti, the Project Advisory Board member who accompanies WP5 more directly.

Table 3. Working tables organization

Topic **Type of resource /circularity**	**Participants**
1. Digitalisation and IoT Facilitator: Carla Gomes (ICS-UL)	16 Total 16 3 LL owners 3 4 R&D 4 9 Tech. providers and others 9
2. Drinking water Facilitator: Helena Alegre (LNEC)	Total 15 LL owners 5 R&D 8 Tech. providers and others 2
4. Nutrients, biosolids and others Facilitator: Rita Ribeiro (LNEC)	Total 8 R&D + LL mentor 4 Tech. providers and others 4
5. Reclaimed water Facilitator: Maria João Rosa (LNEC)	Total 17 LL owners 5 R&D 6 Tech. providers and others 6
6. Stormwater Facilitator: Maria Adriana Cardoso (LNEC)	Total 11 LL owners 4 R&D 5 Tech. providers and others 2

In each worktable, the involved LLs indicated the major P&R issues for the topic. After discussion, each table identified three major issues and, for each, the "Policy & Regulation Recommendations" on the "white board". Each recommendation was tentatively classified regarding scales (EU, National, Regional, local) and PESTLE dimensions (Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)). The results are presented in Annex 2 (as provided by the participants) and in section 5.3 (after LNEC team analysis).

4.3.3 Ranking of topics

Using the Mentimeter online collaborative tool, each participant individually ranked the six topics, according to the relevance for the future the B-WaterSmart policy briefs. The same ranking was carried out by each LL. The results are presented in Annex 2 and discussed in section 7.8.

4.4 Lisbon LL meeting on Policy & Regulation focused on water reuse and related-issues

The Lisbon LL meeting on Policy & Regulation was part of the LL developments of B-WaterSmart in Lisbon (Portugal) and took place on the 12th of January 2024. It aimed to discuss several aspects related to water reuse to contribute to identify relevant recommendations for policy and regulation. It was attended by eighteen participants: four from the Lisbon Municipality (LL owner), four from LNEC (LL mentor), one from ICS-UL (WP5 leader, observer), eight regulator experts (environmental regulation; water and wastewater services regulation), and a lawyer. The set of ten questions prepared by LNEC (Table 4) was discussed.

Table 4. Set of questions for discussion | Lisbon LL meeting on Policy & Regulation

General question applicable from 1-10 **Is it necessary to legislate or regulate at European, national, or local level…?**	
Q1	other uses of reclaimed water (e.g. urban)
Q2	indirect reuse
Q3	emission limits vs. capacity of receiving body and intended uses
Q4	aquifer recharge
Q5	evolution in minimum quality requirements for various uses and monitoring
Q6	prioritize reclaimed water uses in licensing
Q7	allow distribution/sale of reclaimed water to third parties, by licensed users
Q8	autonomize/regulate the reclaimed water supply service
Q9	evolution of economic regulation, namely development of legal and regulatory instruments for the formation of tariffs for reclaimed water supply activity
Q10	relevance of the existence of strategic planning

5 Policy and regulation instruments on water-related circularity addressed in B-WaterSmart

5.1 Overview of EU instruments

5.1.1 General

In the last decades, water policy in Europe has been developed progressively (Figure 3) (WISE, 2023). In 1991, the first EU policies aimed at improving water quality by adopting the Urban Wastewater Treatment (91/271/EEC) and Nitrates (91/676/EEC) Directives (EU, 1991a, 1991b), with the objective of reducing pollution pressures to water. In 2000, an integrated ecosystem-based approach to managing water was introduced by the Water Framework Directive (WFD) (2000/60/EC) (EU, 2000). The Drinking Water (98/83/EC), Bathing Water (06/7/EC) and Floods (2007/60/EC) Directives (EU, 1998, 2006, 2007), were adopted to ensure public safety and health objectives. In 2020, the water reuse regulation addressing the minimum requirements for water reuse for agricultural irrigation has entered into force, in the context of the new Circular Economy Action Plan adopted in 2020 (WISE, 2023).

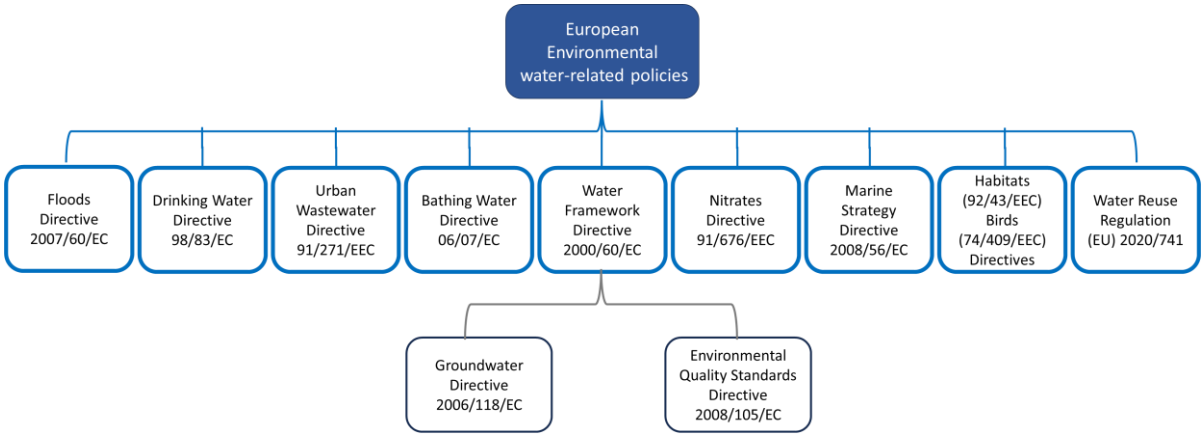


Figure 3. Overview of the European water-related policies (WISE, 2023)

While the Directives tend to be very specific, the importance of water in relation to biodiversity and marine policies is pursued through the EU Biodiversity Strategy to 2030 (EC, 2020a) and the priority objectives of the 8th European Action Program (EU, 2022b). Water quantity remains an area of national competence, although issues linked to overall sustainable water use are of transboundary and thus European interest (EC, 2011b).

The Green Deal (COM(2019) 640 final) is a key European policy to enhance the full implementation of the existing environmental legislation, including the water-related directives summarised in Figure 3. In addition, it proposes a green European Union that supports the global ambition of ensuring that all the ecosystems are restored, resilient, and adequately protected by 2050 (WISE 2023). It is a new strategy that aims to protect, conserve, and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. It commits to the implementation of the EU 2030 Biodiversity Strategy, Zero Pollution Action Plan, Farm to Fork Strategy, Circular Economy Action Plan, Chemicals Strategy for Sustainability, and Climate

Adaptation Strategy (including Climate Law), all water related. The European Climate Law (i) writes into law the goal set out in the European Green Deal for Europe's economy and society to become climate-neutral by 2050 (net zero greenhouse gas emissions), (ii) sets the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, (iii) aims to ensure that all EU policies contribute to this goal and that all sectors of the economy and society play their part. As additional legislation is adopted, further targets and initiatives will come, as the new EU strategy for water resilience planned to be launched in March 2024.

5.1.2 Regulatory and legal barriers for the water reuse in agriculture for irrigation

Indirect water reuse for agricultural irrigation is widespread. During dry conditions, treated wastewater constitutes a significant flow component in many surface water bodies, especially in smaller streams located near wastewater treatment plants (Beard et al., 2019). Direct water reuse, on the other hand, has been practiced in several Mediterranean countries but is still uncommon in large parts of the EU.

Water reuse in agriculture has long been practiced worldwide (for historical reference, see Jaramillo and Restrepo 2017). What is new is the ways in which reuse is being (re)considered in policy and regulation. In 1992, the Food and Agriculture Organization of the United Nations (FAO) established guidelines for water reuse in agriculture (Pescod 1992). Focusing on health protection, these guidelines include effluent quality standards and threshold levels of trace elements for crop production. It then provides an indication of the types of wastewater treatment that are expected to achieve the required microbiological quality. It also lists specific concerns and measures for wastewater reuse in aquaculture. Also, in light of the Sustainable Development Goals, especially SDG targets 6.3 (Water quality and wastewater) and 6.4 (water use and scarcity), increased attention is paid to the potential of reuse.

As part of the European Green Deal, the EU Action Plan for Circular Economy (European Commission, 2020) pushes European policies towards circularity. While water has until recently received relatively little attention (compared to, for example, solid waste management), the EU Action Plan does anticipate the implementation of new regulations for water reuse and nutrient management. Hence, a significant aspect of moving towards a circular economy will involve the further technological and practice development of water reuse and recovery of nutrients from wastewater.

To this effect, policies and regulations can both facilitate and constrain the development and implementation of water reuse practices, and clarity in policies and regulation is key to its successful uptake (Frijns et al., 2016).

A major regulatory obstacle to reuse has been that wastewater, as well as substances extracted from wastewater, may retain their status as 'waste' even after treatment. The EU directive on waste (directive 2006/12/EC) states that 'waste' means any substance or object which the holder discards or intends or is required to discard. However, wastewater is explicitly excluded from the scope of this directive. A key question to reuse, then, is how and under what conditions, water may change status from 'waste' to 'resource'.

5.1.3 European legislation and directives on stormwater and brown water reuse in agriculture

The WFD (Directive 2000/60/EC) establishes a legal framework to protect and restore clean water in the EU and to ensure its long-term sustainable use. The WFD does not include irrigation requirements, nor is there a specific irrigation water directive to address agricultural water use. However, operating under the WFD, several other directives regulate the use and reuse of water for irrigation purposes. Because agricultural irrigation is directly linked to the chemical status of groundwater and surface water bodies, the Groundwater Directive (2006/118/EC), the Nitrates Directive (91/676/EEC), the Environmental Quality Standards Directive (2008/105/EC), as well as the Bathing Water Directive (2006/7/EC), are all relevant frameworks within which water-smart solutions for agriculture must operate.

The Groundwater Directive against pollution and deterioration provides specific criteria for the assessment of good chemical status, while threshold values for pollutants (apart from nitrates and pesticides) are set by the Member States. This is relevant to reuse practices so far as reclaimed water will be infiltrated, rather than discharged into surface water bodies, and to the extent that irrigation water is expected to infiltrate into groundwater layers. In similar, the Nitrates Directive seeks to protect surface waters from nitrates from agricultural sources, safeguarding drinking water and preventing damage from eutrophication. In the implementation of reuse practices, it will be interesting to assess to what extent the nitrates present in reclaimed water might reduce the need for additional fertilizers.

The management of urban wastewater (including domestic, industrial, and rainwater runoff) is stipulated in the Urban Wastewater Treatment Directive (91/271/EEC). This directive provides the conditions under which urban wastewater may be discharged into the environment. Interestingly, the original 1991 text of the directive already stated that: “Treated waste water shall be reused whenever appropriate. Disposal routes shall minimize the adverse effects on the environment” (Art. 12.1). However, how, when, and under what conditions wastewater may be reused is not further specified.

This is changing with the adoption of the Water Reuse Regulation (Regulation EU 2020/741), which is the first European regulatory framework that directly addresses water reuse, and which applies since June 2023. This regulation addresses the reuse of treated urban wastewater for agricultural irrigation. Harmonizing the minimum requirements for reclaimed water at a European level is considered vital to the efficient functioning of the internal market with regard to agricultural products. While the Wastewater Directive requires that wastewater is properly treated before reuse, the Water Reuse Regulation requires that the treated wastewater is of sufficient quality for safe and sustainable reuse.

When it comes to the regulation of water (re)use, the quality of the water is naturally the key concern, as it is associated with human and environmental health. Hence, the Reuse Regulation provides the minimum requirements for water quality and monitoring. These are framed primarily as obligations of the treatment and reclamation facility operator. In addition, the Reuse Regulation outlines risk management requirements. This includes the requirement that the competent authorities (as designated by the Member States) must establish “water reuse risk management plans” in collaboration with the reclamation facility operator, other responsible parties, and end-users.

Besides providing a framework of minimum quality requirements for reclaimed water in agriculture, the regulation also stipulates that “reclamation facility operators and the end-users should cooperate

to ensure that reclaimed water meets the needs of the end-users regarding crop categories" (European Parliament and Council of the European Union 2020: 35). The implications of this in practice have not yet fully crystallized. It suggests that reuse initiatives should be adapted to particular types of agricultural production where possible.

Several European countries have been reusing effluents already before the EU regulation came into force (notably Malta, Cyprus, and Spain). This demonstrates that reusing water has been a viable option within the existing European legislative frameworks but has remained dependent on national and regional initiatives. The Water Reuse Regulation remains fairly non-committal in this regard, considering that it is supposed to provide "an enabling framework for those Member States who wish or need to practice water reuse," which should ensure that it is possible for Member States "to apply those rules when they decide to introduce this practice at a later stage" (European Parliament and Council of the European Union 2020: 33). However, the key change that can be expected from the Reuse Regulation is that Member States must now provide justification for the decision not to reuse water for agricultural purposes in certain basins, for example due to pressures on, or the status of, water resources. Member States also remain responsible for the designation of the competent authorities and deadlines, for designing the appropriate procedures for permits, for setting up the necessary administrative infrastructures, and for establishing appropriate penalties for infringements of the Regulation.

5.1.4 Next Steps: Towards Direct Potable Water Reuse?

An important caveat of the European Water Reuse Regulation is that it considers alternative irrigation sources for agriculture and horticulture, but does not address other forms of water reuse, such as reuse for human consumption or beverage production. The minimum requirements listed in the Regulation do not apply (at least not explicitly) to drinking water purposes. For drinking water, the Regulation refers to the water quality requirements intended for human consumption as laid down in Directive (EU) 2020/2184. However, the Reuse Regulation does outline the requirements for 'Class A' reclaimed water, which should be of sufficient quality to irrigate crops consumed raw, and where the edible parts are in direct contact with the reclaimed water. These 'Class A' requirements still differ from the minimum requirements of drinking water (e.g., the parametric value of E-coli in Class A water is ≤ 10 / 100ml, and 0 in drinking water). In short, the Reuse Regulation does not provide guidelines suitable to provide direction towards direct potable reuse.

Currently, most industrial, and urban wastewater streams are, after treatment, discharged in surface water or used for the replenishment of groundwater. As a result, a significant part of the available surface water is influenced by the outflow of wastewater treatment plants and industrial effluents (Beard, 2019). As surface water is extracted for treatment or irrigation purposes, indirect water reuse for both agricultural and potable uses is already common practice.

Direct Potable Reuse (DPR) does not use the environment (surface water or aquifers) as buffers between discharge and extraction.

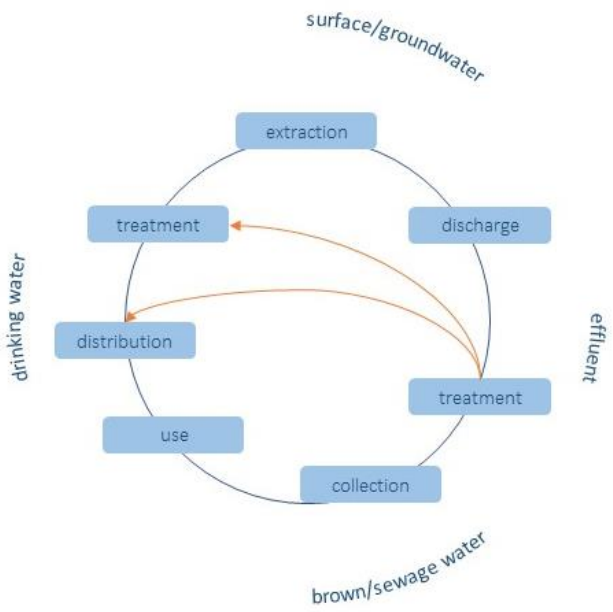


Figure 4 exemplifies how in indirect potable reuse, water changes status from the moment of extraction, through treatment, distribution, and use, to collection as brown or sewage water, and is afterwards as effluent discharged back into the environment.

DPR is represented by the orange arrows. A DPR cycle would 'skip' the discharge and subsequent extraction steps, which means the legal status of the water needs to change along with it: from 'waste' or 'effluent' to 'resource'.

Figure 4: Indirect and direct potable reuse

DPR is already being practiced in several countries outside the EU, including Namibia, South Africa, Australia, Singapore, and the United States. Case studies from these countries show that treated wastewater is in most cases blended with newly extracted surface or groundwater, thus presenting a combination of indirect and direct potable reuse (Aleksić and Šušteršič, 2022).

In the EU, DPR is still uncommon. While the Reuse Regulation does not address reuse for consumption, it does underscore that the water reuse risk management plans "should pay special attention to the protection of water bodies used for the abstraction of water intended for human consumption" (European Parliament and Council of the European Union 2020: 34). Similarly, the Drinking Water Directive requires that the source of drinking water must be protected and kept free from contaminants that could impact its quality. Considering this, the current policy and regulation landscape of the EU does not yet encourage potable reuse. However, as noted, the minimum quality standards are leading and do not exclude treated wastewater as a source.

5.2 Circular business model innovation and policy and regulation

5.2.1 LL orientation towards policies and regulations

Business Model Innovation is an iterative journey that involves experimentation, piloting, gaining experience, and ultimately scaling up solutions (Bocken et al., 2019). The process of transforming or creating new circular business models (CBMs) is referred to as CBM innovation (CBMI) and it is a strategic process that specifically focuses on conceptualizing and implementing CBMs (Geissdoerfer et al., 2020).

In the B-WaterSmart project, after conducting a review in WP4 (Circular economy value chains) on the proposed circular solutions (with an implementation-focus) and CBMs in the LL´s of the B-WaterSmart

project, two distinct contexts of Living Labs (LLs) have been observed characterized by their issues and the relationship of their actions with respect to the policies and regulations affecting to these. On the one side, LLs like Lisbon and East Frisia face direct impacts from restrictive regulatory barriers on the proposed circular solutions (i.e. urban water reuse and industrial water reuse in dairy industry). On the other side, LLs like Alicante (Improve and increase of energy production: codigestion), Venice (increase of industrial reuse), Flanders (stormwater reuse for subirrigation), and Bodø (Increase of energy production through biogas) have a lesser impact by policies and regulations where proposed circular solutions may be limited but not restricted by current regulations.

Given the competencies and capabilities required to overcome strict regulation barriers, LLs affected by these, will tend to be driven by public authorities, while LLs not affected by strict regulations will be generally led by water companies. This differentiation is general in nature and does not necessarily imply that water companies, especially those of a public nature (e.g. East Frisia), lack the capacities and competencies to manage strict regulatory barriers. However, the origin of their actions will have a differentiated character with respect to public authorities and will require the establishment of a channel with public bodies and regulators to overcome obstacles in achieving circular implementation in their processes.

The objective of public authorities is to create social and environmental beneficial impacts to citizens, industrial sectors, and the different communities comprising society. For this reason, their efforts within the LL will be directed towards promoting social and environmental changes through increasing awareness, driving favourable policies and regulations, fostering collaboration between sectors, promoting research, all in all enabling a framework that can promote the development of these solutions and the implementation of circular solutions through successful CBM. Since their focus prioritizes environmental and social aspects, over economic ones, they generally depend on public funding sources to sustain their operational activities and ensure the economic and financial viability of CBMs.

The primary goal of a water company is to ensure water service; therefore, their competencies will be more aligned with technological innovation, and they will be more limited in driving social innovation (referring to the policy and regulations aspects). However, the advantages of LLs led by these entities are that they will develop techno-economic evidence through technology experimentation and detailed impact analysis, providing reliable data for the assessment of CBMs. On the other hand, they will have the ability to identify economic, operational, organizational, and regulatory barriers and drivers related to circular solutions under the existing or developing regulatory framework. These micro and meso level assessments will serve as input for regulators to obtain feedback on existing policies and develop efficient policy instruments specifically targeted at existing issues.

LLs led by public authorities, with the aim of enabling circular solution implementation, generally will address issues from a more macro and less specific context. On the other hand, LLs led by water utilities, through the detection and evaluation of the impacts of policy and regulation P&R, will have greater impact on innovation at a more micro-level of application. Both contexts are not mutually exclusive and should be balanced (presence of both in the LL), with the participation of regulators, and involving public institutions, to obtain feedback from water utilities in the case of LLs led by water utilities; and on the other hand, the participation of water utilities in the development of P&R proposals to overcome barriers. The ideal scenario is that LLs are structured in such a way that all parties are involved, regardless of whether it is guided by one agent or another. This allows for the engagement of all stakeholders in the process.

5.2.2 CBMI stages and dependence on policies and regulations.

The CBMI in a LL can be described as following the next phases: Framing and Scoping, Ideation, Detail Design, and Implementation. Starting from the conception and goal-setting phase of the LL (Framing and Scoping stages), through the Ideation stage (consisting in a generation, selection of ideas and development of a CBM concept phase), the detailed design stage (consisting in a experimentation, prioritization of CBMs, detailed design, and piloting phase), to finally the development of the implementation plan, the impacts of P&R must be taken into account. The main reason is that P&R introduces a bias in the selection of ideas, solutions and subsequently CBMs.

Concurrently during the CBMI, the impacts of P&R that were not initially identified will be clarified in more detail, thus detecting new barriers or opportunities (e.g., when projects are lengthy and new regulations come into effect favouring certain solutions). This will allow for the analysis, evaluation, and reworking of policies to make them more adapted and supportive of the implementation of CBMs in the LLs.

Next, it is described how P&R affect each stage of the CBMI process and how this process can provide feedback for the adaptation and creation of new P&R:

- Framing and scoping stage

  LLs that have a direct impact on P&R (enabling LLs) and their direct objective is the modification, adaptation, or design of new P&R must consider in this phase the scope of these objectives and their impact on the solutions proposed.

  Regardless, all LLs will be impacted by P&R affecting proposed solutions and CBMs to varying degrees. LLs will initially identify these impacts by analysing barriers and drivers. These impacts influence issue selection, with existing regulations often leading to prioritization of certain issues. Environments with fewer restrictions tend to prioritize actions, narrowing the LL's scope. Conversely, detection of favourable policies biases LL´s scope towards issues supported by more favourable policies.

- Ideation stage

  In the ideation phase, proposals for solutions to the problems identified in the previous phase are generated. Preliminary assessments are also conducted to select the most viable ideas. It is at this point where P&R can influence the selection or rejection of ideas, introducing a bias based on the intensity of the impacts of these P&R. It is essential that, if a promising idea is ultimately rejected due to regulatory reasons, this issue is documented and communicated to the authorities. This is crucial because it could be a case of an untapped potential due to lack of awareness. Before definitively rejecting an idea and to avoid potential premature selection bias, an analysis should be conducted to determine if the impact is solvable within a timeframe suitable for implementing the idea. Consequently, this will impact the selection of the business model during the development of the concept and its preliminary design, especially regarding financing mechanisms and potential revenue sources (e.g., regulatory restrictions on the commercialization of certain by-products, waste categorization, etc.).

- Detail design stage

This stage involves of experimentation, detailed design, and piloting. It is a crucial stage for the development of the CBM and requires a deeper analysis of the legal aspects underlying the solutions. While previous phases generally consider P&R from a broader perspective, these stages identify the practical impacts of the P&R framework when applied in real settings.

In the experimentation phase, environmental regulations and quality standards affecting the design of CBM products and services are considered for testing.

During the prioritization phase, there is a bias in selecting solutions and associated CBMs toward those with less regulatory impact or more favorable policies.

In the detailed design phase, experimentation results are incorporated, and CBMs are refined based on detailed analyses that aim to address specific uncertainties that need to be minimized. This refinement process also considers the level of analysis from preliminary feasibility studies conducted in earlier stages.

This phase yields two main feedback loops: implementers analyze P&R impacts on final cost structure, revenue streams, financing instruments, organizational structure, operational processes, risk assessments, and administrative efforts. Regulators observe and analyze current regulation impacts. Incorporating feedback from both implementers and regulators is crucial for optimizing processes, minimizing risks, and planning CBM implementation. This collaborative effort also facilitates information collection, which aids regulators in adapting P&R based on the input from both feedback loops.

During the Pilot Testing Phase, significant impacts stem from P&R. Obtaining permits and meeting necessary requirements for tests can be particularly challenging due to regulatory constraints, leading to potential delays. It is crucial to document and communicate critical factors such as these. This phase involves navigating complex operational processes and bureaucratic procedures, including securing permits and licenses for pilots. Implementers and regulators must carefully assess existing regulatory issues and their real-world application to ensure compliance with regulatory standards. As for the detail design phase, significant feedback loops from both implementers and regulators can be gathered for the adaptation and creation of new P&R.

- Implementation stage

This phase focuses on the practical execution of all plans designed during the previous stages. All risks associated with regulation and its potential evolution should have been detected and considered in earlier phases. Regarding P&R aspects, compliance with existing regulations must occur before implementation, adhering to all permits and licenses necessary to launch the circular business model. Likewise, a plan for periodic monitoring and follow-up of regulations and policies should be established to stay updated on changes related to regulation and adapt and adjust CBMs with minimal impact. To achieve this, it is advisable to maintain communication channels regarding regulatory impacts with the relevant authorities.

Conclusions:

From a LL perspective, it has been observed that we deal with two starting orientations in LLs which will affect CBM innovation: one motivated and oriented from the outset to promote P&R changes (enabling), and another that does not have that function as its end goal. LLs oriented from the outset to encourage changes in P&R tend to work on the more visible aspects of P&R,

and their natural sphere of influence is at the macro level (Figure 5) although this doesn't mean that the operational part of the selected solutions won't also address aspects at the meso and micro levels.

On the other hand, all solutions are affected by P&R, and therefore all LLs, when acting at the micro level during the development of solutions, will serve as perfect detectors in their normal activity to assess the real influence of P&R on innovation activity. It has also been observed that, in many cases, regulators are not aware of the real impact of P&R applied at the micro level, and it is challenging to detect them from the macro level at which they operate.

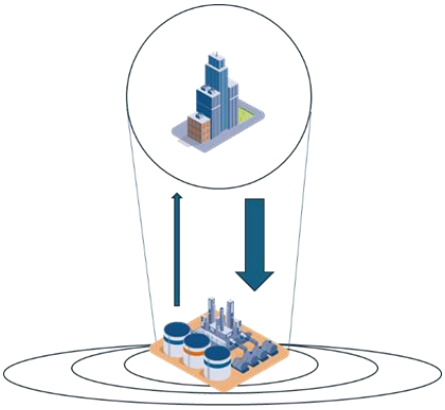


Figure 5. Feedback loop of P&R

The discussion has addressed how, both in establishing the initial objectives of LLs and in the CBMI, multiple filters are applied when selecting goals, problems, solutions, and CBMs based on P&R aspects, and how these biases selections in the best-case scenario or hinder their development in the worst. It is important to note that this information often has internal use and is not usually collected in a structured manner, resulting in its loss.

As a best practice throughout the design of a CBM, it is important that LLs systematically collect such information for analysis and treatment. This will enable the regulator to promote an optimal innovation environment, allowing the best ideas to be carried forward and facilitating the growth of novel and high-impact solutions.

Thus, P&R affect many more aspects than those that can be detected initially, and communication between regulators (macro) and the organization implementing solutions (micro) is crucial to identifying regulatory aspects that may be influencing their decision-making. Therefore, from the regulators' perspective, it is necessary to build a channel that generates a real flow of information so that innovation environments can report all aspects related to P&R that are conditioning the evolution of their project.

5.3 Mapping policy and regulation instruments, issues and strengths at EU and LL level

This section presents a mapping of the policy and regulation instruments, addressing water-related circularity, relevant for recommendations and with focus on the B-WaterSmart resources identified in

chapter 3. Additionally, it identifies the issues and strengths to achieve water-related circularity. A compilation of different sources of information were considered, namely contributions from B-WaterSmart developments, as from the InAll partners developing the strategic planning process (Cardoso et al., 2022), D5.3 (Gomes et al., 2022), D5.5 (Schmidt et al., 2023), strategic agendas of the LLs (Schmuck et al., 2021; Glotzbach et al., 2023), the interactive session on Policy & Regulation (section 4.3 and Annex 2), Lisbon LL meeting on Policy & Regulation focused on water reuse and related-issues (section 4.4). Additional contributions were included by the authors, according to the project's description of work, based on their expertise, as presented in section 4.1.

5.3.1 Digitalisation and IoT

Table 5 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning digitalisation and IoT.

Table 5. Policy and regulation instruments, issues, and strengths in digitalisation and IoT

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • Directive (EU) 2022/2555 - NIS2 Directive on measures for a high common level of cybersecurity across the Union • Regulation (EU) 2016/679 on General Data Protection (GDPR) • Digital Decade policy programme 2030 • EU Artificial Intelligence Act (proposal agreed)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (-) Data confidentiality and security, with implication to data collection from smart meters Source: Interactive session on P&R (-) Lack of open data (-) Lack of investment in the institutions (cost of collecting data) (-) Low perception of the value of collecting and sharing data (-) Need to identify data essential for policy and regulation or other purposes
Alicante, Spain
Policies and regulation • Organic Law 3/2018, of 5 December, on the Protection of Personal Data and the guarantee of digital rights
Issues (-) and Strengths (+) (+) Technical and organizational Security measures against unauthorized access. (-) Lack of clear guidelines on how personal data should be collected and processed in this specific context. (-) Lack of updates addressing the current technological challenges and solutions. (-) Lack of compliance control of the law in this specific context.

Policies and regulation, Issues (-) and Strengths (+)
East Frisia, Germany
Policies and regulation • Federal Data Protection Act (BDSG) • NIS2 • KRITIS • IT security standard water/wastewater (B3S) • Supervisory authorities of the federal states
Issues (-) and Strengths (+) Source: D5.3 (Gomes et al., 2022) assessed regarding the application of tools # 22, #23, and #28. Therefore, case-specific, and not general aspects and strengths of policies and laws are listed (+) Political ambitions to increase the level of digitalization in Germany (-) Multiple regulations for digital solutions (-) Data confidentiality: Citizens' data protection concerns regarding the collection and analysis of personal and household data (-) Interoperability of data must be guaranteed
Lisbon, Portugal
Policies and regulation • General Data Protection Law, Law n.º 58/2019, of 8 August • Portuguese Water and Waste Services Regulation Authority (ERSAR) quality of service assessment | Security and Resilience Index (Cardoso et al., 2021)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (-) Data confidentiality, with implication to data collection from smart meters for all types of water Source: InAll, Cardoso et al. (2021, 2023); Silva et al. (2022) (+) ERSAR's Security and Resilience Index addresses cybersecurity i) governance & operationalization, ii) risk management, iii) communication, iv) planning

5.3.2 Drinking water

Table 6 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning drinking water.

Table 6. Policy and regulation instruments, issues, and strengths in drinking water

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • Directive 2000/60/EC. Water framework directive (WFD) • Directive (EU) 2020/2184. Drinking Water Directive (DWD) • Regulation (EU) 2016/679 on General Data Protection (GDPR)

Policies and regulation, Issues (-) and Strengths (+)
• Regulation (EC) No 852/2004 on the hygiene of foodstuffs • Regulation (EU) 2017/625 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products
Issues (-) and Strengths (+) Source: Interactive session on P&R (+) DWD establishes water leakage level should be assessed by all Member States and reduced if they are above a certain threshold (-) Need to protect drinking water quality from micropollutants or unknown substances in the water sources (-) Need to ensure drinking water quality at point of consumption via network monitoring (-) Need to allocate fit-for-purpose water quality (e.g., avoid using drinking water for non-potable uses) (-) lack of investments to renew drinking water supply network
Bodø, Norway
Policies and regulation • GDPR (data protection)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) High need for better overview of leakages in municipalities in Norway (-) Data confidentiality, with implication to data collection from smart meters (-) Water meters are not mandatory in some municipalities (high costs) Source: D5.5 (Schmidt et al., 2023) (+) Bodø Municipality is testing out new ways to engage citizens, e.g. by organising a Circularity Week in the autumn of 2023 (+) Independent authorities, e.g. the Office of the Auditor General of Norway recently reviewed the Government's efforts to provide safe drinking water and criticised the current effort to reduce leakages and renew water infrastructure (+) Monitoring and evaluation carried out through the Norwegian Environment Agency, and reported in relation to the SDGs and every 4 years to the UN Climate Convention
East Frisia, Germany
Policies and regulation • Drinking Water Ordinance • Food Hygiene Regulation (LMHV) • Federal Water Act (AVBWasserV) • Surface Water Ordinance • Ground Water Ordinance • Federal Data Protection Act (BDSG) • Local and Regional water authorities
Issues (-) and Strengths (+) Source: D5.3 (Gomes et al., 2022) assessed regarding the application of tools # 22, #23, and #28. (-) Measures identified on the basis of the digital tools must take into account the requirements of water quality, water treatment, water abstraction, water supplier obligations and monitoring requirements under the EU Directive and national legislation

Policies and regulation, Issues (-) and Strengths (+)
(-) 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

5.3.3 Energy

Table 7 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning energy.

Table 7 Policy and regulation instruments, issues, and strengths in energy

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • EU Green Deal • COM(2020) on Circular Economy Action Plan (CEAP) • EU taxonomy for sustainable activities (i.e. "green taxonomy") • European Circular Economy Monitoring Framework • Directive (EU) 2018/2001 on use of energy from renewable sources • COM(2022) on urban wastewater treatment (recast) • Directive 2008/98/EC on Waste • European Funds for Regional Development 2021-2027
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) Energy recovery for self-consumption to cope with the WWTPs' high energy demand towards energy neutrality (-) Lack of EU policy for climate efficiency in households, buildings, and neighbourhoods
Alicante, Spain
Policies and regulation • Spanish Circular Economy Strategy • National Biogas Roadmap • Regional Biogas Roadmap • Long-Term Decarbonization Strategy (ELP 2050) • National Integrated Energy and Climate Plan (PNIEC) • Law 7/2022 on waste and contaminated soil for a circular economy • Law 29/2021, adopting urgent measures in the energy sector to promote electric mobility, self-consumption, and the deployment of renewable energies • Law 7/2021 of 20 May on climate change and energy transition • Renewable Energy Plan (PER) 2011-2020
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) Energy recovery for self-consumption and high energy requirement of WWTPs (+) Several potential waste producers for biogas production

Policies and regulation, Issues (-) and Strengths (+)
(+) Promotion of biogas, biomethane, and renewable hydrogen (-) Cost of waste transport (-) Requirement of legal certification for solid waste management (-) Lack of policies and regulations related to new type of renewable energies (-) Civil works for installing energy production only feasible for large WWTPs
Bodø, Norway
Policies and regulation • National Strategy for the Circular Economy (2021) • Regulation on the limitation of pollution (Pollution Regulation), FOR-2004-06-01-931, Department of Climate and Environment • Statal planning guideline for climate and energy planning and climate adaptation • Enova, Norwegian state enterprise promoting the development and upscaling of sustainable energy and climate technology
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) Both Iris and Bodø kommune have expressed interest in the installation of a biogas generator for the Salten region. (-) Regulation on handling digestate products Source: D5.5 (Schmidt et al., 2023) (+) Enough competencies and knowledge (+) Availability of data & information (+) Financing support for establishment of biogas production facilities (+) Bodø Municipality is testing out new ways to engage citizens, e.g. by organising a Circularity Week in the autumn of 2023 (+) Monitoring and evaluation carried out through the Norwegian Environment Agency, and reported in relation to the SDGs and every 4 years to the UN Climate Convention (+) Collaboration with others in the Salten Region. Iris Salten already established an intermunicipal waste management company serving the whole region (-) Need to consider synergies and benefits across municipalities when planning/selecting solutions (-) Need to finalize revision of the national regulation on organic fertilizers. Uncertainty concerning the organic fertilizer regulation has consequences on biogas production
Lisbon, Portugal
Policies and regulation -
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (-) Lack of national policy for climate efficiency in households, building and neighbourhoods
Venice, Italy
Policies and regulation • National Adaptation Strategy (NAS; Directorial Decree n. 86 of 16 June 2015) • National Recovery and Resilience Plan (PNRR) • Regulation of the water sector and incentives (ARERA) • Plan for Circular Economy in 2017

Policies and regulation, Issues (-) and Strengths (+)
• Programs towards greenhouse gases emission reduction and climate change mitigation (C40 Cities, 2022)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) Increasingly defined plans and incentives for energy recovery in the water sector (ARERA) (-) Not clearly defined National/Regional regulatory framework to facilitate the development of the circular paradigm across the nexus water-energy-waste (-) Complexity of the national regulatory system

5.3.4 Nutrients, biosolids and others

Table 8 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning nutrients, biosolids, and others.

Table 8 Policy and regulation instruments, issues, and strengths in nutrients, biosolids, and others

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • Regulation (EU) 2019/1009 laying down rules on the making available on the market of EU fertilising products • European Funds for Regional Development 2021-2027 • The EU taxonomy for sustainable activities (i.e. "green taxonomy") • European Circular Economy Monitoring Framework • Directive 2008/98/EC on waste • Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
Issues (-) and Strengths (+) Source: D5.5 (Schmidt et al., 2023) (-) Lack of a consensus at European level to promote a common roadmap for sludge management Source: Interactive session on P&R (-) Product (value issues): lack of comprehensive strategic plans for nutrient management (in case of sludge valorisation in agriculture); lack of characterization/standardization of byproducts. (-) Market (revenue issues): lack of market penetration and incentives, lack of legislation to promote nutrient recovery and reuse markets, low market acceptance of nutrients/products recovered from wastewater (e.g. compost), need to focus on other upcycling alternatives for nitrogen besides fertilization (e.g., protein production for animal feed) (-) Transaction (buyers and sellers' issues): need to promote a generational change towards an increased market acceptance of nutrients and biosolids reuse, need to change the semantics related with nutrients and biosolids reuse (focus on "recovering", not on "treatment")

Policies and regulation, Issues (-) and Strengths (+)
Alicante, Spain
Policies and regulation • **Spanish Circular Economy Strategy** • Law 47/2022, on the production of water against diffuse pollution caused by nitrates from agricultural sources • Royal Decree 1310/1990, of 29 October, regulating the use in agriculture of sludge from treatment • Orden AAA/1072/2013, of 7 June, on the use in agriculture of sludge from treatment
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (+) Shortage of ammonia-based products (+) Rising ammonia prices (+) Several potential consumers of the recovered product (-) Cost of product transport (-) High cost of equipment (-) Competitive market Source: D5.5 (Schmidt et al., 2023) (-) Inadequate regulatory framework for sludge management and valorisation leading to a lack of funding for new investments (-) Great regulatory uncertainty and heterogeneity of criteria at territorial level (-) Missing review and updating of the regulations related to sludge management, taking into account technological developments, international best practices, and environmental sustainability objectives
Venice, Italy
Policies and regulation • Plan for Circular Economy in 2017 • National Recovery and Resilience Plan (PNRR) • Regulation of the water sector and incentives (ARERA) • DGRV n. 2241/2005 and DGRV n. 1407/2006 – regional regulation about quality assurance of sludge finalized to agricultural application • Legislative Decree N. 99/92 national regulation on sludge application in agriculture and Legislative Decree N. 109/2018 with revision of parameters and limit to be respected for sludge application in agriculture • Legislative Decree n. 152/2006, Part IV - Article 184 ter, about recovery products classification within the End of Waste criteria (Waste Framework Directive, 2008/98/EC) • Regional Decree n. 120/2018 technical requirements for the End of Waste “case by case” evaluation. • Legislative Decree N. 75/2010 national regulation on fertilizers and soil amendments (also derived from recovery products)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (-) Complexity of the national regulatory system (-) Not clearly defined National/Regional regulatory framework to facilitate the development of the circular paradigm across the nexus water-energy-waste (-) Not enough interlinkage between water and waste policy to make sustainable products recovery and reuse (“end of waste classification” delegated to the arbitrary “case by case” evaluation, that in the Venice LL can impact N-salt valorisation) Source: D5.5 (Schmidt et al., 2023)

Policies and regulation, Issues (-) and Strengths (+)
(+) General roles are clear (-) Need to clarify and define regulation to be adopted to the management/delivery of salts produced, for N-recovery by stripping strategy (-) Issues about shared knowledge and coordination of policy, need of a decision support system at regional scale (-) Scattered data to support the implementation and management

5.3.5 Reclaimed water

Table 9 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning reclaimed water.

Table 9 Policy and regulation instruments, issues, and strengths in water reuse

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • COM(2015)614 on Circular Economy Action Plan • European Funds for Regional Development 2021-2027 • Directive 91/271/EEC, the Urban Wastewater Treatment Directive (UWWTD) • Directive 2000/60/EC, the Water framework directive (WFD) • Directive (EU) 2020/2184, the Drinking Water Directive (DWD) • COM(2022)541 final, the Urban Wastewater Treatment Directive recast • The EU taxonomy for sustainable activities (i.e. "green taxonomy") • European Circular Economy Monitoring Framework • Regulation (EC) No 852/2004 on the hygiene of foodstuffs • Regulation (EU) 2017/625 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products • Regulation (EU) 2020/741 on minimum requirements for water reuse (on agricultural irrigation)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (-) Missing EU agenda on water reuse (non-potable water reuse, IPR, DPR) (-) Missing EU regulation and legislation on indirect and direct potable reuse (IPR, DPR) (-) Missing EU regulation and legislation for non-potable reclaimed water for irrigation, urban and industrial uses, and for potable uses (-) Missing EU regulation and legislation to improve risk assessment process (-) Missing EU policies for public engagement, awareness, and communication (-) Lack of a EU regulatory framework that facilitates the development of the circular paradigm across the nexus water-energy-waste Source: Interactive session on P&R (+) Multiple users improve technical (e.g., decrease demand peaks) and economic feasibility of water reuse (-) Business and funding issues (-) Water reuse requires dedicated distribution network (who to build and operate this new network?) (-) Missing guidelines for the water reuse licensing process by the water authorities (-) Perception of worse water quality for irrigation

Policies and regulation, Issues (-) and Strengths (+)

(-) Unclear how extensive risk assessment for agricultural use should be
(-) Need to address (define and report) indirect reuse

Source: EU news (Euractiv.com)
(+) ReWaterEU – proposal of a new initiative intending to help reduce the EU vulnerability to the effects of climate change on water resources by guaranteeing access to water for public supply in terms of quantity and quality at fair prices, as well as the availability of water for agriculture, tourism and industrial uses, and the protection of different ecosystems. The plan is to be financed by EU funds and private investment.
(+) The European Commission is planning to launch, in March 2024, a Water Resilience Initiative, which will include a series of immediate actions and launch a public debate on achieving water resilience.

Alicante, Spain

Policies and regulation

- Ley de Aguas, 1985
- Royal Legislative Decree 2001 (revised Water Act); Royal Decree 1620/2007, a series of measures were introduced to establish the legal regime for the reuse of treated wastewater
- Spanish Circular Economy Strategy 2030 Project Alicante Agua Circular
- Art. 272-273 of the RDPH (Reglamento del Dominio Público Hidráulico) main regulation applicable to water reuse

Issues (-) and Strengths (+)

Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023)
(+) Water reuse provides support to the implementation of other technologies
(-) Complexity in decision making in circular economy
(-) Complexity in the justification to the (public) administrations for the investment on water reuse
(-) Difficulty to model some elements in a simple way
(-) Business model underdevelopment

Source: D5.5 (Schmidt et al., 2023)
(-) The value chain of reclaimed water and roles and responsibilities are not well defined. Overlap and sometimes lack of involvement of the parties
(-) Lack of policy coherence with regard to the water allocated by a concession or a legitimate title for the private use of water, as it is sometimes not used by its holder
(-) Rigidity in administrative concessions can create challenges for certain users, especially in situations where adjustments or adaptations are required due to changes in hydrological conditions or specific user needs

East Frisia, Germany

Policies and regulation

- National Water Strategy
- Food Hygiene Regulation (LMHV)
- Drinking Water Ordinance
- Federal Water Act
- Surface Water Ordinance
- Ground Water Ordinance
- Local and Regional water authorities
- Environmental Information Act

Policies and regulation, Issues (-) and Strengths (+)
Issues (-) and Strengths (+) evaluated regarding the usage of treated cow water in the food production. Therefore, case-specific, and not general issues and strengths of policies and legislations are listed. (-) Water reuse is a new topic, so there is a gap in policy and regulation for reuse of recycled water in different areas (e.g. industrial sector) (-) Responsibility for water reuse in dairy industry is spread across different authorities, which complicates decision-making. Therefore, it needs political empowerment of authorities to also consider the contribution of re-use approaches to overarching environmental policy objectives in the approval process (-) Not enough investment support and the refinancing of high opex and capex (+) Relevant authorities for LL East Frisia are open to an experience exchange across the federal state borders with other authorities in whose areas such reuse has or will be approved (+) Public interest and support for resource-saving reuse solutions (+) Recently issued national water strategy is a good starting point for the implementation of reuse measures. The national strategy needs to be complemented by a federal state water strategy that can promote industrial reuse at the level where the actual decisions are taken (+) Integrity and transparency practices across water policies, water institutions and water governance frameworks for greater accountability and trust in decision-making
Flanders, Belgium
Policies and regulation -
Issues (-) and Strengths (+) Source: D5.5 (Schmidt et al., 2023) (+) Dashboards information-sharing platforms are in place (-) Need to align federal and regional risk assessment procedures. Disparities in risk assessment for water reuse as environment and water are regulated at the regional level, health is regulated at a federal level (-) Need to improve access to and coherence among different data platforms and stimulate cross-border data sharing (-) Return on investment for water-related innovations is low, causing heavy reliance on public funding (-) Need of a broader involvement of stakeholders in the value chain and in upstream and downstream areas could improve shared problem ownership and investment opportunities
Lisbon, Portugal
Policies and regulation • Decree Law 119/2019, of 21 August, establishing the legal regime for producing reclaimed water, obtained from wastewater treatment – (all non-potable uses) reclaimed water production licence and utilisation licence issued by ARH Tagus • Decree Law 16/2021, of 24 February, clarifying reclaimed water production is part of the wastewater service and a new activity committed to multi-municipal wastewater systems • Decree Law 11/2023, of 10 February, reforms and simplifies environmental licensing • Portuguese Water and Waste Services Regulation Authority (ERSAR) quality of service assessment | Reclaimed water production indicator with reference values depending on WEI+ (Cardoso et al., 2021) • Portuguese Water and Waste Services Regulation Authority (ERSAR) guidelines for financing water reuse • PENSAARP2030 – Portuguese strategic plan for the decade, for water, wastewater, and stormwater services • PERAL – Lisbon water reuse strategic plan • PNA – National Water Plan

Policies and regulation, Issues (-) and Strengths (+)

- PNUEA – National Plan for Efficient Water Use

Issues (-) and Strengths (+)

Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023)
(+) National strategic plan for the decade, for all water services (drinking water, urban wastewater, and stormwater) and addressing water circularity
(+) Regulation of the water and wastewater services, including quality of service assessment and guidelines for financing the services
(+) Pioneer national legislation on water reuse, covering all non-potable uses and based on ISO standards
(+) Local (Lisbon) political awareness and willingness to reuse water and a strategic plan for the municipality
(-) Unclear legal framework regarding the existence of water supply utilities in Lisbon other than EPAL
(-) Current legislation does not allow selling/transferring reclaimed water to third parties to increase water reuse potential and viability (no secondary users allowed)
(-) National legislation after the new UWWTD will be needed

Source: D5.5 (Schmidt et al., 2023)
(-) Need for planning and action at local and basin levels. Drought issues should be dealt in advance by incorporating the principles and good practices in the use of water in non-potable uses in the city, evolving from the current situation
(-) Outdated regulations on building water systems are a barrier to the licensing of rainwater harvesting and water reuse systems
(-) Lack of knowledge and information on reclaimed water quality evolution in the distribution network
(-) Lack of public awareness of the local context that may increase water scarcity in Lisbon
(-) Lack of collaboration with stakeholders and potential users focusing on the benefits of using reclaimed water in fit-for-purpose uses
(-) Need to improve a common ground of knowledge on quantity and quality aspects, for reaching consensus with the authorities and involved stakeholders, and engagement with the users (urban, rural, or industrial) of reclaimed water
(-) Need for adjusting the legal framework of the water distribution service in Lisbon, as new water types (e.g. reclaimed water) should be delivered via a public distribution network

Source: euroactiv.com
(+) ReWaterEU plan with regard to the management of water resources, the Portuguese government proposes to implement measures such as reducing water losses in distribution systems, optimising storage, and transport infrastructures, reusing water for non-potable purposes in the urban, tourist, industrial, and agricultural sectors, and investing in desalination plants.

Source: Lisbon LL meeting on P&R (section 4.4)
Is it necessary to legislate or regulate at European, national, or local level?

Q1. Other (than agricultural irrigation) reclaimed water uses

- At EU level, a future revision of the Regulation (EU) 2020/741, should consider the establishment of minimum requirements for other uses than agricultural irrigation, namely industrial and urban uses.
- In Portugal, these uses are already legislated, for example for air conditioning in buildings, dust production control on construction sites (industrial) and urban irrigation, street cleaning, vehicle, and municipal waste bins cleaning.

Q2 & Q3 & Q4.
Indirect water reuse & Emission Limit Values vs. capacity of receiving body and intended uses (different permit types) &
Aquifer recharge

Policies and regulation, Issues (-) and Strengths (+)

- Current lack of a uniform position among the EU countries regarding the accounting of indirect water reuse, e.g., in Spain it is, whether in Portugal it is not - only licensed water reuse (e.g. direct reuse) is accounted for.
- ERSAR recommendation for water reuse financing is based on the “user pays” principle, meaning the additional treatment for reuse should be paid by the water user and not charged to the wastewater service.
- Environmental uses (i.e., support of wetlands and supplementation of stream, river, and lake flows, without contact with the human body) used to be considered as water reuse in the Portuguese legislation and are no longer considered.
- If WWTP discharges have a significant impact on water quality in a water body that is used for water abstraction (e.g., irrigation or industry) there are no clear boundaries between discharge and (indirect) reuse. The downstream water abstraction permit should take into account if the flow for the ecosystem maintenance is safeguarded and if the treated wastewater quality (discharge permit) after dilution in the water body fits the intended purpose. If additional treatment is needed, according to ERSARs’ recommendation, the additional cost should be charged to the water abstraction permit owner.
- Currently, there is not a uniform position among the EU countries regarding the aquifer recharge as water reuse. In Portugal, the legislation does not consider it, but in the 2024 State budget includes funding for a pilot project on managed aquifer recharge for a sound assessment of the environmental impact of this potential complementary solution for tackling water scarcity.

Q5. Evolution in minimum quality requirements and monitoring

- The fit-for-purpose principle should be maintained.
- Increased quality requirements for treated wastewater discharge to be introduced by the recast of the Urban Wastewater Directive can make water reuse easier (closer and not necessarily higher water quality requirements for reuse and lower additional/advanced treatment needed for reclamation).
- How to cope with monitoring results affected by external sources of contamination resulting from non-authorised uses of the space (e.g., irrigation in urban gardens or parks used for camping by homeless people). Monitoring is relevant but must not represent a big share of the direct costs of water reuse.
- Monitoring effort is expected to be higher initially (validation period) and then to decrease upon data records of water quality reliability. Simpler and cost-effective, ideally on-line, monitoring of proxy/screening indicators of water quality.

Q6. Prioritize reclaimed water uses in licensing

- The prioritization of water reuse should be decided according to the local environmental, technical, economic, and social circumstances.
- Reclaimed water should be clearly integrated in local/regional water balance. There will be no investment in reuse if there is no security of supply continuity.

Q7. Allow distribution/sale of reclaimed water to third parties, by licensed users &
Q8. Autonomize/regulate the reclaimed water supply service &
Q9. Evolution of economic regulation &

- In Portugal, current legislation does not allow a licensed reclaimed water user to pass on the reclaimed water to third parties due to risk management concerns. This is a major barrier to the implementation of water reuse in urban areas. The creation and regulation/licensing of a reclaimed water supply service could overcome this bottleneck through a producer- distributer-user(s) model, each party with an adequate risk management. Multiple users likely offer a steadier consumption with the inherent technical and financial advantages.

Policies and regulation, Issues (-) and Strengths (+)

- In Portugal, reclaimed water production and/or distribution can be included in the activity of a water utility, with a proper adjustment of the concession contract. It should be noted that the financial model for economic viability of reclaimed water supply is much more complex than for drinking water supply (variation in demand throughout the year and among years, and fewer interested parties).
- The 'cost-recovery principle' established at EU level and the 'user pays' principle recommended in Portugal may impair the affordability/willingness-to-pay for water reuse *vs.* freshwater abstraction, unless water scarcity is reflected on the freshwater costs and/or the wastewater treatment for discharge, supported by the respective tariff, gets closer to the water reclamation requirements, as expected through the UWWTD recast.
- Water reuse often secures freshwater availability for other purposes, including drinking water production, agriculture irrigation, so the financial model should assess a fair share of water reuse costs, particularly investment, across water services and freshwater abstraction.

Q10. Relevance of the existence of strategic planning

Strategic planning for water reuse, integrated in a broader regional water balance, is essential and should involve all key stakeholders and economic activities, and consider all existing sources, including reclaimed water.

Venice, Italy

Policies and regulation

- National Adaptation Strategy (NAS; Directorial Decree n. 86 of 16th June 2015)
- Plan for Circular Economy in 2017
- Water Safeguard Plan Veneto region
- Regional Plan for the lagoon protection (Regional Masterplan 2000)
- Ministerial Decree n. 185/2003 national regulation on water reuse for agricultural, urban, and industrial purposes
- Law 68/2023 -Decree Law 39/2023 Urgent provisions for contrasting water scarcity (referring to EU Regulation 2020/741 for water agricultural reuse)
- National Recovery and Resilience Plan (PNRR)
- Regulation of the water sector and incentives (ARERA)
- Legislative Decree n. 152/2006 Part III - about protection of surface, marine and groundwater against pollution
- Ministerial Decree of 30 July 1999 (from "Ronchi-Costa" Decree) for the quality protection of the Venice lagoon

Issues (-) and Strengths (+)

Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023)
(-) Lack of a national water reuse strategy
(-) Not clearly defined national/regional regulatory framework to facilitate the development of the circular paradigm across the nexus water-energy-waste
(-) Complexity of the national regulatory system

Source: D5.5 (Schmidt et al., 2023)
(-) For the agricultural water reuse there are ambiguities on roles/responsibilities distribution among the water reuse chain
(-) Lack of data to support the implementation and management

5.3.6 Stormwater for agricultural irrigation and other uses

Table 10 presents the policy and regulation instruments relevant for recommendations, as well as issues and strengths concerning stormwater for agricultural irrigation and other uses.

Table 10 Policy and regulation instruments, issues, and strengths in stormwater

Policies and regulation, Issues (-) and Strengths (+)
European
Policies and regulation • Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources • Directive 2000/60/EC, the Water framework directive (WFD) • Directive 2007/60/EC, on the assessment and management of flood risks • Regulation (EU) 2020/741 on minimum requirements for water reuse (on agricultural irrigation)
Issues (-) and Strengths (+) Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023) (-) Lack of international agreements on transboundary water flow (across borders), particularly for the Southwest region, where inflow of surface water is important Source: Interactive session on P&R (+) Opportunity to use nature-based solutions to manage stormwater quantity and quality (-) Need to improve governance (define roles, responsibility, and ownership) (-) Who and how to pay for an unstable source as stormwater (-) Need to promote storage and use of rain/stormwater in rural and urban (including households) spaces (-) Need to involve stakeholders in heavy rain/stormwater management as a shared challenge
Flanders, Belgium
Source: Vlakwa **Stormwater collection** in Flanders is a municipal competence. In practice, most municipalities outsource this to intermunicipal companies or Aquafin. There is not yet a specific legal framework for agriculture irrigation water in Flanders. Depending on how rainwater is collected and stored, it can be considered groundwater, surface water or rainwater. In the first two cases regulations (and fees) might apply (see section below on rainwater reuse). Wastewater collection, including rainwater (stormwater) collection is regulated at two geographic levels: i) Wastewater collection and rainwater collection at the municipal level is a municipal competence. Many municipalities have appointed another party as responsible for sewage water collection, often an intermunicipal company (intercommunale), or in some Aquafin NV (see below); ii) Aquafin NV is responsible for the supra-municipal treatment (and transport) of wastewater in Flanders. Most municipal WWTPs are owned and operated by Aquafin. Flemish municipalities are encouraged to make a **Rainwater and Drought Plan (HWDP).** Municipalities that do not have such a plan by 2024 will not have access to water-related subsidies. A HWDP contains a long-term vision on rainwater infrastructure and source measures to retain rainwater, reuse it, and infiltrate it. In more detail: i) the HWDP outlines the future system, in which rainwater will be separately collected. This is in contrast with the current systems, where often (not always) rainwater and household discharge are collected together in a combined system; ii) HWDPs indicate where water should be buffered and where it can be infiltrated, in order to prevent rainwater flooding and to recharge the phreatic aquifer where possible; iii) the HWDPs seek to avoid that future investment will require separate plans, by making sure a municipality-wide standardized plan is available. In many cases, the waste hierarchy model (‘Lansink"s Ladder’) is applied for prioritization: reuse – infiltration – buffering.

Policies and regulation, Issues (-) and Strengths (+)

In practice, HWDPs are developed by external consultants or by the intermunicipal company that is responsible for wastewater in the municipality. B-Watersmart's partner Aquafin takes up this role for some municipalities in Flanders.
Newly built houses and other buildings are subject to regulations concerning the collection of rainwater (Vlaamse Regering n.d.(a)): i) a rainwater well is mandatory, with volumes depending on the roof surface; ii) an infiltration facility is mandatory, in some cases at a collective level; iii) municipalities and provinces can impose more stringent rules than those at the regional (Flemish level).
The Flemish Government approved the regional Rainwater Ordinance 2023 on February 2023 (RWO, 2023). It defines that: (for new constructions or large renovations) rainwater must be collected separately from (urban) wastewater; the (minimal) size of rainwater wells; the infiltration of the overflow water; and the obliged installation of a rainwater-piping network in houses (Vlaamse Regering, 2022). The feedback procedure can be followed online (for the SERV and Minaraad feedback, see SERV 2022).
In Flanders there is regulation on use of the different water sources for irrigation: i) depending on volumes, there is a notification duty or a permit requirement for groundwater use, which includes charges (Vlaamse Regering, n.d.(b)); ii) depending on volumes, there is a notification duty or a permit requirement for water capture from surface water bodies (Vlaamse Milieumaatschappij n.d.(a)). The exact regulation depends on the type of water course and which authority is responsible for the course.
During periods of drought, the provincial governor can impose a temporary ban on the capture of water from surface water bodies. Over the last few years dry summers have seen such bans for most of the territory, and for some regions bans were in place all year round.
Collected rainwater that is transported through a ditch to a buffer basin might fall under the regulations of surface water bodies. An online tool, the "Vlaamse Hydrografische Atlas", maps all official surface water bodies and describes which authority is responsible. It allows actors to check whether the water body is considered as a surface water body (Vlaamse Milieumaatschappij n.d.(b)).
Water bodies that are not surface water bodies but are connected to the groundwater fall under the groundwater regulations (Inagro 2023). This includes, for example, 'open' rainwater basins that are not separated from the groundwater by e.g. a lay of clay or plastic foil. Water bodies that are isolated from groundwater do not fall under this regulation.
If rainwater is to be stored underground before reuse, it should follow the regulations in Vlarem 5.54 ("het kunstmatig aanvullen van grondwater"; Vlaamse Regering 1995). Infiltration of non-polluted rainwater including the use for irrigation is example from these regulations (Vlarem II Bijlage, Rubriek 54, Sectie 54.2).

Policies and regulation

- National adaptation strategy
- National adaptation plans at the national and regional levels. Flemish Climate Policy Plan (VKP) 2013-2020. Flemish Mitigation Plan (VMP) 2013-2020 and the Flemish Adaptation Plan (VAP) 2050
- Flemish Blue Deal
- River Basin Management Plans 2022-2027 for Scheldt and Maas
- Flemish Decree on Integrated Water Policy
- Regulation on infiltration of water
- 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
- Water price structure is fixed by law and is the same for a) drinking water; b) sanitation; and c) wastewater treatment.
- Regulation for drinking water: Drinkwaterwetgeving (EMIS Navigator (vito.be))
- Permit requirement for groundwater use, which includes charges

Policies and regulation, Issues (-) and Strengths (+)

Issues (-) and Strengths (+)

Source: Vlakwa
(+) Incentive/penalty related to development of rainwater and Drought Plans
(+) Regulations on the collection of rainwater in buildings
(+) New Rainwater Regulation Decree
(+) During periods of drought, the provincial governor can impose a temporary ban on the capture of water from surface water bodies
(-) Lack of a legal framework for agriculture irrigation

Source: InAll, D5.3 (Gomes et al., 2022), Strategic Agendas (Schmuck et al., 2021; Glotzbach et al., 2023)
(-) Missing National policies for public engagement, awareness, and communication
(-) Missing National policies for stormwater management including its reuse
(-) Improving permit issue process at national/local level
(-) Lack of national/regional water reuse regulation
(-) Missing national/regional guideline to clarify applicability of the regulation on water infiltration to water reused
(-) Lack of National legislation for stormwater management including its reuse
(-) Lack of a National/Regional regulatory framework that facilitates the development of the circular paradigm across the nexus water-energy-waste
(-) Lack of regulations about fertilizers and pesticide usage

Source: D5.5 (Schmidt et al., 2023)
(+) Dashboards information-sharing platforms are in place
(-) Need to improve transboundary coordination and the translation of EU legislation to the national and regional level
(-) Need to align federal and regional risk assessment procedures. Disparities in risk assessment for water reuse as environment and water are regulated at the regional level, health is regulated at a federal level
(-) Data on groundwater use in agriculture is likely to underrepresent actual use
(-) Need to improve access to and coherence among different data platforms and stimulate cross-border data sharing
(-) Need of a broader involvement of stakeholders in the value chain and in upstream and downstream areas could improve shared problem ownership and investment opportunities.
(-) Lack of clarity and disparities between the regulation of rainwater, stormwater, and infiltration methods.

6 Analysis of major water-related issues

The major water-related issues identified in section 5.3 are herein analysed and presented, identifying the common issues among the LLs and the specific issues.

6.1 Common issues

6.1.1 Digitalisation and IoT on water

Most issues related to Digitalisation and IoT in water systems are shared among the LLs:

- National data protection laws derived from the GDPR, with consequences in data confidentiality and security, hinder data collection by the water utilities from smart meters of third parties (consumers)
- Lack of open data
- Low investment in data collection
- Low perception of the value of collecting and sharing data
- Need to identify the essential fit-for-purpose data

6.1.2 Drinking water supply

Regarding drinking water supply, the common issues fall under three dimensions, i.e. water efficiency, smart allocation, and extended quality for micropollutants and other contaminants of emerging concern:

- Need to improve water efficiency, as recently introduced by the new DWD, which establishes water leakage level should be assessed by all Member States and reduced if they are above a certain threshold. This requires planning and investment on the renewal of the supply network, and smart metering for water leakage and water consumption management, which requires to overcome the limitations related with the data confidentiality and security (see section 6.1.1).
- Need to allocate fit-for-purpose water quality, avoiding using drinking water for non-potable uses.
- Need to protect drinking water quality from micropollutants or unknown substances in the water sources, and to promote smart and cost-effective monitoring for these contaminants.

6.1.3 Energy

Regarding the energy, the common issues identified are:

- Need to promote energy efficiency in water systems and self-sufficiency in WWTPs, as considered in the recent EU policy development (Table 7) towards energy neutrality.
- Need to facilitate the management between the water systems and the energy distribution grid, in order to minimise the need for energy storage while ensuring the quality of electricity on the distribution grid.
- Lack of EU policy for climate efficiency in households, buildings, and neighbourhoods.

6.1.4 Recovery of nutrients, biosolids and others

Concerning these resources recovery and beneficial use, the common issues identified are most related with biosolids/sludge and fertilizer nutrients, namely:

- Need for a consensual EU roadmap for biosolids/sludge management.
- Need to revise the EU directive concerning biosolids/sludge beneficial use in agriculture and the required characteristics/standards.
- Need for a consensual EU regulation concerning the organic fertilizers obtained from the urban wastewater treatment, including the required characteristics/standards, to promote their recovery and market acceptance.
- Need to look for value prepositive markets, such as urban landscaping; currently, the market for valuing nutrients is not appellative (low revenue).
- Need to shift the mindset and the semantics from “wastewater treatment” to “resource recovery”.
- Need to promote a generational change towards an increased market acceptance of recovered nutrients and biosolids (wording shift would help).

6.1.5 Water reuse

Regarding water reuse, a strong focus in five B-WaterSmart LLs, many common issues were identified:

- Lack of EU agenda and strategy on water reuse covering all uses, non-potable and potable, indirect (including managed aquifer recharge) and direct (going beyond the current regulation on minimum quality requirements for agriculture irrigation), to monitor and increase the safety of the current indirect reuse, and to facilitate the development of the circular paradigm across the water-energy-waste-food nexus.
- Lack of EU regulation and legislation for non-potable water reuse for urban (including irrigation and others) and industrial uses, and for potable uses, maintaining the fit-for-purpose principle and with clear instructions on the risk assessment process e.g., on how extensive the risk assessment for agricultural use should be.
- Lack of a uniform position across the EU countries regarding the accounting of indirect water reuse (some national statistics include, others do not).
- When WWTP discharges significantly impact the quality of a receiving water used for water abstraction (e.g., irrigation or industry), discharge and (indirect) reuse overlap. Therefore, either the water abstraction permit safeguards the treated wastewater quality (discharge permit), after dilution in the water body, fits the intended purpose, or the discharge permit safeguards the water quality for downstream indirect reuse. In both cases, the abstraction permit should secure the ecosystem maintenance flow. The cost coverage of the additional treatment (if needed) should reflect the best site-specific water resource management.
- Increased treated wastewater quality requirements for discharge to be introduced by the recast of the Urban Wastewater Directive can facilitate water reuse (lower or no additional/advanced treatment needed for reclamation).
- Monitoring is very relevant but often represents a big share of the direct costs of water reuse.
- Need of EU policies for public engagement, awareness, and communication to overcome the perception of worse water quality and high risk, among other (“yuck”) factors, to increase the water reuse acceptance.
- Business models, funding and pricing are critical factors.
- Multiple users improve technical (e.g., decrease peak demands) and economic feasibility of water reuse.
- The need to clarify if reclaimed water supply must be defined as an autonomous water service with a clear definition of responsibilities. Water reuse often requires a dedicated

treatment for reclamation and direct water reuse always requires a distribution network, the production and the distribution are not necessarily conducted by the same utility.
- The need of guidelines for the water reuse licensing process by the water authorities.

6.1.6 Stormwater for agricultural irrigation and other uses

Regarding stormwater for agricultural irrigation and other uses, governance aspects include:

- adequate international agreements on transboundary water flow, particularly for the Southwest region, where surface water inflow is important;
- stakeholders' involvement in rain/stormwater management as a shared challenge with a clear definition of roles, responsibility and ownership, including who and how to pay for an unstable source as stormwater.

Major technical aspects identified are:

- the need to promote storage and use of rainwater/storm water in rural and urban (including households) spaces;
- the opportunity to use nature-based solutions to manage stormwater quantity and quality.

6.2 Specific issues

6.2.1 Digitalisation and IoT on water

In **Alicante, Spain**, technical and organizational security measures against unauthorized access were highlighted, as well as the lack of compliance control of the law and of clear guidelines on how personal data should be collected and processed in this specific context, and of updates addressing the current technological challenges and solutions.

In **Portugal**, the Portuguese Water and Waste Services Regulation Authority in the 4th Generation of the Quality of Service Assessment System, proposed the Security and Resilience Index, one for the water and another for the wastewater services, that addresses cybersecurity, together with other categories (water or wastewater safety, security (facilities, infrastructure and product), contingency to drought or floods, and emergency/crisis management). All categories cover different sub-classes within i) governance and operationalization, ii) risk management, iii) communication, and iv) planning (Cardoso et al., 2021, 2023). These indices were included in the WaterSmartness Assessment Framework (Silva et al., 2022).

6.2.2 Drinking water supply

Regarding drinking water supply, in **Norway**, the Norwegian Environment Agency monitors the SDGs and reports every 4 years to the UN Climate Convention.

6.2.3 Energy

Concerning energy, in **Spain**, even if several potential waste producers for biogas production exist, its use is limited by the waste transport cost and requirement of legal certification.

In **Norway** there is state financial support for establishing biogas production facilities but, due to its low populated areas, it was highlighted the need of scale optimization of these facilities, promoting

the already established intermunicipal collaboration. In addition, the consequences from the existing uncertainty concerning the organic fertilizer regulation were also identified.

In **Venice, Italy**, a not clearly defined National/Regional regulatory framework on the water-energy-waste nexus to promote circular economy, the complexity of the national regulatory system and the lack of regulation on energy recovery were identified.

6.2.4 Recovery of nutrients, biosolids and others

In **Spain**, there are opportunities for nutrients recovery due to shortage of ammonia-based products, the rise of ammonia prices, and the existence of several potential consumers of the recovered product. However, the cost of the required equipment and product transport, and the penetration of these products in this competitive market are issues to overcome. In addition, the current regulatory framework exhibits inconsistency and heterogeneity, presenting a significant obstacle to achieving effective territorial governance in this domain. The great regulatory uncertainty and heterogeneity of criteria on sludge application generate a lack of confidence in the agents involved in the sector. This fragmented approach and absence of consensus further impede the formulation of a comprehensive plan for monitoring and evaluating sludge management practices. As a result, there are no proper assessment and monitoring mechanisms in place for the management of sludge. Moreover, it leads to a lack of funding for new investments and requires an update considering technological developments, international best practices, and environmental sustainability objectives.

In **Venice**, **Italy**, general roles are clear. However, the complexity of the national regulatory system and the unclear National/Regional regulatory framework on the water-energy-waste nexus, promoting circular economy, were again highlighted, as for the energy (section 6.2.3), as well as: not enough interlinkage between water and waste policies (e.g., “end of waste classification” delegated to the arbitrary “case by case” evaluation may impact N-salt valorisation); the need for a clear regulation concerning the N-recovery products; the need of a decision support system, shared knowledge and policy coordination at regional scale; scattered data to support the implementation and management.

6.2.5 Water reuse

In **Alicante, Spain**, whereas water reuse was signalised as **beneficial** to the implementation of other technologies, the underdevelopment of business models and the complexity in decision making (including the justification of the investment on water reuse to local administrations) were identified as **major issues**. Additionally, the value chain of reclaimed water and roles and responsibilities are not well defined, and there is an overlap and sometimes lack of involvement of the parties. Furthermore, there is a lack of policy coherence regarding the water allocated by a concession or a legitimate title for the private use of water, as it is sometimes not used by its holder, and rigidity in administrative concessions can create challenges for certain users, especially in situations where adjustments or adaptations are required due to changes in hydrological conditions or specific user needs.

In **LL East Frisia, Germany**, the topic of industrial water reuse is still new. A **national water strategy** has been finalized and adopted in 2023, in which water reuse was identified as a good option for protecting resources. Water reuse was also included in the amendment to the Drinking Water Ordinance. The microbiological stability of the water is an important factor for approval. The water must not only comply with the Drinking Water Ordinance at the time of sampling, but also

demonstrate a good prognosis for a very low microbial regrowth potential. Assessment and approval are carried out by the responsible regional authority. For **LL East Frisia** the responsibility for water reuse in dairy industry is spread across different authorities, which complicates decision-making. At federal level, one needs (i) a decision support and guidelines for authorities to approve water reuse for dairy industry solutions, (ii) to strengthen coordinated technical advice, (iii) bundled responsibility for industrial water supply in a central point of contact as Federal Office / Authority or others similar, (iv) political empowerment of health authorities to also consider the contribution of reuse approaches to overarching environmental policy objectives in the approval process. In addition, there is **a need** to politically uptake the technical input provided by water associations and to define required water for intended use, focusing on water quality instead of 'history'. Furthermore, there is **a need** for more investment support for refinancing of high opex and capex.

In **Flanders, Belgium**, there is the **need** (i) to improve transboundary coordination and the translation of EU legislation to the national and regional level; (ii) to align federal and regional risk assessment procedures, to overcome disparities as environment and water are regulated at the regional level, whereas health is regulated at a federal level, (iii) to improve access to and coherence among different data platforms and stimulate cross-border data sharing, (iv) to promote a broader involvement of stakeholders in the value chain and in upstream and downstream areas to improve shared problem ownership and investment opportunities – return on investment for water-related innovations is low, causing heavy reliance on public funding. A **positive aspect** is the dashboards information-sharing platforms in place.

In **Lisbon, Portugal**, the national legal framework clarifies reclaimed water production as a new activity committed to multi-municipal wastewater systems and covers all non-potable uses (agricultural but also urban and industrial) though environmental uses were recently (2023) excluded. It does not allow selling/transferring reclaimed water to third parties (no secondary users allowed), which would increase water reuse potential and viability. ERSAR recommendation for water reuse financing is based on the "user pays" principle, meaning the additional treatment for reuse should be paid by the water user and not charged to the wastewater service. New national legislation will be needed after the new UWWTD is issued, which is an opportunity for a better coherence between urban wastewater treatment and water reuse policy and regulation. There is the need for planning and acting at local and river basin levels, e.g., drought and water scarcity issues should be dealt in advance by incorporating the principles and good practices in non-potable water uses in the city, evolving from the current situation to avoid the use of drinking water. Strategic planning, essential for successful water reuse, exists in Lisbon, also with the contribution from the B-WaterSmart project, evidencing the political awareness and willingness to reuse water. The national strategy and the regulatory environment for the water services are also favourable. On the one hand, the national strategic plan for 2030 addresses water circularity. On the other hand, the Portuguese (waste)water utilities must have in place strategic plans and ERSAR's quality of service assessment (Cardoso et al., 2021) includes a reclaimed water production indicator with reference values depending on local water scarcity. The reclaimed water storage is also a success factor and, although the national legislation does not consider water reuse for aquifer recharge, the 2024' State budget includes funding for a pilot project on managed aquifer recharge for a sound assessment of the environmental impact of this potential complementary solution for tackling water scarcity. It is important to integrate water reuse in local/regional water balance, and prioritise its uses, which should be decided according to the local environmental, technical, economic, and social circumstances. Regarding water resources management, in the scope of the ReWaterEU plan, the Portuguese government

proposes to implement measures for reducing water losses in distribution systems, optimising storage and transport infrastructures, reusing water for non-potable purposes in the urban, tourist, industrial and agricultural sectors, and investing in desalination plants. Outdated regulations on building water systems are a barrier to the licensing of rainwater harvesting and water reuse systems. Knowledge and information on reclaimed water quality evolution in the distribution network is lacking, as well as a service model defining who builds and operates this new network. In Lisbon, the legal framework is unclear regarding the existence of water supply utilities other than EPAL. Public awareness about the factors that may increase water scarcity in Lisbon, and nationwide, need to be promoted as well as collaboration among authorities, stakeholders, and potential users (urban, rural, or industrial), focusing on the benefits of using reclaimed water of fit-for-purpose quality.

In **Venice, Italy**, a national water reuse strategy and a clear national/regional regulatory framework facilitating circular economy across the nexus water-energy-waste are lacking. The national regulatory system complexity, ambiguities on roles/responsibilities in agricultural water reuse chain, and lack of data to support water reuse implementation and management are other issues identified.

6.2.6 Stormwater for agricultural irrigation and other uses

In **Flanders, Belgium**, the Flemish Government recently approved the regional Rainwater Ordinance, incentives/penalties related to the development of Rainwater and Drought Plans (e.g., during drought periods, the provincial governor can impose a temporary ban on the capture of water from surface water bodies) exist, as well as regulations on use of the different water sources for irrigation and on rainwater harvesting in buildings. Nevertheless, several **major issues** are missing: a legal framework for agriculture irrigation, regulations about fertilizers and pesticide usage, and national policies for public engagement, awareness, and communication to improve shared problem ownership, environmental practices and investment opportunities; clarity between the regulation of rainwater, stormwater, and infiltration methods and national/regional guideline to clarify applicability of the regulation on water infiltration to water reused; national policies for stormwater harvesting and use, and improved permit issue process at national/local level; national/regional regulatory framework that facilitates the development of the circular paradigm across the nexus water-energy-waste; improved transboundary coordination and the transposition of EU legislation to the national and regional level; aligned federal and regional risk assessment procedures (e.g., environment risk assessment for water reuse is regulated at the regional level, whereas health risk assessment is regulated at a federal level). Dashboards information-sharing platforms are in place but the access to and coherence among different data platforms must be improved to stimulate cross-border data sharing, and data on groundwater use in agriculture is likely underestimated.

7 Recommendations

Based on the analysis of the major water-related issues (chapter 6), cross-cutting and water-related resource-specific recommendations were developed to policy makers at (i) European level, i.e., EU Commission, (ii) National/Regional level, i.e., Government, Water Resources and Water Services regulators/authorities, and (iii) local level, i.e., Municipalities, local authorities/agencies. The different degree of detail reflects each topics' relevance across the six LLs (cf. chapter 3 with the corresponding tools and technologies developed in B-WaterSmart to facilitate the uptake of water-smart solutions). The tools, particularly the #34-Water-smartness assessment framework and tool (a web tool assessing how 'water-smart' a system is), support the implementation of the recommendations proposed.

7.1 Cross-cutting recommendations

To support the development and implementation of water-related policies and regulations, cross-cutting recommendations include:

- Ensure coherence among sectors (water, energy, waste, food, health) and across levels (EU, national, local).
- Promote a problem-driven research and innovation environment, e.g. water-oriented LLs.
- Promote stakeholders' engagement and co-work (e.g. following up B-WaterSmart Communities of Practice (CoPs) and the Innovation Alliance (InAll)), data-based decision-making, strategic planning, and resource allocation.
- Develop coherent EU-national-local strategic plans on water and related resources, supported by a clear, quantitative, and objective-driven assessment, e.g., the B-WaterSmart Assessment Framework, identifying the strategies/actions and estimating the human, financial and technological resources needed to reach the targets on the short, medium, and long-term.
- Create incentives to train and capacitate human resources regarding the adequate knowledge and competences to implement the strategic plans.
- Promote the SDGs' monitoring and international benchmark.
- Implement the assessment of the impact of performance-based access to funds for green-field investment and renewal.
- Create/empower to create/empower national, regional, and local water governance boards to enhance water governance and facilitate inclusive decision-making processes. These boards can contribute to more sustainable and effective water governance by overseeing water management policies, ensuring transparency, and facilitating inclusive decision-making. They would consist of representatives from government and regulation agencies, the water sector (public and private), water users, civil society, and academia.
- Promote collaborative work of competent authorities and water managers to continuously review and update regulations, taking into account technological advancements, international best practices, and environmental sustainability goals.
- Engage the scientific community and other experts of the sector in decision-making processes to integrate their knowledge in robust and innovative governance.
- Promote public-private collaboration and facilitate information exchange among water management entities through discussion forums and benchmarking initiatives.

- Promote the mindset and semantics' shifting from "wastewater treatment" to "resource recovery" and valuing the water quality rather than its 'history', i.e., privileging 'water' over 'wastewater'.
- Promote a generational change towards an increased market acceptance of recovered water, nutrients and biosolids (wording shift would help).

7.2 Digitalisation and IoT on water

European level

- Promote mechanisms for the continuous update and monitoring of IT threats and solutions to ensure updated technical and organizational security measures against unauthorized access. These mechanisms often rely on sound performance assessment practices. An example is the use of the Security and Resilience Index for the water and for the wastewater services included in the WaterSmartness Assessment Framework (Silva et al., 2022). These indices address cybersecurity (as well as safety, security (facilities, infrastructure, and product), contingency to drought or floods, and emergency/crisis management), and cover governance & operationalization, risk management, communication, and planning (Cardoso et al., 2021, 2023).
- Produce guidelines or standards of fit-for-purpose data specification, comprehensively demonstrating the value of the shared data, both from the economic and the innovation points of view and addressing the integration of multiple systems and data sources.
- Clarify the boundaries between confidential and open data, promoting the safe availability of sound anonymous shared data.

National, regional, and local level

- Transpose the above to national and/or regional levels, when and if applicable.

7.3 Drinking water supply

European level

- Regulate or provide incentives for the development of strategic asset management of water supply systems for the prioritization of most cost-effective investments on the long term, towards network renewal and smart monitoring, assessing the progress through quantity and quality indicators.
- Minimise the discharge of microcontaminants in the water sources, by promoting point source control (e.g. of X-ray contrast media, cytostatics, cancer treatments and some antibiotics, in medical facilities) and considering that an improvement will be expected after the new UWWTD (COM(2022)541) enters into force, as it includes improved control.
- Promote research on simpler and cost-effective monitoring of proxy indicators of contaminants of emerging concern of costly and difficult analysis, e.g. pharmaceuticals.
- Monitor and regulate, particularly in water-scarce regions, the non-potable uses of drinking water, e.g., via licencing restrictions of water meters for irrigation.

National, regional, and local level

- Transpose the above to national and/or regional levels, when and if applicable.

7.4 Energy

European level

- Promote and provide the means for energy efficiency in water systems and self-sufficiency in WWTPs towards energy neutrality, as considered in the recent EU policy development.
- Facilitate the management, regarding production and use of energy by water utilities, between the water systems and the energy distribution grid, in order to minimise the need for energy storage while ensuring the quality of electricity on the distribution grid.
- Provide incentives for the adoption of water-energy efficiency certificates for households, buildings, and neighbourhoods.

National, regional, and local level

- Transpose the above to national and/or regional levels, when and if applicable.
- Better harmonise the water, energy, and waste policies, e.g.
    - assessing the impact of energy production from hydrogen on water resources and facilitate the co-digestion of waste for improved biogas production;
    - clarify the legal restrictions for sludge agricultural application, considering the contaminants involved, as this affects this use of sludge vs. energy production.

7.5 Recovery of nutrients, biosolids and others

European level

- Co-produce an EU roadmap for biosolids/sludge management; consider net societal benefits in the decision making on management options, accounting for aspects such as the bioavailability of nutrients (e.g., phosphorus) and the energy content.
- Ensure coherence of policy and targets between biosolids recovery and biogas production.
- Revise the EU directive concerning biosolids/sludge beneficial use in agriculture and the required characteristics/standards, defining a clearer allocation of responsibility along the biosolids value chain.
- In the above revision, exclude biosolids/sludge from waste legislation to overcome the existing barriers to circular economy (no uniform rules across the EU), to improve predictability for investments for water utilities, and enhance confidence for the end-users.
- Deliver a comprehensive EU regulation concerning the organic fertilizers obtained from the urban wastewater treatment, including the required characteristics/standards, to promote their recovery and market acceptance, alongside with a clearer allocation of responsibility along the nutrients value chain.
- Promote monitoring of phosphorus (P) as a critical raw material in Europe and accordingly update regulations by adjusting the targets of P recovery from urban wastewater via biosolids land application at agronomic rate, irrigation with reclaimed water, fertilisers (Silva et al., 2016).
- Promote research and the use of technologies that recover nutrients (nitrogen, phosphorus, and potassium) from wastewater and sludge streams in a concentrated form (e.g., the inorganic precipitate struvite), increasing the options for reuse with reduced pathogen risk and improved ease of transportation.
- Promote research on the impacts on soil, vegetation, animals, and humans resulting from the use of biosolids/sludge in agriculture.

National, regional, and local level

- Integrate local specificities in the nutrient and biosolids management systems: different solutions for different contexts.
- Prioritise the adaptation of existing sludge infrastructures for co-digestion, rather than solely focus on funding new infrastructures, to optimise resources and maximise the benefits of existing facilities.
- Establish a "Sludge Round Table" at the regional or national level to ensure effective monitoring and evaluation of sludge management practices, bringing together various stakeholders, including government authorities, companies, scientific and expert communities, and users. This initiative can help update regulations and address legal concerns within the sector.

7.6 Water reuse

European level

- Develop an EU strategic agenda on water reuse covering all uses (non-potable and potable), indirect (including managed aquifer recharge) and direct (going beyond the current regulation on minimum quality requirements for agriculture irrigation), to monitor and increase the safety of the current indirect reuse, and to facilitate the development of the circular paradigm across the water-energy-waste-food nexus.
- Encourage the member-states to define priorities for reclaimed water uses, which should be decided according to the local environmental, technical, economic, and social circumstances. Reclaimed water should be clearly integrated in local/regional water balance (no investment in reuse if supply continuity is not secure).
- Agree on a uniform position across the EU countries on if and how to account for indirect water reuse – clarifying the boundaries between treated wastewater discharge and (indirect) water reuse, which impact the permits and the treatment required; the cost coverage of the additional treatment (if needed) should reflect the best site-specific water resource management; the environmental uses should be accounted for as direct or indirect water reuse, as well as managed aquifer recharge.
- Regarding managed aquifer recharge, clear instructions should be delivered for a sound assessment of its environmental impact and for risk assessment and management.
- A future revision of the Regulation (EU) 2020/741 should (i) consider the establishment of minimum requirements for other uses than agricultural irrigation, namely industrial and urban uses, maintaining the fit-for-purpose principle, (ii) provide clearer instructions on the risk assessment process, e.g., on how extensive the risk assessment should be, and (iii) reflect in the monitoring the knowledge about the system and its reliability, i.e., a higher effort during the validation period and then a decrease upon data records of water quality reliability, including simpler and cost-effective, ideally on-line, monitoring of proxy/screening indicators of water quality.
- Promote research and provide guidance on how to upgrade the current urban WWTPs to cope with the new requirements of the UWWTD recast and enable water reuse (e.g., to address both quaternary treatment and disinfection).
- Account for the beneficial use or recovery of P through the irrigation with reclaimed water, (coherent with the policy and targets of P recovery for urban wastewater).
- Promote EU policies for public engagement, awareness, and communication to overcome the often-biased perception of worse water quality and high risk, among other (“yuck”)

factors, to increase the water reuse acceptance – water quality should matter not its source, providing risk management is ensured.

- Develop guidelines for a Europewide coherent water reuse licensing (e.g., how far should the risk assessment go) and water reuse service provision (dedicated treatment, storage, and conveyance) and pricing.
- Promote research & innovation and subsequently develop policy and regulation on water reuse business models, funding mechanisms, and pricing, valuing opportunity costs and considering multiple users to improve economic (as well as technical, e.g., decrease peak demands) feasibility of water reuse.
- Promote research and pilot demonstration projects of direct potable reuse to develop sound guidelines of water quality and treatment process operation and redundancy needed to anticipate a solution for aggravated water scarcity, localised needs, emergency situations, as well as to build the trust of the society in water reuse safety.

National, regional, and local level

In the **Alicante LL, Spain**, it is important to establish clear roles and responsibilities to promote the efficient use of reclaimed water. This can be achieved by defining common protocols that prevent entities from relying solely on their own discretion to promote reclaimed water, ensuring a more coordinated and efficient approach to the management of these resources. However, to ensure policy coherence at both regional and national levels, it is crucial to develop a more unified and consistent approach, that prioritises the long-term sustainability of resources and emphasises the promotion and support for the expansion of reclaimed water. By aligning policies and strategies, a comprehensive framework can be created that effectively addresses the needs of all stakeholders involved. One of the key barriers in managing water resources is finding a balance between different water users, rural and urban areas, and future generations. To tackle this issue, it is necessary to change perceptions and increase flexibility in administrative water concessions. This can be achieved by implementing certain limits and supervision to ensure the responsible and efficient exchange of water resources. With proper oversight, it can prevent the misuse of water and ensure that it is utilised in a sustainable manner.

Regarding **East Frisia LL, Germany**, the following should be promoted at federal level: (i) a decision support and guidelines for authorities to approve water reuse for dairy industry solutions, (ii) to strengthen coordinated technical advice, (iii) bundled responsibility for industrial water supply in a central point of contact as Federal Office / Authority or others similar, iv) political empowerment of health authorities to also consider the contribution of reuse approaches to overarching environmental policy objectives in the approval process. In addition, there is a need to politically uptake the technical input provided by water associations and to define required water for intended use, focusing on water quality instead of ‘history’. Furthermore, there is a need for more investment support for refinancing of high opex and capex.

In **Flanders LL, Belgium**, the following recommendations should be addressed (i) to improve transboundary coordination and the translation of EU legislation to the national and regional level; (ii) to align federal and regional risk assessment procedures, as environment and water are regulated at the regional level, whereas health is regulated at a federal level, (iii) to improve access to and coherence among different data platforms and stimulate cross-border data sharing, (iv) to promote a broader involvement of stakeholders in the value chain and in upstream and downstream areas to improve shared problem ownership and investment opportunities (return on investment for water-related innovations is low, causing heavy reliance on public funding).

In **Portugal (Lisbon LL)**, all the recommendations at EU level apply. Regarding the specific context, current legislation does not allow a licensed reclaimed water user to pass on the reclaimed water to third parties due to risk management concerns. This is a major barrier to the implementation of water reuse in urban areas. The creation and regulation/licensing of a reclaimed water supply service could overcome this bottleneck through a producer- distributer-user(s) model, each party with an adequate risk management. Multiple users likely offer a steadier consumption with the inherent technical and financial advantages resulting from a decreased variation in demand throughout the year and among years, by a wider and more diverse number of interested parties.

The 'cost-recovery principle' established at EU level and the 'user pays' principle recommended in Portugal may impair the affordability/willingness-to-pay for water reuse vs. freshwater abstraction, unless water scarcity is reflected on the freshwater costs and/or the wastewater treatment for discharge, supported by the respective tariff, gets closer to the water reclamation requirements, as expected through the UWWTD recast. Water reuse often secures freshwater availability for other purposes, including drinking water production, agriculture irrigation, so the financial model should assess a fair share of water reuse costs, particularly investment, across water services and freshwater abstraction.

Strategic planning for water reuse, integrated in a broader regional water balance, is essential and should involve all key stakeholders and economic activities, and consider all existing sources, including reclaimed water. Facilitating factors include the B-Water Smart Assessment Framework and the regulatory context, which requires the utilities to have in place strategic plans.

In **Venice LL, Italy**, it should be developed: (i) a national water reuse strategy and national/regional strategic plans, (ii) national/regional regulatory framework facilitating circular economy across the nexus water-energy-waste, (iii) national/regional regulation and legislation on industrial water reuse including specific substances, (iv) national policies for public engagement, awareness, and communication, (v) clarification of roles/responsibilities in agricultural water reuse chain, (vi) data to support water reuse implementation and management are other issues identified.

7.7 Stormwater for agricultural irrigation and other uses

European, national, regional, and local level

Regarding stormwater for agricultural irrigation and other uses, recommendations cover governance and technical aspects, namely:

- provide adequate international agreements on transboundary water flow, particularly in EU regions where surface water inflow is important;
- promote stakeholders' involvement in rain/stormwater management as a shared challenge with a clear definition of roles, responsibility, and ownership, including who and how to pay for an unstable source as stormwater;
- promote storage and use of rainwater/stormwater in rural and urban (including households) spaces; promote the use nature-based solutions to manage stormwater quantity and quality;
- promote smart monitoring and control of the water quality for the safety of the fit-for-purpose stormwater use with the appropriate treatment.

7.8 Next step - policy briefs development

Additional discussions need to be carried out for the topics selection to better reflect the B-WaterSmart efforts and results, and to also address the developments relevant to this subject from other projects of the CIRSEAU cluster (of five sister H2020 projects (on the topic “Building a water-smart economy and society”).

Even though, in order to contribute to the definition of the topics for the policy briefs to be developed, based on the current recommendations, as described in section 4.3, each participant of the Policy and Regulation interactive session individually ranked the six topics discussed, according to their relevance for the B-WaterSmart policy briefs, and the same ranking was carried out by each LL. The results correspond to the following ranking (more details presented in Annex 2):

- Water reuse (1st rank individually and per LL)
- Drinking water supply (2nd rank individually and per LL)
- Stormwater (3rd rank individually, 4th rank per LL)
- Digitalization and IoT on water (4th rank individually, 6th rank per LL)
- Energy (5th rank individually and per LL)
- Recovery of nutrients, biosolids and others (6th rank individually and 3rd per LL)

The ranking is not coincident and may be biased by the different number of participants per table, which reflects the direct interest of the participants (section 4.3.2). This reinforces the need for further discussions.

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Annex 1 | List of B-WaterSmart tools and technologies

B-WaterSmart tools and technologies

#	Name of tool / technology
1	**Water reclamation protocol for potable water reuse in beverage industry:** piloting of Water Resource Recovery Facility (WRRF) effluent post-treatment for using in artisanal beer production
2	**Aquifer storage recovery:** suitability of aquifer storage recovery for strategic storage of drinking water.
3	**Effluent reuse for drinking water production:** technologies to upgrade secondary effluent for input into the drinking water cycle.
4	**Compact combinatory treatment technologies for industrial water reuse:** Pilot combination of technologies
5	**Urban stormwater reuse for agriculture:** Demonstration of treatment technologies.
6	**Combined treatment of vapour condensate & milk/whey permeate for reuse in dairy industry:** Demonstration of treatment combination to assess quantity and quality of reuse water, residuals, operational costs and monitoring.
7	**Nitrate-selective electrodialysis reversal (EDR):** Piloting of novel membrane for nutrients separation from brines and use in fertigation.
8	**Brine Electro-chlorination:** Piloting of technology for on-site production of sodium hypochlorite.
9	**Ammonia evaporation CEVAP:** Piloting of a novel low thermal evaporation technology (CEVAP) for ammonia recovery from co-anaerobic digested sludge.
10	**Oil and fat co-digestion technology:** Pilot scale validation of the valorisation of oil and fats
11	**Ammonia recovery from concentrated WWTP streams:** Stripping/absorption pilot system.
12	**Efficient small-scale biogas production** at **small wastewater treatment plants**: Clustering of plants, combi solutions with several material flows
13	**Microturbines for energy recovery:** Demonstration of energy recovery from WWTP effluents.
14	**IoT sensors for infiltration detection:** Registration of inflow to wastewater networks and testing of sensor combination.
15	**Smart water meters for leak detection:** Piloting of online capabilities to sample pressure, flow, temperature, and acoustic data from household smart meters
16	**Water Reuse Strategic Platform:** Comprehensive, transferable, interoperable evaluation system for Water Reuse based on FIWARE based Internet of Everything platform.
17	**Environment for decision support and selection of alternative courses of action**
18	**RE-ACTOR:** Smart water allocation & negotiation tool for water reuse
19	**Sludge Management Platform:** Comprehensive, transferable, interoperable evaluation system for Sludge Management based on FIWARE Internet of Everything platform.

20	**UWC Observatory:** Urban Water Cycle Observatory: Open data information for public and reserved data sets to input into decision-making tools.
21	**Stormwater Reuse Management System:** Operational management of a stormwater buffer basin and the connected sub-irrigation system
22	**UWOT:** model for simulation of the urban water cycle from source-to-treatment-to-tap, supporting planning and assessment of distributed interventions.
23	**Regional Demand-Supply Matching GIS tool:** Tool for GIS-based analysis of optimal demand-resource patterns (using FREEWAT)
24	**Reclaimed water quality model in the distribution network**
25	**Water-energy-P balance planning module**
26	**QMRA+:** Quantitative Microbial Risk Assessment for water reuse and agriculture
27	**RA-Reuse:** Risk Assessment (RA) for Urban Water Reuse module
28	**Short-Term Demand Forecasting Tool:** Automatized day-to-day water demand forecasting
29	**iWidget+ Platform** **(or Fiware enabled multi-dashboard):** Online platform for water information at utility and customers premises
30	**iWidget+ Platform** **(or Fiware enabled multi-dashboard):** Online platform about I/I for wastewater networks
31	**ASR-pro tool:** predicting water quality after subsurface storage
32	**Digital Enabler:** Integrated digital support system to enable Resource Recovery (RR) and Circular Economy (CE) at regional scale
33	**Climate-readiness Certification tool:** Toolkit for 'Water Smart for Climate-Ready' Building Certificates
34	**Water-smartness assessment framework and tool:** a web tool assessing how 'water-smart' a system is.

Annex 2 | Interactive session on policy and regulation

Discussions outcomes

a. Digitalisation and IoT | Table 1

Table 1 counted with sixteen participants and discussed the main needs and requirements to support the recommendations on policy and regulation regarding **Digitalisation and IoT**. The output is presented in Figure 6 and Table 11.

Figure 6. Digitalisation and IoT | Working table 1.

Table 11. Working table 1 outcome | Digitalisation and IoT

Working table 1 - Digitalisation and IoT			
Issue	**P&R Recommendation**	**Scale** EU, National (N), Regional (R), Local (L)	**Dimension** Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)

1. Lack of open data 2. Lack of investment in the institutions (cost of collecting data)	- Improve the knowledge of the data standard FIWARE	-	-
	- to get data from companies you have to make it worth for them	- EU, N	- E
	- marketing advantage (would facilitate getting access to some type of data)	-	-
	- Funding: make eligibility depend on the projects complying with data standards	- EU	- E
3. Data confidentiality 4. Low perception of the value of collecting and sharing data •	- Incentives: “connecting Europe facility” equivalent for smart water systems	-	-
	- incentives with sings attached		-
	- Differentiation: for governmental data for enforcement versus company data for decision support	- N	-
	- Confidentiality		
• What data and what metrics are essential to the policy and regulation objectives? • Do we have a data strategy with data for which purpose	- Pose and hopefully answer the question	-	-
	- What is different for after “post BWSM”	-	-
	- Data the strategy exists at the “high” level but needs to be defined for each **type** of data and **purpose**	- N - R	-
	- the BWS project is in a good position to make recommendations on		

	what data and metrics are key for policy and regulation		
	- link to EU open data spaces initiative		
	- who needs to be involved (at what stage)		

b. Drinking water | Table 2

Table 2 counted with fifteen participants and discussed the main needs and requirements to support the recommendations on policy and regulation regarding **Drinking water**. The output is presented in Figure 7 and Table 12Table 12. Working table 2 outcome | Drinking water. In blue text are identified the LL three major issues.

Figure 7. Drinking water | Working table 2

Table 12. Working table 2 outcome | Drinking water

Working table 2 – Drinking water			
Issue	**P&R Recommendation**	**Scale** EU, National (N), Regional (R), Local (L)	**Dimension** Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)
1. Protecting drinking water quality: which micropollutants or unknown	- guidance on safe practices enabling reuse of water while adequately protecting the quality of	- EU, N	- P, En, T, L

substances could be in reclaimed water? - No groundwater recharge in drinking water protection areas - first use of the water sources like rain or drainage water?	resources (e.g., groundwater)		
	- enhance the role of drinking water supply company regional groundwater management and stakeholder engagement	-	- En, S
2. ensuring drinking water quality at point of consumption (network monitoring) incentives for safe fast meters in pipelines	- clear technical guidelines for monitoring drinking water network	- EU, N	- T, L
	- public information about drinking water quality easily available: more tests? marking of consumption points?	- EU - N	-L - S
3. definition in regulations: - where do you need drinking water and where could it also be water (reclaimed water) that fulfils certain quality aspects - fit for purpose	- clear technical guidelines national for using alternative water sources	- N	- T, L
	- to decrease pressure on drinking water, prioritize the use of reclaimed water in sectorial areas such as agriculture industry	- E, N	- P
- more easy introduction of new technologies (lightening the GDPR rules) - leakages in distribution - effective production of drinking water from sea water Use	- implementation of drinking water regulation enabling substitution of drinking water by reclaimed/reuse of water		
	- safety related with the decrease of raw		

Reverse Osmosis, lower costs less use of energy - lack of investments to renew drinking water supply network which leads to a massive waste of potable water and of course, to a lot of energy waste (indirect)	water quality and quantity		
	- leakage pressure demands management		
	- integrated and quick response monitoring for integrated water plans		- L
	- reliable long term drinking water supply (CC): decentralize, multiple sources, (indirect) use, concentrate disposal, health issues (risk assessment methodologies)		
	- help all water providers prepare for the coming climate change challenges through a framework for preparing		
	- country “relevant” purposeful legislation, e.g., the water directive being “irrelevant”/ making management unnecessary in one country than in another		

c. Nutrients, biosolids and others | Table 4

Table 4 counted with eight participants and discussed the main needs and requirements to support the recommendations on policy and regulation regarding **Nutrients, biosolids and others**. The output is presented in Figure 8 and Table 13. In blue text are identified the LL three major issues.

Figure 8. Nutrients, biosolids and others | Working table 4.

Table 13. Working table 4 outcome | Nutrients, biosolids and others

Working table 4 – Nutrients, biosolids and others			
Issue	**P&R Recommendation**	**Scale** EU, National (N), Regional (R), Local (L)	**Dimension** Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)
1. Product / value issues - Dynamic discharge licensing for nutrients - Require strategic plans for nutrient	- Nutrients and sludge (biosolids) are different. Sludge needs to be clearly integrated in directive → treatment issues (*note: UWWTD revision*)	- EU	- P

management across water / farming / land use, etc. - Regulation policy: characteristics / standards of by-products are not defined	- Product value: to look at recover and reclamation. Semantics.	- EU	- P
2. Market / revenue issues - Market penetration - By-products market incentives. Agriculture - Scarce market acceptance of nutrients recovered from WWT - Taxing conventional fertilizers - Enabling legislation for nutrient recovery and reuse markets - Upcycling N, not only fertilizers, e.g. protein production for animal feed	- Value prepositive market - e.g., urban landscaping: (*for*) valuing nutrients (*but*) revenue is hard	- EU	- E
	- Build markets at national scale: necessary to move to decentralized - Digital tools (*note: for supporting these markets*)	- EU - EU	- E - T, IoT
3. Transaction / buyers and sellers' issues - Quality standards - Knowledge: systematic treatments, standardize waste types - Sludge reuse in agriculture: lack of a coordinated EU directive - Arrangements for nutrients neutral developments	- Generational change → students	- E, R, N, L	- S
	- Wording → change semantics: not wastewater treatment, change to recover	- EU, N	- P

4. Non-specified issues - Old infrastructure - Financing - Incentives - Develop/implement new technologies / more efficient (e.g., IEX, membranes) - Nitrogen and P recovery, not just removal	--	--	--

d. Reclaimed water | Table 5

Table 4 counted with seventeen participants and discussed the main needs and requirements to support the recommendations on policy and regulation regarding **Reclaimed water**. The output is presented in the Figure 9 and Table 14. In blue text are identified the LL three major issues.

Figure 9. Reclaimed water | Working table 5.

Table 14. Working table 5 outcome | Reclaimed water

Working table 5 – Reclaimed water			
Issue	**P&R Recommendation**	**Scale** EU, National (N), Regional (R), Local (L)	**Dimension** Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)
1. business and funding issues - no secondary users allowed - secondary uses, the possibility of a user to	- subside - incentives = money not spent or groundwater wells, other conventional sources	-N - R	- P, E
	- funding investment for companies to do	- EU	- E, S

sell and bought reclaimed water - the responsibility to build and operate the reclaimed water network - CAPEX costs for infrastructure (storage, transport) - can it be financed by the drinking water tariff? - a new infrastructure needed, new costs - water reuse: need for regulation for other reuse, e.g. drinking water; Reg. 2020/741 requires rationale market development for users	investment: water efficiency label		
	- reclaimed water funding scheme supported partially by drinking water tariff	- EU	- E
	- secondary users allowance	- N - EU	- L - P, E
2. water quality issues - missing guidelines for the water authorities - perception of worse water quality for irrigation - unclear how extensive risk assessment for agricultural use should be - water quality, is legislation sufficient? - Licensing process	- Improve control at source, e.g. anti-contrast effluent	- EU	- S,P, L, En
	- actual risks, a major definition: to align freshwater-reclaimed water-the actual agricultural source - avoid arbitrary precautionary approach		
3. indirect reuse - the indirect the best/self-intrusion	- reports direct and indirect reuse independently	- EU	- P, L, Env

- for the direct costs and responsibility distribution	- we need a clear definition of what is meant with indirect reuse	- EU	- P, L, Env

e. Stormwater | Table 6

Table 6 counted with eleven participants and discussed the main needs and requirements to support the recommendations on policy and regulation regarding **Stormwater**. The output is presented in Figure 10 and Table 15. In blue text are identified the LL three major issues.

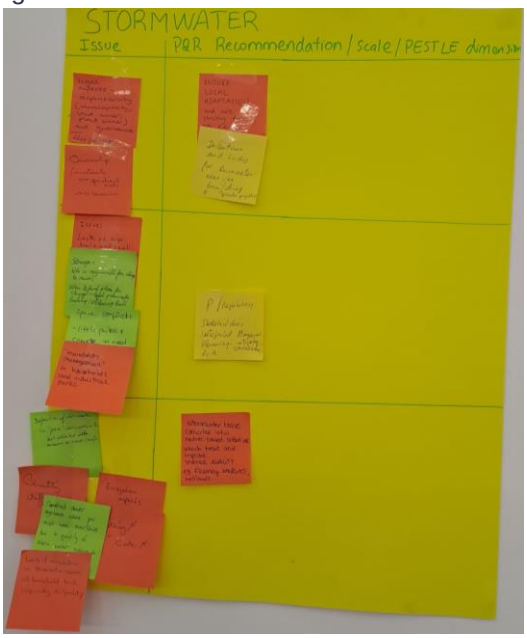

Figure 10. Stormwater | Working table 6.

Table 15. Working table 6 outcome | Stormwater

Working table 6 – Stormwater			
Issue	**P&R Recommendation**	**Scale** EU, National (N), Regional (R), Local (L)	**Dimension** Political (P), Economic (E), Social (S), Technological (T), Legal (L), Environmental (Env)
Synthesis LLs 3 Major issues: 1. Unstable source of water: how to cope with costs, who pays per unstable source 2. stop drainage, start to store and reuse rainwater/storm			

water is business case 3. stakeholder involvement: heavy rain/stormwater management as a shared challenge			
- legal aspects: responsibility (municipality, land owner, plant owner) and governance - ownership: investments versus operational costs and revenues	- ensure local adaptation and not strictly focus on the population equivalent or plant size		- P, E
	- incentives and codes for rainwater use in buildings, private properties		- E
- lack of large scale and small scale infrastructure to retain water in the cities storage who is responsible for storage to reuse? - where to find place for storage: legal process for obtaining l - space conflicts little public space: need to cooperate to do measurements in private property - mandatory management in households and industrial parks	- stakeholders integrated management and planning integrating stakeholders	- R, L	

- definition of stormwater “pure rain water” but polluted because of roads and roofs - quality differences - ecosystem aspects - increasing monitoring will increase costs - combined sewer systems: where you must have overflows due to quantity of stormwater rushing to the treatment plants - Lack of regulation on stormwater reuse at household level (especially its quality)	- stormwater basins converted into nature-based solutions which treat and improve water quality, e.g., floating structures, wetlands…		

Ranking of 6 topics | relevance to produce the B-WaterSmart policy briefs

Using the Mentimeter, each participant individually ranked the six topics (1. Digitalisation and IoT; 2. drinking water; 3. energy; 4. nutrients, biosolids and others; 5. reclaimed water; and 6. stormwater.), according with the relevance to produce the B-WaterSmart policy briefs. The same ranking was carried out by each LL. The results are presented in Figures 6 and 7, respectively.

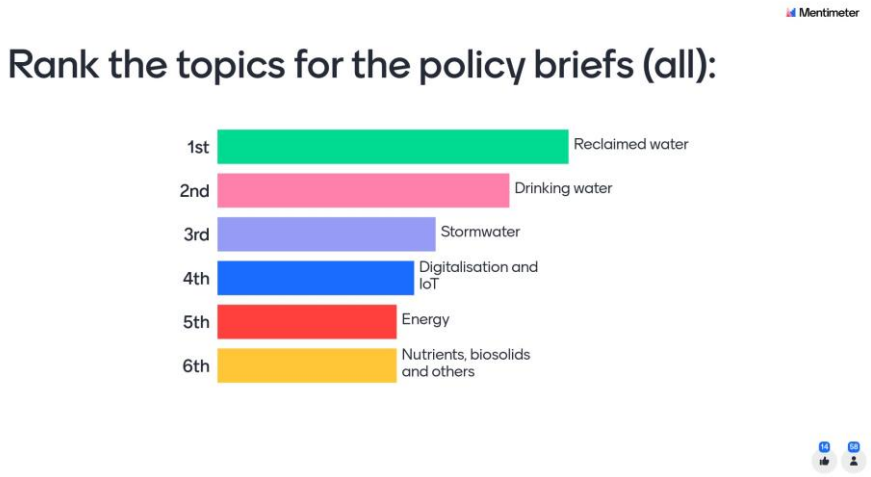

Figure 11. Ranking of all participants

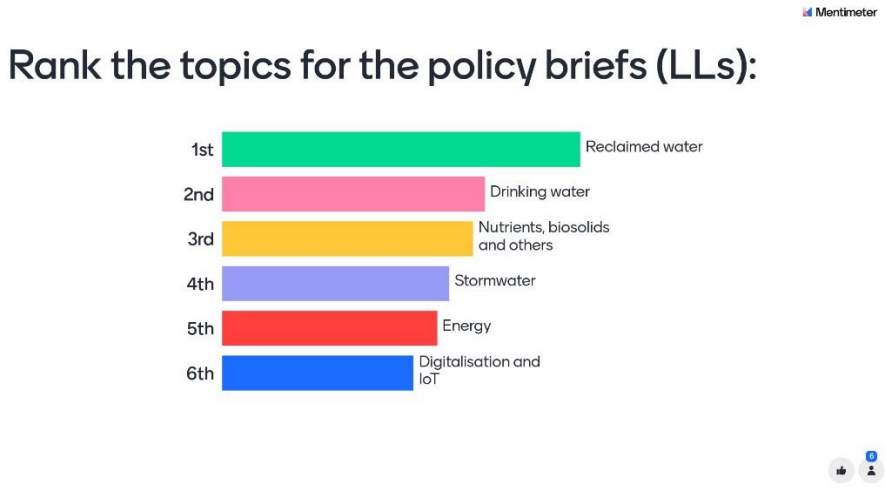

Figure 12. Ranking of LLs

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