nextGen
Circular Water Solutions

D4.3 Challenges and opportunities across policy and regulatory frameworks

Final revised report

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Update from previous version

Review of NextGen D4.3

The report provides a comprehensive elaboration on the relevant policies and the conducted surveys and interviews. The report clearly expresses regulatory variations within the EU and UK. It is notable to see that incentives in a strict regulatory environment creates less de-facto activity, i.e. less regulation supports more de-facto action. Furthermore, it gives a good overview on financing models and alternatives as well as recommendations at different levels. However, the number of responses per demo site is included only in chapter 4.2 regarding policies on recovery of materials and energy and missing for others. The mentioned one is however very low (11 in total from 4 countries) and its representativeness can be questioned. The report should be completed with the numbers of respondents and interviewees for within the other chapters. Also, a summary of updates compared to the previous version should be added.

Reviewer's comment	Revision	Explanation
The report should be completed with the numbers of respondents and interviewees for the other chapters.	Done for chapter 2.	For chapter 2, Table 21 was restructured and the number of respondents was added.
	Done for chapter 3.	The number of respondents was added to Table 3-1.

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Executive Summary

The transition to circular water systems and services requires supportive policies and regulations. This report addresses the regulatory and policy frameworks that impact circular water systems and services, at key stages of the value chain. Circular Economy (CE) is often presented as a sustainable development strategy wherein economic benefits are increased while reducing the burden on natural resources. In the water and wastewater sector, a circular economy is concerned with the technologies and practices that allow the shift from the linear model of clean water production and wastewater disposal, and to realise the inherent value in 'waste' water, thereby generating economic, social, and environmental benefits.

In this report we explore the policy and regulatory landscape to identify the enablers for, and barriers to, adopting circular value chains in the water and wastewater sector, upscaling solutions and transferring technologies to other geographic areas. The work examines European legislation (concentrating on the recent 'CE package'), and where feasible, examines national/regional legislative frameworks in the different Member States.

The report concentrates on four aspects of policy and regulation for circularity for the sector:

1. the implementation of the new Water Reuse Regulation for large-scale water reuse schemes;
2. small-scale circular schemes (notably rainwater and greywater recycling) and their incorporation into planning and building frameworks;
3. the regulatory landscape surrounding the recovery of materials and energy from water and wastewater systems; and
4. the development of innovative financing options for circular solutions.

The specific objectives of the report are to:

- Identify, based on the experiences of real-world cases, the opportunities for, and barriers to, the wider uptake of circular water technologies within current policy and regulatory frameworks
- Identify potential innovative financing mechanisms for circular systems
- Propose recommendations to adapt current policy and regulatory frameworks, and/or highlight opportunities for developing new policy and regulatory mechanisms (with a focus on EU legislation)

Methods included reviews of literature as well as primary data collection (via questionnaires and interviews) with a selection of NextGen demo cases.

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Conclusions:

Findings identified a number of persistent challenges that could be hindering the wider uptake of circular solutions in the sector, as well as a number of opportunities to create a more supportive regulatory landscape.

- For the *Water Reuse Regulation*, there is concern over how compliance will be supported within each Member State's national structures, and how uncertainty over compliance could hinder further development in the sector.
- For *planning and building regulatory frameworks*, there is wide variation between Member States, and an overall regulatory gap, around how smaller-scale (building-scale) circular solutions are addressed.
- For *energy and materials recovery*, the growing interest around these technologies amongst utilities in the European sector has not yet been matched with the emergence of a coherent policy and regulatory framework around technology adoption and bringing products to market.
- For *financing*, there is clear opportunity for circular solutions to become part of the ESG (Environmental, Social and Governance) investment landscape, and to become the focal point for more public-private partnerships.

Recommendations:

Based on these findings we propose a number of recommendations, which are intended to inform the national legislative frameworks of Member States, as well as European legislation (with particular reference to the Urban Wastewater Treatment Directive, as well as other associated directives).

Recommendations for national governments of Member States:

1) Support active stakeholder engagement in Water Reuse Risk Management Plans

2) Adjust tariff systems to better support circular solutions

3) Explicitly incorporate small-scale circular solutions in planning and building frameworks

4) Support efficient risk sharing in contracting for Public-Private-Partnership arrangements

Recommendations for EU policy and legislation:

5) Improve clarity and transparency for the Water Reuse Regulation
    a. Clarify responsibilities for water reuse permit allocation
    b. Support a public evidence database of reuse schemes
    c. Create a master list of water quality parameters

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6) Improve alignment between directives and incentivise circularity
    a. Introduce reporting requirements for recovered products
    b. Include the water / wastewater sector in energy efficiency and renewable energy strategies, but improve alignment with environmental ambitions

7) Create simpler and less costly routes to market for recovered resources
    a. Create dedicated End-of-Waste routes for products recovered from wastewater and sludge
    b. Ensure that End-of-Waste status can be recognised across Member States

8) Ensure that circular systems for water and wastewater can be targeted with ESG (Environmental, Social and Governance) / green financing.

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1. Introduction

1.1 EU CE Action Plan and related regulations

The Circular Economy (CE) concept was first introduced by Pearce and Turner in "Economics of Natural Resources and the Environment" in 1990. CE is a sustainable development strategy wherein economic benefits are increased while reducing the burden on natural resources[1]. Circular economy (CE) is an evolving 'umbrella' concept embodying internal complexities and multiple definitions but is defined as an economic system that aims at minimising waste and making the most of resources [2]. In a circular system, resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops. This concept represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions, and governments) levels[3]. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces, and consumes[4]. It is estimated that the market for CE in the next 10 years will boost economic growth by up to 4% [5]. In Europe, technologies and business models can improve resource productivity and reduce the costs of mobility, food and built environment sectors at almost € 1 trillion by 2030[6].

A circular economy for water is concerned with the alternatives, technologies and practices that allow the shift of focus from finding new non-renewable water resources to the recovery of water and other renewable resources from wastewater, thereby generating economic, social, and environmental benefits[7]. Thus, wastewater, greywater and rainwater are considered valuable sources for water, energy, and materials[8]. Water can be reclaimed from waste and rainwater for potable or non-potable purposes, energy can be recovered to generate heat and electricity, or nutrients and other materials can be recovered. It entails managing water and wastewater resources using the reduce, reuse, recycle, reclaim, recover, and restore (6Rs) strategies of CE and shift the concept of wastewater treatment shifted from 'disposal' to 'reuse and resource recovery' for environmental, economic, and social benefits[9].

However, the secondary market is not yet widespread for CE for water. Moreover, there is still research and practical insights on the inherent systemic nature, integration materialization,

[1] Pearce, D.W. and Turner, R.K., 1990. Economics of natural resources and the environment. JHU press.
[2] Kakwani, N.S. and Kalbar, P.P., 2020. Review of Circular Economy in urban water sector: Challenges and opportunities in India [Online]. Journal of Environmental Management, 271, p.111010.
[3] Bilal, M., Khan, K.I.A., Thaheem, M.J., and Nasir, A.R., 2020. Current state and barriers to the circular economy in the building sector: Towards a mitigation framework. Journal of Cleaner Production, 276, p.123250
[4] Abu-Ghunmi, D., Abu-Ghunmi, L., Kayal, B., and Bino, A., 2016. Circular economy and the opportunity cost of not 'closing the loop' of water industry: The case of Jordan. Journal of Cleaner Production, 131, pp.228–236.
[5] Hieminga, G., 2015. Rethinking Finance in a Circular Economy - Financial Implications of Circular Business Model. ING Economics Department, The Netherlands. Available in: www.ing.nl/media/ing_ezb_financing-the-circular-economy_tcm162-84762.pdf.
[6] Pearlmutter, D., et al 2019. Enhancing the circular economy with nature-based solutions in the built urban environment: green building materials, systems, and sites [Online]. *Blue-Green Systems*, 2(1), pp.46–72.
[7] Kakwani, N.S. and Kalbar, P.P., 2020. Review of Circular Economy in urban water sector: Challenges and opportunities in India. Journal of Environmental Management, 271, p.111010.
[8] Lieder, M. and Rashid, A., 2016. Towards circular economy implementation: A comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, 115, pp.36–51.
[9] Dionisi, D., Geris, J., and Bolaji, I.O., 2018. Water and the circular economy-where is the greatest sustainable economic benefit for resource recovery in the water cycle?

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and operation of its circular value models. This is a critical gap because the role of managing and applying circular innovation for water and within the built environment is often neglected. Its implementation is also hampered by a lack of knowledge and how to implement it in business models. The barriers also show inadequate awareness, understanding and insight into CE, especially within the built environment [10].

In this context, laws and regulations are vital for facilitating (and perhaps driving) the adoption and uptake of CE for water. Thus, this report aims to present and define what policies exist in European countries to improve uptake and promote a new circular economy for water delivery models and make recommendations for improvements.

CE Action Plan

The EU's Circular Economy Action Plan, published by the European Commission on 11th March 2020, is a promising continuation of the EU executive's ambition from 2015. The plan acknowledges the need to address the block's resource consumption and to reduce environmental pressures driven by consumption[11]. This Circular Economy Action Plan presents a set of interrelated initiatives to establish a strong and coherent product policy framework that will make sustainable products, services, and business model. The aim is to revise the norm and transform consumption patterns so that no waste is produced in the first place. This product policy framework is being progressively rolled out, while key product value chains are being prioritised. Further measures will be put in place to reduce waste and ensure that the EU has a well-functioning internal market for high quality secondary raw materials e.g., nutrients derived from wastewater processes. The capacity of the EU to take responsibility for its waste will be also strengthened.

The new EU Circular Economy Action Plan (2020) aims to streamline regulations made fit for a sustainable future. With relevance to the water sector, the EU CE Action Plan 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 CE Action Plan priorities is the new Water Reuse Regulation to encourage circular approaches to water reuse in agriculture.

Table 1-1 summarises the most notable EU water-related regulations and directives that informed the outcomes from this report.

[10] Adams, K.T., Osmani, M., Thorpe, T., and Thornback, J., 2017. Circular economy in construction: current awareness, challenges, and enablers [Online]. Proceedings of the Institution of Civil Engineers - Waste and Resource Management, 170(1), pp.15–24.

11 EU communique: A new Circular Economy Action Plan For a cleaner and more competitive. Online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

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Table 1-1 Related European regulations for Circular Water

Regulation	Aim
Drinking Water Directive (EU) 2020/2184	The objectives of this Directive are to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean, and to improve access to water intended for human consumption.
Urban Wastewater Treatment Directive 91/271/EEC	The objective of the Directive is to protect the environment from the adverse effects of the discharge of urban waste water and of waste water from certain industrial sectors.
Water Framework Directive 2000/60/EC	The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater.
Regulation on minimum requirements for water reuse (EU) 2020/741	This Regulation lays down minimum requirements for water quality and monitoring and provisions on risk management, for the safe use of reclaimed water in the context of integrated water management, and especially for agricultural uses.
Sewage Sludge Directive 86/278/EEC	The purpose of this Directive is to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man, thereby encouraging the correct use of such sewage sludge.
Fertilising Products Regulation (EU) 2019/1009	The objective of this Regulation is to ensure that EU fertilising products on the market fulfil the requirements providing for a high level of protection of human, animal, and plant health, of safety and of the environment. This regulation includes EU-wide end-of-waste criteria for compost which can be used in organic fertilisers, soil improvers and growing media.
Waste Framework Directive 2008/98/EC	This Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.
Industrial Emissions Directive 2010/75/EU	This Directive lays down rules on integrated prevention and control of pollution arising from industrial activities. It also lays down rules designed to prevent or, where that is not practicable, to reduce emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole.
Energy Efficiency Directive 2012/27/EU	This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union.

1.2 Aims and objectives of the report

This report aims to examine existing and emerging policy and regulatory frameworks, both at the European level and (to a lesser degree) within Member States, to identify enablers of and challenges to the wider uptake of circular solutions in the water sector. It also aims to inform emerging European policy on the CE for water and propose ways of addressing identified challenges. The specific objectives are to:

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- Identify, based on the experiences of real-world cases, the opportunities for, and barriers to, the wider uptake of circular water technologies within current policy and regulatory frameworks, with a focus on:
    - Larger-scale water reuse
    - Smaller-scale (building level) circular systems
    - Recovery of energy and materials from water and wastewater systems
- Identify potential innovative financing mechanisms for circular systems
- Propose recommendations to adapt current policy and regulatory frameworks, and/or highlight opportunities for developing new policy and regulatory mechanisms (with a focus on EU legislation)

Contribution to the NextGen project

The findings in this report are primarily feeding into Task 4.3, which is concerned with developing a roadmap towards circularity for the European water sector. They are also providing a key input for the development of policy briefs under WP6. Lastly, they are helping to shape the value chain discussions occurring within WP5, by helping partners to identify potential regulatory hurdles affecting emerging value chains for circular solutions.

1.3 Report structure

Each chapter of the report provides detail about the methodology used, but the approaches for each chapter are summarised in Table 1-2.

Table 1-2: Summary of demo cases and methods utilised in each chapter

Report chapter	Demo cases / countries	Data source / method
2. Regulatory frameworks for water reuse	Germany, Spain, Romania, Greece	• Literature review • Interviews with NEXTGEN partners undertaking the demonstrating projects
3. Regulatory frameworks for building and planning	Greece, Romania, Netherlands, UK, Germany, Spain	• Literature review • Interviews with selected stakeholders
4. Regulatory frameworks for recovery of materials and energy	All demo cases (follow-up interviews focused on Spernal, La Trappe and Westland)	• Policy survey with participants from the NEXTGEN demo cases • Follow up discussions with selected demo cases

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5. Innovative financing mechanisms for circular solutions	General	• Literature review and desktop study

The second chapter on “Regulatory Frameworks for Water Reuse” focuses on the new EU Regulation 2020/741 on the minimum requirements for water reuse, which establishes the quality standards for water reuse in agriculture, and examines how this affects local reuse projects. It examines the relationship between this new standard and existing national regulations and explores the opportunities and implications of the new standards for operators of reuse schemes.

The third chapter on “Regulatory frameworks for urban development and building applications” examines the extent to which legislative planning frameworks, and relevant building and construction regulations promote smaller-scale, decentralised circular solutions (such as rainwater harvesting) in housing developments across Europe. Case studies and interview findings are also used to explore the opportunities and barriers to circular water technologies.

The fourth chapter on “Regulatory frameworks for recovery of materials and energy” focuses on regulations concerning the classification, handling and marketing of materials and energy recovered from wastewater – heat, biogas, sludge, nutrient products (e.g., P and N), and other products. It considered the full range of products that can potentially be recovered from wastewater, not only those technologies that are being trialed within the NextGen project.

The fifth chapter on “Innovative financing mechanisms for circular solutions” focuses on the emergence of innovative financing mechanisms (such as green bonds) for circular technologies and considers their implications for market development. It aims to provide a comprehensive overview of innovative financing mechanisms, from both public and private sources, including public-private partnerships. The requirements, conditions, and structure of the deals originating from various types of financing mechanisms were investigated and financial tools to support the exploitation and capitalisation of CE technologies for water were enumerated.

The final chapter consolidates the findings and makes holistic recommendations for the national policy and legislation of Member States and for European policy and legislation.

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2. Regulatory frameworks for water reuse

2.1 Introduction

This chapter uses case studies to explore the new EU Regulation 2020/741 on the minimum requirements for water reuse, and the extent to which it establishes the quality standards for water reuse in agriculture that affects local reuse projects. It examines the relationship between this new standard and existing national regulations and explores the implications of the new standards for operators of reuse schemes. As a European Regulation (unlike a Directive) does not need to further be transposed into national law, the requirements set out in Regulation 2020/741 will become automatically binding on June 26, 2023.

The information discussed in this section was gathered through a questionnaire distributed to 9 different water utilities, food processing companies, individual operators and catchment authorities which were contacted through the network of NextGen partners. Countries surveyed include Spain, Germany, Romania, and Greece. The findings, therefore, represent a summary of the information received and therefore not an all-encompassing review of the effects of the Regulation. This is because the sample size was opportunistic and small, and the distribution of the questionnaire was not done in a manner to equally cover all situations potentially affected by the Regulation. The quantity of responses does not reflect preference or importance: for instance, the multiple agencies interviewed in Romania were simply more available during the interview timeline than those in the other countries. The full questionnaire is provided in Appendix B.

Table 2-1 Respondents to the water reuse survey.

Country	Respondent	Designation	Number of respondents
Germany	Abwasserverband Braunschweig	Wastewater association	1
Spain	Consortium Costa Brava	Consortium of municipalities	1
	Catalan Water Agency	Catalan catchment authority	1
Romania	Aquaserv Satu Mare	Water and wastewater utilities	4
	ApaVital SA		
	Aquaserv SA		
	Dunarea Braila		
	Agricola Bacau	Meat processing company	1
Greece	National Technical University of Athens (NTUA)	Research project: Sewer Mining demonstration case in Athens	1

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2.2 Findings

The participants were asked which of the 17 different pieces of legislation mentioned in Regulation (EU) 2020/741 applied to their facility. Almost all respondents confirmed that the Urban Wastewater Treatment Directive (UWWTD) affects their existing or planned water reuse schemes (Figure 2.1). Other legislation considered to be applicable included the Groundwater Directive (GWD), the Drinking Water Directive (DWD), the Nitrates Directive, the Environmental Quality Standards (EQS) Directive, and Directive 86/278/EU regulating sewage sludge in agriculture. This accurately reflects that most respondents were public water and wastewater utilities.

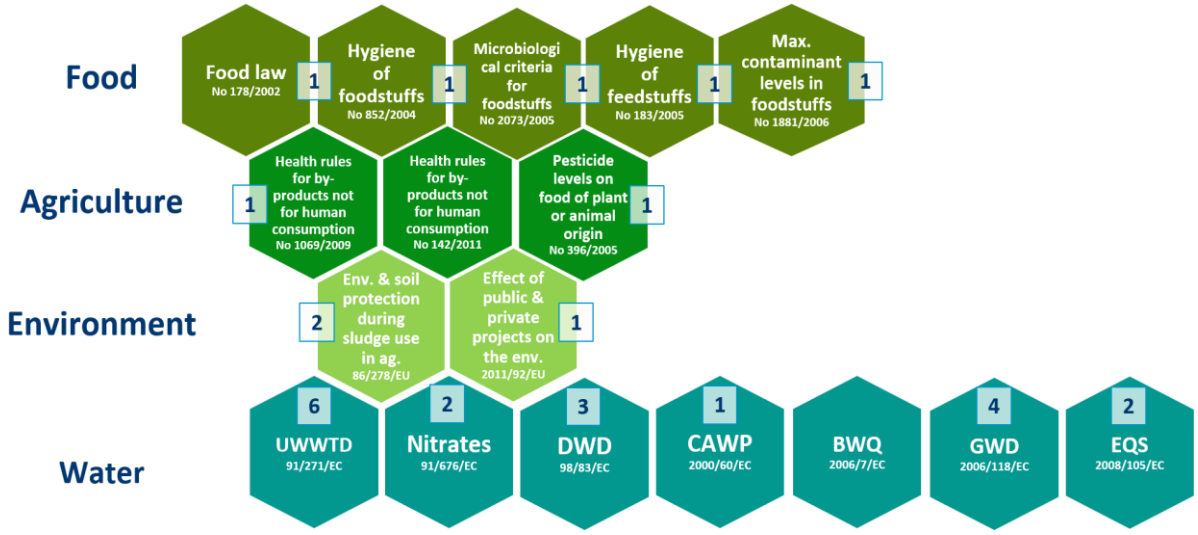

Figure 2.1 Categories and frequency of importance of EU legislation as noted by the questionnaire respondents.

By including these 17 regulations within Regulation 2020/741, reuse schemes are indirectly required to comply with their requirements, but advice on how to proceed or which regulation has greater importance when values or parameters are potentially conflicting is not provided.

Responses to the questionnaire are summarised in the following tables: Table 2-2 (Spain), Table 2-3 (Germany), Table 2-4 (Romania), Table 2-5 (Greece). The tables cover advantages and barriers (financial, technical, infrastructure and legislative) that respondents foresee related to adapting to and complying with the new Regulation, new responsibilities for treatment plant operators and agencies, costs, uncertainties, and an outlook on what effect the Regulation may have on reuse in the respective country.

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2.2.1 Costa Brava, Spain

Table 2-2 Water reuse legislation case studies from Spain.

Current local legislation	**Royal Decree 1620/2007 for water reuse outlines limitations for parameters for different reuses of reclaimed water.**
Current status/type of water reuse	The current framework in Catalonia and Spain already enables the rapid development of new reuse schemes via public investment and some private initiatives. Several reclaimed water applications have been demonstrated in Spain. In the case of Tossa de Mar (Costa Brava, Spain) reclaimed water is used for public garden irrigation. Other examples can be found for agricultural reuse, and amenity-related, industrial, and environmental reuse is also already being practised in Spain.
Potential benefits of Regulation 2020/741	The Regulation will help to assess goals and obligations related to reuse.
Areas of concern regarding Regulation 2020/741	
Technical	Attaining the log removal of microorganisms; the analytical load on the user may influence whether reuse is established at all.
Legislative	Risk management plans should be enforced by a party that is above all the other stakeholders; without the involvement of the public administration, it is difficult to promote new reuse facilities.
Infrastructure	Additional tertiary treatment in the urban WWTPs; new water reclamation plants (WRP); improvements in the tertiary treatment of urban WWTPs.
Financial	Funding is often the most critical parameter in determining the success of reuse projects as currently local operators and municipalities are sharing costs of urban WRPs. Therefore, more public investment to increase the number of WRP facilities and extend water reclamation practices is needed.
Additional treatment necessary and responsibilities of involved parties	
Numerous existing reclaimed water treatment trains will need to be re-evaluated. In the case of CCB, disinfection will be improved by enlarging the existing UV systems, and enhanced filtration may also be required. The responsibility for the tertiary advanced treatment and monitoring water quality will probably lie with the WRP operator. If there is an environmental or social benefit, the public administration has a good reason to be able to fund the additional treatment required for the existing reclaimed water treatments or to promote and pay new WRP, or also to partially subsidized the cost of reclaimed water. But when there is not a demonstrated environmental improvement (e.g., non-priority use without any positive environmental impact), private users pay for the treatment for obtained reclaimed water. The health department (in general) and the catchment authority (to control final water uses) will likely be finally responsible for approving water quality results.	

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Costs

The current price per unit of water is related to both source and volume. Therefore, reclaimed water is not cheap due to small volumes and treatment and monitoring needs. Investment costs (for tertiary treatment of a WWTP or WRP) depend on the quality of the effluent of the WWTP secondary treatment, reclaimed water quality goals and the volume to be treated. The estimated investment required for additional treatment steps (sand filtration, chlorination, UV disinfection) might be around 1 million euros per facility, although final costs depend on site-specific considerations. Implementation costs could be around 0.25 EUR/m^3 depending on salinity treatment.

Operational costs (treatment, pumping) of reclaimed water will rise due to the increased reclaimed water quality requirements of the EU Regulation compared to the Spanish RD 1620/2007 as well as the increased quantity and frequency of controls required by the EU Regulation. Ground- and surface water users pay a tax that is currently rarely applied to reclaimed water (depending on the use). Water for agricultural uses is also currently not subject to taxes, which could change in the future through the EU Regulation.

Tougher obligations will result in more difficulties in developing private initiatives, except perhaps for big corporations. Overall costs associated with the increased monitoring frequency and quantity of parameters in existing reuse schemes could not yet be estimated.

Remaining uncertainties

Although the basic water quality measurement criteria are established in (inter)national regulations, permits for reclaimed water use are granted on a case-by-case basis. For reuse in irrigation (crops, golf) or industrial cases, permit allocation is standardised. But when indirect potable reuse could occur due to aquifer recharge, the health authority requires further studies which can result in a requirement to additionally monitor many non-regulated parameters. Although there is a notable amount of illegal groundwater pumping, most are pumped for agriculture, which is not subject to taxes: therefore, there is no big difference in terms of competition between legal and illegal farms/crops.

Future reuse outlook

Overall, significant interest in all types of reuse**s** exists in Spain. Examples of currently operational industrial reuse include the petrochemical complex in Tarragona / Golden Coast and the salt mining (mineralogical industry) operation in Central Catalonia. Although ‘amenity-related’ reuse is not defined in the Regulation, reclaimed water is already being used in municipalities and by golf courses. Finally, environmental reuse is occurring via the refilling of wetlands in coastal areas with reclaimed water (e.g., Aiguamolls d’Empordà, Llobregat Delta). Drawing from these experiences, respondents suggested that Spain should perhaps focus on reclaimed water uses which can cover the additional costs incurred from the Regulation such as aquifer recharge, which is of great importance in Spain. Other usage types (agriculture, urban, environmental) were thought to require significant sponsoring or governmental support to have a greater chance of success.

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2.2.2 Braunschweig, Germany

Table 2-3 Water reuse legislation case study from Braunschweig.

Current local legislation	Only the legally non-binding DIN 19650[12], particularly the section on the water for irrigating crops consumed raw (class 4), is relevant for the area in question. Currently, no legal framework for water reuse exists.
Current status/type of water reuse	Agricultural reuse.
Potential benefits of Regulation 2020/741	Establishment of a continuous legal basis for water reuse overall, and specifically, a broader cultivation range of field crops if class A water quality is achieved by a new disinfection unit.
Areas of concern regarding Regulation 2020/741	
Technical	
Legislative	Currently, no German governmental body is responsible for answering questions on Regulation implementation.
Infrastructure	Planning and construction of an additional pathogen reduction step in the time remaining before 2023 will be difficult for the Braunschweig WWTP.
Financial	Investment risk is foreseen due to the fact that the German government will most likely increase removal requirements (micropollutants, pathogens) for agricultural reuse which go beyond the EU minimum requirements.
Additional treatment necessary and responsibilities of involved parties	
Disinfection will be achieved either through ozonation with UV disinfection (if quality class A requirements are desired), through ozonation with GAC post-treatment, or an appropriate combination of ozonation, post-filtration and UV disinfection. Ozonation is preferred due to the future German guidelines foreseen which will likely restrict both micropollutant and pathogen concentrations. As the current irrigation setup in Braunschweig (from February-November) often exceeds actual plant water demand, this may need to be switched to demand-based irrigation to comply with Regulation 2020/741. In terms of responsibilities, the WWTP owner is responsible for risk management, whereas monitoring is the joint responsibility of the owner and technical operator. Compliance oversight is not yet clear and not specified in Regulation 2020/741.	
Costs	
Since no microbiological monitoring is currently conducted, achieving at least class B quality will require weekly E. coli monitoring (50-60€ per sample). If class A water quality is to be achieved, an additional UV disinfection unit after the ozonation will cost an	

[12] https://www.beuth.de/de/norm/din-19650/10573159

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estimated 1.7 Mio. € and have ~2.0 ct/m³ operational costs (estimates from 2015) [13]. Due to this, the cost for reclaimed water will be higher, also in comparison to groundwater costs. However, existing limits on legally extractable groundwater mean that reclaimed water will likely still be attractive (even if costs are higher than for groundwater) since alternative sources are needed to bridge the gap between what is needed for irrigation and what can be extracted from groundwater.

Costs for additional treatment required to reach class B quality cannot be transferred to the customers of the wastewater utility and would need to be recovered from irrigating farmers. However, in light of likely forthcoming German legislation limiting the concentration of certain micropollutants in discharges from WWTPs larger than 100.000 PE, co-financing of additional treatment for water reuse through wastewater fees seems possible.

Remaining uncertainties

In Germany, a national list of parameters that must be measured exists but does not include microbes or micropollutants. Water authorities (of which there are 3 levels) can extend the list as necessary. Illegal pumping is a problem, but officially not allowed according to national groundwater regulation. Only a few cases of illegal pumping for agricultural purposes are known.

Future reuse outlook

There is great interest in industrial water reuse to reduce costs of drinking water usage, fees for wastewater discharge, and fees for groundwater extraction rights.

2.2.3 Timisoara, Romania

Table 2-4 Water reuse legislation case studies from Romania.

Case study	Aquaserv Satu Mare, ApaVital SA, Aquaserv SA, Dunarea Braila, Agricola Bacau
Current local legislation	Government Decision 188/2002 requires disinfection only for wastewater recovery, but not for normal WWTP operation and discharge - therefore most WWTPs do not have disinfection units. No legal framework for reclaimed water usage exists. Additional relevant pieces of legislation are Water Law 107/1996 and amendment 120/2020.
Current status/type of water reuse	No reuse is currently implemented.
Potential benefits of	The establishment of a continuous legal basis for water reuse; allowing reuse of water with nutrient content simplifies the operation of

[13] Demoware Project Deliverable 1.1 - Partial disinfection technologies for water reuse - case studies and design. Accessed 30.6.21. http://demoware.ctm.com.es/en/results/deliverables/deliverable-d1-1-partial-disinfection-technologies-for-water-reuse-case-studies-and-design-guidelines_updated-data.pdf/view

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Regulation 2020/741	treatment plants, as eliminating nutrients is a difficult part of the process. Reuse may also reduce operating costs (electricity, chemical needs), and decrease the specific production of sludge and associated disposal costs.
Areas of concern regarding Regulation 2020/741	
Technical	Unfamiliar with technologies relevant for water reuse; most WWTPs do not have disinfection units; nutrients present in the reclaimed water used for irrigation during dry weather must be retained
Legislative	Lack of involvement of competent authorities coordinating between water supply companies and end-users (e.g., farmers, industry, etc.); lack of initiative for pilot projects
Infrastructure	Lack of water storage facilities; lack of water transport infrastructure (e.g., to a client and/or farm)
Financial	Uncertainty regarding who will be responsible for paying the high costs of water transport; worry about the overall costs of the additional requirements; lack of economic initiative for pilot projects. Romania's Sustainable Development Operational Program 2021-2027 will provide financing for project implementation.

Additional treatment necessary and responsibilities of involved parties

In Romania, the annual precipitation is normally enough for irrigation (except under unusual circumstances) but could be seasonally supplemented by reclaimed water. Declining precipitation has however put water supply at risk, especially in the southern regions. Providing the supplemental reclaimed water could be difficult due to a) the need for additional treatment, as disinfection does not exist in most WWTPs, and b) the need for this additional treatment to be in 'stand-by' mode. If farmers' requests for reclaimed water are unpredictable, operators will face operational difficulties and financial risks when recovering costs for the additional treatment. Most facilities are not equipped to conduct the microbiological monitoring required in the Regulation but could turn to commercial laboratories for analysis. The water utility/WWTP/AWT operator would be responsible for monitoring water quality, whereas compliance would be overseen either by the DSP (Public Health Department) or the National Administration of Romanian Waters[14], depending on the surveyed location. Water quality results could also be verified either by the beneficiary of the reclaimed water or by another neutral local public organization.

In the case of Agricola Bacau, which is currently drafting technical specifications for a small reclamation pilot for water reuse within a slaughterhouse (but not in the meat-processing unit), a UV disinfection unit is being discussed.

Costs

If a WWTP is responsible for the additional treatment, it will have to assume the costs. In this case, customers of the public sewage services will have to pay all the costs (for basic and additional treatment) even if these costs are not related to the public service they

[14] https://rowater.ro/

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request. Therefore, a specific reclaimed water tariff that is only based on the additional costs is needed. With such a tariff, farmers will pay for the reclaimed water delivered to them and operators will recover the costs of additional treatment. State subsidies could also be used to recover costs. However, current Romanian regulations are not prepared for this.

If an AWT operator would be responsible for additional treatment, costs would also be his/her responsibility and the final users (farmers) would be charged. However, since an AWT provider is not a public wastewater service provider, recovering the costs for treatment is a simple trade issue.

Costs associated with microbiological monitoring could not be estimated, although most facilities surveyed (and most WWTPs) are not equipped to address them. Costs of reclaimed water were estimated to be higher than costs for treating groundwater and surface water, although no reuse is currently in operation.

In the case of Agricola Bacau, a cost estimate for the reclamation plant will likely be available in summer 2022.

Remaining uncertainties

A basic list of quality indicators of treated wastewater exists (HG nr. 352/2005, HG nr. 188/2002), with more focused legislation also in place. Local environmental authorities can request additional groundwater monitoring when distributing environmental permits.

Future reuse outlook

Responses regarding the future of reuse in Romania varied. Some participants mentioned that due to lack of experience with water reuse in the country, they would be keen to learn from the applications in other EU states and exchange with other EU water supply companies. Others discussed the associated risk and hurdles remaining relating to public acceptance of water reuse. This was attributed to unrelated infrastructure problems and lack of knowledge, which could be improved through training on the importance of water reuse and WWTP water efficiency. Other respondents were very interested in developing new business models to be applied locally (e.g., reuse for certain processes in a food processing facility, delivering water to car wash services, washing the parking lot, etc.) to recover costs. Implementation of pilot projects, such as the SCDA Lovrin case study in NextGen, could support the adaptation of existing legislation to comply with Regulation 2020/741.

2.2.4 Athens, Greece

Table 2-5 Water reuse legislation case study from Greece.

Case study	Sewer Mining in Athens
Current local legislation	Joint Ministerial Decrees 145116/11 and 191002/2013
Current status/type of water reuse	Current local legislation promotes the implementation of reuse interventions in Greece. Agricultural reuse is being explored in the case study in NextGen.

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Potential benefits of Regulation 2020/741	The Regulation can help achieve goals and obligations regarding water reuse in a more horizontal manner across all EU countries.
Areas of concern regarding Regulation 2020/741	
Technical	Efficiency and performance of Sewer Mining Water quality (depending on country or area requirements)
Legislative	Limited engagement and coordination between state, regional and local authorities as well as end-users (e.g., farmers, tourism industry, etc.)
Infrastructure	A limited quantity of decentralised and autonomous water treatment systems; limited quantity of circular economy configurations which are currently operational and/or tested.
Financial	Ambiguity regarding the possibilities of Sewer Mining technologies; more public investment is needed to increase the number of Sewer Mining facilities and expand water reuse practices.

Additional treatment necessary and responsibilities of involved parties

As this case study was focused on a NextGen demonstration case (e.g., plant nursery irrigation), the Sewer Mining technology under investigation was already designed to monitor all the necessary parameters. Currently, the AWT operator is responsible for wastewater treatment and water quality monitoring, as it is an autonomous system monitored separately in terms of quantity and quality parameters. After the culmination of NextGen's research activities, the Municipality of Athens will take over the operation and monitoring of the reuse scheme. Since only plant irrigation is planned in this reuse scheme - no agricultural product irrigation - the parameter limits are set for unrestricted irrigation according to national legislation. Water permits are given by regional authorities[15].

Costs

For the current system, a life-cycle cost (LCC) analysis will be performed in NextGen to assess the cost of the investment of Sewer Mining in comparison to the cost of the current irrigation system in the plant nursery. The Sewer Mining technology in general is a viable and profitable scheme and can be an interesting alternative water source to more conventional options (e.g., potable water from the central system).

In terms of additional treatment in general, a proposed plan would be that the WWTP covers the capital costs, while operational costs could be covered by the users of the reclaimed water (e.g., farmers, municipalities, tourism facilities).

Remaining uncertainties

There is extensive illegal pumping in the country: about 40,000 wells of the existing 200,000 in Greece are illegal. Large fines are imposed on those who do not comply with the law mandating the declaration of existing wells. The higher costs of legally sourced

[15] Water Directorate of the Decentralised Administrations of the country, based on the framework of national Law 3199/2003 and the Presidential Decree 51/2007

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groundwater are balanced by the high fines imposed on those who still have illegal wells and on those who use more water than allotted in their permit. Ecological issues are more prevalent in agricultural areas, as about 60% of groundwater is used for crops.

Future reuse outlook

There is interest in water reuse for industrial purposes, mainly for cooling, boiler feed water and treatment of industrial water. Amenity related and environmental purposes are only of minor importance and are only found in pilot-scale or research projects.

2.3 Discussion

For operators considering reuse, consulting the database of the status of European reuse projects is recommended[16]. Although agricultural reuse in Braunschweig, Germany has been operational since the 1960's[17], no other large-scale agricultural reuse schemes have been introduced in the country since then. A similar tendency can be observed in France, where despite the existence of the Clermont-Ferrand[18] agricultural reuse scheme since 2001, no increases in similar projects have been observed. In contrast, agricultural reuse in Spain has increased since the national legislation was passed in 2007. And most recently, Portugal has developed and in part supplemented Regulation 2020/741 with their own risk-based reuse regulations[19]. Although Regulation 2020/741 will ensure that water quality in agricultural reuse and therefore product quality is uniform throughout the EU, whether it will encourage more Member States to pursue agricultural (and industrial, amenity-related, and environmental) water reuse remains to be seen.

During the interview process, very strong resistance to reclaimed water usage from a water operator in Romania was discovered. This was not thought to be attributed to a lack of education about water reuse, but likely to a conflict of priorities and time (the utility was dealing with infrastructure leakages). High risk, high cost and high uncertainty were mentioned as negative aspects attributed to potable reuse. Specifically mentioned were examples of water reuse in California, where reuse schemes have been in operation for over 50 years, but the public's assumption of high risks for public health and the environment must be overcome by every new reuse project. Although such opinions are unavoidable, addressing them requires interaction with stakeholders early in the development process so that location-specific strategies for risk mitigation can be developed. Even though the water reuse risk management plan described in Regulation 2020/741 does not require stakeholder engagement, introducing such a requirement on a national level would improve public acceptance of a specific water reuse scheme and increase understanding that controlled reuse is safer than *de facto* reuse[20].

[16] https://www.hotspotreuse.com/application
[17] Ternes, T.A.; Bonerz, M.; Herrmann, N.; Teiser, B.; Andersen, H.R. Irrigation of treated wastewater in Braunschweig, Germany: An option to remove pharmaceuticals and musk fragrances. Chemosphere 2007, 66, 894–904.
[18] Devaux, I.; Gerbaud, L.; Planchon, C.; Bontoux, J.; Glanddier, P.Y. Infectious risk associated with wastewater reuse: An epidemiological approach applied to the case of Clermont-Ferrand, France. Water Sci. Technol. 2001, 43, 53–60.
[19] Rebelo, A.; Quadrado, M.; Franco, A.; Lacasta, N.; Machado, P., Water reuse in Portugal: New legislation trends to support the definition of water quality standards based on risk characterization. *Water Cycle* **2020,** *1*, 41-53.
[20] Dingemans, M.; Smeets, P.; Medema, G.; Frijns, J.; Raat, K.; van Wezel, A.; Bartholomeus, R., Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits. *Water* **2020,** *12*, (5).

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The cases of the food processing industry in Romania are an interesting new area to branch out into when considering water reuse. In regions of Europe where a significant portion of food is grown and/or processed, reclaimed water from one operation (e.g., food production) can be used as source water for another (e.g., agricultural irrigation), therefore closing the loop of water usage and keeping surface water sources clean and local. To this end, Romania (and other countries) can learn from the Dutch experiences[21] of reusing wastewater in agriculture in Lieshout[22] and horticulture in Dinteloord[23].

The interest expressed by Greece in reusing water for cooling towers could look at the experiences in Tarragona, Spain[24], whereas the novel agricultural reuse demonstrated in the current Greek case study could be transferred to other agricultural reuse areas for irrigation of non-agricultural crops. For cases such as Romania and Germany (and many other Member States) with little to no water reuse practices, the knowledge of more experienced reclaimed water users (Spain, Greece) can be drawn upon and used as case studies to direct the development of reuse schemes.

[21] Dingemans, M.; Smeets, P.; Medema, G.; Frijns, J.; Raat, K.; van Wezel, A.; Bartholomeus, R., Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits. *Water* **2020,** *12*, (5).

[22] Bartholomeus, R.P.; Huijgevoort, M.H.J.; van Loon, A.H.; van den Eertwegh, G.A.P.H.; Raat, K.J. Matching agricultural freshwater supply and demand – using recycled water for subirrigation purposes. In Proceedings of the Paper Presented at the 12th IWA International Conference on Water Reclamation and Reuse, Berlin, Germany, 16–20 June 2019.

[23] Zuurbier, K.G.; Smeets, P.W.M.H.; Roest, K.; van Vierssen, W. Use of Wastewater in Managed Aquifer Recharge for Agricultural and Drinking Purposes: The Dutch Experience. In Safe Use of Wastewater in Agriculture; Hettiarachchi, H., Ardakanian, R., Eds.; Springer: Cham, Switzerland, 2018.

[24] Pintilie, L.; Torres, C.M.; Teodosiu, C.; Castells, F. Urban wastewater reclamation for industrial reuse: An LCA case study. J. Clean. Prod. 2016, 139, 1–14.

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3. Regulatory frameworks for building and planning

3.1 Introduction

Urban planning refers to the technical and political process that is focused on the physical shaping of urban developments[25]. It assesses physical, social, and environmental factors and determines the allocation, development, and usage of urban structures such as buildings, infrastructure, and parks[26]. It has a key role to play in unlocking circular economy opportunities in the various interlinked urban systems. It also has a powerful impact on how people and goods move around a city and can have a strong impact on whether materials, products, and nutrients can be re-captured and kept in use. Factors such as size, configuration, density, and compactness each play a role[27]. Urban systems that minimise waste, stimulate the circulation of valuable resources and make productive use of city assets can create new value and thrive, liveable, and resilient cities.

The integration and implementation of circular water solutions through urban planning and building can occur at different scales and take place under various forms:

- Local regulations can make certain circular water solutions mandatory in developments or define requirements for their integration within local practices.
- Technical requirements for buildings and planning can be established, such as minimum water quality requirements or the sizing of rain- and greywater reuse systems components.
- Financial incentives can be implemented to finance the purchase of circular water systems or in the form of tax reductions for their adoption.
- Experimental projects can be implemented in newly developed residential areas, in order to improve communication with residents and the general public to raise awareness and increase acceptance of circular water solutions.

Water supply infrastructure in urban settings in most EU member countries can be characterized as centralised. Whereby, freshwater is captured and treated at one location for distribution to a larger municipal region. In addition to the centralised systems, the CE for water principle can be applied and two scales of decentralised water reuse infrastructure can be envisioned: satellite and onsite. In the satellite scenario, raw grey, and rainwater from several dwellings in one or multiple sub-divisions are collected at one satellite treatment plant for treatment and redistribution within the same region. In the onsite scenario, grey and rainwater from each dwelling are collected, treated, and re-supplied using a small-scale treatment unit located within the dwelling. The three scales of requiring different types of infrastructures and as a result, the economic, environmental, and societal implications vary.

[25] Pinson, D., 2004. Urban planning: an 'undisciplined' discipline? [Online]. Futures, 36(4), pp.503–513.
[26] Taylor, N., 1998. Urban planning theory since 1945. Sage.
[27] LEVERS, U.P., 2019. CITY GOVERNMENTS AND THEIR ROLE IN ENABLING A CIRCULAR ECONOMY TRANSITION.

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The following sections utilise case studies to explore opportunities and barriers within the national legislations, building regulation and planning requirements for decentralised water solutions in EU counties. The chapter concludes with recommendations to further enhance best practices and opportunities for water reuse implementation, particularly in the housing sector.

3.2 Findings

Six NextGen demo cases from six European countries were sampled. The methods include a desk-top review, self-administered structured questionnaires to capture basic information of the cases, followed by in-depth open-ended interviews. Interview questions comprised both open-ended and close-ended questions. Open-ended questions allow the respondents to answer in their own words, thus, they provide richer and more valuable information. Close-ended responses were analysed statistically, while open-ended questions were thematically analysed for their content. The full interview guide is provided in Appendix C. The full case study questionnaire form is provided in Appendix D.

Table 3-1: Respondents to the survey and interviews

Country	NextGen demo case	Respondent	Designation	Number of respondents
Greece	Athens urban tree nursery	NTUA	Research project: Sewer mining demonstration in Athens	2
Romania	Timisoara WWTP	Aquatim	Water and wastewater utilities	1
United Kingdom	Filton airfield development	YTL	Housing developer	1
The Netherlands	Urban water buffer Westland region	KWR water	Urban water research institute	2
Germany	Hamburg Water Cycle	Hamburg Water project	Wastewater company	1
	Braunschweig water reuse	Abwasserverband Braunschweig	Wastewater association	1
Spain	Costa Brava hotel Samba greywater harvesting	Eurecat	Water reuse technologies research	2

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The interview questions addressed the following points:

- Questions with predefined possible answers/ratings were asked to gather information related to the respondent's attitudes (e.g., reactions to the concept of greywater reuse, risk perception, confidence in a greywater reuse system).
- Characterization of dwelling and household.
- Characteristic of the circular water solutions available in the project.
- The motivations which led to the use of circular water solutions in the project
- The evaluation of the project: does it meet one or more set objective (s)? Other purposes? If it does not work, what are the barriers?
- The operation of the system and its cost
- The maintenance of the system

Detailed results from the case study questionnaire are available in *Appendix E*. Responses were analysed by going through all the open-ended responses and manually coding similar or related responses to generalise their responses and develop suggestions and recommendations. These analysed results are presented below.

The sections below consolidate the main findings and highlight some of the barriers, challenges, and opportunities of implementing CE for water in the building, notably the housing sector.

3.2.1 Barriers and challenges

Figure 3.1 shows the emerging themes that inform the drivers and barriers to the adoption of circular water technologies. These factors are further summarised in this section.

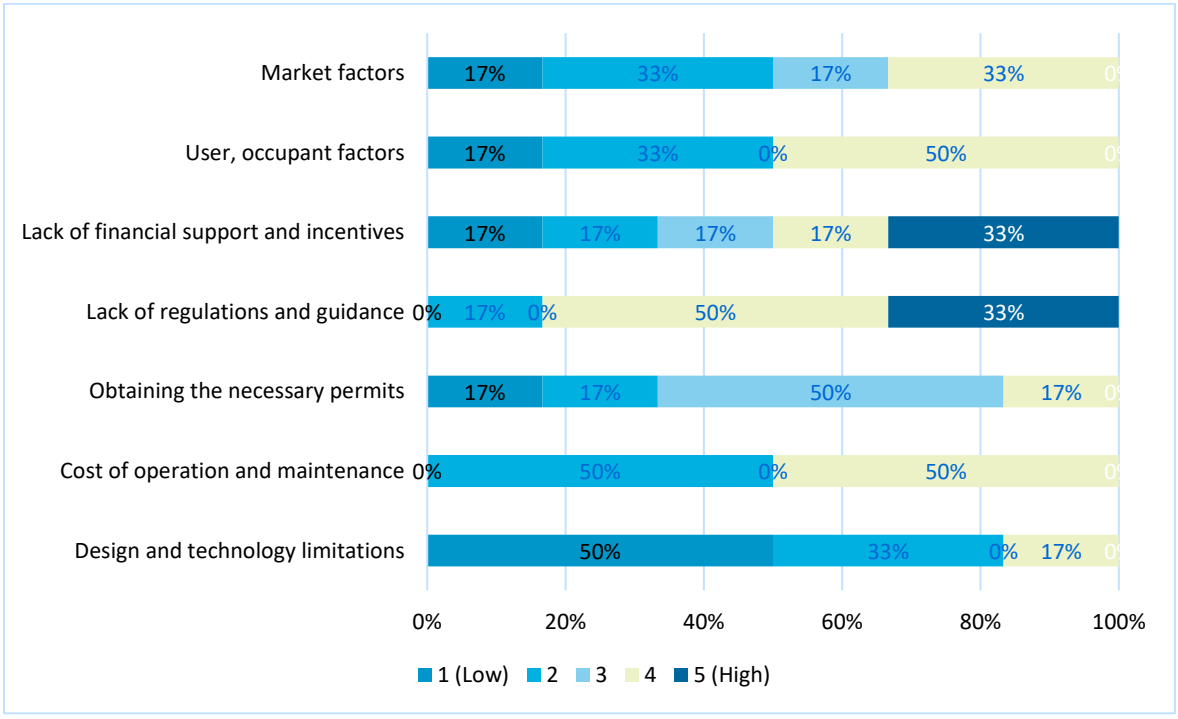

Figure 3.1 Respondents' ranking of the barriers to implementing the circular water/water reuse solutions in the project.

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Policy and regulations

Apart from the proposed EU Regulation 2020/741 on the minimum requirements for water reuse due to become automatically binding on June 26, 2023, to our knowledge, there are no new building/planning or circular water reuse solutions regulations that are due to be active soon in any of these countries. There are no indications that a similar regulation will also apply in the UK post-exiting the European Union. Therefore, the current regulatory framework and building codes in many of the demo-cases countries do not particularly encourage developers to use circular water and energy solutions, as there are no explicit provisions for this purpose. Only general provisions for water management and water-saving solutions are included in the building code of Greece, the UK, Germany, and Romania.

Although current building regulations might not be limiting for circular solutions, they are also not encouraging. Disparate rules and requirements may be required at different levels of government, by different government departments and across different municipalities and regions. The planning and building regulations are not often up to date and circularity as a concept has not been yet integrated. Nevertheless, in domestic projects, water reuse solutions can be implemented as they mostly refer to greywater reuse and/or rainwater harvesting systems. Depending on the design they can be profitable and innovative, e.g., using also subsurface water solutions.

Cost and incentives

Except for the demo cases in Rotterdam- Netherlands and Hamburg-Germany, no other case study has received a direct governmental financial incentive. Some of the case study participants highlighted that the local authorities usually do not have the required legislative and financial tools to impose innovation and circular water solutions and they remain cautious in imposing them unless there are scarcity issues with water supply. Most local authorities (except the cities seen as innovative) are reluctant to enforce circular water requirements as these can be seen as investment repellent and they cannot be seen denying investment over such technicalities.

Furthermore, large housing developers and builders would not be interested in installing decentralized circular water solutions unless forced through legislation as there is no direct commercial incentive. Thus, benefits to the end-users rather than the developers or investors can discourage implementation. Local authorities currently do not have enough legal and legislative tools to influence developers towards using circular water reuse solutions, as they are sometimes not even familiar with these systems. There is no cost-benefit to developers, and while they can be innovative regarding designing and implementing circular water solutions, it could impact their profit margins.

Permit and authorisation

From the respondents, it was clear that due to the rather innovative nature of the water solutions available in these projects, there was hardly any regulation in place for small-scale application leading to potential inaction by local authorities to adopt these solutions. Furthermore, all the projects reported that there were no one specific local law or regulation concerning water reuse in their cities or regions related to urban planning and housing. This is more apparent on a domestic level where these cities are still debating the type of regulations and measures required for the use of circular solutions.

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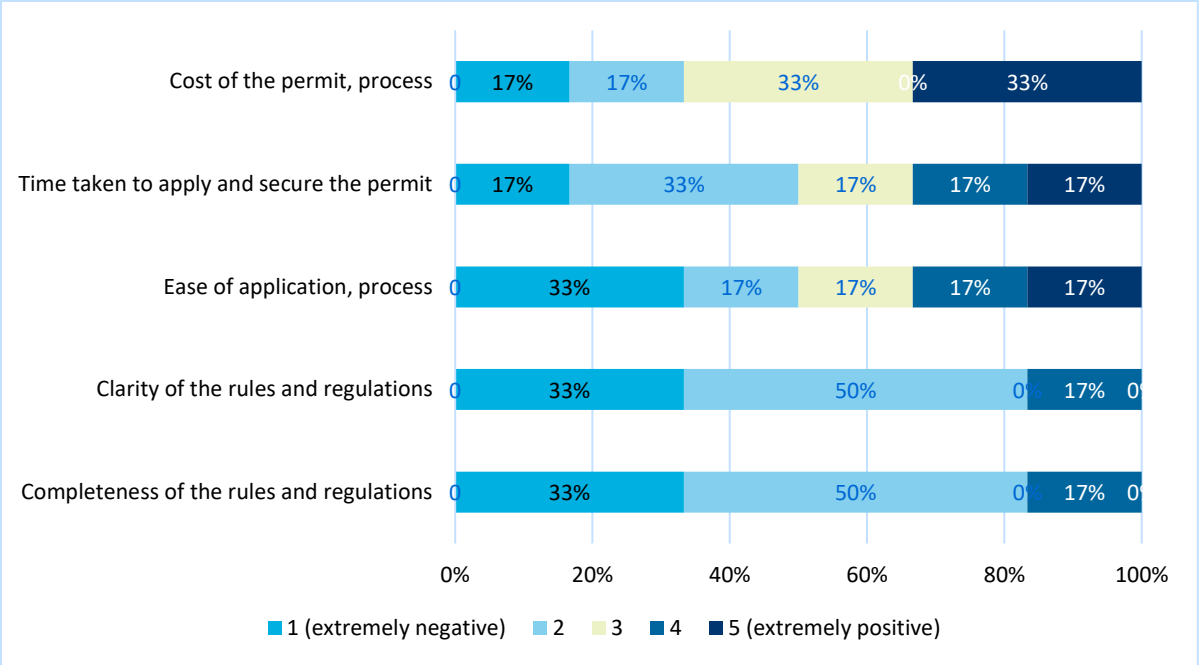

Figure 3.2 Participants' ranking of the factors associated with securing the right permits for the scheme

In most of these cases, the permits and regulations followed in the planning and installing circular water solutions were more related to the general construction and building approvals that all projects must follow. This includes safety requirements, fire prevention, state-of-the-art technologies, and public health. Therefore, the building codes were not of a particular barrier. However, when asked to rank the barriers and forces associated with planning circular water solutions participants ranking of the clarity and availability of building rules and regulations was the lowest (see Figure 3.2). This indicates a bureaucratic barrier due to the absence of clear regulations, so these authorities are very reserved when it comes to circular water solutions. Furthermore, the customers and users of the reclaimed and treated water are sceptical and must be convinced of the quality of the reclaimed water also due partly to the vacuum of a dedicated building and planning related regulation. In Germany and the UK, the DIN and the BSI standards for reused water are only cited for reference and guidance rather than having and legal requirement statutes.

In the case of Rotterdam, to tackle issues of regulation vacuum a guide for the competent authority, a handbook was drafted by the applied research institute of the regional water authorities and province (i.e., STOWA). This guide provided a supportive framework for technical and legal aspects of risk assessments of smaller-scale applications of circular water solutions for non-potable applications. This guide has played an important role in enhancing decision-making for adopting the water solutions in Spangen (Sparta) in Rotterdam. This illustrates the importance and power of suitable regulations on the uptake of domestic circular water solutions.

Overlapping spheres of influence

In addition to the absence of clear and enforcing legislation, regulations and permits requirements in most of the European countries are still vague and overlapping when it comes to circular and decentralised water solutions. This is more obvious in housing where multiple permits such as water authority, safety, health, and municipality are required in many cases.

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Many projects are being undertaken throughout Europe, therefore the need to update regulations when it comes to acquiring permits to reutilize the different material flows (service water, nutrients) are becoming more and more essential. The current lack of a regulatory framework is the main barrier. However, with the implementation of the new EU regulation, similar circular water initiatives in Europe will have a continuous legal basis with which to operate until more suitable legislation is adopted in their regions.

Users and customers appreciation

Another limitation regarding implementing dementalized and circular water solutions come from the fact that the main benefactors of circular water solutions are usually the end-users who still undervalue such solutions. Customers are also still sceptical and suspicious of their quality and must be convinced of the quality of the reclaimed and harvested water. To improve the uptake of water circular solutions, the users should be more informed and the technologies attractive and efficient. In some cases, sustainable and circular solutions are only good for marketing and not for the actual housing values. Furthermore, grey and wastewater are less attractive for developers and users than rainwater for example which can reduce the possibilities of their uptake in future projects. Due to this, mortgage lenders in the UK do not value innovation in circular and sustainable housing solutions and would not finance them unless forced by law or other drivers applied. Individual property owners and landlords are also unlikely to value water reuse systems unless they benefited them directly.

Furthermore, in most European countries with little water stress, water prices are still very cheap to justify using such domestic solutions. In the case of Hamburg, Germany, the beneficiaries of the water reuse scheme are the users of the water because it is available in a greater amount than groundwater and as a result much cheaper and more environmentally appropriate. The water has a better quality after the treatment and the WWTP saves treatments costs which are passed on to the end-users as they pay reduced water tariffs. A win-win scenario for all stakeholders. The wastewater fees, by which the wastewater treatment is financed, is proportional to the consumption of freshwater. At the end of our water reuse scheme, the plants from the irrigated fields are used to produce bioenergy. The public corporation intends to finance wastewater treatment and keep the wastewater fees for the citizen's low. However, the leaders of this project expressed their concern that the new EU regulation on minimum requirements for water reuse can cause some financial worries because a further cleaning step is needed to fulfil the statutory provisions.

Possible harm to water companies

Some water companies in members states charge based on the water consumption (both for water supply and for sewage discharge). However, water discharge in many regions is based on the amount of water consumption and not discharge. Applying circular water solutions might lead to lower water demand while keeping the water discharge level the same if not increasing them such as in the case of using rainwater harvesting. This would lead to significant revenues loss for these companies. Therefore, circular solutions can reduce income, drive an increase in water prices, and harm local water companies financially unless the charging model is changed, or a new service model is proposed. Although, large-scale circular water reuse solutions may minimise financial harm to the water companies as the company might benefit from a reduction of costs by not treating the extracted sewage that is treated locally.

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3.2.2 Opportunities

The case study projects were part of initiatives to used reclaimed and recycled water that benefits the local authorities rather than residents and users of the project. Therefore, financial costs were not comprehensible or quantifiable. And as a public institution, paid by taxes, their focus is more on the environment and pilot testing similar future projects and not on profits. However, there are still some unique opportunities that still exist in the field of decentralised water solutions that can increase both the public and developers' interest in the topic and raise the uptake of such decentralised water projects required to combat water shortage and climate change.

For instance, developers might want to implement decentralised water technologies for different reasons such as water-saving requirements, environmental beliefs. Innovative circular water solutions are also a good marketing strategy as they make developments more attractive and competitive for investment. Additionally, local government and water authorities /companies are open to the idea of reusing water as there is likely a need for major investments in the centralised water infrastructure if the system has not been modernised. A circular solution for water on housing and local street levels can help fix existing issues with sewage and storm drainage which can directly benefit local municipal and water authorities.

New housing developments provide good opportunities to implement and drive circular solutions innovation. Housing developers in many EU countries already usually install rainwaters butts and rainwater control measures on plots as they are required by most planning frameworks. These can be made to be retrofitted or upgraded in the future for rainwater harvesting. Similarly, new housing mixed-use development could be built with a dual piping system (one for greywater and one for blackwater) in a way that allows future house owners to install greywater treatment and heat recovery systems. There is also still a possibility of implementing circular regulations on ongoing projects if the timing is right.

In the previously mentioned case studies, it was demonstrated that successful pilot projects can drive and encourage local and national legislation. First, it is important to have pilot projects as demonstration/reference points of innovative circular technologies. Then, it is important to train, educate and sensitise the local authorities' personnel, to be able to support the operation of such configuration and technologies. This should be done in a well-structured manner through a dedicated piece of legislation. This kind of activity can be implemented through a top-down approach as first the decision of the planning is down to a high level and then the implementation part is performed from a user/technician.

There already exist some water-saving requirements in many building codes and legislations which can be altered and tweaked to include compulsory circular water solutions. This is appropriate as long as suitable financing options and incentives were provided to increase the uptake of these solutions.

Some current circular water technologies allow water to be extracted from sewers, treated locally in a very space-limited unit and reused at the point of demand. What is left to be done is the optimisation of the configuration in terms of efficiency and cost-benefit balance for developers and users. High density and mixed-use developments provide both economic advantages and better chances to deliver such compact circular solutions in design and urban planning.

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Green spaces, soft landscapes and water features require a significant amount of water to maintain that drives the need for communal circular solutions. Many of the participants of the study reported that due to increasing water stress, especially in the summertime, there might be a rethinking in water reuse policy, which could get circular water solutions more into the focus. However, they all agree there is much work to be done on a political level to promote water reuse in Europe.

3.3 Discussion

This study found inconstancies in the policy aspects of circular water solutions shows across various European countries and member states. For instance, some countries allow indoor non-potable reuse of treated grey and rainwater, some do not include greywater in regulations. Currently, only a few countries have compulsory standards on water reuse enforced through specific water reuse legislation (e.g., Spain, France, Greece). However, these standards are mainly geared toward agricultural irrigations and through centralised wastewater treatment plants. Only the UK, Germany and Belgium have presented guidelines and standards for decentralised circular water solutions mainly geared toward non-potable purposes.

In most of the reviewed countries, planning and designing a water reuse scheme is informed by risk and environmental assessments frameworks, to identify the potential benefits and any potential drawbacks and risks to public health and the environment. Therefore, it is worth noting that many benefits and risks found will be specific to local circumstances and, therefore, need to be determined on a case-by-case basis[28].

Figure 3.3 compares the reviewed EU countries based on the availability of clear building and planning regulations directed towards circular water solutions. It was also found that there is a need to include water reuse in broader water supply and urban /neighbourhood planning legislations and requirements.

[28] Voulvoulis, N., 2018. Water reuse from a circular economy perspective and potential risks from an unregulated approach [Online]. Current Opinion in Environmental Science & Health, 2, pp.32–45.

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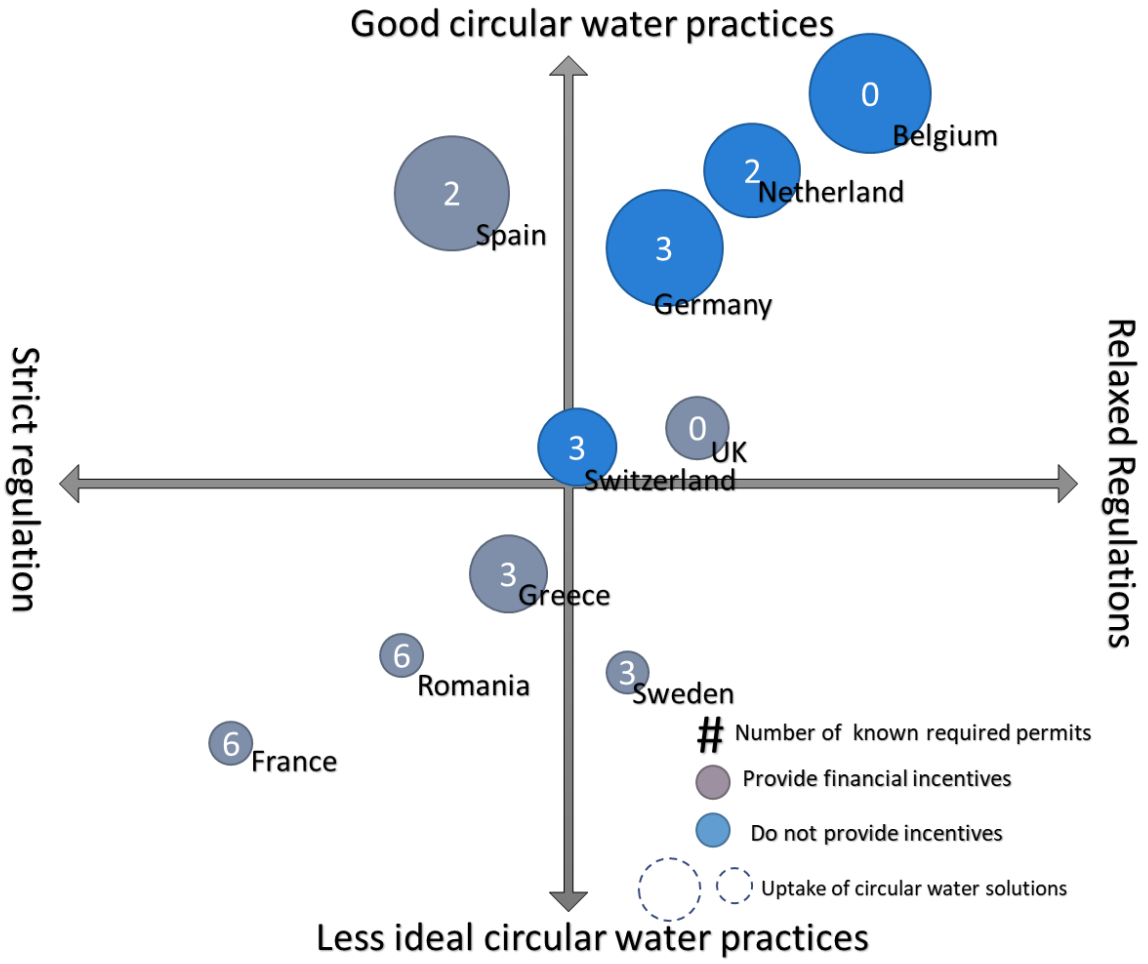

Figure 3.3 Regulatory position of EU member states towards circular water solutions

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4. Regulatory frameworks for recovery of materials and energy

4.1 Introduction

This sub-task focuses on regulations concerning the classification, handling and marketing of materials and energy recovered from wastewater – heat, biogas, sludge, nutrient products (e.g., P and N), and other products. We have considered the full range of products that can potentially be recovered from wastewater, not only those technologies that are being trialed within the NextGen project.

Data was primarily drawn from a policy survey that was sent to every demo case, as well as follow up discussions with selected demo cases (notably Spernal, La Trappe, and Westland). The initial plan for the subtask was such that discussions would be conducted as part of 2nd or 3rd Community of Practice (CoP) meetings at selected demo sites, during which the results of the policy survey would be presented, and further discussions would explore the reasoning behind the responses. However, this was made difficult due to Covid, as all face-to-face CoP meetings were cancelled. For the Westland site, an online CoP meeting was held, where the results of the survey were briefly discussed and generated further insights. However, it was recognized that the online format did not provide the best forum for in-depth exploration of these complex policy issues. At the other sites, suitable CoP meetings have not yet been held, so follow-up discussions were held online with key partners (Severn Trent Water and Biopolous). When face-to-face CoP meetings resume (e.g., STW has a CoP meeting planned for October 2021) more in-depth policy discussions will be integrated into the agenda. Furthermore, discussions with Timisoara were planned, but have not yet taken place due to difficulties in making suitable arrangements. These discussions will take place before the end of 2021. The insights generated from these additional discussions will either be published in an update to this deliverable or incorporated into the outputs from Task 4.3 (roadmap development).

4.2 Findings

The policy survey received 11 completed responses from the demo sites between February and August 2020. Eight of the respondents stated which of the demo site their responses corresponded with. The survey questions template is available in Appendix F.

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Table 4-1 Respondents to the survey and interviews.

Country	Respondent	Designation	Number of responses
Greece	Sewer Mining Athens	Research project	1
Germany	Abwasserverband Braunschweig	Wastewater association	2
UK	Filton Airfield	Real estate developers	2
	Spernal WWTW	Wastewater treatments plant	1
Netherland	La Trappe	A biological wastewater treatment plant	1
	Westland Region	High-Temperature Aquifer Thermal Energy Storage	3
	Not stated		3

The survey asked if the respondents considered different areas of policy and regulation as 'Helpful' or 'Hindering'. Each of the areas listed could include European, national, or regional/local legislation and associated regulations. 'Helpful' could mean that they provided an incentive or funding mechanism, or eased pathways to potential markets, or clarified roles and responsibilities, or somehow supported the feasibility of the scheme. 'Hindering' could mean that they created burdensome requirements or procedures, or created barriers to potential markets, or somehow detracted from the feasibility of the scheme. Several elicitation methods were used which gave varying results but also some insight into the different dimensions of the subjective evaluations.

Responses referred to a mix of policy domains spanning National and Regional policy, there was no clear pattern or focus across the demo sites. Within the limitations of the small sample, responses to different elicitation methods indicated that the potentially more **Helpful** policy domains were:

- Energy Usage and Efficiency
- Discharge to/Pollution of the Water Environment
- Sludge Management
- Procurement and Use of Public Funds

The potentially more **Hindering** policy domains were:

- Agricultural Land Management (incl. fertiliser use)
- Waste handling
- Certification & Registration of Products

The more 'Helpful' area of policy was Energy Usage and Efficiency with five positive responses (Figure 4.1). The most 'Hindering' areas were Planning and building (incl. land purchase) with five negative responses and Agricultural Land Management (incl. fertilizer use) with four

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'hindering responses. Overall, the response rate was low and many of the policy areas received high proportions of 'not applicable' or 'don't know'.

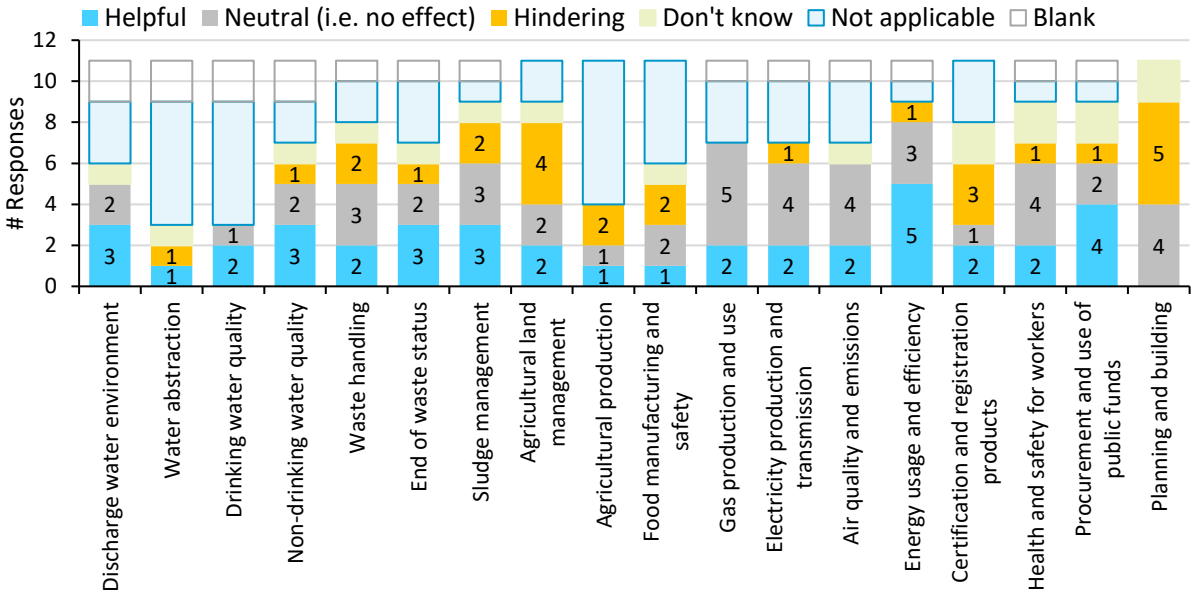

Figure 4.1 Areas of Policy and Regulation Rated as Helpful or Hindering

A second elicitation method was used that asked respondents to rank the most Hindering and the most Helpful areas of policy and regulation. In terms of most Hindering areas, Agricultural Land Management received the most responses (4) with a range of ranks from 1 to 5 (Figure 4.2). Waste handling and Certification & Registration of Products were both ranked most Hindering by two respondents. Respondents expanded on their selections, stating that:

- Registering struvite as a fertiliser project in Germany was an issue and the REACH registration at the European level was a barrier to using struvite in agriculture.
- At La Trappe, the classification of 'waste' products hinders the licensing process for reuse.

In terms of the most Helpful areas of policy and regulation, Discharge to the Water Environment was ranked most Helpful by two respondents (Figure 4.3). Sludge Management and Procurement and Use of Public Funds both received three rankings in the top four. Further elaboration provided by the respondents included:

- Regulated low discharge limits help to enhance the nutrient removal from wastewater, Braunschweig (DE)
- Drinking water requirements helped to set clear standards for the reuse of treated effluent in the production of beer, La Trappe (NL)
- Standards for water reuse for irrigation, sludge management (and use in agriculture) helped set the parameters to develop the scheme, Athens (GE).

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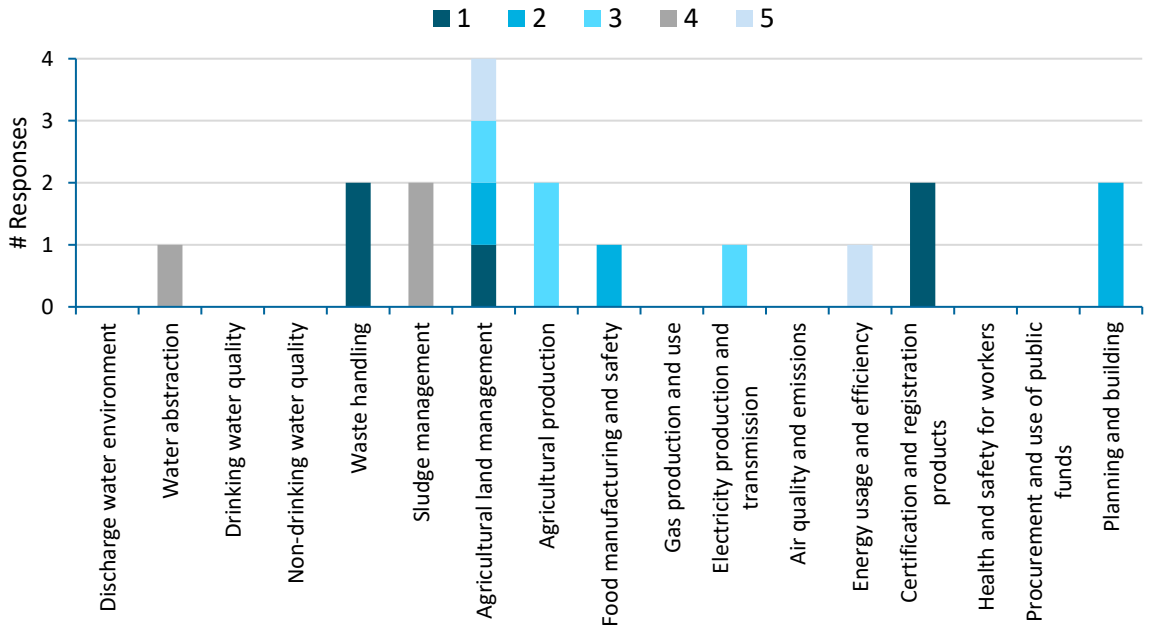

Figure 4.2 Most Hindering Ranks (1=most hindering)

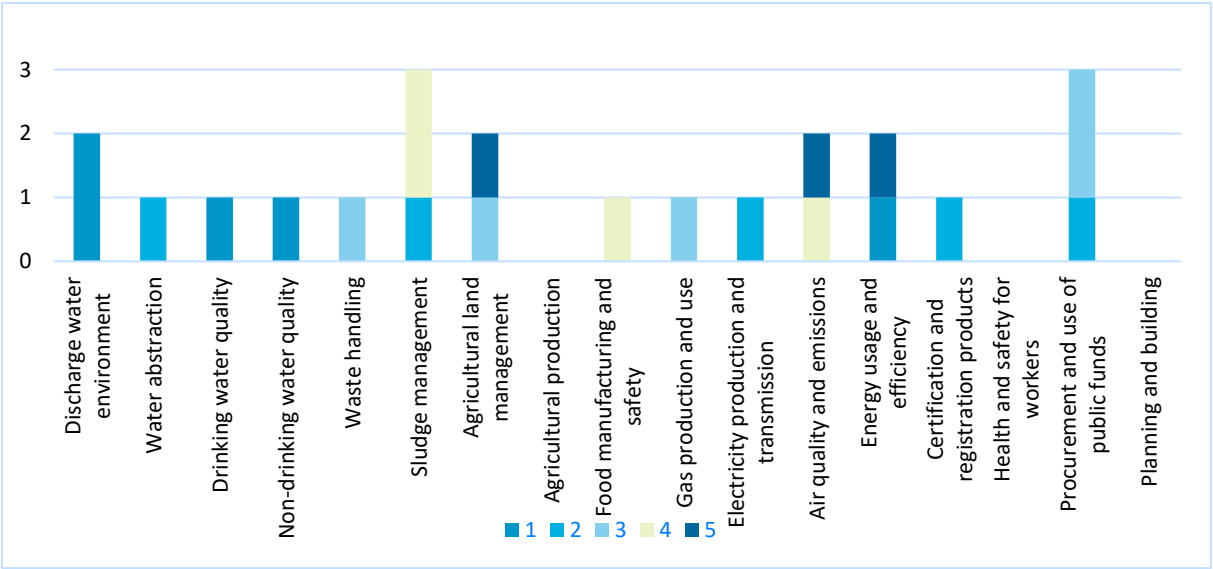

Figure 4.3 Most Helpful Ranks (1=most Helpful)

The results from the *follow-up discussions* are summarised in Tables 4.2 and 4.3 below. The discussions specifically considered the impacts of key pieces of European legislation (notably the Sewage Sludge Directive, the Urban Wastewater Treatment Directive, the Fertiliser Regulation, the Waste Directive, REACH regulations and, to a lesser degree, the Industrial Emissions Directive). National policy and regulatory frameworks associated with wastewater, waste management, fertiliser use, and small-scale energy production were also considered to a lesser extent.

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Table 4-2 Opportunities and challenges for recovered materials

Material products from wastewater and/or sludge	Policy-related opportunities and challenges
Biosolids from sludge applied to land ***Current focus of the Sewage Sludge Directive**	• Several countries (e.g., Netherlands) do not allow the use of biosolids as fertiliser • Where the application to land is allowed, biosolids are important as a soil conditioner (carbon) • Quality certification schemes can help water utilities recognise value from the product (not just as a waste disposal route) • Anaerobic digestion (AD) processes are leaky, and sludge emits gas when drying or applied to land (making it less attractive for GHG emissions) • Incentives for AD plants are ending • Land availability is a challenge for biosolids application • Monitoring (lab-based) is difficult and expensive for micro-pollutants, hard to get accurate results for trace amounts • Further restriction on biosolids use might prompt a shift from AD towards thermal processes (pyrolysis, gasification) for sludge treatment – this creates air pollutants that need to be scrubbed, but also additional useable products (e.g., biochar, P from burned fraction) • Other alternatives would be increased landfilling of sludge
P products – struvite, calcium phosphate	• Struvite is the product that has achieved the most attention, and has achieved legal end-of-waste status and REACH registration in more than one country; also, likely to be recognised under EU fertiliser regulation (slow and costly processes) • Struvite can be high purity but may not be of high value to large-scale agriculture (slow-release, small quantities) • Other markets (small-scale agriculture, domestic use) have not been explored thoroughly • Uncertainties remain over whether much value can be recognised from the sale of struvite
N products – many possibilities **Volatile fatty acids**	• Ammonia products can take many forms and are of growing interest – linked to the hydrogen economy (see below) • Many recovered products are not clearly covered under current legislative frameworks • Recovered products will often have difficulty competing with mainstream products (small quantities, higher cost) – may require bespoke markets that recognise the true added value (not just financial value)

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Bioplastics (PHA) and polymers **Cellulose** **Hydrogen**	• The scale of the treatment works is not the key issue – context and stakeholders are key • Ownership of wastewater, sludge and associated products can be legally uncertain (important for realising value and making arrangements with the other actors) – more of a concern for public utilities • Route to legal end-of-waste status (under Waste Fr. Directive, as no other route currently exists) is slow, burdensome, difficult to navigate and costly – inhibits market exploration and creation, esp. for SMEs • Must be done per product and per country • Some chemical products also require REACH registration (equally slow, burdensome, and costly)

Table 4-3 Opportunities and challenges for recovered energy

Energy from wastewater and/or sludge	Policy-related opportunities and challenges
Biogas	• One of the most commonly practised forms of energy recovery – can be improved and injected directly into gas grids, or burned to generate electricity for on-site use or power grid • Selling gas or electricity to the grid requires appropriate 'feed-in tariffs' from authorities to make it worth the cost • Increased restrictions on GHG emissions could make this energy recovery route less attractive Policy-driven subsidies for related technologies (e.g., CHP engines) may be disappearing
Heat	• Heat recovery from sewer lines or thermal treatment processes has seen greater interest Mainly limited by cost and practicalities (proximity to the heat source) rather than policy
Hydrogen	• Hydrogen can be produced directly from wastewater; ammonia products can also be used as 'carriers' for hydrogen transport • Interest in the hydrogen economy is growing, driven strongly by drivers for decarbonisation Not yet clear how such a trend would fit with policy and regulatory frameworks

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4.3 Discussion

Findings from this sub-task have shown that, while interest in energy and materials recovery from wastewater appears to be growing in the European sector, the policy and regulatory frameworks have not yet caught up with this momentum. The NextGen cases have particularly highlighted that two types of policy-related needs exist at the European level to support the adoption of these kinds of technologies more fully: 1) the need for better policy drivers to incentivise interest in circular technologies; and 2) the need for better policy enablers to facilitate the transition of recovered products to market. BOTH needs must be addressed to fully support adoption, and it is important to emphasise that they might be addressed by different policy frameworks (though overlaps certainly exist).

The findings show that the policy and regulatory requirements covering circular economy technologies and their products are split between many different directives, and alignment between them is still poor. This has been clear in other sub-tasks as well – for instance, there is uncertain alignment between the Industrial Emissions Directive and the quality requirements in the Water Reuse Regulation in terms of effluent for reuse. A broader, systemic view of the different products and materials that could be recovered is badly needed at the policy level, as the current disjointed frameworks can create unintended trade-offs (i.e., adopting one option may undermine another).

There is also a need for clearer drivers and incentives for circular solutions in the policy landscape. Currently, the Urban Wastewater Treatment Directive (UWWTD) contains only one phrase that encourages the reuse of treated effluent where feasible. In its new phase, the UWWTD should create much stronger incentives for a wider range of circular economy technologies, not just recycled water. Such incentives could be instigated through reporting requirements, or potentially through energy efficiency or carbon reduction or renewable energy requirements.

The UK experience has shown that sector-wide, policy-driven carbon neutrality targets can be a strong driver of interest and investment in energy and resource recovery technologies for water and wastewater utilities. Similarly, targets for renewable energy production and usage could incentivise energy recovery solutions such as biogas production, heat recovery and links with the hydrogen economy. Sector-level targets (rather than targets for specific types or sizes of treatment plants) may also allow better agility to coordinate initiatives between large and small UWWTPs.

In addition to policy mechanisms that drive interest in circular technologies, there is also a need for policy mechanisms that enabling the use of recovered products. It is clear from many demo cases (as well as other H2020 projects) that the complexity and cost of achieving the legal end of waste status presents a significant barrier. The widely known experiences of undertaking this process for struvite has undermined the confidence of many utilities and SMEs in pursuing status for other products. However, the lack of legal status for such products can prevent market exploration and market creation activities.

Some recovered products may realise the higher value in small-scale, niche markets (rather than trying to compete directly with mainstream products). Data (including from NextGen) indicates that such niche markets may exist, where premium prices could be used to reflect the true added value (including social and environmental value) of such recovered products.

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5. Innovative financing mechanisms for circular solutions

5.1 Introduction

The model of the circular economy is one method of reducing negative externalities from the consumption process in the economy. The ideal economic solution to externalities is to apply a corrective tax equal to the marginal external damages but this requires perfect market assumptions, which requires that there are no market failures. In a practically applied space, this is not the reality. In the absence of the right market conditions, practical solutions to the implementation of a circular economy must be sought[29]. The regulatory environment for circular economy solutions remains very heterogenous. This poses a series of challenges to financing solutions at the pan-European level, something that will be addressed in this section. While the lack of a homogenous regulatory environment is a limitation, the market for "green" investment products has begun to develop. The need for ESG investment – i.e. investment in companies that score highly on environmental, social and governance (ESG) responsibility criteria – has grown rapidly during the period of COVID-19. In the case of large capital projects, bond financing (otherwise known as a fixed-income investment) is a method of investment that is attractive, especially in the current, low-interest-rate environment. The potential for successful financing via the ESG pathway has improved over the last 18 months. As of May 2021, ESG assets under management stood at $374bn, tripling in value over the past 3 years. In terms of comparison, the wider ESG bond investment only grew 12% in comparison to the 66% for ESG in 2020[30]. This section explores how circular economy solutions can become part of that ESG investment delivery.

5.2 Understanding the value chain: Green Finance

The importance of the European Green Deal has been outlined in European Commission[31] and elaborated upon by Claeys et al. [2019][32], Elkerbout et al. [2020][33] and Leonard et al. [2021].[34] This has created a demand for so-called ESG investments in Europe and globally. The challenge of ESG investment is ensuring that it is compliant with the requirements of ESG criteria. ESG investments, when placed in the fixed income market, are commonly referred to as "Green Bonds". Green Bonds are investments whose proceeds are directed towards projects with environmental benefits.[35] The European Central Bank (ECB) has aligned 3.5% of its investment

[29] Fullerton, D., & He, S. (2021). Do Market Failures Create a'Durability Gap'in the Circular Economy?. *NBER Working Paper 29073*. https://www.nber.org/papers/w29073?utm_campaign=ntwh&utm_medium=email&utm_source=ntwg16

[30] Mooney, A. (2021, June 26). Firey five months as investors pile $54bn into esg bond funds. *Financial Times.*

[31] European Commission (2021). A european green deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en Accessed: 26 June 2021

[32] Claeys, G., S. Tagliapietra, and G. Zachmann (2019). *How to make the European Green Deal work*. Bruegel.

[33] Elkerbout, M., C. Egenhofer, J. Núñez Ferrer, M. Catuti, I. Kustova, V. Rizos, et al. (2020). The european green deal after corona: Implications for eu climate policy. *CEPS Policy Insights* (2020–06).

[34] Leonard, M., J. Pisani-Ferry, J. Shapiro, S. Tagliapietra, and G. Wolff (2021). The geopolitics of the european green deal. *Bruegel Policy Contribution* (04), 2021.

[35] Please see the European Central Bank: https://www.ecb.europa.eu/pub/economic-bulletin/focus/2018/html/ecb.ebbox201807_01.en.html

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portfolio to green bonds as part of its asset purchase programme in 2019 and intends on expanding its role in the support of the European Union's Green Deal policies.[36]

The European Union has provided a useful framework for European Green Bond Standards. Investments must align to activities that substantially contribute to one or more of six environmental objectives. These are climate change mitigation; climate change adaption; protecting marine and water resources; transitioning to a circular economy; preventing pollution; and protecting or restoring biodiversity and ecosystems. ESG data disclosure in this space will be necessary as of 2022 to avail of the green bond taxonomy.

There are some major challenges to this approach. Namely that the EU's encouragement of Green Bonds and green finance generally changes the nature of finance in Europe. Views summarized by Ilzetzki and Jia [2021] in a recent VOXEU.org article, highlight how the work of the ECB can be considered detrimental to the legislated aim of price stability.[37] It highlights that the tools for price stability in the Eurozone and those needed for the implementation of the Green Bond strategy are profoundly different.

At present, the EU Green Bond Standards have yet to be implemented but this has not prevented major institutional investors from dramatically increasing their demand for ESG bond funds. Approximately, 81% of Nordic and Dutch pension funds are now invested in green bonds.[38] The challenge for ESG investment is data transparency. Concerns have been voiced that existing ESG investment practices are following a pattern of "Greenwashing" their investment portfolios.

"Greenwashing" is a pejorative description of investments that appear on face value to be supporting ESG goals, such as the UN Sustainable Development Goals, but are in fact nothing more than traditional investments subject to a re-branding exercise. The figure below, from the Urban Land Institute, highlights the changing understanding of how capital is to be used in the context of sustainable investment. The move towards a more sustainable approach to finance reflects the adoption of the UN Sustainable Development Goals by many during the COVID-19 pandemic as the foundation of the "Building Back Better" movement[39].

The sustainability financing plan of the European Commission with the European Investment Bank (EIB) can be found in Figures 2-4. The Commission's plan is to support over €1 trillion in sustainable investment over the next decade.[40,41] The EIB has already stepped forward to support this policy objective with 40% of lending being directed towards environmental sustainability [Figure 2][42]. This exercise aims to ensure that the European Union achieves the goal of a 55% reduction in GHG emissions, with the targeted investment of €260bn per annum

[36] Ilzetzki, E. and J. Jia (2021). The ecb's green agenda. https://voxeu.org/article/ecb-s-green-agenda.
[37] Izetzki, E. and J. Jia (2021). The ecb's green agenda. https://voxeu.org/article/ecb-s-green-agenda.
[38] Mooney, A. (2021, June 26). Firey five months as investors pile $54bn into esg bond funds. *Financial Times*.
[39] Urban Land Institute (2021). ZOOMING IN ON THE "S" IN ESG A ROAD MAP FOR SOCIAL VALUE IN REAL ESTATE. London: Urban Land Institute.
[40] European Commission (2020, January 14). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Sustainable Europe Investment Plan European Green Deal Investment Plan Brussels, 14.1.2020 COM(2020) 21 final.
[41] European Commission (2021). A european green deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en Accessed: 26 June 2021.
[42] European Investment Bank (2021). Climate Action and Enviromental Sustainability Overview.

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by 2030[43]. The ECB has the potential to bring sufficient liquidity to the table to ensure that a viable and liquid market for financial instruments orientated towards ESG is developed and the objectives of EU policy are achieved.

Source: Impact Investing Institute, Bridges Fund Management and Impact Project Management

Figure 5.1 The New Spectrum of Capital. Source: Urban Land Institute (2021). ZOOMING IN ON THE "S" IN ESG A ROAD MAP FOR SOCIAL VALUE IN REAL ESTATE. London: Urban Land Institute.

The bottom line is that the ECB can use the instrument of money creation to favour environmental investments without endangering price stability. Of course, one could also argue that the ECB could use its monetary instrument to favour other worthwhile projects, such as poverty reduction. If most of the population were to desire this, it should be done. But it would create the risk that the ECB was loaded with too many social responsibilities which it could not handle properly. Given the existential threat of the degradation of the environment, including climate change, the priority should be to use the ECB's money-creation capacity towards the support of environmental projects. This can be done without creating inflation.[44]

[43] European Commission (2021). A european green deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en Accessed: 26 June 2021.

[44] DeGrauwe, Paul. "Green Money Without Inflation." *Social Europe.* https://socialeurope.eu/ green-money-without-inflation

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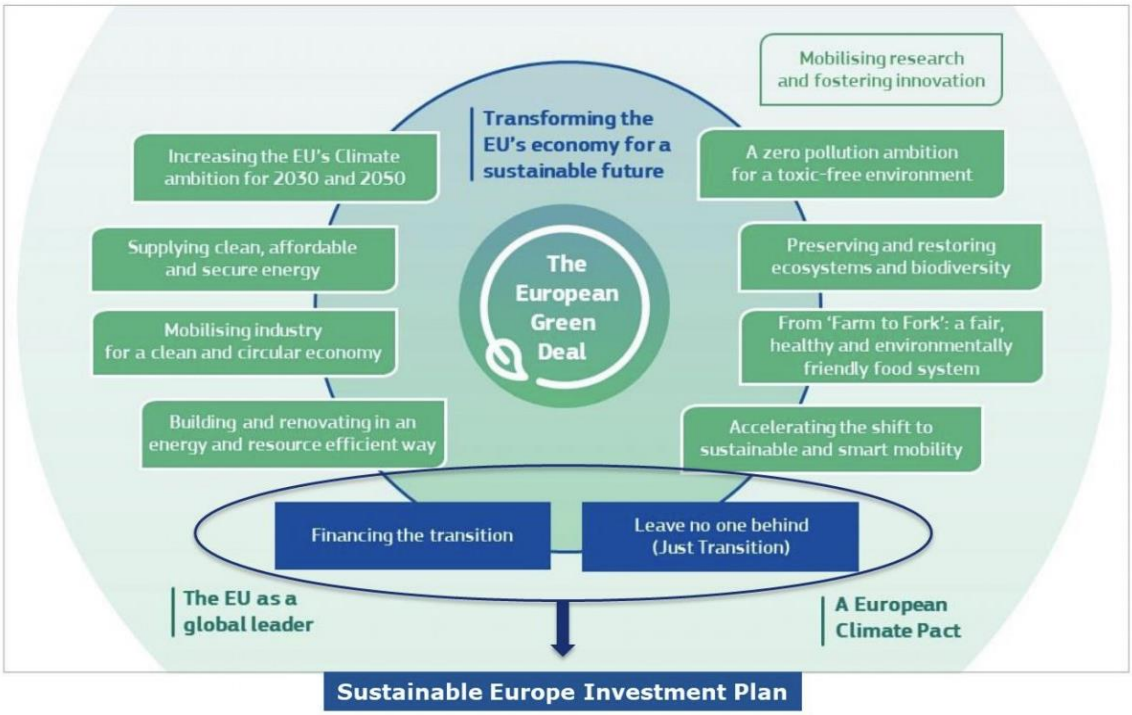

Figure 5.2: The European Union Green Deal. Source: Figure 1: The Investment Plan within the European Green Deal. European Commission (2020, January 14). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Sustainable Europe Investment Plan European Green Deal Investment Plan Brussels, 14.1.2020 COM(2020) 21 final.

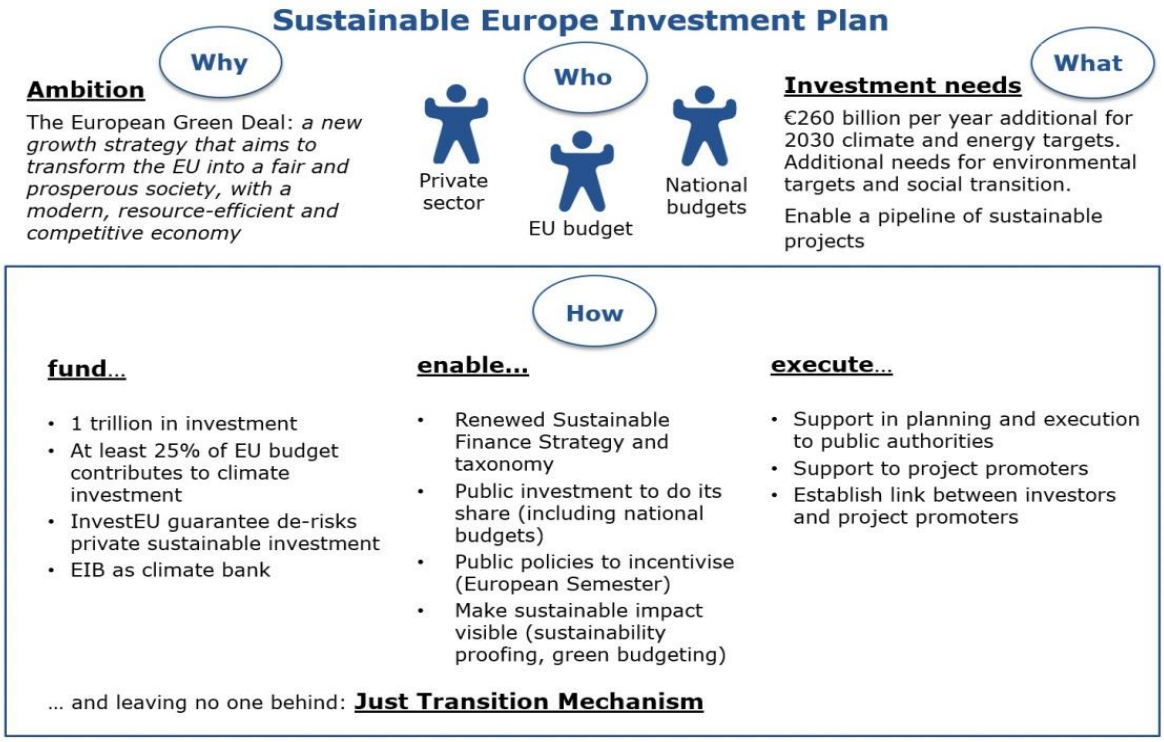

Figure 5.3: The Sustainable Europe Investment Plan. Source: Figure 2 European Commission (2020, January 14). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Sustainable Europe Investment Plan European Green Deal Investment Plan Brussels, 14.1.2020 COM(2020) 21 final.

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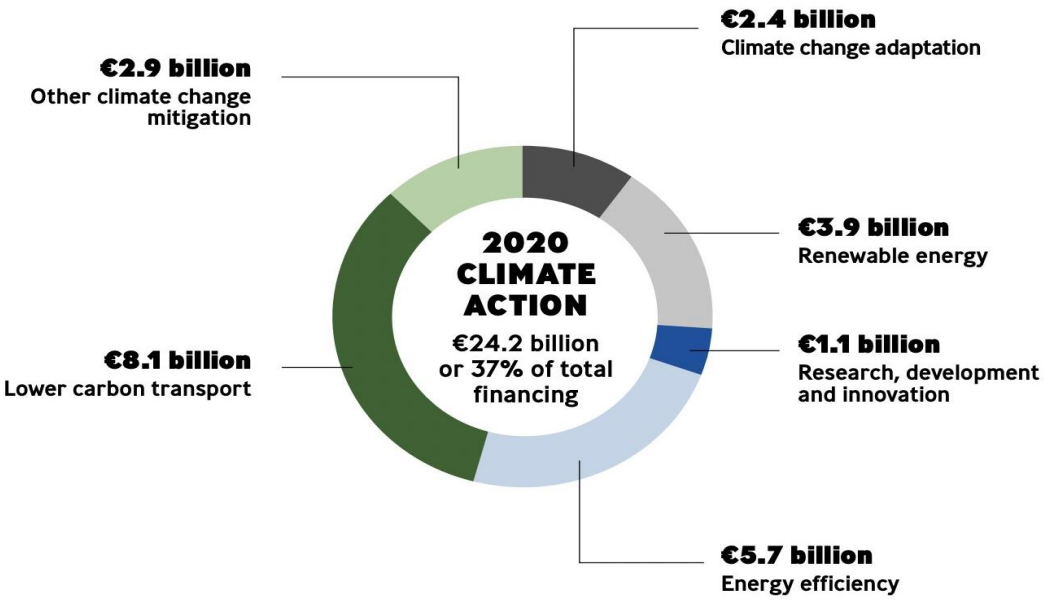

Figure 5.4 The European Investment Bank. Source: European Investment Bank (2021). Climate Action and Environmental Sustainability Overview.

The EU policy in this space has been enhanced since March 2021 with the publication and subsequent approval of the EU Taxonomy arising from the EU Taxonomy Climate Delegated Act. The Taxonomy regulation took effect from 12 July 2020[45]. Depending on the size of the energy and water savings made via these circular economy solutions, the projects may individually or as part of a consortium meet the minimum criteria.

This taxonomy is part of the first deliverables for the EU Green Finance framework, which has given rise to three key regulations:

1. To create a sustainable taxonomy for the EU (Regulation (EU) 2020/852).
2. To make disclosures relating to sustainable investments and sustainability risks clearer (Regulation (EU) 2019/2088); and
3. To establish low-carbon benchmarks (Regulation (EU) 2019/2089), setting the requirements for 'EU Climate Transition Benchmarks' and 'EU Paris-aligned Benchmarks'.

The criterion for electricity generation as it relates to hydroelectric is that the activity complies with either of the following criteria:

- The electricity generation facility is a run-of-river plant and does not have an artificial reservoir
- The power density of the electricity generation facility is above 5 W/m2
- The life cycle GHG emissions from the generation of electricity from hydropower are lower than 100gCO2e/kWh.
- Quantified life cycle GHG emissions are verified by an independent third party.

This also applies to infrastructure enabling low carbon transport of water. The activity complies with one or more of the following criteria:

[45] https://eur-lex.europa.eu/legal-content/EN/TXT

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- The infrastructure is dedicated to the operation of vessels with zero direct (tailpipe) CO2 emissions: electricity charging, hydrogen-based refuelling
- The infrastructure is dedicated to the provision of shore-side electrical power to vessels at berth
- The infrastructure is dedicated to the performance of the port's own operations with zero direct (tailpipe) CO2 emissions
- The infrastructure and installations are dedicated to transhipping freight between the modes: terminal infrastructure and superstructures for loading, unloading and transhipment of goods.
- The infrastructure is not dedicated to the transport or storage of fossil fuels.

5.2.1 Green Bond Criteria of the International Capital Markets Association

The International Capital Markets Association (ICMA) clearly states that under the wider Green Bond issuing guidelines, which are more encompassing than those provided by the EU, that sustainable water and wastewater management, including sustainable infrastructure for clean and/or drinking water, wastewater treatment, sustainable urban drainage systems and river training and other forms of flooding mitigation are projects that fall under the remit of a green bond. This would mean that generally a green bond could be created for the NextGen circular economy demo cases presented in this report.

There are currently **four types of green bonds** supported by the ICMA that align to the Green Bond Principles (GBP):

1. **Standard Green Use of Proceeds Bond**: a standard recourse-to-the-issuer debt obligation aligned with the GBP.
2. **Green Revenue Bond**: a non-recourse-to-the-issuer debt obligation aligned with the GBP in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes etc., and whose use of proceeds go to related or unrelated Green Project(s).
3. **Green Project Bond**: a project bond for a single or multiple Green Project(s) for which the investor has direct exposure to the risk of the project(s) with or without potential recourse to the issuer, and that is aligned with the GBP.
4. **Green Securitised Bond**: a bond collateralised by one or more specific Green Project(s), including but not limited to covered bonds1, ABS1, MBS1, and other structures; and aligned with the GBP. The first source of repayment is generally the cash flows of the assets.

The final version, the green securitised bond, will be returned later in this report as an option for financial support.

Crucially, circular economy projects would need to develop a framework of key performance indicators (KPIs) to indicate that they are compliant with the green bond principles. At present some projects have begun to develop their own KPIs, as reported above, which will open possibilities for financing using these structures. Why is this important?

At the core of enabling any form of Green Finance is reporting. The International Capital Markets Association (ICMA) provides a clear and continuously updated manual for the

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reporting requirements of Green Finance. The principles of which are outlined in Figure 5.5.[46] Usefully, underwriters and originators tend to put in place clear structures of reporting. A useful practical example is provided by the DNB group, a Norwegian financial services group. Their green covered bond framework aligns with the EU Taxonomy but addresses some of the data gaps that currently exist on the precise definition of a near-zero energy building. The most important measurement for these bonds is related to energy demand for the building stock. In the context of the DNB Group portfolio, the aim is to achieve the Norwegian building code of TEK 10 or TEK 17, indicating a maximum energy consumption of 126kWh/m^2. At present, the existing housing stock consumes on average 256kWh/m^2 and projects under the DNB green covered bond consume on average 122kWh/m^2 per annum, 53% less than average and well within the criteria laid down by the ICMA and the European Union. Circular economy solutions, while producing carbon offsets, do not consistently result in such dramatic reductions as those required by the DNB or the European Commission.

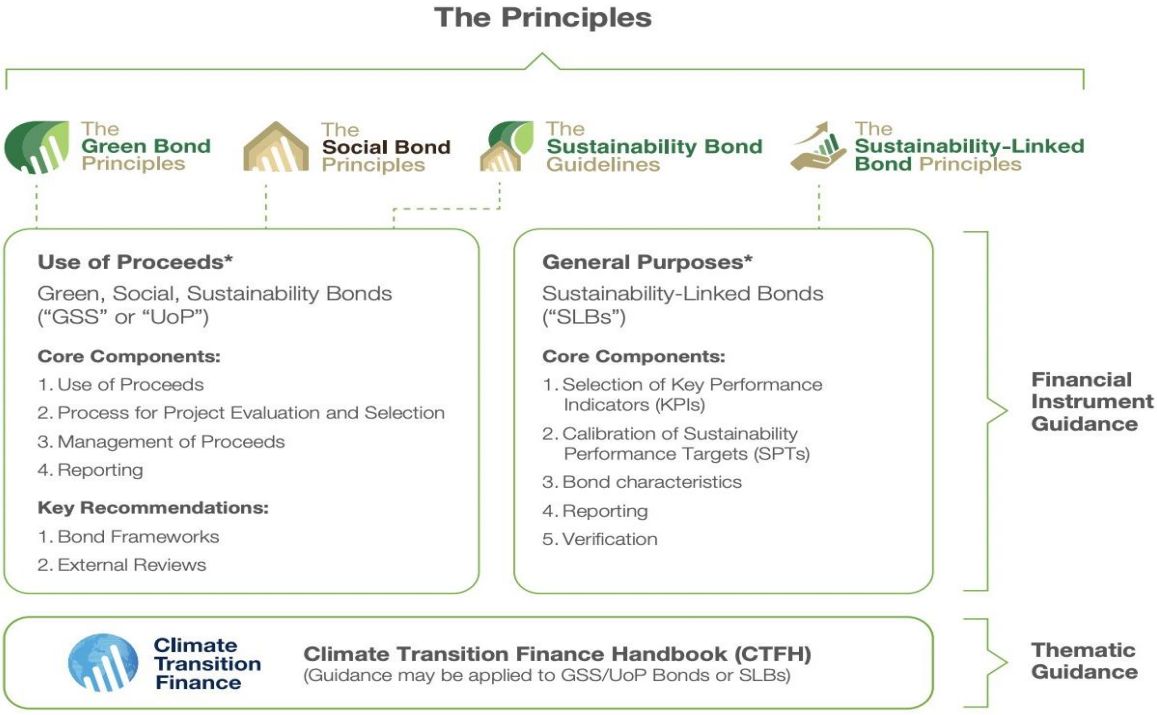

Figure 5.5 ICMA Principles. Source: Green Bond Principles June 2021 https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Green-Bond-Principles-June-2021-140621.pdf.

5.2.2 Financing opportunities and limitations

Circular economy solutions presented in the case studies above come in various types. Some are retrofits to existing structures and systems. Other examples included new builds which include circular economy technologies, this would allow the project to avail of several different avenues of green finance, either direct or indirect EU support. In the case of multiple smaller projects or retrofits, the financing can be securitised in the form of a green covered

[46] The manual can be found here on the ICMA Group website.

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bond. Covered bonds are also useful for municipalities and utility providers[47], aligning well to existing financing avenues.[48]

There are possible pathways for financing, which will work under the existing EU green finance framework. This is to rely on existing and newly developed covered bond structures. The challenge for circular economy solutions will be to meet the thresholds associated with Green Lending. Residential buildings would comply under the following circumstance:

- New residential buildings where the net primary energy demand of the new construction is at least 20% lower than the primary energy demand resulting from the relevant NZEB (near-zero energy building) requirements, and/or
- Renovated residential property where the renovation achieves savings in net Primary Energy Demand of at least 30% in comparison to the baseline performance of the building before the renovation.
- Alternatively, holding a BREEAM49 'Outstanding' or 'Excellent' or LEED50 'Platinum' or 'Gold' Certification, and/or be a new or existing commercial building belonging to the top 15% of buildings in the country in question terms of energy performance.

Existing surveys of SME financing can be found in Mateev et al. [2013] [51] and with respect to sustainability finance in SME in Klewitz and Hansen [2014].[52, 53,54] In the context of water systems, the decision to invest will occasionally be made by a small municipality, small or medium-sized enterprise (SME) or an individual household or farm. Such groups tend not to have access to bond or equity finance and rely upon borrowing from banking entities for finance. Reliance on bank finance is particularly prominent in Europe.

The current heterogenous approach to regulation means that the installation of circular economy solutions will need to be evaluated from the point of view of costs, with installation requiring investment decisions to follow a standard pattern of project appraisal as laid out in the decision flow chart in Figures 5.6. These models orientate the decisionmaker towards the use of cost-benefit analysis. At the core of a cost-benefit analysis is the use of the net present value calculation. A net present value calculation represents the discounted cash flows generated from the project over the life of the project, inclusive of the negative cash flow incurred for the initial investment. When the net present value is positive, the investment

[47] Nassr, I. K. and G. Wehinger (2015). Unlocking sme finance through market-based debt: Securitisation, private placements and bonds. *OECD Journal: Financial Market Trends* 2014(2), 89–190.
[48] Saha, D. and S. d'Almeida (2017). Green municipal bonds. *Leaders* 5(98), 886.
[49] BREEAM is a recognised sustainability assessment method for masterplanning projects, infrastructure and buildings www.breeam.com.
[50] LEED (Leadership in Energy and Environmental Design) is a widely used green building rating system https://www.usgbc.org/leed/why-leed
[51] Mateev, M., P. Poutziouris, and K. Ivanov (2013). On the determinants of sme capital structure in central and eastern europe: A dynamic panel analysis. *Research in international business and finance 27*(1), 28–51
[52] Mateev, M., P. Poutziouris, and K. Ivanov (2013). On the determinants of sme capital structure in central and eastern europe: A dynamic panel analysis. *Research in international business and finance 27*(1), 28–51
[53] Klewitz, J. and E. G. Hansen (2014). Sustainability-oriented innovation of smes: a systematic review. *Journal of cleaner production 65*, 57–75.
[54] This reflects the existing knowledge of SME finance that the cost of borrowing increases with the increasing levels of asymmetric information. In addition SME's become more effective at sustainability innovations the more they interact with third parties, especially research institutes. For retrofitting, many implementers would be SMEs.

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decision is to carry out the project. When the net present value is negative, the investment decision is to reject the project. The discounted cash flows are sensitive to the choice of the discount rate, taken as being the prevailing interest rate for the economy in question. In the UK, the Treasury Green Book recommends a rate of 3.5%. In most circumstances, rates are not constant and will reflect market conditions and monetary policy decisions. In the current context of unconventional monetary policy to support the Eurozone and mitigate the impact of COVID-19, prevailing ECB policy has created an ultra-low interest rate environment, rendering viable projects that would otherwise be ended.[55]

Whether undertaking **cost-benefit or cost-effectiveness analysis**, several important considerations arise:

- There may be significant costs or benefits which do not affect the Sponsoring Agency, but which are important to other persons or agencies or to society in general. These are usually called 'externalities' (i.e., they are external to the sponsor's direct concerns).
- There may be no market prices available for evaluating some costs or benefits associated with project options as they may not be traded items.
- In some cases, though resources consumed, and outputs produced may be traded, the prices may not reflect the real value to society of those resources or outputs.

In the case of jurisdictions where the regulatory environment actively encourages circular economy solutions or clearly requires it, then the cost-benefit calculation is superseded by a cost-effectiveness calculation. The differences in application between the cost-benefit and cost-effectiveness methodologies are outlined below.

Cost-benefit and Cost-effectiveness analyses are very similar. Ideally, a cost-benefit analysis would always be undertaken. However, there are situations where significant costs or benefits associated with a project cannot be quantified or valued, and where this occurs cost-effectiveness analysis may have to be relied on. CEA is employed to determine the least cost way of determining the capital project objective.

In cost-benefit analysis, all the relevant costs and benefits, including indirect costs and benefits, are considered. Cash values, based on market prices (or shadow prices, where no appropriate market price exists) are placed on all costs and benefits and the time at which these costs/benefits occur is identified. The analytic techniques outlined above (i.e., NPV method, IRR method, etc.) are applied using the TDR [Test Discount Rate]. The general principle of cost-benefit analysis is that a project is desirable if the economic and social benefits are greater than economic and social costs. However, meeting this test may not necessarily show that a project should proceed, since other projects competing for the same limited funds may have a higher net present value. Cost-benefit analysis must be objective. Its conclusions should not be prejudged. It should not be used as a device to buttress a case already favoured for or against a proposal. Factors of questionable or limited relevance to a project should not be brought into analysis to bias the result in a preferred direction.

Cost-Effectiveness Analysis (CEA): It is difficult to measure the value to society of public investment in social infrastructure (e.g., schools and hospitals) because the outputs may be difficult to specify accurately and quantify and are frequently not marketed. In cases like

[55] European Commission protocols on cost benefit analysis can be found here: https://ec.europa.eu/regional_policy/sources/docoffic/2007/working/wd4_cost_en.pdf

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these, the cost of the various alternative options should first be determined in monetary terms (although the benefits need not be). A choice can then be made as to which of the options (if they all achieve much the same effects) is preferable. CEA is not a basis for deciding whether a project should be undertaken. Rather, it is concerned with the relative costs or the various options available for achieving a particular objective. Evaluating options in CEA is best done by applying the principles of the NPV method to the stream of cash outflows or costs. The recurring costs of using facilities as well as the capital costs of creating them should be considered, particularly if they differ between alternative options. Usually, the aim will be to select the option which minimises the net present cost[56].

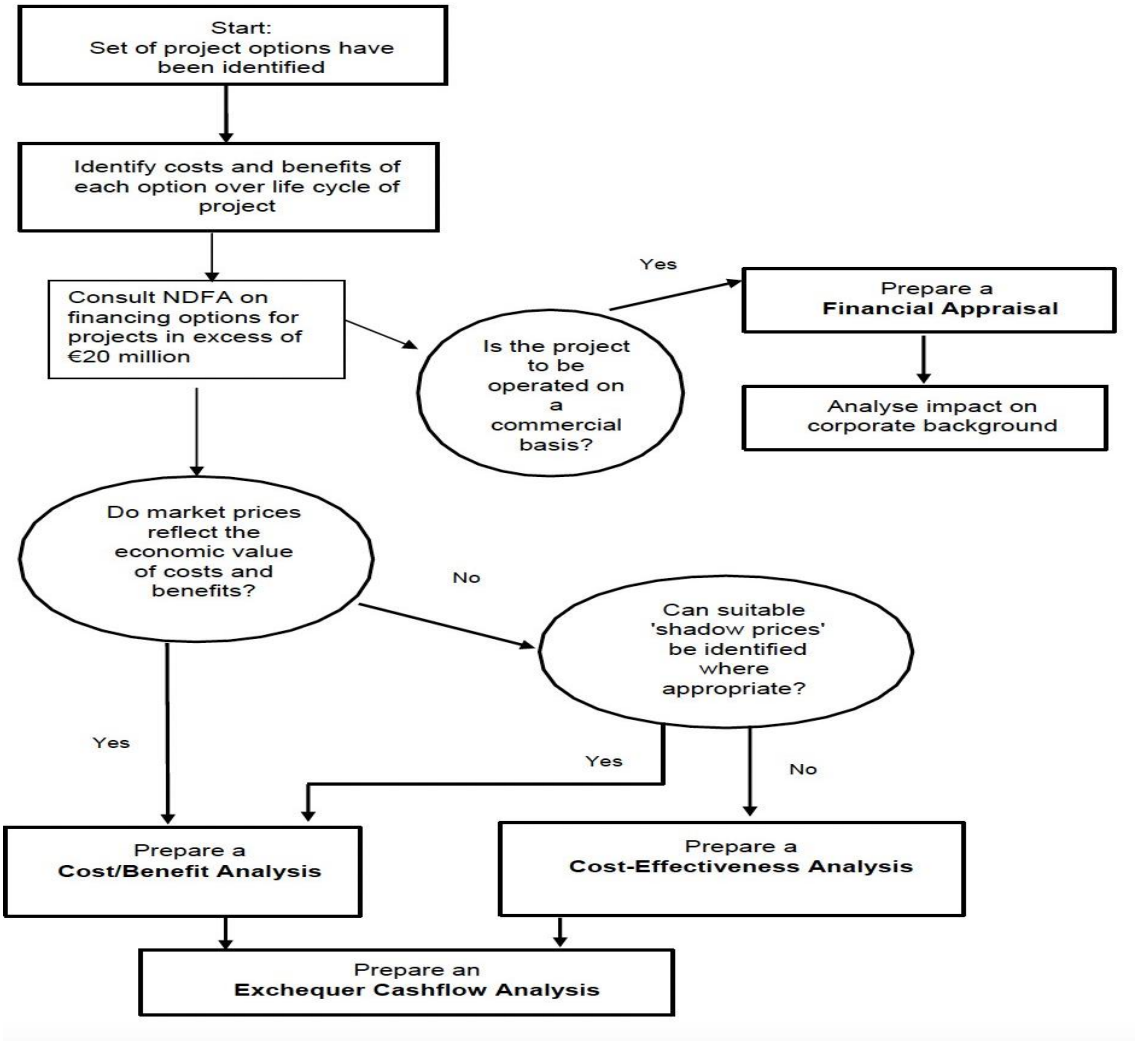

Figure 5.6: Correct Cost Evaluation Method Choice. Source: Figure 6. Identifying the Appropriate Type of Analysis of Costs. Ireland Department of Finance (2005). Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector. Stationery Office. *NDFA = National Development Finance Agency

Even following the completion of these forms of analysis, in order, all projects will be subject to a further evaluation framework. In the context of the requirements of EU green finance criteria need to add to the investment decision and they exist outside of the traditional forms of project appraisal:

[56] Ireland Department of Finance (2005). Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector. Stationary Office. pp 38-40.

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Does the investment meet one of the following environmental objectives?

1. Climate change mitigation
2. Climate change adaptation
3. Sustainable use and protection of water and marine resources
4. Transition to a circular economy, waste prevention and recycling
5. Pollution prevention and control
6. Protection of healthy ecosystems.

5.3 Building Developments and Green Criteria: Financing Alternatives

5.3.1 The Danish model

The Danish model is attractive as it is an existing structure that allows for capital improvements and real estate development that is low cost, socially orientated and does not require meeting green bond principles or EU taxonomy requirements. Emulating the Danish model for socially beneficial and green investments allows for a solution for investments that while not meeting the EU green investment criteria are nonetheless green-orientated. This structure of covered bonds would assist the EU in meeting the overarching objectives of climate action and enable many small bank-originated green and transition-oriented loans across the European Union to be packaged. This structure could be facilitated via the European Investment Bank as the underwriter into the structure presented in Figures 5.7 and 5.8.

This does not mean that any development project can ignore the normal forms of project appraisal. The project must make performance returns that indicate the ESG key performance indicators agreed with the loan originator are met. What this method will allow is a more flexible set of criteria that can be applied in a wider context of ESG finance even when it operates at the edge of the Green Bond Principles. It is yet another approach to financing via Green Covered Bonds.

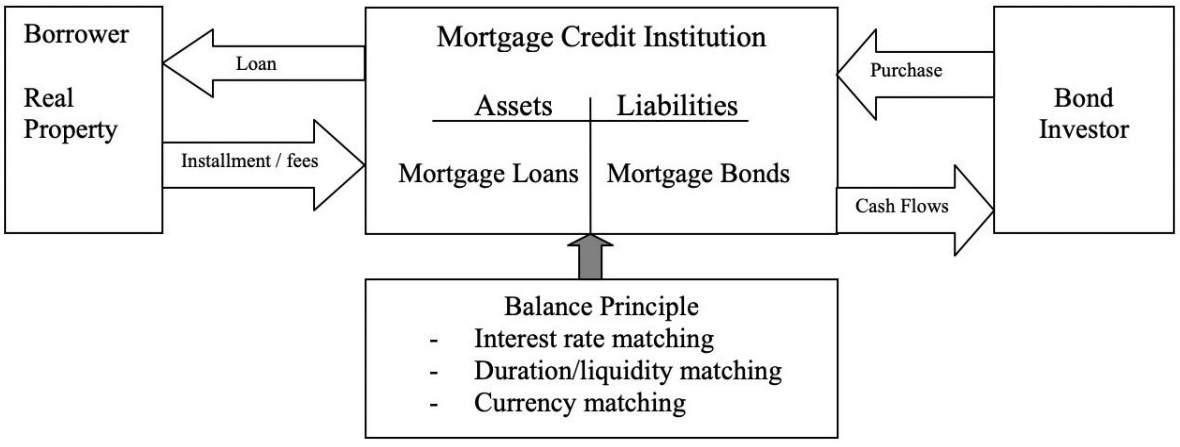

Figure 5.7: Balance Principle. Source: Figure 1. The Balance Principle. International Monetary Fund (2007). Denmark: Financial Sector Assessment Program—Technical Note—The Danish Mortgage Market—A Comparative Analysis - IMF Country Report 07/123. Washington, DC: International Monetary Fund.

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The Danish system, founded in 1797 and referred to as Nykredit in Denmark, is highly robust due to very extensive regulation that spreads outside of just the mortgage credit market and into the wider banking sector.

The Nycredit structure is an ESG-orientated system that existed before the terminology became commonplace. The system was necessary as a solution to the housing crisis in Denmark following the destruction of the Napoleonic Wars and it has evolved into a structure to aid social cohesion and government policy objectives. This model has been very effective at ensuring the stability of the housing market and the realization of public policy objectives in Denmark.[57] This makes it ideally suited to deployment for green and transition-orientated investment

The balance principal in Figure 5.7 links the mortgage to the market via the bank. The mortgages are issued to borrowers under the regulations. The mortgages are then securitized and sold in the market. There is a straight line between the borrower and the market.

These are long tenor bonds that are designed to repay over 30 years, and many secondary instruments are available to allow the markets to be flexible for interest rate risks, early repayment, and equity release. This system regularly produced securities that trade at lower interest rates due to the stability of these bonds, which regularly trade below the Danish sovereign bond and below the 30 Year US Treasury (which is the global riskless asset). The low-risk profile is due to strict borrower assessment criteria and the rigorous application of macroprudential policies resulting in less than 1% default risk in the Danish case, and less than 2% max default risk if the global figures are taken.[58]

These bonds are desirable! AAA/AAA+. They will allow for investment in circular economy systems with larger sunk costs.

	Covered Bonds	Danish Mortgage Bonds	Asset/Mortgage-Backed Securities
Mortgage Loan Production	Bundled Process	Bundled Process	Unbundled Process
Type of Securitization	On-Balance sheet	On-Balance sheet	Off-Balance sheet Securitization
Source of Cash Flows	Issuer cash flows	Issuer cash flows	Collateral cash flows
Risk exposures:			
- Credit risk	Issuer	Issuer	Investor/credit enhancer
- Prepayment risk	Issuer	Investor	Investor
- Market risk	Investor	Investor	Investor
Structure of loan pools	- Dynamic pool, with substitutable and mainly heterogeneous assets - Eligible assets defined by law	- Dynamic pool, with substitutable, and mainly heterogeneous assets - Eligible assets defined by law	- Generally static pool, with not substitutable and mainly homogeneous assets - Eligible assets not necessarily defined by law
Over collateralization	Usually defined by law	Usually defined by law	Required to achieve high rating
Credit quality	Asset quality, strength of the originating institution and legal framework	Asset quality, strength of the originating institution and legal framework	Asset quality and over collateralization, Strength of the issuing structure, and quality of the guarantor
Investor protection (bankruptcy of the issuer /originator)	Bankruptcy privilege and asset segregation	Bankruptcy privilege and asset segregation	Bankruptcy Remoteness

Figure 5.8: Characteristics of Balance Principle Covered Bonds. Source: International Monetary Fund (2007). Denmark: Financial Sector Assessment Program—Technical Note— The Danish Mortgage Market—A Comparative Analysis - IMF Country Report 07/123. Washington, DC: International Monetary Fund.

[57] International Monetary Fund (2007). Denmark: Financial Sector Assessment Program—Technical Note— The Danish Mortgage Market—A Comparative Analysis - IMF Country Report 07/123. Washington,DC: International Monetary Fund.
[58] Ibid.

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5.3.2 Public-Private Partnership

In order to reach compliance with regulatory requirements or to finance the circular economy retrofits to existing infrastructure, the investments can be reconsidered as a non-ESG-investment opportunity. This would diminish the ease at which these projects would be financed using European Investment Bank or EU-supported funds but could be used as a method of distributing risk between the public and private sectors.

Circular economy solutions, when removed from the ESG context, would be a strong candidate for investment via Public-Private Partnership (PPP) where municipal or publicly owned/funded entities are involved. The successful design and execution of a PPP as well as the many pitfalls of the model have been outlined in Hodge and Greve [2017][59] and Osei-Kyei and Chan [2015].[60,61] It is important to note that unless very precisely contracted, there are significant tail risks[62] borne by the public entity in a PPP and this should be considered if this funding pathway is undertaken.

5.4 Market Strategy for Commercialization Prospects

Circular economy water systems can provide a powerful basis for cost reduction on the part of municipal water systems, which ultimately reduces the need for subsidization or cost-induced price increases for consumers. In the case of a municipality, the requirements for an operating surplus are less essential as the existing water systems may be seeking to deliver a service to citizens and will seek to have that service subsidized as there exists a market failure. In such cases where a subsidy is in place to support the water system, that can be divided into an operational expenditure subsidy or a capital expenditure subsidy or a mixture of both.

Individual circular economy projects may find it difficult to meet all EU requirements for green finance. In an aggregated context, they would become a successful green finance project. In such a context, financial engineering tools as outlined above would be best suited to an investment platform where circular economy devices, systems and their management are given over to a designated activity company (for ease described as CE Co). This company would purchase, own, install, maintain, operate, and manage the CE devices in a country or countries within the European Union. Individuals, households, farms, and firms as well as municipalities (for ease Works Co) would enter into a service level agreement (SLA) with the CE Co which would enable the CE Co a continuous cash flow from the Works Co-based upon the combined economic value of the savings generated by the circular economy installation in terms of water

[59] Hodge, G. A., & Greve, C. (2017). On public–private partnership performance: A contemporary review. *Public Works Management & Policy*, *22*(1), 55-78.

[60] Osei-Kyei, R. and A. P. Chan (2015). Review of studies on the critical success factors for public–private partnership(ppp) projects from 1990 to 2013. *International journal of project management* 33(6), 1335–1346

[61] These papers highlight the many risks related to the development and deployment of PPPs. While a method of bringing in access to off-balance sheet finance for the government and the potential for private sector efficiencies for the project it can result in a "hire purchase" style arrangement for the acquistion of capital and it requires dedicated project management and careful contracting. PPPs can also result in the government taking on unusually large risks if the project is in danger of failing or under-performing.

[62] Those risks that would occur outside of three standard deviations from the mean in a normal distribution. In more direct language, a rare event that would impose significant losses on the investor. If the distribution of returns is skewed then you can have so-called "fat tails". The most famous book on tail risks was by Nassim Taleb in *The Black Swan* (2007).

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savings, electricity generated and carbon offset. Works Co would have no requirement to own, install, maintain, or manage the devices/system, as that would be the responsibility of the CE Co. This would ensure that from the point of view of the end-user the decision to participate in a CE project would be determined by the cash flow generated by the CE devices/system to the CE Co. The SLAs would be largely the same, exclusive of necessary local legal and regulatory considerations.

What happens next?

1. The CE Co would then have an aggregated cash flow from the different SLAs which would form the basis of the cash flow for the repayment profile to

a. bank lending (green or otherwise).

b. a specialized covered bond framework like that of the Danish system.

c. a unitary charge to a PPP Co.

2. Under this scaling structure, which is a standard arrangement, the CE Co would then have sufficient scale to avail of existing European Investment Bank (EIB) funding under the green finance criteria if following option (a).

3. In the case of option (b) cash flows would be sufficiently steady to build a green covered bond or avail of existing covered bond structures.

4. In the case of option (c), a municipality could put in place a PPP Co to finance an CE Co to put in place an SLA with the Works Co ensuring the deployment of circular economy devices/systems within the water system. The PPP Co would be able to avail of the more sophisticated green finance options and allow for more efficient risk sharing between the municipality and the CE provider.

5. Further downstream products could be deployed by the CE Co as additional products to the core SLA with the Works Co.

5.5 Discussion

The financing of circular economy solutions has many avenues. The main challenge for the efficient financing of such systems is the heterogeneity of the regulatory space in Europe. In some jurisdictions, the regulations will make circular economy solutions a necessity and cost-effective, opening the door to PPPs and to green finance solutions. In order jurisdictions where the regulatory systems are less flexible with respect to circular economy solutions, the financing of their installation will be a function of their ability to generate revenue or sufficiently reduce costs to create yield for an investor. Circular economy solutions have the potential to reduce the energy consumption and carbon footprint of the water sector in Europe. While it falls within the taxonomy of green finance, the reduction in energy consumption and how it is deployed in different jurisdictions makes it difficult to place consistently with the green bond principles, even for green covered bonds, which would be the effective method for pan-EU financing of their implementation. European firms have a propensity to rely on bank finance, which is often not the most cost-efficient method but does offer avenues to the use of covered bonds. The use of a covered bond solution modelled on a Danish Nycredit structure, which allows for the close evaluation of borrowers and has a proven design for achieving policy objectives, could be implemented as a method of financing circular

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economy solutions. If all ESG or green finance options are unavailable, circular economy devices and solutions do offer opportunities for PPP investment with careful oversight and management. Ultimately, a service innovation approach facilitated through PPP, SLA and other tools offers viable financial strategies for widespread commercialisation and capitalisation of circular economy solutions across the EU. This would require a variation of the current EU ESG financial regulatory frameworks but will ensure a risk-free or less-risky approach to the adoption and uptake. These circular economy solutions offer an economically viable solution to reduce energy and water consumption.

In addition to targeting ESG / green financing for their circular water systems, companies need to incorporate the policy and regulatory landscape in their business model, e.g., by making it a part of the triple layer model as presented in D5.1.

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6. Conclusion

6.1 Summary of findings

This report aims to examine existing and emerging policy and regulatory frameworks, both at the European level and (to a lesser degree) within Member States, to identify enablers of and challenges to the wider uptake of circular solutions in the water sector.

Chapter 2 focused on the EU Regulation 2020/741 for water reuse, which is scheduled to come into effect in 2023, and identified a number of challenges that each member state will need to address in order to comply with the treatment and monitoring requirements within their individual national structures.

Chapter 3 focused on the current planning policy and building regulations for water reuse, and identified wide variation between member states in terms of how smaller-scale (building-scale) circular solutions are addressed.

Chapter 4 showed that while interest in energy and materials recovery from wastewater appears to be growing in the European sector, the policy and regulatory frameworks have not yet caught up with this momentum.

Chapter 5 explored how circular economy solutions can become part of the ESG investment landscape and also reiterated that public-private partnerships can play a key role in the adoption of circular water technologies.

Overall, our assessment and experience from NextGen demo cases showed that the CE challenges embedded thinking beyond traditional sectoral governance paths. Indeed the CE brings together a number of policy and regulatory regimes resulting in potential gaps and overlaps that affect the feasibility of circular water solutions. Tensions between different regulatory frameworks need to be resolved as the CE is very much a transition from waste management and disposal towards value creation within and between sectors.

The Urban Wastewater Treatment Directive (UWWTD) and the Sewage Sludge Directive (SSD) may no longer be fit for purpose in regard to the CE and the exploitation of the value in water. Although the UWWTD states that “treated wastewater shall be reused whenever appropriate”, the directive contains no mechanism to support the implementation of this clause, and it is not addressed in the reporting requirements for Member States. In other words, the reuse of treated wastewater was suggested but not encouraged. The new Water Reuse Regulation is a step forward as it aims to facilitate water reuse for agricultural purposes by creating an enabling framework with minimum water quality requirements. However, the effect of the regulation on the advancement of water reuse for agriculture remains uncertain, and it has been acknowledged that overly stringent quality standards can hinder water reuse schemes if they impose rigorous treatment or monitoring requirements.

Water reuse for other (non-agricultural) applications, as well as the recovery of other products from wastewater (nutrients, materials, energy), have yet to be thoroughly addressed in the directive or the associated regulatory framework. The need to establish ‘end of waste’ status (under the banner of the Waste Framework Directive), is a severe hindrance to the marketability of products recovered from municipal wastewater and sludge. National authorities generally consider the recovery and reuse of such products as a means of waste

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handling. The establishment of 'end of waste' criteria – the legal point at which products are no longer considered waste materials – is a time consuming and resource intensive process and must be undertaken for each product individually. This acts as a significant bottleneck for CE in the water sector.

6.2 Recommendations

Each chapter of the report discussed its own set of findings and recommendations, and those recommendations are summarised and further synthesised in the sections below.

6.2.1 Recommendations for national governments of Member States

1) Support active stakeholder engagement in Water Reuse Risk Management Plans (WRRMPs)

The Regulation 2020/741 encourages (but does not explicitly require) stakeholder engagement in the preparation of WRRMPs. Organising a proper framework for active stakeholder engagement at a national level could improve public acceptance of a specific water reuse scheme and increase understanding that planned reuse is potentially safer than unplanned de facto reuse[63].

2) Adjust tariff systems to better support circular solutions

Tariff structures for water and wastewater services vary greatly between (and within) Member States. For water reuse, countries with existing reuse schemes must decide how, and through which means any additional treatment required in the Regulation 2020/741 will be funded. The suggestion in this study (from Romania) of creating a new dedicated tariff for the usage of recycled water is perhaps a feasible solution for this. However, the fact that recycled water is often more expensive to produce than 'conventional' water sources presents a challenge for creating an affordable and attractive tariff.

Tariff structures (and other supporting regulations) can also support water reuse more effectively by adequately pricing other water sources, in order to level the relative affordability of recycled water. In some countries, groundwater extraction in particular should be appropriately priced, and more emphasis should be placed on combatting illegal withdrawals and the idea that groundwater is free.

More broadly, beyond water reuse, tariff structures can be used to create sources of financing for new circular solutions. Levies on service tariffs can be ring-fenced to fund the implementation more innovative and sustainable solutions (models in this vein have been adopted in some regions of Germany for instance).

[63] Dingemans, M.; Smeets, P.; Medema, G.; Frijns, J.; Raat, K.; van Wezel, A.; Bartholomeus, R., Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits. *Water* **2020,** *12*, (5).

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3) Explicitly incorporate small-scale circular solutions in planning and building frameworks

This report has highlighted that there is an urban planning and building regulation and codes vacuum related to implementing circular water solutions, especially at the communal or the small, decentralised housing scale (notably rainwater harvesting and greywater recycling schemes). The absence of adequate regulation can lead to health risks and poor public perception of the use of circular water solutions.

Regulatory frameworks for planning and building are typically determined at national and local levels, and these should explicitly promote the use of small-scale circular systems where feasible (e.g., by requiring their incorporation in new housing or commercial developments). Technical standards for design, installation, water quality parameters and monitoring should be adopted and referenced in support of planning requirements and building codes. Aspects of such standards (e.g. water quality requirements for non-potable purposes at building scale) do exist in some countries but their coverage is patchy. A key aspect of this is the need to clarify how capital costs, as well as longer-term responsibilities for operation, monitoring, and maintenance, should be distributed between developers, property owners, and public authorities.

4) Support efficient risk sharing in contracting for PPP arrangements

The finance chapter of this report highlighted that circular economy solutions can be strong candidates for investment via Public-Private Partnerships (PPP) where municipal or publicly owned/funded utilities are involved. Circular solution providers can enter into service level agreements (SLAs) with municipalities or public utilities, which may also help the solution providers to secure access to wider green financing tools. However, such PPP arrangements require careful contracting, to ensure efficient risk sharing between the parties. National governments should work to ensure that the national legal landscape lays the groundwork for such contracting arrangements.

6.2.2 Recommendations for EU policy and legislation

5) Improve clarity and transparency for the Water Reuse Regulation

a. Clarify responsibilities for water reuse permit allocation

With less than two years before the regulation comes into effect, identifying the responsible parties/agencies who should oversee water reuse permit allocation is of the highest priority. This must be done to ensure that questions can be answered before the law comes into effect on June 26, 2023.

b. Support a public evidence database of reuse schemes

To level the playing field and experiences in Member States and the UK, documents on learning and experiences could be made publicly available for parties interested in developing reuse schemes. As the transparency provisions specified in Regulation 2020/741 require that information on water reuse is made publicly

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available, this is a logical first step in raising awareness and disseminating accurate information.

c. Create a master list of water quality parameters

Confusion or uncertainty could be circumvented by the creation of a master list of water quality parameters (e.g., chemicals and pathogens) to help in the drafting of the water reuse risk management plans (WRRMP). Such a list could be made freely available for all parties interested in pursuing water reuse in general, as Regulation 2020/741 also encourages industrial reuse and reuse for amenity-related and environmental purposes. This would be helpful since some parties interested in water reuse may be lacking technical or practical knowledge and experience in implementing reuse schemes. A database with acceptable risk levels or water qualities for different reuse purposes, and relevant preventive measures, would facilitate the implementation of the proposed regulations. Then, referencing practical case studies (not only limited to agricultural reuse) would provide insight into which monitoring is practical, feasible and meaningful for reuse operators and others involved in creating the WRRMP to further specify site-specific monitoring requirements.

A list of technical specifications would also be helpful. Identifying which disinfection processes (e.g., UV disinfection, ozonation, chlorine, etc) are suitable and which are not, and allowing more treatment processes to be included in a reuse scheme, depending on the desired removal of chemicals, could increase uptake of reuse. Regulation 2020/741 currently does not discuss options for water storage, which could discourage some potential water reuse schemes and rather increase de facto reuse if required monitoring is too expensive (for the AWT) or there is a lack of expertise on either side (AWT or water users).

6) Improve alignment between directives and incentivise circularity

The findings show that the policy and regulatory requirements covering circular economy technologies and their products are split between many different directives (urban wastewater, waste framework, water framework, energy efficiency, renewable energy, sludge, industrial emissions, etc.) and alignment between them is still poor. In the case of potential gaps or conflict, there is little guidance on which legislation should take priority, and it is unclear whether the order of importance needs to be decided upon at a national or regional level. Furthermore, while the uptake of circular systems is generally encouraged, it is not directly incentivised.

a. Introduce reporting requirements for recovered products

While some transparency requirements have been introduced for water recycling schemes under Regulation 2020/741 (see above), there are no reporting requirements for other types of circular schemes (e.g. those focused on nutrient, materials or energy recovery). The revision of the UWWTD, for instance, could introduce a requirement to make information on such schemes publicly available, which could help build awareness of schemes, and help incentivise their adoption.

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b. Include the water / wastewater sector in energy efficiency and renewable energy strategies, but improve alignment with environmental ambitions

Findings highlighted the potential for misalignment between ambitions for energy and for land management. Through circular schemes, there is considerable potential for recovering renewable energy from water and wastewater systems and improving their energy efficiency. One key mechanism is the production of biogas from sludge treatment, which is often converted to electricity. The RED II has set ambitious targets for the production of renewable energy in Member States, including the use of biogas. Such targets should explicitly encourage the recovery of renewable energy (such as biogas) from water and wastewater.

However, biogas generally goes hand in hand with the production of biosolids, which are still applied to land in some countries (such as the U.K.). If the application of biosolids to land is further restricted (e.g. through the revision of the Sludge Directive) this could ultimately undermine the production of biogas from the wastewater sector. Therefore, greater alignment is needed between the UWWTD, the RED II, and the Sludge Directive to ensure that biogas from water and wastewater systems can be used in a sustainable way to help meet renewable energy ambitions.

7) Create simpler and less costly routes to market for recovered resources

One of the key barriers to the uptake of circular schemes, identified in this and other reports, is the cost and complexity of achieving legal 'end of waste' (EoW) status for materials recovered from water and wastewater systems (e.g. nutrient products, cellulose fibres). While some regulatory instruments have attempted to create smoother routes to market for some products (such as in the Fertiliser Regulation), many gaps and hurdles still exist. The resulting confusion and risk act as deterrents for potential scheme developers.

a. Create dedicated EoW routes for products recovered from wastewater and sludge

While the EoW process is typically governed under the Waste Framework Directive, an alternative process could be created under a revised UWWTD, which could specifically manage risks as more of a 'one-stop-shop' for products recovered from municipal wastewater and sludge (which could then be exempted from the EoW process under the Waste Framework Directive).

b. Ensure that EoW status can be recognised across Member States

One of the concerns raised by participants in this study was that, for some recovered products, EoW status had to be achieved on a country-by-country basis, adding significantly to the cost. If EoW status could be recognised across multiple Member States, it could lower the cost and risk associated with these schemes.

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8) Ensure that circular systems for water and wastewater can be targeted with ESG / green financing

Adapt the EU ESG / green financing system to ensure that circular water solutions can fall within the landscape of green bonds, especially covered green bonds. A covered bond system modelled on the Danish Nycredit structure could offer an avenue for this, that could minimise opportunities for 'greenwashing'. This could open new, less risky mechanisms for investment in circular solutions from those wishing to target investment towards environmentally and socially beneficial schemes. In addition, companies need to incorporate the regulatory landscape in their business model, e.g., by making it a part of the triple layer model as presented in D5.1.

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Appendix A: Overview of demo cases used in the report

The NextGen circular water technologies at the 10 demo cases are presented in Table A-1.

Demo Case	Technologies		
Braunschweig (DE)	Two-stage digestion and sludge hydrolysis	Nutrient recovery: Ammonia stripping; Struvite precipitation	
Costa Brava (ES)	Multi-purpose water reclamation and reuse	Membrane filtration with regenerated RO membranes	
Westland Region (NL)	Closing the regional water cycle: urban water management, ASR for horticulture	HT-ATES: high temperature aquifer thermal energy storage	Material brokerage
Altenrhein (CH)	Ammonia membrane stripping	P-recovery by thermochemical treatment of sludge	Granulated activated carbon via pyrolysis
Spernal (UK)	Multi-stream anaerobic MBR for decentralized water reuse	Energy recovery from AnMBR	Nutrient recovery from AnMBR via adsorption and ion exchange
La Trappe (NL)	Metabolic Network Reactor to produce fit-for-purpose water	Protein production in Bio-Makery	
Gotland (SE)	Rainwater harvesting and decentralized membrane treatment	Energy efficient reclamation of wastewater	
Athens Urban Tree Nursey (EL)	Sewer Mining mobile wastewater treatment for decentralized reuse applications	Heat recovery from MBR	Nutrient recovery for urban agriculture
Filton Airfield (UK)	Integrated drainage system for urban water reuse	Heat recovery from sewer	Eco-sanitation systems with nutrients recovery
Timisoara (RO)	Sludge management with production of byproducts and/or energy	Reuse of effluent for urban, industrial and agricultural applications	

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Table A-2 presents the application of the demo cases in this report.

Name and Location	Application in report	Method	Report Chapter
Braunschweig WWTP (Germany)	Rainwater harvesting, Greywater recycling, Blackwater recycling, Nutrient recovery,	Interviews, Case studies, Survey questionnaire	**2, 3, 4**
Filton Airfield (UK)	Rainwater harvesting, Greywater recycling, Heat recovery	Interviews, Case studies, Survey questionnaire	**3, 4**
Timisoara WWTP, (Romania)	Rainwater harvesting, Greywater recycling, Blackwater recycling	Case studies, Survey questionnaire	**2, 3**
Athens Urban Tree Nursery (Greece)	Blackwater recycling, Nutrient recovery, Heat recovery	Interviews, Case studies, Survey questionnaire	**2, 3**
Tossa de Mar WRP (Spain)	Greywater recycling,	Interviews, Case studies, Survey questionnaire	**2, 3**
Westland Region (Netherlands)	Rainwater harvesting	Case studies, Survey questionnaire	**3, 4**
La Trappe, NL	Blackwater recycling, Nutrient recovery,	Interviews, Case studies, Survey questionnaire	**4**
Spernal WWTW, UK	Blackwater recycling, Nutrient recovery, Heat and energy recovery	Interviews, Case studies, Survey questionnaire	**4**

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Appendix B: Interview questions used in chapter 2

Directions for the interviewer

The interview is meant to elicit as much information about the local condition as possible. It is important to follow the format of the following questions, as they progress from generic questions to more specific situations.

Please write down the responses in the spaces provided after each question. As these questions will be distributed to at least 3 different countries, it is important that some consistency in the reporting of the results is maintained.

Abbreviations which can be found in the next section are outlined below.

WWTP = wastewater treatment plant

AWT = advanced wastewater treatment

GWD = Groundwater Directive

Questions

Please answer the following questions. The main question has been bolded, with additional prompts following in normal font. **Please provide an answer for all questions and prompts.**

1. **Which of the following pieces of legislation mentioned in Regulation 2020/741 is most applicable for your reuse practice? Please mark all appropriate ones and elaborate on your reuse practice and national legislation in the space provided below.**

Food	Agriculture	Environment	Water
☐ **Food law** No 178/2002	☐ **Health rules for by-products not for human consumption** No 1069/2009	☐ **Environment & soil protection during sludge use in agriculture** 86/278/EU	☐ **Urban Waste Water Treatment Directive** 91/271/EC (Evaluation/revision forthcoming)
☐ **Hygiene of foodstuffs** No 852/2004	☐ **Health rules for by-products not for human consumption** No 142/2011	☐ **Effect of public & private projects on the environment** 2011/92/EU	☐ **Nitrates directive** 91/676/EC (Evaluation/revision forthcoming)
☐ **Microbiological criteria for foodstuffs**	☐ **Pesticide levels on food of plant or animal origin**		☐ **Drinking Water Directive**

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No 2073/2005	No 396/2005		98/83/EC (Updated in 2020)
☐ **Hygiene of feedstuffs** No 183/2005			☐ **Community action in water policy** 2000/60/EC
☐ **Maximum contaminant levels in foodstuffs** No 1881/2006			☐ **Bathing water quality** 2006/7/EC (Under evaluation)
			☐ **Groundwater Directive** 2006/118/EC (Evaluation in 2021)
			☐ **Environmental Quality Standards** 2008/105/EC

2. **What is your primary area of concern stemming from the legislation?**
    - Technical, legislative, infrastructure, financial (general/overall costs), water quality, capacity, other?
    - Are there opportunities/advantages which you foresee?

3. **Will additional treatment steps will be necessary as a result of the regulation? Which ones?**
    - Are reuse schemes seasonally operated & how will this be affected?
    - Can you already estimate costs for capital/operation of new treatment steps?

4. **Who is responsible for the technical treatment?**
    - Do the WWTP operator and the AWT operator share responsibility, or is all responsibility transferred to the latter?
    - Who pays for the additional treatment? WWTP, AWT, consumers, farmers, other?

5. **Will additional monitoring be necessary? What kind/frequency?**
    - How do costs for this compare to the monitoring status quo?

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6. **How does the EU regulation affect the cost of recycled water compared to other water sources?**
    - If the cost will be higher, why? What is the current status quo operation like (i.e. is there 'free' illegal pumping, etc..)

7. **Who is responsible for the risk management (log credits) specified in 2020/741?**
    - Who is responsible for monitoring water quality?
    - Who is responsible for approving water quality results?

8. **Which areas of law & legal uncertainties are the biggest sticking points in your country?**
    - Are water permits given on a case-by-case basis, where the authorities decide on which chemicals/pathogens must be monitored anew every time? Or does a basic list exist, on top of which additional parameters are added? Please provide information on the legislation.
    - If there is illegal pumping, is this problematic in view of the Groundwater Directive, and if so, how can the higher costs of legally extracted GW compete with the free cost of illegal extracted GW?

9. **Is there any interest in your country in reuse for ‚industrial, amenity-related, and environmental purposes'?**
    - If yes, for which ones?

10. **Are there any other concerns or comments you have which weren't addressed in prior questions?**

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Appendix C: Interview guide used in chapter 3

Participant (Title and Name):

Interviewer:

Purpose of the interview

This study is part of the NextGen project, which is funded by the European Union's 2020 research and innovation program. For further information please go to the website https://nextgenwater.eu/. This interview aims to examine legislative urban development and planning frameworks, as well as relevant building and construction regulations, and consider their implications for new housing and commercial developments that incorporate more decentralised circular solutions.

You have been invited to this interview because you have been identified as someone who has a great deal to share about circular water solutions in residential projects. The project you worked on will be one of several case studies around Europe. These case studies will enable us to reveal and overcome technological and regulatory issues to increase the uptake of circular water solutions for future residential projects.

Interview protocol

This interview is planned to last no longer than half an hour. During this time, we have several questions that we would like to cover. If time begins to run short, it may be necessary to interrupt you to push ahead and complete this line of questioning. The Interviewer will sometimes ask a follow-up question to the original points being discussed to ensure that all points were covered during the interview.

To facilitate our notetaking, please note that this interview will be video recorded. Only researchers on the project will have access to the recording which will be eventually destroyed after they are transcribed.

Ethics and confidentiality

All data will be handled in accordance with the Data Protection Act (1998), and the General Data Protection Regulation (GDPR, 2018). Participation in this study is entirely voluntary. Data related to this interview including the video recording will be stored on a password—secured computer. You may choose not to participate or withdraw at any point during the interview. Your identity as a participant in this research study will remain confidential with respect to any publications of the results of this study. There will be no reimbursement for participation in the study.

Interview guide

You have been selected to speak with us today because you have been identified as someone who has a great deal to share about circular water solutions in residential projects. The project was selected as a case study within your regions.

Our research project focuses on the improvement of teaching and learning activity, with a particular interest in understanding how faculty in academic programs are engaged in this activity, how they assess student learning, and whether we can begin to share what we know about making a difference in undergraduate education. Our

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study does not aim to evaluate your techniques or experiences. Rather, we are trying to learn more about teaching and learning, and hopefully learn about faculty practices that help improve student learning on campus

1. **Would you please introduce yourself?**
   - 1.1. **What is your current job title/position?**
   - 1.2. **How many years of experience do you have in your current role?**
   - 1.3. **What do you consider your main area of expertise?**
     - **1.3.1. In which ways? Can you please elaborate?**
   - 1.4. **Can you please describe your responsibilities and your role within this project?**

2. **What circular water solution does the project utilise?**
   - 2.1. **What was the main motive and reason for implementing these circular solutions in the project? (e.g., sale, environmental, or regional authorisation)**
   - 2.2. **Did the project achieve those goals? If yes, how? If not, why?**
   - 2.3. **Do developers in your region prefers one type of circular water solution over the other? Which one is more prevalent? Why?**
   - 2.4. **In addition to these circular solutions what other water-related design and specifications were required by local or national building code? (e.g., reduction of water consumption or wastewater discharge requirements)**

3. **Did the installation of circular water/water reuse solutions in your project required any prior authorisation or planning permits?**
   - 3.1. **If no, why? If yes, who required the approval/permit?**
   - 3.2. **Can you describe the process required to get the permit? How long did it take? Do you think the regulation requirements are reasonable?**
   - 3.3. **Did you or the developer/owner of the projects face any issues while planning, designing, or acquiring authorisation for the circular water/water reuse solutions in this project?**
   - 3.4. **If Yes, what were they? (e.g., permit-related, technical, bureaucratic)**
   - 3.5. **If no, are you aware of any common regulatory or planning issues that similar projects face in your country/ region? What are they? Why?**
   - 3.6. **Do these issues reoccur with each project? Why? Were they solved? Why? How could they be avoided?**

4. **What were the main building codes and regulations that applied to the project including the design, planning, operation, and maintenance phases?**
   - 4.1. **What are the requirements? What conditions apply?**
   - 4.2. **What would you consider to be the positive and negative aspects of these planning codes, regulations and planning requirements?**
   - 4.3. **What are the challenges to compliance and implementation?**
   - 4.4. **Do you have any concerns about legislations? What are they? Why?**

5. **Are there planning rules and requirements that apply to the implementation of circular water technologies and solutions to buildings?**
   - 5.1. **What are the requirements? What conditions apply?**
   - 5.2. **What are the challenges to compliance and implementation?**
   - 5.3. **What would you consider to be the positive and negative aspects of these codes and regulation requirements?**

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5.4. **Do you have any concerns about the legislations concerning the use of circular water technologies in buildings? E.g. Technical, procedural (time, cost), financial (general/overall costs), water quality requirements, capacity to implement etc.**
5.5. **Did these codes and regulations include incentives including tax, financial support?**
5.6. **If yes, was this project eligible? In what way or form?**
5.7. **What were the criteria required to get the funding/to subsidise? Can you describe the application process? How long did it take?**

6. **To what extent does the planning and building regulations impact on decisions to implement circular water/water reuse solutions in your scheme?**
6.1. **Do you think the current regulatory framework and building code encourage developers to use circular water and energy solutions? If no, why? If yes, how?**
6.2. **What barriers did you experience? How can they be avoided?**
6.3. **Are you aware of any new building/planning or circular water/water reuse solutions regulations that are due to be active soon? What are they? How are they different?**
6.4. **What are the challenges?**
6.5. **How do you think these can be addressed?**

7. **Who were the beneficiaries of the scheme?**
7.1. **How do they benefit?**
7.2. **Were they and other stakeholders consulted? During which stages of the project?**
7.3. **Are there any stakeholders not benefiting or being affected negatively by the use of circular solutions in the project? Who are they? How? How could this be fixed?**
7.4. **Some water companies and authorities' price water and tax sewage based on consumption alone and not discharge, is that is the case in your region? If this is the case, would large scale domestic circular water/water reuse solutions harm water companies financially? Why? How? What can be done?**
7.5. **Did the use of circular solutions for water impact the unit' value, sale, lease of the building or property? If so, How?**
7.6. **Who is responsible for maintaining the system and paying the energy bill? What is the current arrangement?**
7.7. **In your opinion are the circular water/water reuse solutions valued, effectively utilised by end-users?**
7.8. **Was the use of circular water/water reuse solutions profitable? For whom, the provider or the end-user? Why? What are the main issues? What could be done?**

8. **In your opinion, do current planning and building regulations drive innovation in practices toward circular water/water reuse solutions in housing projects?**
8.1. **Why? How? What barriers did you experience/exist? How can it be improved?**
8.2. **Can most developers be innovative when it comes to circular water/water reuse solutions in domestic projects? Can they be innovative and profitable? Why? How?**

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8.3. **Do local authorities currently have enough legal and legislative tools to influence developers towards using circular water/water reuse solutions? How? Why?**
8.4. **What innovative planning policies and regulations do you think are needed? What legislations are missing?**
8.5. **Should they be implemented top-down or bottom-up? Why? How?**
8.6. **How can these be adopted and implemented? Where are the bottlenecks?**
8.7. **Is the developer interested in using circular solutions in future projects? Why? What are their concerns? How to overcome it? What would your future advice be? Why?**
8.8. **What else can be done to improve the uptake of domestic water circular solution?**

9. **What other factors inform your decisions to implement circular water technologies**

10. **Any other comments, observations?**

Thank you for your time.

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Appendix D: Case study survey form used in chapter 3

This study is part of the NextGen project, which is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 776541. Our study aims to examine legislative urban development and planning frameworks, as well as relevant building and construction regulations, and consider their implications for new housing and commercial developments that incorporate more decentralized circular solutions. For further information please go to the website https://nextgenwater.eu/ (https://nextgenwater.eu/).

This survey aims to collect general data and information about building projects that have implemented circular water technologies across Europe to gain insight and create collective learning opportunities to accelerate the uptake of circular water solutions in residential projects.

*All data will be handled in accordance with the Data Protection Act (1998), and the General Data Protection Regulation (GDPR, 2018). Participation in this study is entirely voluntary. You may choose not to participate or withdraw at any point up until the completion of the survey by simply exiting the browser page, and all the files will be destroyed. Your identity as a participant in this research study will remain confidential with respect to any publications of the results of this study. There will be no reimbursement for the participation in the study.

Thank you.

1. **Project's name:**
2. **Location (City, Country):**
3. **Year constructed or installed:**
4. **The main use/purpose of the project:**
    - **Residential**
    - **Non-residential**
    - **Mixed-use**
    - **Agricultural**
    - **Other:**
5. **If it is residential, what types are available (please select all that apply):**
    - **Detached Houses**
    - **Semi-Detached Houses**
    - **Terraced Housing**
    - **Flats/ apartments**
    - **Non-applicable**
    - **Other:**
6. **The approximate number of units:**
7. **The approximate number of occupants/ users:**
8. **What types of water reuse systems were implemented in the project? (Please select all that apply)**

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- Rainwater harvesting
- Greywater recycling
- Black (waste) water recycling
- Nutrition recovery
- Wastewater Heat recovery
- Other:

9. Who were the main beneficiaries of the circular water/water reuse solutions? (Please select all that apply)
    - The owner/developer of the scheme
    - Occupants /users of the project
    - The managing companies
    - Local authority/municipality
    - Other:
10. What are the main applications for the recycled or reclaimed water or energy? (Please select all that apply)
    - Non-potable domestic use e.g. toilet flushing, cleaning
    - Non-potable industrial use e.g. cooling systems
    - Garden and other irrigation uses
    - Outdoor communal purposes only e.g. Vehicle washing
    - Water and/or space heating
    - Other:
11. If known, what was the approximate cost of the system?
12. Was the answer for the previous question (Q.12) per:
    - Unit installation
    - Scheme
    - Other
13. What was the expected rate of return on investment (ROI) for the circular water/water reuse solutions?
    - Less than 2.0%
    - 2.0% - 3.5%
    - 3.6% - 5.0%
    - 5.1%- 8.0%
    - More than 8.0%
14. What is the expected Payback Period for the circular water/water reuse solutions?
    - Less than 12 months
    - 1 - 2 years
    - 2-5 years
    - 5-10 years
    - 11-20 years
    - More than 20 years
15. What types of incentives/subsidies were available for the project? (Please select all that apply)
    - None were available/offered.
    - Direct financial subsidies/ grant

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- Indirect financial subsidies (e.g. Tax breaks)
- Logistic aid and planning/design
- Special building permit authorization
- Other:

16. Who provided the incentive?
    - Transnational government (e.g. EU)
    - Central government
    - Municipal, Local government
    - Private financial institution
    - Other governmental agency
    - No incentives were received
    - Other:
17. What type of permit(s) were required for the installation? (Please select all that apply)
    - None required
    - Planning permit
    - Building regulations or compliance permit
    - Environmental permit
    - Health and safety permit
    - Water abstraction/authority permit
    - Waste-water discharge permit
    - Municipal permit
    - Other:
18. Please rate the following factors associated with securing the right permits for the scheme? (1 = extremely negative , 5 = extremely positive)

	1 (extremely negative)	2	3	4	5 (extremely positive)
Completeness of the rules and regulations					
Clarity of the rules and regulations					
Ease of application, process					
Time taken to apply and secure the permit					
Cost of the permit, process					

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19. Please rank the drivers for implementing the circular water/water reuse solutions in the project? (1 = low , 5 = high)

	1 (Low)	2	3	4	5 (High)
Environmental benefit					
Social benefit					
Financial benefit					
Corporate image, reputation					
Competitiveness e.g. more sales, share value, increase in market share.					
Green building rating and certification purposes					

20. Please rank the barriers to implementing the circular water/water reuse solutions in the project? (1 = low , 5 = high)

	1 (Low)	2	3	4	5 (High)
Design and technology limitations					
Cost of operation and maintenance					
Obtaining the necessary permits					
Lack of regulations and guidance					
Lack of financial support and incentives					
User, occupant factors					
Market factors					

21. Any other comments. Thank you for participating

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Appendix E: Detailed case study results from chapter 3

Athens Urban Tree Nursery, Greece

The Athens Urban Tree Nursery is part of the Goudi Park, an area in the process of redevelopment and regeneration to become the key metropolitan park of the capital. The area, which lies in the heart of Athens, is a mixed-use area, comprising of urban green and urban agriculture spaces as well as administration and residential uses. The regeneration is an effort to boost both the local economy and improve the quality of life for the 4 million citizens of the Attica Region.

The nursery comprises 4 ha of vegetation, supplies all urban parks and green spaces of Athens with plant material and uses potable water from Athens's Water Supply and Sewerage Company (EYDAP) for its irrigation. The city is seeking alternative water sources leveraging circular economy solutions to achieve environmental, social, and financial benefits for the city.

The installation of a sewer mining modular unit for urban green irrigation at the point of demand would be of direct benefit to the sustainability of the new metropolitan park. Additionally, compost-based eco-engineered growing media products will be reused as an onsite fertilizer, as part of a portfolio of autonomous, decentralized water, energy, and materials circular solutions for cities in water-scarce areas. Finally, thermal energy recovery schemes will be investigated to minimize the pilot's environmental footprint. The characteristic of the case is summarized in Table E-2 below.

Table E-1 Survey results from the Greek Demo case

Location (City, Country)		Athens, Greece	
Year constructed/installed		2019-2021	
Purpose of the project		Urban irrigation	
Types of water reuse systems		Blackwater, Nutrient recovery, Heat recovery	
Beneficiaries		Local authority/ municipality.	Water Companies
Main water applications		Garden and other irrigation uses	
Expected ROI		3.6% - 5.0%	
Payback Period		More than 20 years	
Incentives/	Subsidies	Direct financial subsidies/ grant	
Incentive provider (s)		Transnational government (e.g., EU)	
Required Permits		Municipal permit	

The findings from the interviews are summarised in Table E-3.

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Table E-3 Interview results from the Greek Demo case

Motive for implementing circular water solutions	**To address problems in water scarcity with direct benefits for the environmental sustainability of green urban areas**
Status of the project	The project was successful in replacing potable water with on-site treated sewage to irrigate the plant nursery. Heat and nutrient recovery are also being tested.
Preferred type of circular water solution in the region	WWTP is the dominant circular water method. Other decentralised methods are only encouraged
Areas of concern regarding Greek regulations	
Provisions for circular water solutions	In the more recent Building Regulation of 2020, there are only provisions for the installation of water-saving and equipment in new houses. Other circular water solutions do not have any explicit provisions and are only encouraged.
Permit requirements	The use of the circular solutions required a permit to install a new power supply installation (Department of Electrical Supply of the Municipality of Athens). The approval of the Municipality of Athens for using the space for this project was also necessary. The permit was issued within 4 months. No other issues emerged while planning, designing, or acquiring authorisation as the project received preferable treatment.
Authorizations and permit issues	Issues that could arise in a similar project, would be requirements set by more than one authority (e.g., local, and regional authority). When more than one authority is involved in one permit there are delays and possible difficulties in the issuing of permits.
Main building codes and regulations applied on the project	The same national and local building codes and planning requirements applied to the project. However, As the specific project is a pilot research project, the requirements were minimal, and the competent authorities just needed to be informed on the project concept, potential, and results.
Beneficiaries	
The beneficiaries of the scheme are mainly the end-users (e.g., municipalities) as they increase resource availability and reduce the cost of water use. Additionally, the technology providers benefit from testing these technologies in real-world situations and can optimise the operation of the systems and advance them accordingly. Various stakeholders were consulted after presenting the technology potential to them e.g., local, and regional authorities, state authorities, water companies, n this project, all the involved stakeholders were benefited, and no one was affected negatively using the circular solutions. However, the fact that the project was implemented on a pilot scale, results appear in a situation where only part of the	

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irrigation needs are covered through this technology and a large part of the needs remain as it was in the baseline condition.
Costs
in Greece, water companies charge based on water consumption (both for water supply and for sewage discharge). In a case of a large-scale circular water reuse solution, there won't be financial harm to the water companies as the company will also benefit from less treatment of wastewater that has been extracted and treated locally. Regarding the responsibility for maintaining the system, in terms of paying the energy cost and following up the operation of the configuration, this is agreed to be performed by the Municipality of Athens, as the end-user of these technologies. Currently, the circular water reuse systems are valued as effective solutions by the current end-user, the Municipality of Athens. They are considering implementing the full-scale project in the Plant Nursery, and elsewhere in new urban green spaces. The use of circular water reuse solutions has environmental benefits; the financial profit needs to be further elaborated through optimisation in the operation of the systems.
Challenges and Barriers
The treated water is used for irrigation and aquifer recharge; this means that this water should comply with specific standards. Thus, in a full-scale project, this would require a specific survey to be conducted and submitted for approval by the responsible regional and national authorities. The introduction of the new standards might make it harder for the project to achieve its goals.
The current regulatory framework and building code do not particularly encourage developers to use circular water and energy solutions, as there are no explicit provisions for this purpose. Concerning water reuse, the projects**,** and initiatives in Greece, are mostly fragmented and not under more holistic planning; there is currently no strategic plan at a national level that has as a priority water reuse actions to mitigate the situation of water availability. To our knowledge, there are no new building/planning or circular water reuse solutions regulations that are due to be active soon.
Local authorities currently do not have enough legal and legislative tools to influence developers towards using circular water reuse solutions, as most of the time they are not even familiar with these systems.
The planning and building regulations are not updated and circularity as a concept has not been integrated. This can be improved if the competent authorities that are responsible for implementing this kind of configuration, approve and encourage the circularity concept in the new proposed systems.
Opportunities
In domestic projects, water reuse solutions can be implemented as they mostly refer to greywater reuse and/or rainwater harvesting systems. Depending on the design they can be profitable and innovative, e.g., using also subsurface water solutions.

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Similar projects can be implemented through a top-down approach as first the decision of the planning is down to a high level and then the implementation part is performed from a user/technician.
Pilot projects work as demonstration/reference points of innovative circular technologies. Then, it is important to train, educate and sensitise the local authorities' personnel, to be able to support the operation of such configuration and technologies.
The project leaders felt that other developers are interested in implementing circular water solutions in their projects with encouragement and help from local authorities.

Timisoara wastewater treatment plant (WWTP), Romania

Timisoara is in western Romania and the country's third-largest city. The city's wastewater treatment plant (WWTP) is designed for a 440,000-population equivalent (PE) and an average flow of 250 000 m3 per day. It is managed by Aquatim, who operate 28 drinking water treatment plants and 22 WWTPs.
Wastewater enters the treatment plant through four main sewers and goes through the mechanical and advanced biological treatment facilities, before being discharged into the Bega River. Today, the aerobically stabilized excess sludge is dewatered, solar-dried and landfilled. For future-proof sludge handling, more sustainable alternative solutions must be found. The characteristic of the case is summarized in Table E-4 below.

Table E-2 Survey results from the Romanian Demo case

Location (City, Country)	Timisoara, Romania
Year constructed/installed	2021
Purpose of the project	Mixed-use
Types of water reuse systems	Greywater, Rainwater, Blackwater
Beneficiaries	Local authority/ municipality
Main water applications	Public parks and other irrigation use. Non-potable industrial use
Expected ROI	2.0% - 3.5%
Payback Period	2-5 years
Incentives/ Subsidies	Direct financial subsidies/grants. Logistic aid and planning/design
Incentive provider (s)	Subsidy from Horizon program at present.
Required Permits	Planning permit; Building regulations or compliance permit; Environmental permit; Health and safety permit; Waste-water discharge permit; Municipal permit.

The findings from the case study are summarised in Table E-5.

Table E-3 Interview results from the Romanian Demo case

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Motive for implementing circular water solutions	Demonstrate sludge management with production of by-products and energy via pilot-scale testing of thermochemical conversion. Feasibility study of water reuse. Investigate potential applications for effluent from the Timisoara and other AQT WWTPs. Assessment of options in the urban, industrial, and agricultural sectors.
Status of the project	The project is still undergoing but initial results show success in treating sewage water for agricultural purposes. Today, the aerobically stabilized excess sludge is dewatered, solar-dried and landfilled. For future-proof sludge handling, more sustainable alternative solutions are needed.
Preferred type of circular water solution in the region	Only through the treatment facility. Wastewater enters the treatment plant through four main sewers and goes through the mechanical and advanced biological treatment facilities, before being discharged into the Bega River.
Areas of concern regarding Romanian regulations	
Provisions for circular water solutions	No mention of explicit provisions circular water solutions.
Permit requirements	Multilabel permits were required for planning, environment, health, safety and authorisation from the local government and water company.
Authorizations and permit issues	The project leaders had to go through a lengthy process to obtain all the necessary authorisations. The process was time-intensive although the project did not receive any objections after explaining the objective and process of the treatment.
Main building codes and regulations applied on the project	Regular building and planning codes with extra requirements due to the innovative nature of the project and the absence of clear regulations.
Beneficiaries	
The local municipality/government are the main benefactors of the project as well as the 440,000 population that the plant is serving.	
Costs	
The total coasts of the project are to be determined. The project is receiving Subsidies from the Horizon program for the moment. However, the cost of operation and maintenance are rather high.	
Challenges and Barriers	
Most of the challenges that faced the project through its planning and implementation stages are related to the lack of regulations and guidance. Regulations are incomplete, requires a lot of clarity and are extremely difficult, very costly and time intensive.	

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Lack of financial support and incentives is another issue that the project is facing. The plant is only subsided by the Horizon program for the moment, an external funding program. No internal governmental or non-governmental bodies have provided an incentive for the project.
Opportunities
Similar projects would provide great environmental and financial benefits for local governments in Romania. The success of similar projects in Romanian could lead to changes in local regulation to increase the uptake of circular water solutions and address the water scarcity issue while providing financial benefits for local communities.

Filton airfield development, UK

Filton is a former airfield located in South Gloucestershire, north of Bristol. The site was recently bought by YTL, a large Malaysian company with global operations, including Wessex Water in the UK and YTL Developments (UK) Ltd who are developing the site. The site will be developed into an attractive and sustainable area where people can live, learn, work, and prosper. A master plan has been approved, but further evolution of sustainable development ideas to implement is required. Within NextGen water and energy management as part of this master plan will be further developed and implemented. The investment project (construction starts 2018) includes a strategic Surface Water System (SSW), ensuring reliable drainage and allow local use of captured rainwater and water reuse. The characteristic of the case is summarized in Table E-6 below.

Table E-4 Survey results from the UK Demo case

Location (City, Country)	Bristol, UK
Year constructed/installed	Ongoing
Purpose of the project	Mixed-use
Types of water reuse systems	Rainwater, Blackwater, Greywater, Heat recovery, Nutrient recovery
Beneficiaries	Occupants /users of the project;
Main water applications	Non-potable domestic use; Outdoor communal purposes.
Expected ROI	Unknown
Payback Period	Unknown
Incentives	None were available/offered.;
Incentive provider (s)	No incentives were received;
Required Permits	Building regulations or compliance permits; Planning permit.
Location (City, Country)	Bristol, UK
Year constructed/installed	Ongoing
Purpose of the project	Mixed-use

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Types of water reuse systems	Rainwater, Blackwater, Greywater, Heat recovery, Nutrient recovery
Beneficiaries	Occupants /users of the project.
Main water applications	Non-potable domestic use; Outdoor communal purposes.
Expected ROI	Unknown
Payback Period	Unknown
Incentives/ subsidies	None were available/offered.
Incentive provider (s)	No incentives were received
Required Permits	Building regulations or compliance permits; Planning permit.

The findings from the interviews for each case are summarised in Table E-7 below.

Table E-5 Interview results from the UK Demo case

Motive for implementing circular water solutions	**The aim is to install rainwater harvesting within the Brabazon Arena and to form lakes within the airfield development. The motive is Amenity (placemaking), Environmental and commercial.**
Status of the project	The project is still in its planning and design stages.
Preferred type of circular water solution in the region	Housebuilders and developers in the UK usually only install rainwaters butts on a plot-by-plot basis if required by the local planning authority. The use of circular water solutions in the UK is linked to customers and owners wishes.
Areas of concern regarding UK regulations	
Provisions for circular water solutions	There are no comprehensive building regulations for circular water solutions in UK national or regional building and planning codes. There are quality and installation guidelines in the British Standards and the Environment agency guidebooks which are not legal or planning requirements.
Authorizations and permit requirements	There were no special requirements for the use of circular water solutions. The inclusion of water circular solutions did not cause any delays to the planning submission.
Main building codes and regulations applied on the project	There were no special requirements for planning or design circular water solutions. The rainwater tank in the Arena was shown on the planning application. This was not a prerequisite within planning but was an added benefit. There is a water calculation that forms part of building regulations – this does not appear to be strictly enforced
Beneficiaries	
The developers of the project benefit from the existence of circular water solutions include marketing and public image. However, the commercial benefits are passed on	

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to the end-users rather than the developers which can be discouraging implementation by developers.
Cost
For developers, the use of circular water solutions could add financial pressures to developers. Furthermore, these solutions are not always appreciated by individuals or house buyers.
Challenges and Barriers
The lack of robust legislation for water reuse and water reduction is the main barrier.
The commercial benefits are passed on to the end-users rather than the developers.
No form of incentives is provided by central or local governments targeted toward circular water solutions.
Opportunities
These issues and barriers could be addressed through appropriate design codes/Building regulations.

Urban water buffer, Westland region, The Netherlands

Westland is a dense region of urban and industrial areas (including Rotterdam harbour) and greenhouse complexes. The Province of South Holland, cities, the water sector, industry, and agriculture are working towards a more circular use of water, resource recovery and renewable energy sources.

Several initiatives are active including excess rainwater falling on greenhouses temporally stored in the subsurface and used for irrigation. Inside the greenhouses, water is recirculated, the evaporated water is condensed, and emission of nutrients and pesticides is minimised. Advanced purification, green gas production and resource recovery are practised in several WWTPs and recovered materials are brokered to end-users through an innovative nationwide business model (by AquaMinerals).

Horticulture companies are exploring collective purification and investment in High-Temperature Aquifer Thermal Energy Storage (HT-ATES). New communal efforts to better exploit this resource are underway: specifically, a 'heat roundabout' is being constructed through which excess heat from the port of Rotterdam is transferred to the Westland Region and used by greenhouses.

In the urban areas, several circular water management measures are being introduced, such as greywater recycling, green roofs and rainwater harvesting. A striking example is the Urban Water Buffer (UWB) project in Rotterdam. Here, the rainwater collected from the Sparta soccer stadium is sub-surface stored in an UWB and reused for irrigation of the green areas and sport fields.

The characteristic of the case is summarized in Table E-8 below.

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Table E-6 Survey results from the Dutch Demo case

Location (City, Country)	Rotterdam, Netherlands
Year constructed/installed	2018
Purpose of the project	Sports facility and stadium
Types of water reuse systems	Rainwater
Beneficiaries	Local authority/ municipality; The managing company; and users of the project;
Main water applications	Football field and other irrigation
Expected ROI	5.1%- 8.0%
Payback Period	11-20 years
Incentives/ Subsidies	Co-benefits spatial development municipality and Sparta for Water conservation;
Incentive provider (s)	Municipal, Local government; Private financial institution; regional water authority
Required Permits	Health and safety permit. Environmental permit. Municipal permit. Permits necessary for water infiltration and extraction from the regional water authority.

The findings from the interviews for each case are summarised in Table E-9 below.

Table E-7 Interview results from the Netherlands Demo case

Motive for implementing circular water solutions	The scarcity of space in the urban environment is often a major issue for climate adaptation measures such ponds, wetlands or bioswales require much space. Sub-surface water storage through the Urban Water Buffer (UWB) provides a solution for water storage that does not require much space. Key interests of the municipality to adopt this scheme are reducing pressure on the sewer system that they must maintain as well as improving spatial development through balancing water supply and water demand. By storing rainwater, they can maintain urban green space during droughts without depending on the drinking water supply. This spatial development also includes reducing water nuisance which is the responsibility of the municipality
Status of the project	The project is still in its planning and design stages.

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Preferred type of circular water solution in the region	Wastewater treatment plants
Areas of concern regarding Dutch regulations	
Provisions for circular water solutions	Because it is a rather innovative solution, there was hardly any regulation in place for small-scale application leading to potential inaction by local authorities to adopt this solution. To tackle this issue a guide for the competent authority (handreiking bevoegd gezag in Dutch) was drafted by the applied research institute of the regional water authorities and province (i.e., STOWA). This guide provided a supportive framework for technical and legal aspects of risk assessments of smaller-scale applications of UWB for non-potable applications.
Authorizations and permit requirements	The municipality of Rotterdam facilitated all the necessary authorization and permits requirements
Main building codes and regulations applied on the project	The water authority, Local municipality water monitoring and planning permits.
Beneficiaries	
The developers of the project benefit from circular water solutions include marketing and public image. However, the commercial benefits are passed on to the end-users rather than the developers which can be discouraging implementation by developers.	
Cost	
The municipality of Rotterdam is a frontrunner in climate change adaptation. In this role, they also played a key role in adopting the UWB and financed most of the project. The football club Sparta co-financed the project. At present, the maintenance of the scheme is mainly under the responsibility of the water utility Evides and the municipality. This is by choice since the law does not yet specify maintenance issues for these kinds of UWB projects.	
Challenges and Barriers	
Water utility is strictly regulated in the Netherlands.	
Because it is a rather innovative solution, there was hardly any regulation in place for small-scale application leading to potential inaction by local authorities to adopt this solution.	
Permits and quality standards form most of the barriers.	
Opportunities	
The UWB for rainwater harvesting has hardly any health requirements or monitoring obligations by law.	
The municipality has the ambition to reduce urban heat islands and address water scarcity through improved climate-adaptive urban design. Replacing drinking water for	

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watering the football field by subsurface stored rainwater runoff reduces cost and CO2 emissions due to reduced wastewater and drinking water treatment.

Braunschweig water reuse & Hamburg Water Cycle, Germany

Braunschweig water reuse (Abwasserverband Braunschweig)

The Abwasserverband Braunschweig hosted one of the earliest modern methods of sewage treatment in the world in 1894 with the construction of the sewage fields using soil filtration to purify and absorb wastewater from the city. However, since the population of Braunschweig continued to rise, the sewage fields were no longer sufficient to absorb and purify all the wastewater. Due to this and a measure of the federal and state governments to keep public waters clean, a new organizational structure was required for the city of Braunschweig regarding wastewater recycling. The result was the founding of the Braunschweig wastewater association in 1954. In sewage treatment plant Steinhof 1979, a pre-treatment plant was taken with a mechanical and biological treatment in operation. This reduced the odour nuisance to a minimum. Up to 1991 the expansion to a fully biological sewage treatment plant took place. In 2000, the sewage treatment plant was supplemented by sludge digestion.

In 1990 the sewage fields were also converted into a biological post-treatment facility. In 1991 the “meander system” was introduced as a new cleaning process in the trickle operation. In 2007, the wastewater association built a biogas plant in Hillerse to convert the energy crops that grow in the rainwater area into biogas. The characteristic of the case is summarized in Table E-10 below.

Table E-8 Survey results from the Hamburg-Braunschweig Demo case

Location (City, Country)	Braunschweig Germany
Year constructed/installed	2019
Purpose of the project	Agricultural
Types of water reuse systems	Blackwater, Nutrient recovery
Beneficiaries	Local authority/municipality; Farmers
Main water applications	Garden and other irrigation use; agricultural irrigation;
Expected ROI	Unknown
Payback Period	Unknown
Incentives/ Subsidies	financed by wastewater fees;
Incentive provider (s)	Municipal, Local government;
Required Permits	Building regulations or compliance permits. Health and safety permit;

The findings from the interviews for each case are summarised in Table E-11 below.

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Table E-9 Interview results from the Hamburg-Braunschweig Demo case

Motive for implementing circular water solutions	Due to the increasing population of Braunschweig the WWTP was overloaded and the given values for the outflow could not have complied. KlärWert was installed to reduce the nitrogen and phosphorous concentrations in the reclaimed water as well as to set up pilots for a nutrient recovery plant (KlärWert).
Status of the project	The project was successful in reducing demand on the original WWTP and reducing the nitrogen and phosphorous concentrations in the reclaimed water in a cost-efficient manner. Reclaimed water quality was also improved due to the reduced demand for the original plant.
Preferred type of circular water solution in the region	Water reuse in Germany is mainly cantered in the Braunschweig region with two initiatives, due to the availability of sandy soil with low water-holding capacities. In large parts of Germany, there is no need for water reuse so far, because there is enough groundwater, and so there is no experience or a range of circular water solutions.
Areas of concern regarding German regulations	
Provisions for circular water solutions	There are no regulations for circular water solutions in German building and planning codes, just a DIN standard which is not a legal or planning requirement.
Authorizations and permit requirements	The process to get the approval to install new circular solutions for water reuse in agriculture had a lot of bureaucratic issues. Because there are no clear regulations on which the authorities can orientate, so they are very reserved.
Main building codes and regulations applied on the project	There are no laws concerning water reuse. There are general construction approvals that everyone has to follow when building an (industrial) plant. Like safety requirements, fire prevention, state-of-the-art technologies. The building codes and planning permits were not an issue to get.
Beneficiaries	
The beneficiaries of the scheme are the end-users of the water because it is available in a greater amount than groundwater and as a result much cheaper. Furthermore, if the given values for the outflow could not have complied without the KlärWert plant, the citizens had to pay higher wastewater fees. There are no stakeholders who are affected negatively. The wastewater fees, by which the wastewater treatment is financed, is proportional to the consumption of freshwater. At the end of our water reuse scheme, the plants from the irrigated fields are used to produce bioenergy. The public corporation intends to finance wastewater treatment and keep the wastewater fees for the citizen's low.	

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Cost
So far, the project was able to treat water and sell it to farmers at a reasonable price. However, the new EU regulation on minimum requirements for water reuse can cause some financial worries, because a further cleaning step is needed to fulfil the statutory provisions. The construction of a stage for the dimension needed is a large cost factor. As long as German authorities don't tighten the requirements for passing reclaimed water in water bodies similar to the requirements for water reuse, the German population would not see a need to pay higher fees for water reuse in agriculture.
Challenges and barriers
The current lack of a regulatory framework is the main barrier.
With the implementation of the new EU regulation, we will have a continuous legal basis for water reuse. The project leaders expect that German authorities will tighten the regulation regarding micropollutants. That makes a further cleaning step including disinfection necessary, which is associated with further costs for the planning and implementation of a full-scale plant.
Customers like farmers are sceptical and must be convinced of the quality of the reclaimed water.
Opportunities
Water scarcity concerns is a topic that is starting to emerge in Germany, so there might be a rethinking in policy, which could get water reuse more into the focus.

Hamburg Water Cycle in the Jenfelder Au, Germany

The Hamburg Water Cycle aims to demonstrate a holistic approach to sewage disposal and energy supply on a dementalized level in urban areas. In this demo case, the water and energy infrastructure sectors are interlocking and complementary fields of activity. This protects the valuable resource of drinking water and simultaneously helps to use wastewater to generate energy. Within the project material, circulation cycles are also closed. The most important component of this case is the partial flow treatment of wastewater. Rainwater, sewage from the toilet (blackwater) and wastewater from kitchen and bath, e.g., from washing hands or laundry (greywater) are separated from one another and processed differently. The least possible dilution with rinsing water is required to make it possible to recover the valuable resources (nutrients and energy) contained in blackwater, in addition to separate drainage. This is made possible using vacuum toilets. The project is located within the "Jen-felder Au" urban district in the east of Hamburg, the experiences there is very successful and is transferred to the larger scale of the Jenfelder Au with about 2500 inhabitants. The characteristic of the case is summarized in Table E-12 below.

Table E-10 Survey results from the Hamburg-Jenfelder Au Demo case

Location (City, Country)	Hamburg, Germany
Year constructed/installed	2013-2022
Purpose of the project	Residential

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Types of water reuse systems	Blackwater, Greywater, Rainwater
Beneficiaries	The managing company and residents of the project;
Main water applications	local discharge, irrigation, or commercial use;
Expected ROI	Unknown
Payback Period	Unknown
Incentives/Subsidies	Direct financial subsidies/ grant;
Incentive provider (s)	Transnational government (e.g., EU);
Required Permits	Environmental permit; Waste-water discharge permit;

The findings from the interviews for this case are summarised in Table E-13 below.

Table E-11 Interview results from the Hamburg-Jenfelder Au Demo case

Case study	Hamburg Water Cycle in the Jenfelder Au
Motive for implementing circular water solutions	The main motive is the increase in energy prices and the wishes of Hamburg Water company to be able to recover heat and produce energy on-site and use it to treat water or distribute it to local homes. Water stress is not yet a common issue in Germany, so the focus of this project is to work as a demo case to test these solutions and to help in the recovery of nutrients on a decentralized level and use them on site. However, this project is also demonstrating solutions for the water cycle and help reduce the flooding effect in extreme weather conditions.
Current status of the project	The project is ongoing and is deemed successful and profitable in demonstrating that such a system works, and all the stakeholders are happy. It also has provided a lot of experience for the Hamburg water company, the developer, contractors, and the local authorities.
Preferred type of circular water solution in the region	The most common practice is conventional by discharging wastewater to the sewage water and take it to the WWTP. Green roofs are a popular solution to deal with excess rainwater in Germany. However, as summer is getting drier local municipalities are encouraging residents to have more circular solutions to water these green roofs and façade in dry seasons. This includes rainwater tanks which are becoming popular.
Areas of concern regarding German regulations	
Provisions for circular water solutions	None exist so far as known in hamburgers or in Germany in general. Some circular water solutions provisions exist for green building certificates only. There is funding for green walls and roofs now and recently there are incentives for rainwater harvesting but the goal of these incentives is to

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	reduce extreme weather conditions like flooding and are not much concerned with the circularity of water.
Authorizations and permit requirements	The approval of the local wastewater directive board which regulates everything related to the connection of buildings to sewers was required. Hamburg Water company acquired a special permit as this type of circular decentralised solution is not yet covered in the local regulations. A special permit was acquired from the water board. This project was the first and only one so far to be regulated through a special selling contract that states if someone wants to buy a house, they must connect it to the special system. This was a positive thing because the project's managers would not have a legal basis for this system. The new law amendment has been pending for a few years now and is not yet activated. Currently, anyone who wishes to build a sewage separation system will have to go through the wastewater board to get a special permit.
Main building codes and regulations applied on the project	There were only requirements decided through stakeholders and experts' meetings facilitated by the Hamburg water company to decide the most optimal requirements for this system as it was never done before. Recommendations from the DIN manuals were used as well as minimum requirements for reused greywater set by local health authorities. Hamburg Water company helped homeowners install separate piping systems for grey and black water as well as for rainwater. These are DWA codes for vacuum and gravity-based sewage systems that were used in the project which are not new. The DWA provided suggestions on how to plan the material flow for waste (black) and greywater. On a domestic level, there are none known so it was done through conversations between stakeholders with Hamburg Water company supporting and design it. It is still the full responsibility of the owners/investors to comply with water quality and how to run/monitor the system. There were also requirements for sound insulation as the domestic greywater treatment system can generate some noise. Homeowners or developers need to meet strict sound insulation requirements and minimum noise/sound level and insulation.
Beneficiaries	
No one was harmed by the project because all the stakeholders were involved since the early stage of planning. The main beneficiary is the wastewater company as this project reduces the amount of wastewater required for treatment in the centralized plant and reduces energy and treatment costs. The owners of the houses also benefited directly from reduces water charges and they also feel proud now to be part of this project and	

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being the first who get to use it. The investors/developers benefitted by getting the land where the decentralized black water system was built on. They were the first to build such a system, so they have more experience building and maintaining these systems. They might have also sold the houses for a bit higher price, however, the developers had to invest more money into sound insulation and toward installing the separate pipe systems.
Cost
The water supply company was not harmed by the project but that would be a topic for pricing water not for discharge/supply water balance. The water company is partially funded by taxpayers' money and the project was profitable and successful in demonstrating that the system works, and all the stakeholders are happy, and it has provided a lot of experience for the wastewater company and local authorities. The systems are valued by their users, and they feel proud being part of the project and run satisfaction surveys regularly to maintain this situation.
Challenges and Barriers
The current lack of a regulatory framework is the main barrier.
The wastewater company have a legal monopoly on wastewater treatment and if a private developer came and wanted to do onsite treatment or recuse project, he would not be able to.
The wastewater company has different departments that cover the different topics, for example, discharging rainwater (rainwater is considered wastewater and need to be discharged and treated first) has a different department from discharging rainwater mixed with sewage and another one for sewage alone and different departments for the reuse of treated water and so on. This is proving difficult to have so many departments and separate regulations instead of one.
Someone should be responsible for checking that the treated water quality is suitable for domestic non-potable use which is not clear in the current regulation. (The wastewater company is responsible for the system at present, but it won't be feasible on a larger scale project)
Opportunities
The discussion has started on this topic and on studying requests for decentralized solutions but there need to be more pilot projects to demonstrate that they work first.
Solving and overcome these issues requires demo and pilot cases/projects. Solutions come from both Top and Bottom sides but mostly from the bottom because the top (legislative) would not know what the requirements for water are, design, monitoring and so on.
The availability of regulations is good in the sense they make people feel safe and trust these systems are good to use.

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Costa Brava hotel Sambla greywater harvesting, Spain

Costa Brava is a touristic region located on the Mediterranean east coast of Spain, characterized by high seasonal demand, frequent water scarcity episodes which are causing saltwater intrusion. It is one of the first areas in the uptake of water reuse in Europe with 14 full-scale tertiary treatments that provide 4 hm3/year (2016) for agricultural irrigation, environmental uses, non-potable urban uses and, recently, indirect potable reuse. This demo case is aimed toward implementing and piloting greywater harvesting solutions in the hospitality sector and increasing public acceptance toward such decreolized systems. The characteristic of the case is summarized in Table E-14 below.

Table E-12 Survey results from the Spanish Demo case

Location (City, Country)	Lloret de Mar, Spain
Year constructed/installed	Ongoing
Purpose of the project	Hospitality (Hotel)
Types of water reuse systems	Greywater
Beneficiaries	The managing company and users of the project.
Main water applications	Garden and other irrigation use.
Expected ROI	Unknown
Payback Period	Unknown
Incentives/ Subsidies	Direct financial subsidies/ grant.
Incentive provider (s)	Transnational government (e.g., EU).
Required Permits	Health and safety permit; Municipal permit.

The findings from the interviews for each case are summarised in Table E-15 below.

Table E-13 Interview results from the Spanish Demo case

Motive for implementing circular water solutions	The main motive comes from the fact that in Spain and within our coastal regions we experience very high levels of water stress especially in summer times where the population could be double, due to tourism and we there are not enough water resources to cover this demand.
Status of the project	The project is still in the pilot phase, but it has been proven before that this type of greywater reuse system is financially viable.
Preferred type of circular water solution in the region	People in Spain and around the case study region prefer rainwater harvesting. This is because it has a relatively long history of use, especially on a centralized scale. Many regions

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	and cities in Spain have been using it for crops irrigation and other non-potable water purposes. Greywater however is where people have concerns regarding sanitary and health concerns that accompany the use of such systems. In general, people in Spain are aware that the government has been reusing and treating wastewater for irrigation and agriculture purposes and do not object to that and appreciate it most of the time. Developers' preferences are mostly connected to the coasts of these systems.
Areas of concern regarding Spanish regulations	
Provisions for circular water solutions	There are no regulations for circular water solutions on the decentralised level in Spain. Local authorities do not enforce any circular water solutions except for water-saving measures and equipment. There are municipal regulations for promoting the use of circular solutions since 2005 in Catalunya. However, no specific legislation is applied. Regulations should be implemented so to further promote these systems. Regional legislation would be needed. There are municipal regulations for promoting the use of circular solutions since 2005 in Catalunya. However, no specific legislation is applied. Regulations should be implemented to further promote these systems. Regional legislation would be needed.
Authorizations and permit requirements	Local authorities only require water reduction measures in the form of special devices linked to housing tabs and showers to reduce water pressure. Besides the permit from the local municipality another permit should be obtained from the Health Authority which comes and sets a few parameters and if they were demonstrated (water quality and microbiological parameters) they give you the permit. Local authorities are trying to " promote" the use of decentralized water solutions especially rainwater and greywater especially in houses or hotels that have a water pool and use the water for irrigation. is encouraged by helping the individuals and developers secure the necessary permits and make it easy for them to acquire building authorization.
Main building codes and regulations applied on the project	There were no special requirements for planning or design circular water solutions. Besides the health and safety permit, there were the usual municipal building and planning requirements. There are no legal documents but a technical guide for water reuse which is prepared by the building association in Spain which suggests which treatment to use in which situation. It is not a legal obligation or requirement.
Beneficiaries	

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The principal beneficiary is the users, as they get a reduction in their water consumption. In Spain, the industrial users pay for water discharged whereas citizens pay per water consumed. No stakeholders are involved in the greywater reuse projects. The user is responsible for all the costs. At this moment, the solutions are not profitable due to the cost associated with the operation and the low cost of freshwater.

Cost and effort

The main issue is that there are not many newly developed or constructed buildings. Implementing systems such as greywater reuse is hard in existing buildings while maybe rainwater harvesting is easier and should be encouraged in old buildings. I am not aware of any incentives or grants directed towards circular water solutions, but it highly depends on the city and municipality because the money comes from the local city and there is no national regulation regarding this matter. The process itself would also be very dependent on the local government.
The main issue is that it can be constructed and installed but the people who live there need a specialist to operate them and they are not acquainted with it and not sure if they are doing the right job after they spent so much money on the system and would stop using them.

Challenges and Barriers

Existing buildings are very hard to retrofit or equipped with water solutions due to technical difficulties and no regulations exist currently to enforce this.

There is no regulation for reusing and treating water on a small scale and users must acquire multiple permits. There is also no standard procedure or regulation, and applications are treated case by case.

Another issue is with compliance with health and water quality monitoring requirements. Homeowners might not afford or know how to do it. These requirements are usually hard to achieve or demonstrate on small scale.

The main negative aspects are that the requirement for monitoring is the same between large and small scale (domestic) and required a lot of experience and need to be a bit specialized or have enough knowledge which can be very challenging for normal people of how to operate them based on government regulations. At present, they are quite focused on the type of use and when they give permits**,** they give recommendations on existing types of use such as agriculture (they measure E. co**li** and similar parameters) but there are no requirements or recommendations for example for using urban treated water for watering private gardens and public parks. They can be very strict on this matter although using treated water for urban and non-food production should have different parameters for different uses and that's what I think they need to focus on. (They base the same requirements of centralized systems on smaller scales).

Opportunities

The demo case and the absence of unified regulation can provide an opportunity of repeating the experience in other cities and encouraging them to adopt a relaxed approach toward promoting circular water solutions on the base it has worked

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elsewhere with no health issues so let's try it here. It gives the security its safe since it has been working fine so far.
Another opportunity is proposing a new approach to make a business or make a company interested in running and operating these systems on behalf of the people in exchange for fees, subscriptions, or support.

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Appendix F: Policy and regulation survey form used in chapter 4

Thank you for your interest in this research. This survey is part of the NextGen project, which is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no.776541. For further information please go to the website https://nextgenwater.eu/. In this survey we are examining views around the policies and regulations that affect circular systems.

Your response will NOT be anonymous, and you will be asked to provide your name and organisational affiliation. However, this is for project management purposes only, and only authorised persons directly involved in this study will be able to access the data. The results will only be reported in an aggregated format, not linked to any individual, and respondents will not be identified in project outputs (unless explicit permission is sought and granted for this).

All data will be handled in accordance with the General Data Protection Regulation 2018 (GDPR), which ensures that all data which is collected as part of this research will be anonymised and stored confidentially. Participation is entirely voluntary and you are free to withdraw at any point up until the completion of the survey by simply exiting the browser page. Once the survey has been completed we will be unable to remove your data from the pool. Electronic data will be stored in a secure data file on a password protected computer for 5 years. The survey data will be analysed and written up as academic research and as part of NextGen project deliverables.

The survey will take approximately 15-20 minutes to complete. If you have any questions at any time about the study, please contact Heather Smith at Cranfield University: h.m.smith@cranfield.ac.uk

Clicking the 'next' button indicates you agree to take part in this research and have read and are satisfied with the information provided above.

○ Next (1)

Q1.1Please state your name and the organisation you work for

_____

Q1.2 Which NextGen demo site do your responses relate to? (leave blank if not applicable)

_____

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Q2 At which point are you filling in this questionnaire?

- ○ **Immediately before a COP meeting (a COP meeting will be held in the next month) (1)**
- ○ **During a COP meeting (2)**
- ○ **Immediately after a COP meeting (a COP meeting was held in the past month) (3)**
- ○ **None of the above (unrelated to a COP meeting) (4)**

Q3 Which of the following recovered products are applicable for your demo site? (tick all that apply)

- ☐ **Reclaimed water for drinking purposes (1)**
- ☐ **Reclaimed water for agricultural irrigation (2)**
- ☐ **Reclaimed water for other purposes (3)**
- ☐ **Organic nutrient product intended for agricultural use (e.g. biosolids) (4)**
- ☐ **Chemical / mineral nutrient product intended for agricultural use (e.g. struvite) (5)**
- ☐ **Other chemical / material product (e.g. cellulose) (6)**
- ☐ **Biogas (7)**
- ☐ **Electricity (8)**
- ☐ **Heat (9)**
- ☐ **Other (10)** _____

Q4
Consider the different areas of policy and regulation listed below. Each of the areas listed could include European, national, or regional/local legislation and associated regulations.

To the best of your knowledge, were each of these areas more helpful or more hindering in the development of your demo site? 'Helpful' could mean that they provided an incentive or funding mechanism, or eased pathways to potential markets, or clarified roles and responsibilities, or somehow supported the feasibility of the scheme 'Hindering' could mean that they created burdensome requirements or procedures, or created barriers to potential markets, or somehow detracted from the feasibility of the scheme

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	Helpful (1)	Neutral (i.e. no effect) (2)	Hindering (3)	Not applicable (4)	Don't know (5)
Discharge to / pollution of the water environment (1)	○	○	○	○	○
Abstraction of water (2)	○	○	○	○	○
Quality of water for drinking purposes (3)	○	○	○	○	○
Quality of water for non-drinking purposes (4)	○	○	○	○	○

Q5
Consider the different areas of policy and regulation listed below. Each of the areas listed could include European, national, or regional/local legislation and associated regulations.

To the best of your knowledge, were each of these areas more helpful or more hindering in the development of your demo site? 'Helpful' could mean that they provided an incentive or funding mechanism, or eased pathways to potential markets, or clarified roles and responsibilities, or somehow supported the feasibility of the scheme 'Hindering' could mean that they created burdensome requirements or procedures, or created barriers to potential markets, or somehow detracted from the feasibility of the scheme

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	Helpful (1)	Neutral (i.e. no effect) (2)	Hindering (3)	Not applicable (4)	Don't know (5)
Waste handling (incl. transport and disposal) (1)	○	○	○	○	○
'End of waste' status (6)	○	○	○	○	○
Sludge management (2)	○	○	○	○	○
Agricultural land management (incl. fertiliser use) (3)	○	○	○	○	○
Agricultural production (4)	○	○	○	○	○
Food manufacturing and safety (incl. retail and trade) (5)	○	○	○	○	○

Q6
Consider the different areas of policy and regulation listed below. Each of the areas listed could include European, national, or regional/local legislation and associated regulations.

To the best of your knowledge, were each of these areas more helpful or more hindering in the development of your demo site? 'Helpful' could mean that they provided an incentive or funding mechanism, or eased pathways to potential markets, or clarified roles and responsibilities, or somehow supported the feasibility of the scheme 'Hindering' could mean that they created burdensome requirements or procedures, or created barriers to potential markets, or somehow detracted from the feasibility of the scheme

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	Helpful (1)	Neutral (i.e. no effect) (2)	Hindering (3)	Not applicable (4)	Don't know (5)
Gas production (incl. biogas) and use (1)	○	○	○	○	○
Electricity production and transmission (2)	○	○	○	○	○
Air quality and emissions (incl. greenhouse gases and odour) (3)	○	○	○	○	○
Energy usage and efficiency (4)	○	○	○	○	○

Q7
Consider the different areas of policy and regulation listed below. Each of the areas listed could include European, national, or regional/local legislation and associated regulations.

To the best of your knowledge, were each of these areas more helpful or more hindering in the development of your demo site? 'Helpful' could mean that they provided an incentive or funding mechanism, or eased pathways to potential markets, or clarified roles and responsibilities, or somehow supported the feasibility of the scheme 'Hindering' could mean that they created burdensome requirements or procedures, or created barriers to potential markets, or somehow detracted from the feasibility of the scheme

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	Helpful (1)	Neutral (i.e. no effect) (2)	Hindering (3)	Not applicable (4)	Don't know (5)
Certification and registration of chemical / material products (1)	○	○	○	○	○
Health and safety for workers (2)	○	○	○	○	○
Procurement and use of public funds (3)	○	○	○	○	○
Planning and building (incl. land purchase) (4)	○	○	○	○	○

Q8 Are there other areas of policy and regulation that have affected your demo site but are missing from the lists above? If so what are they? Please describe whether they were helpful or challenging.

_____

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Q9 Please rank the following areas of policy and regulation from most hindering to least hindering, according to how they affected your demo site (with most hindering ranked as 1):

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Discharge to / pollution of the water environment [Hindering]

_____ **Discharge to / pollution of the water environment (1)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Abstraction of water [Hindering]

_____ **Abstraction of water (2)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Quality of water for drinking purposes [Hindering]

_____ **Quality of water for drinking purposes (3)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Quality of water for non-drinking purposes [Hindering]

_____ **Quality of water for non-drinking purposes (4)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Waste handling (incl. transport and disposal) [Hindering]

_____ **Waste handling (incl. transport and disposal) (5)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Sludge management [Hindering]

_____ **Sludge management (6)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Agricultural land management (incl. fertiliser use) [Hindering]

_____ **Agricultural land management (incl. fertiliser use) (7)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Agricultural production [Hindering]

_____ **Agricultural production (8)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Food manufacturing and safety (incl. retail and trade) [Hindering]

_____ **Food manufacturing and safety (incl. retail and trade) (9)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Gas production (incl. biogas) and use [Hindering]

_____ **Gas production (incl. biogas) and use (10)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Electricity production and transmission [Hindering]

_____ **Electricity production and transmission (11)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Air quality and emissions (incl. greenhouse gases and odour) [Hindering]

_____ **Air quality and emissions (incl. greenhouse gases and odour) (12)**

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Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Energy usage and efficiency [Hindering]

_____ **Energy usage and efficiency (13)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Certification and registration of chemical / material products [Hindering]

_____ **Certification and registration of chemical / material products (14)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Health and safety for workers [Hindering]

_____ **Health and safety for workers (15)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Procurement and use of public funds [Hindering]

_____ **Procurement and use of public funds (16)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Planning and building (incl. land purchase) [Hindering]

_____ **Planning and building (incl. land purchase) (17)**

Q9 For the area of policy and regulation that you ranked as most hindering in the previous question, please indicate which scale you're referring to (tick all that apply):

☐ **European policy & regulation (1)**

☐ **National policy & regulation (2)**

☐ **Regional policy & regulation (3)**

☐ **Other (4)** _____

Q10 Please describe, in general terms, how this area of policy and regulation has been particularly hindering for your demo case:

_____

_____

_____

_____

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Q11 How might this area of policy and regulation be improved to make it less of a hindrance?

Q12 Please rank the following areas of policy and regulation from most helpful to least helpful, according to how they affected your demo site (with most helpful ranked as 1):

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Discharge to / pollution of the water environment [Helpful]

_____ **Discharge to / pollution of the water environment (1)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Abstraction of water [Helpful]

_____ **Abstraction of water (2)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Quality of water for drinking purposes [Helpful]

_____ **Quality of water for drinking purposes (3)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Quality of water for non-drinking purposes [Helpful]

_____ **Quality of water for non-drinking purposes (4)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Waste handling (incl. transport and disposal) [Helpful]

_____ **Waste handling (incl. transport and disposal) (5)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Sludge management [Helpful]

_____ **Sludge management (6)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Agricultural land management (incl. fertiliser use) [Helpful]

_____ **Agricultural land management (incl. fertiliser use) (7)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Agricultural production [Helpful]

_____ **Agricultural production (8)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Food manufacturing and safety (incl. retail and trade) [Helpful]

_____ **Food manufacturing and safety (incl. retail and trade) (9)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Gas production (incl. biogas) and use [Helpful]

_____ **Gas production (incl. biogas) and use (10)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Electricity production and transmission [Helpful]

_____ **Electricity production and transmission (11)**

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Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Air quality and emissions (incl. greenhouse gases and odour) [Helpful]

_____ **Air quality and emissions (incl. greenhouse gases and odour) (12)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Energy usage and efficiency [Helpful]

_____ **Energy usage and efficiency (13)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Certification and registration of chemical / material products [Helpful]

_____ **Certification and registration of chemical / material products (14)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Health and safety for workers [Helpful]

_____ **Health and safety for workers (15)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Procurement and use of public funds [Helpful]

_____ **Procurement and use of public funds (16)**

Consider the different areas of policy and regulation listed below. Each of the areas listed coul... = Planning and building (incl. land purchase) [Helpful]

_____ **Planning and building (incl. land purchase) (17)**

Q13 For the area of policy and regulation that you ranked as most helpful in the previous question, please indicate which scale you're referring to (tick all that apply):

- ☐ **European policy & regulation (1)**
- ☐ **National policy & regulation (2)**
- ☐ **Regional policy & regulation (3)**
- ☐ **Other (4)** _____

Q14 Please describe, in general terms, how this area of policy and regulation has been particularly helpful for your demo case:

_____

_____

_____

_____

_____

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Q15 Can you think of any new policy or regulatory instruments (which aren't currently in place) that might further support the uptake of circular systems?

_____

_____

_____

_____

_____

Q16 Any other comments?

_____

_____

_____

_____

_____

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