

## Policy Brief

# Unleashing the untapped energy potential of wastewater

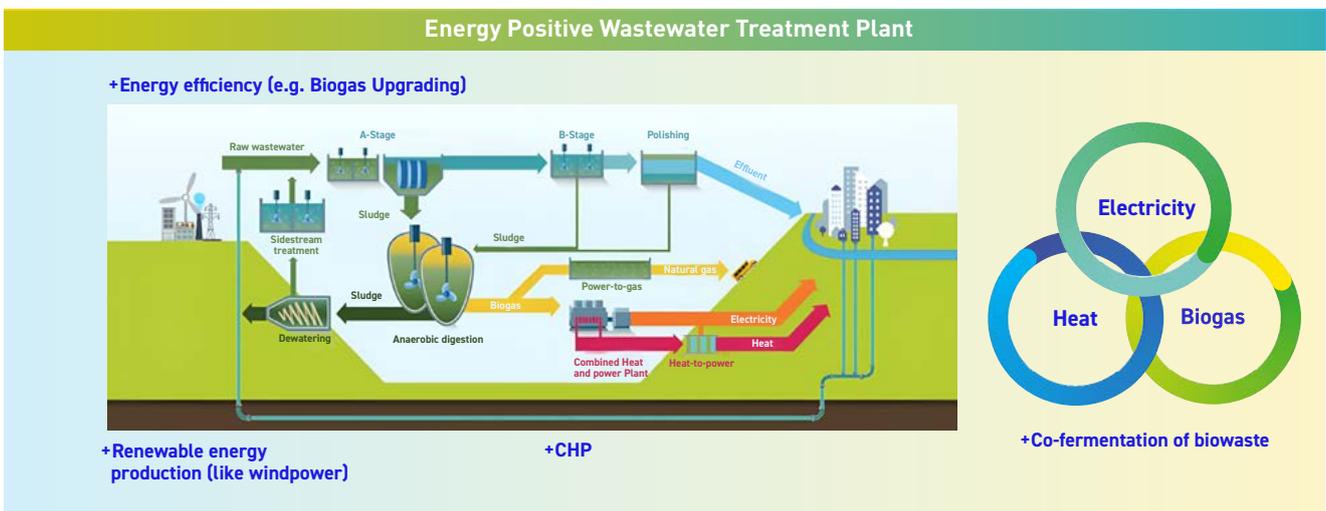
Recommendations for achieving the energy neutrality targets of the revised EU Urban Wastewater Treatment Directive



## Abstract

The revision of the EU's Urban Wastewater Treatment Directive (UWWTD) has recently been adopted by the European Parliament and awaits formal approval by the Council of the European Union before entering into force. The revision entails sweeping changes regarding the way wastewater utilities will have to think about energy. By 2045, all urban wastewater treatment plants (WWTPs) larger than 10.000 population equivalent in EU Member States (MS) must achieve energy neutrality. This will require WWTP operators to both generate their own renewable energy and to make major advances in energy efficiency. The policy will be impactful in the context of the EU's climate mitigation efforts as the wastewater treatment sector is one of the most expensive public industries in terms of energy requirements, accounting for more than 1% of consumption of electricity in Europe. At the same time, wastewater contains roughly five times the energy needed for its own treatment. Through a combination of innovative technologies and management strategies this energy can be harnessed (see Figure 1). This policy brief looks at the challenges and opportunities of realising this ambitious target and provides policy recommendations to stakeholders involved in the implementation process at national and regional levels. It draws on insights from the EU Horizon 2020 project B-WaterSmart (grant agreement No. 869171), which explores different wastewater-to-energy solutions, focusing on Living Labs (LLs) in Spain and Norway<sup>(1), (2)</sup>.

**Figure 1:** An Energy Positive Wastewater Treatment Plant adapted from: **Loderer and Hananel (2018)**



<sup>1</sup>While Norway is not part of the EU, it collaborates closely with the EU and has aligned many of its policies with EU Directives.

<sup>2</sup>Rani, A., Snyder, S. W., Kim, H., Lei, Z., & Pan, S. Y. (2022).

---

## The EU's untapped energy potential in wastewater

WWTPs are significant energy consumers, contributing substantially to the carbon footprint of municipalities and local governments. Their energy demand often also constitutes a significant portion of the operational expenses of wastewater utilities. Despite wastewater being a substantial source of electricity and heat through biogas production, its energy potential is often overlooked. Recently, an increasing number of utilities have adopted energy-efficient strategies and innovative technologies to maximize this potential. Assessments of pioneering initiatives have shown that utilities can achieve energy self-sufficiency and even become energy providers, thereby diversifying the local energy mix<sup>3</sup>.

---

## Implementing the energy neutrality target across EU Member States

Coordinated efforts in the EU Member States, from national to local level, are needed to implement the energy neutrality target outlined in the revised UWWTD. Pathways for utilities to achieve this will depend on contextual factors such as the existing wastewater treatment and sludge management assets, the plant's size and its location. In addition to adopting energy-saving practices, utilities can boost biogas production, particularly by co-digesting organic waste. Technologies such as biogas upgrading and power-to-gas can enhance the use of biogas by providing biomethane for the gas grid. Successfully implementing wastewater-to-energy approaches, specifically when including co-digestion with organic waste, affects policies in the water, wastewater, energy, and solid waste sectors and thus requires a cross-sectoral approach involving a broad range of stakeholders. B-WaterSmart has explored wastewater-to-energy solutions in a number of LLs, which are demonstration sites designed to assess solution feasibility and scalability of different approaches (see Table 1).



<sup>3</sup> Mueller (2019) Policies recommendations for improving the legal framework for fostering "wastewater-to-energy" solutions in Europe. Power Point Presentation based on Project Deliverable D.T.2.4.2 (Internal) <https://programme2014-20.interreg-central.eu/Content.Node/05-Policy-Recommendations-Andre--Muller-adelphi.pdf>.

## Description of the Living Labs

The Alicante LL investigates technologies that recover and reuse energy and nutrients from wastewater along with salts from brine resulting from the reverse osmosis process. Whilst an array of different technologies is investigated in the project (including the energy potential of microturbines and nutrient recovery), this policy brief focuses on co-digestion to enhance biogas production.

The Bodø LL is carrying out a feasibility study to explore different activities aimed at harnessing the energy potential in small wastewater treatment plants. This policy brief examines biogas production through collectively managing sludge disposal and biogas production of multiple small-scale wastewater treatment plants (including systems to improve information for, and collaboration with, stakeholders).

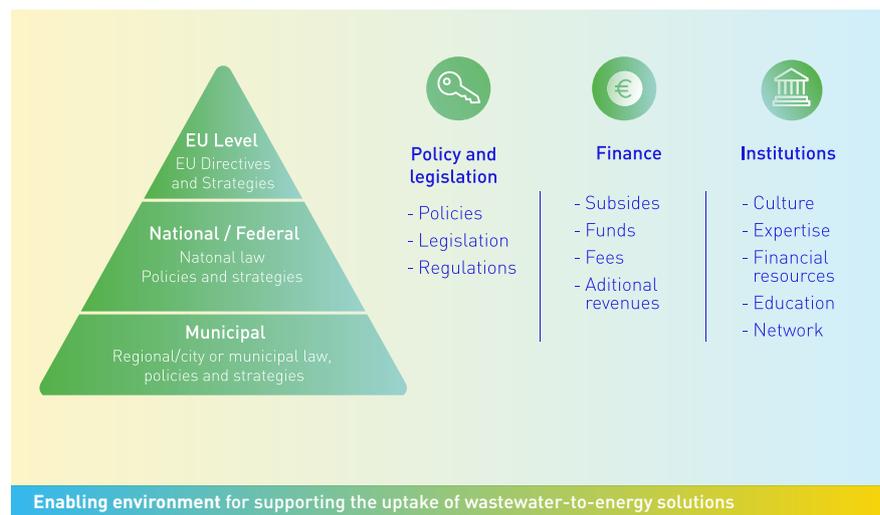
## Barriers & enablers

- Spain's long history of water scarcity and drought has culminated in extensive expertise in water innovation and an enabling environment that can benefit the uptake of wastewater-to-energy solutions.
  - Public policies generally support the transition to a circular economy and climate adaptation, but provide limited support for wastewater-to-energy solutions.
  - The legal and regulatory framework for sludge management and use insufficiently promotes biogas production from wastewater.
  - While some financial support for biogas exists (e.g. the government provides funding opportunities in the context of the EU recovery funds during the Corona pandemic), funding is generally inadequate to stimulate a large-scale uptake of solutions for improving energy efficiency and selling energy to the grid.
  - On-site biogas production is constrained through high costs of organic waste transportation and legal requirements for wastewater treatment plant operators to become certified to process organic waste.
  - Lack of market transparency for and seasonal variations of available organic waste represent a challenge in obtaining a stable supply, hampering co-digestion projects.
  - Injection of biomethane in the gas grid is limited by high costs for gas purification and pressurization.
- The combination of accessible funding, widespread knowledge, collaborative governance structures, and public awareness regarding the importance of circularity establishes a conducive environment for energy recovery initiatives.
  - The current state-of-the-art practices in Norway involve storing sludge in open beds, leading to high methane emissions. This deficiency could be leveraged to drive improved solutions for sludge treatment and biogas production in the future.
  - The small size of many municipalities and their remoteness in sparsely populated Northern Norway results in low sludge availability and high costs (incl. for transport), which can make biogas production difficult.
  - Norway's electricity costs, kept low by abundant hydroelectricity, as well as the already high energy efficiency of wastewater plants, deter investments in biogas projects with high initial expenses, particularly for smaller facilities.
  - Small municipalities struggle to pursue biogas projects independently due to the high administrative and operational requirements. As a result, they often rely on regional waste management facilities for project management.
  - Municipal regulations for water and waste fees pose hurdles for municipalities to establish viable business models for biogas production. Legal support is required to establish a collaborative agreement between municipalities and regional waste treatment facilities in charge of biogas production.

**Table 1:** Barriers and enablers for implementing B-WaterSmart approaches and technologies in the Spanish and Norwegian Living Labs

## Towards an enabling environment for the implementation of wastewater-to-energy solutions

The extent to which wastewater-to-energy solutions are adopted differs significantly among EU MS, but in general implementation is at an early stage. Creating an enabling environment for wastewater-to-energy solutions is a complex endeavour that can take decades. The required framework conditions including supportive policies and regulations, institutions and finances are only in their infancy, if present at all (see Figure 2).



**Figure 2:** Key dimensions and enabling factors for supporting the uptake of wastewater-to-energy solutions (Mueller, 2019)



### Policy and regulations

In most EU MS, **regulations struggle to incentivise wastewater-to-energy** solutions. One common problem is that utilities are legally prohibited, or at least constrained, from venturing outside their core business of treating solid waste and wastewater. This is the case in Spain and Norway. Moreover, there are rarely any incentives to produce and sell energy to the grid or regulatory pressure to save energy. Other, more environmentally harmful forms of biogas, such as biofuels from feedstock, receive more policy support than wastewater-to-energy solutions. Furthermore, specific regulations that promote technologies or management solutions, for example permission to blend organic waste and sludge for co-digestion, are often still missing. While far from being sufficient, some governments have taken initial steps to promote wastewater-to-energy solutions, and awareness of the need to make use of the energy in wastewater is growing.



## Finance

Introducing wastewater-to-energy systems involves **significant upfront expense, especially when it involves co-digestion**. Operators usually depend on subsidies to cover such costs. However, such subsidies are not common in most EU MS. Operators must therefore recover costs through energy savings, improved self-supply or selling excess energy to the grid. One significant challenge is that revenues from cost savings or energy sales can only be used for limited purposes, often excluding reinvestment in energy-related measures. This can make the adoption of wastewater-to-energy solutions economically unviable and unattractive. In Spain, for example, many wastewater sector contracts stipulate that cost savings from energy efficiency measures reduce the plant's future operational budget, with no bonuses awarded. In Norway, electricity prices are lower than in most of Europe, thanks to the abundance of clean hydroelectric power. This disincentivises investments in costly wastewater-to-energy solutions, especially for smaller plants. In Northern Norway, the size of settlements and their remoteness make biogas use from wastewater unviable due to long transportation distances and the limited volumes of sludge produced.



## Institutions

Water utilities adopt a cautious approach to innovation for two main reasons. They act as protectors of public health, and they oversee significant asset bases with long operational lifespans. Especially small municipalities and utilities lack the time, financial resources and expertise to engage with and implement innovations. Guidelines, such as the Spanish biogas roadmap published in 2022, can offer support to utilities to overcome implementation hurdles. Implementing and operating these technologies, however, poses an even bigger challenge. In the Bodø example, small municipalities tend to find it easier to deliver sludge through a regional waste management facility, and subsequently do not participate in biogas projects, due to the significant operational and maintenance burdens they entail. Co-digestion involves additional hurdles for utilities. In Spain, promoting co-digestion could benefit from the establishment of smart organic waste marketplaces, providing essential data on waste properties, reliable supply, and delivery services. Currently, gaining access to regular quantities of organic waste represents a significant barrier.

## Opportunities & Policy Recommendations

### **Increase the support for wastewater-to-energy solutions in national and sub-national legislation and policy**

For example, by integrating targets for energy recovery from wastewater into national energy strategies and climate plans. Policies and legislation should recognize the enhanced environmental performance of bioenergy produced from solid waste and wastewater compared to forms using unsustainable feedstocks.

### **Harmonise policies and regulations by integrating cross-sectoral interlinkages and conflicts between the energy, water and solid waste systems innate to wastewater-to-energy solutions**

For example by dissolving the regulatory issue that organic waste from food cannot be combined with sludge to produce biogas through co-digestion. Policies should encourage collaboration between the energy, water, and waste management sectors. This can be achieved by forming inter-agency working groups that streamline regulations, ensuring that the policies of one sector do not hinder those in another.

### **Provide financial incentives such as subsidies, tax breaks, or feed-in tariffs to reduce the initial investment burden and make biogas projects more financially viable**

High upfront costs currently dissuade operators from pursuing biogas production, co-digestion and biogas upgrading. As highlighted for Spain, potential options include performance-based contracting or performance bonuses tied to high energy efficiency in the wastewater sector. Additionally, it is crucial to ensure that co-digestion projects in existing WWTPs are eligible for government financing schemes to promote biogas generation.



### **Enable utilities to take advantage of multiple revenue streams from wastewater treatment to improve their business case, considering varying local contexts**

This will help utilities to become independent of subsidies in the long-term with a focus on developing a profitable way of managing co-digestate. To this end, it is important to simplify the regulatory process for biogas projects, including streamlined permitting and support for connecting biogas facilities to the gas grid. This can reduce administrative barriers and accelerate project development. Importantly, WWTPs need to be enabled to make profits from producing and selling energy from wastewater, for example by implementing long-term budget fixes (over five years).

### **Foster a waste regime that drives up the production of, and easy access to, organic waste and consequently stimulates co-digestion in WWTPs as an economically attractive disposal pathway**

Potential measures are supporting smart local-to-regional marketplaces to efficiently match supply and demand for waste streams at national or regional level or simplifying the certification process for utilities to purchase and process organic waste for co-digestion.

### **Increase multi-sectoral information transfer, education and targeted support**

For example by offering advice and guidelines on how wastewater operators and municipalities can find legal and regulatory workarounds to generate profits from biogas, such as the inter-municipal and regional strategies for biogas production outlined for the Norwegian case. The government could also support strategic alliances for wastewater treatment, as exists in Spain. Also useful are guidelines for utilities and municipalities (e.g. on lessons learnt and best practices for implementing wastewater-to-energy projects).

---

## References

Rani, A., Snyder, S. W., Kim, H., Lei, Z., & Pan, S. Y. (2022). **Pathways to a net-zero-carbon water sector through energy-extracting wastewater technologies**. NPJ Clean Water, 5(1), 49.

Loderer and Hananel (2018) **The potential of the wastewater sector in the energy transition (Policy Brief)**. Retrieved from <http://powerstep.eu/system/files/generated/files/resource/policy-brief.pdf>

Mueller (2019) **Policies recommendations for improving the legal framework for fostering “wastewater-to-energy” solutions in Europe**. Power Point Presentation based on Project Deliverable D.T.2.4.2 (Internal) <https://programme2014-20.interreg-central.eu/Content.Node/05-Policy-Recommendations-Andre--Muller-adelphi.pdf>.

## Imprint

This policy brief was compiled by André Müller and Jonathan Schieren (both from adelphi research) based on the work of the research project B-WaterSmart

with special contributions from Ignacio Casals Del Busto (Aguas de Alicante, Spain), Eric Santos (Cetaqua, Spain) and Rachelle Collette (Bodø kommune, Norway). The authors also express their gratitude for the quality assurance of Paul Jeffrey (Cranfield University) and Carla Gomes (ICS-ULisboa).

### Coordination and Contact

André Müller  
Advisor  
adelphi research  
[mueller@adelphi.de](mailto:mueller@adelphi.de)  
[b-watersmart.eu/](http://b-watersmart.eu/)

### Suggested citation

Mueller, A. and Schieren, J. (2024) Unleashing the untapped energy potential of wastewater: Recommendations for achieving the energy neutrality targets in the revised EU Urban Wastewater Treatment Directive. Policy Brief, B-WaterSmart.

See the download section of the B-Water Smart website [b-watersmart.eu](http://b-watersmart.eu) for further reading.



Policy Brief | Unleashing the untapped energy potential of wastewater - August 2024



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.