D2.4.1: 5 REPORTS ON THE LEGISLATIVE/ADMINISTRATIVE FRAMEWORKS IN THE INVOLVED REGION – STRUCTURE AND QUESTIONNAIRE

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Table of content

1. Introduction 2

2. Scope of the Study 3

3. The EU-Legal and Policy Framework 4

3.1. Environmental policy and law making in the EU 4

3.2. Key drivers of wastewater-to-energy solutions and resulting trends across EU member states 4

3.3. Overview of key EU legislation and policies 5

3.3.1. Water & Wastewater 5

3.3.2. Climate change mitigation 6

3.3.3. Renewable energy production and energy efficiency 6

3.3.4. Natural Gas 7

3.4. Solid waste management 8

3.5. Legal drivers and barriers 8

4. Overview on legal and policy situation in Croatia 10

4.1. National Level: 10

4.2. Federal Level and Municipal Level: 12

to begin in 2018. 12

5. Main legal and policy barriers in Croatia 13

6. Drivers and existing approaches to overcome barriers in Croatia 14

7. Appendix I: Questionnaire for Legal and Policy Barrier Analysis 15

Literature 16

1. Introduction

Innovation in the water sector is stifled by multiple barriers, keeping innovation outcomes lower than in other sectors. Factors commonly include risk aversion of water and wastewater utilities, lack of public or commercial funding and too stringent and conflicting regulations (Kiparksy et al., 2013, Ajami et a. 2014, Speight, 2015). A growing body of studies is investigating the barriers that particularly apply to nascent wastewater-to-energy systems. Dierich et al. (2017) for example mentions an unsuitable legal framework, low political priorisation of inter-sectoral action, and insufficient experience in utilities as main barriers. In another study (WERF, 2012), the authors find that "inadequate payback/economies" feature as the most dominant among 10 barriers impeding the implementation of biogas usage in the US wastewater treatment plants (WTPs). Financial hurdles also rank high up in a global study focusing on energy efficiency in US water and wastewater utilities, alongside governance issues and knowledge gaps (ESAMAP, 2012).

These studies indicate that the dissemination of wastewater-to-energy systems is generally confined by a wide range of different barriers, rather than a few single ones. Some of the barriers are applicable to all water-related innovations. Others are unique to wastewater-to-energy systems, their specific type of technological or managerial solution, and the local or regional context the utility is situated in. This becomes obvious in studies that examine specific aspects of wastewater-to-energy systems, for example the "flexibilisation" of energy production and consumption in waste water treatments plants (WWTPs) for optimized energy supply (Dierich et al., 2017). Barriers concern cultural or behavioural aspects within the utility itself (e.g. low commitment of top management) as much as external conditions, for example low regulatory pressure to reduce energy consumption (ESAMAP, 2012). Identifying these barriers is a critical step in order to form measures for setting up framework conditions conducive to the uptake of innovative wastewater-to-energy systems.

As with any other environmental reform, improving the energy performance of wastewater utilities (WWUs) requires strong backing through legislation and policy at various political levels. In this report, we understand legislation and policy and the framework they form to include all laws, policies, regulations, strategies, rules and other instruments used to improve energy outcomes of WWUs. These affect a large host of disciplinary fields, like economics, spatial planning, finance, or utility governance and management relevant to wastewater-to-energy systems. implementing the framework, national and sub-national governments play a key role. They need to grant high-level political support for establishing national legislation and policies, take up the role of the regulator and financier, and initiate other important steps, such as creating a well-engaged and connected agency that provides leadership and coordinates efforts nation-wide (e.g. to produce necessary information like energy maps) (Vogt et al., 2010).

In overcoming key barriers, there are different types of legal and policy measures. With respect to heat generation in WWTPs, Kretschmer (2017) distinguishes between regulatory, incentive-oriented and actor-supportive measures. Necessary regulations, for example, require utilities to reduce CO2 emissions, to track and improve energy performance through energy audits, or to prescribe phasing out energy-inefficient

technologies. Incentives, in contrast, may link government funding or tariff reforms to the utility's energy performance. Or they remove subsidies for electricity that discourage utilities from taking steps towards more energy-efficient operations. Typical actor-supportive measures help utilities to gain access to information about new innovations, their costs, benefits, and available funding opportunities, or offer educational programs for and advice to utility staff. Governments can further establish policies to shore up financing, such as specific financial vehicles for investments in energy efficiency and renewable production in WWTPs or by facilitating access to cross-sector financing programs (e.g. climate funds).

2. Scope of the Study

The objective of deliverable 2.4.1 is to

I) examine the **legal and policy situation** with respect to energy efficiency (EE) and renewable energy (RE) production outcomes of WTPs in the five countries participating in the project REEF2Water;
II) identify the main **legal and policy barriers;**
III) and discern **drivers and existing approaches** to overcome them.

The analysis is based on **desktop research**, information compiled in D1.1.1 on the legal situation and experience of the authors themselves.

The aim of deliverable D2.4.1 is to contribute **to improving the legal and policy framework conditions** that are central for the uptake of wastewater-to-energy systems in each of the five countries. The resultant outcomes form the basis for D2.4.2, in which concrete recommendations for improving laws and regulations are provided. These will subsequently be shared and discussed with policy makers from the participating countries. Furthermore, D2.4.1 will form the basis of a position paper (D5.2.3), which identifies local legislation and regulatory barriers hindering REEF2Water regional implementation strategies, as well as measures to dismantle them.

The nature of the Reef2Water solutions implies that their implementation is affected by a **complex legal and policy framework**. Given that the solutions are part of the wastewater, energy, and solid waste system, a **cross-sectorial perspective** that relates to legal and policy aspects of each of these three systems was taken. This ensures that necessary **sector linking** is achieved in practice.

The analysis considers the **different ways to exploit energy** from wastewater, including energy from biogas production, on-site renewable generation and operational energy efficiency. Here, it is being distinguished between **thermal and electrical energy.** Given the project's particular ambition to enrich sludge through **organic substrates** in the treatment process, the analysis considers applicable legislation and policies of the solid waste system. Furthermore, as the project aims at exploring the potential for WWTPs to become local providers of energy, legislation and policies regulating **temporary energy storage** (such as power-to-gas solutions) and **feed-in into the grid** (including relevant

market-based mechanisms) are considered. All of these aspects are examined for **different political-administrative levels**, at which policy and legislation are given effect at (international/EU, national, federal, and municipal). This helps to locate barriers more precisely, as well as to find scale-sensitive measures to overcome them.

3. The EU-Legal and Policy Framework

3.1. Environmental policy and law making in the EU

This chapter summarizes the most relevant EU Directives affecting the implementation of measures to increase EE and RE production in WWTPs. It then analyses a range of legal and policy barriers that are central in doing so.

Directives form the most common regulation in the EU legislative framework. They set the standard conditions and rules. According to the Subsidiarity Principle, member states have to transpose these into national legislative systems, following a clearly defined timetable and a way that best suits national circumstances (LeBlanc et al. 2008).

While member states are aiming at the same goals, the means they use to achieve them can be quite distinct, the heterogeneous development of EU energy markets serving as a very good example.

3.2. Key drivers of wastewater-to-energy solutions and resulting trends across EU member states

The share of renewables in the EU energy mix reached 17 % in 2016. It increased twofold since 2004, being mainly driven by legally binding energy saving and decarbonisation targets (Edwards et al., 2016).

- Renewable energy markets have distinctly developed across member states in what regards their scale and composition of different renewable energy forms. For example, biogas is predominantly used to produce electricity while much of the heat potential remains unexploited (Kampman et al., 2016). Also, only some frontrunners such as Sweden actively pursue producing biomethane for the transport sector.

- Only a few countries, such as Spain, use sewage sludge as a main feedstock for biogas production, making it the feedstock being used the least overall (Scarlat et al., 2018). In most member states, such as Germany and Italy, crops dominate as a feedstock while the potential to use sewage remains largely untapped (Figure 1.).

- The EU has began to embrace a circular economy approach. Its stringent regulatory regime is changing waste streams and disposal options. Importantly, while bio-waste and sludge production increase (Zsirai, 2011), limits are put on landfilling, and particularly of biodegradable material. Applying sludge as a fertiliser and soil conditioner is still the preferred options in most member states, more stringent rules confine this end-use form (Spinosa 2010). Together these developments have driven wastewater-to-energy solutions.

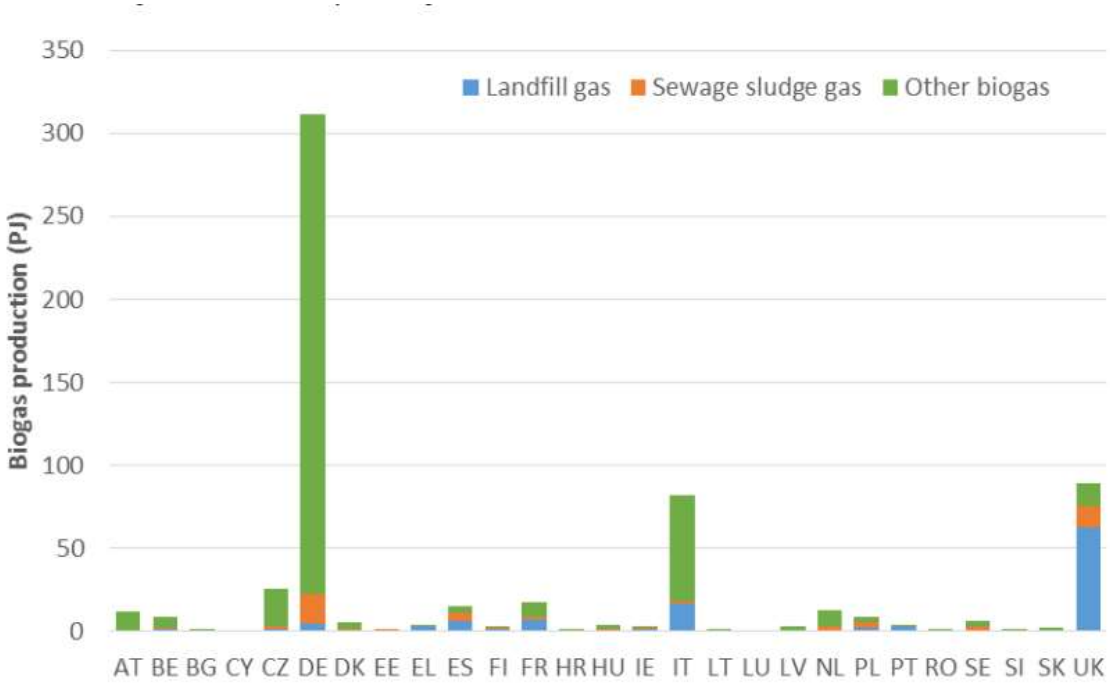

Figure 1: Biogas production per Member State in 2014, differentiated by source (Kampman et al., 2016)

3.3. Overview of key EU legislation and policies

3.3.1. Water & Wastewater

The Water Framework Directive (2000/60/EC)

This directive (here referred to as the WFD) requires that rivers, lakes, transitional waters, coastal waters, and groundwater obtain "good status" by 2027. To achieve this goal, the EU has determined a clear timeline and three six-year management cycles for the member states. One of its main elements is the introduction of River Basin Districts, which form the management units for managing water resources. Importantly, the WFD pertains to services of both water and waste water.

The Urban Waste Water Treatment Directive (91/271/EEC)

The main objective of the Urban Waste Water Treatment Directive (UWWTD) is to protect the environment from negative effects of urban wastewater discharges. It comprises the collection, treatment, and discharge of domestic wastewater, mixture of wastewater, and wastewater from certain industrial sectors. It stipulates the level of treatment and the removal of nutrients and basic sanitary parameters, as well as conditions for sludge disposal and reuse.

The Sewage Sludge Directive (86/278/ EEC)

The Sewage Sludge Directive (SSD) is concerned with the management of sewage sludge. It particularly seeks to encourage the use of sewage sludge as a soil conditioner and fertiliser in agriculture. It bans applying untreated sludge on agricultural land. Also, it sets all the requirements and provisions to prevent potential harmful effects on humans, animals, soil and vegetation as well as surface and groundwater. The Directive lays down the basic limits for potentially toxic elements (PTEs, which are HMs) in SS and soil.

3.3.2. Climate change mitigation

2020 Climate and energy package ("20-20-20 targets")

This package was established in 2007. Its goal is to ensure that the EU meets its climate and energy targets. In consequence, the legislation encompassed three main targets for the year 2020:

- 20% increase in energy produced from renewables
- 20% enhancement in energy efficiency
- 20% cut in greenhouse gas emissions (compared to 1990 level)

Emissions Trading System (ETS)

The ETS is a central element in the EU's policy to tackle climate change and a key tool for reducing greenhouse gas emissions in a cost-effective manner. It is based on a "cap and trade" system. The cab limits the amount of greenhouse gas emissions a certain user or industry is allowed to emit. As the cap is gradually lowered over time, emissions are expected to fall. Within the cap, companies receive or buy emission allowances that cover their emissions. These can be traded.

Effort sharing agreement for the non-ETS sectors

The Effort Sharing Decision establishes binding annual greenhouse gas emission targets for Member States for the period 2013–2020. These targets concern emissions from most sectors not included in the EU Emissions Trading System (EU ETS), such as transport, buildings, agriculture and also waste. The regulation aims to ensure that the non-ETS sectors emissions reduction target of 30% by 2030 compared to 2005 levels.

3.3.3. Renewable energy production and energy efficiency

Renewable Energy Directive (2009/28/EC)

The Renewable Energy Directive (RED),which is currently being revised, establishes a policy framework for producing and encouraging renewable energy in the EU, including biogas. The directive requires that 20 % of the EU's energy mix in 2020 must be renewable. It translates this general goal into individual targets for each of the member states. In a recent proposal to revise the directive the Commission elevated that goal to 27 % by 2030. The RED also defines sustainability criteria for biofuels and bioliquids in the transport sector.

Directive to reduce indirect land use change for biofuels and bioliquids ((EU/2015/1513)

The ILUC was established as response to sustainability challenges concerning bio-energy made out of food-based crops, most importantly indirect land-use change. It amends current legislation on biofuels, including the Renewable Energy Directive (2009/28/EC) and Fuel Quality Directive (2009/30/EC). For example, it limits the share of biofuels produced from crops in the transport sector (7% in overall fuel mix). It also requires that biofuels produced in new installations emit at least 60% fewer greenhouse gases than fossil fuels.

Energy Efficiency Directive (2012/27/EC)

The Energy Efficiency Directive (EED) mandates energy efficiency improvements. It establishes a common framework for the promotion of EE within the EU to meet its EE headline target of 20% by 2020, in all stages and sectors of the supply chain. EU member states have to prepare a National Energy Efficiency Action Plan every three years and report on their progress in the different sectors (i.e. industry, residential, services, public, transportation, electricity and heat generation).

Directive for combined heat and power generation (2004/8/EC)

This directive promotes the use of combined heat and power (CHP) units to improve the efficiency of electricity and heat production. It sets rules on guarantees of origin, efficiency criteria, administrative procedures, and other issues. Member states are encouraged to provide support schemes for CHP units to enable their widespread implementation (including specific support for WTTPs).

3.3.4. Natural Gas

Directive on services in the internal gas market (2009/73/EC)

This 'Gas Directive' establishes common rules for the transmission, distribution, supply and storage of natural gas. It stipulates rules relating to the organisation and functioning of the natural gas sector, access to the market, the criteria and procedures applicable to the granting of authorisations for transmission, distribution, supply and storage of natural gas and the operation of systems. The rules also apply in a non-discriminatory way to biogas and gas from biomass, i.e. sewage gas from WWTPs.

Directive for internal electricity market (2009/72/EC)

This directive establishes common rules for the generation, transmission, distribution and supply of electricity, together with consumer protection provisions, with a view to improving and integrating competitive electricity markets in the EC. It lays down the rules relating to the organisation and functioning of the electricity sector, open access to the market, the criteria and procedures applicable to calls for tenders and the granting of authorisations and the operation of systems such as transmission or distribution systems, including the request for unbundling of electricity production.

Directive for taxation of electricity and other energy products 2003/96/EC (EU 2003a) sets a framework for taxation of electricity and other energy products, e.g. gas or other fuels. It defines the energy products to be taxed and the minimum

amount. The project “Full scale demonstration of energy positive sewage treatment plant concepts towards market penetration” (POWERSTEP) has received funding under the European Union HORIZON 2020 –

3.4. Solid waste management

The Waste ´Framework Directive (2008/98/EC)

This directive defines basic concepts such as the “waste hierarchy” (a priority order set among waste prevention and management options), and stipulates requirements for waste management, such as to up a separate collection of waste, waste management plans, and waste prevention programmes. It also establishes legally binding targets such as for household waste streams including biodegradable materials).

The Landfill Directive (1999/31/EC)

This directive aims at preventing or reducing adverse environmental impacts from landfilling of waste through stringent technical requirements for waste and landfills. It obliges Member States to reduce the amount of biodegradable municipal waste that they landfill to 35% of 1995 levels by 2016 (for some countries by 2020) while current legislative of the proposal of it consider a complete ban of landfilling.

3.5. Legal drivers and barriers

Paucity of energy aspects and targets in water legislation

Energy-related issues remain vastly absent from the EU’s legal and policy framework of the water sector. The key water-related directives, the WFD and the UWWTD, make no provisions that specifically focus on targets, measures or incentives to improve EE or renewable production measures in WWTPs, whether motivated by ambitions of cost-efficiency or decarbonisation. Also, more recent water policy documents such as the “Blueprint to Safeguard Europe's Water Resources” (2012) poorly make that linkage. A legislative proposal of the Drinking Water Directive adopted this year comprises one of the first attempts to embrace the water energy-water nexus by encouraging member states to increase energy efficiency.

Lack of overall cross-sectoral and coherent legal framework

The absence of a cross-sectoral approach spanning across various relevant EU energy, waste, water, agricultural and other concerned directives stifles legal backing needed to more systematically support wastewater-to-energy solutions. Energy-related issues are missing in EU water sector policy and law, which predominantly focus on water quality and quantity goals. The RED, on the other side, fails to articulate specific provisions on how, for example, the waste water sector can contribute to achieving targets concerning carbon reduction and renewable production. Incoherence of the overall legal and policy framework has been ranked as the top barrier for biogas production (Kampmann et al., 2016).

Inadequate priorisation of second generation bio-energy

Member states have been free to opt through which form of renewable energy they accomplish these targets. This flexibility has given rise to divergent developments of the biogas market across the member states (Torrijos, 2016), with in part undesirable outcomes. A prominent example applies to the rise of crop-based biogas, which ranks as the EU's main type of bio-energy and dominant renewable energy form (Kampman et al., 2016). As a feedstock, however, crops have proven adverse environmental impacts (e.g. land use change). The environmental footprint of biogas produced from waste streams, in contrast, is significantly better, but their share in the biogas market lag behind that of crop-based biomass (see. Figure 1). This is because the EU legal and policy does not systematically support renewable energies according to their sustainability performance. Sustainability criteria, which form one central pre-condition towards doing so, exist only for the transport sector while they lack cross-national harmonisation (Kampman et al., 2016).

An improving yet unreliable base of bio-waste feedstock

The EU's stringent regulatory regime for waste functions as a strong driver for wastewater-to-energy systems. The Landfill Directive is viewed as the most important factor propelling the growth of anaerobic digestion (AD) (including on-farm applications) in treating biowaste and industrial feedstock (Edwards et al., 2015). This is because the ban on landfilling and tightening quota for reducing landfilled biodegradable organics increase the need to find solutions for disposing growing amounts of bio-waste (Torrijos, 2016). However, many member states do not have a reliable bio-waste feedstock base (Edwards et al., 2016). Only 25 % of the total bio-waste in the EU is recycled while recycling rates are considerably lower in many member states (Mateescu et al., 2008). In some countries like the UK, access to adequate organic feedstock is already a barrier (Kampman et al., 2016). Additionally, current regulations do not promote AD as a preferable disposal option for biowaste. Legal loopholes still allow member states incinerate or landfill biowaste (Iacovidou et al., 2012). The European Biogas Association (2016) remarks that incineration may become the main disposal option for biowaste as the as the landfilling ban takes effect.

Under-development of heat usage due to weak incentives

Whether WWTPs achieve high potential of energy and carbon emissions savings depends on exploiting both heat and electricity generated during the combustion of biogas. Biogas markets have expanded in several EU member states. However, despite some positive development, often only the electricity generated from biogas is used while the heat potential remains untapped. Currently, only 25 % of the heat is used in Europe's WWTPs (Scarlat et al., 2018). While plant operators face pressure to improve the economics of biogas plants (ibid), weak incentives at the EU-level comprise one key factor responsible for the slow development of heat usage from biogas (Kampman et al., 2016).

Lacking revenue streams for sewage-based co-digestate

Using co-digestate of sewage sludge and bio-waste as soil conditioner or fertiliser (for example in agriculture) can spur the uptake of wastewater-to-energy solutions (Edwards et al., 2015). Such "end-use" applications guarantee that sewage sludge,

whose production in Europe will rise over the next years (Werle, 2015), will be harnessed in the spirit of a circular economy. Currently, however, sludge-based co-digestates are subject to an incoherent and partially conflicting legal and regulatory regime (Iacavidou et al., 2012), which compounds the dissemination of AD technologies. One main barrier is that co-digestate containing sewage sludge is currently classified as waste and not a valuable product. This legal definition only allows WWTP operators to market the biogas, but not its by-products, undermining additional revenue streams (Kampmann et al., 2016).

Ambiguous financial mechanisms for wastewater-to-energy solutions

Access to inexpensive renewable energy will become increasingly important because the cost of sewage sludge treatment is bound to rise due to higher treatment standards and rising energy costs, among others (Zsirai, 2011). Cost pressures, which the imposed by the cost-recovery principle in the WFD, theoretically attractive for WWUs to deploy RE production. However, new technologies such as AD are capital-intensive, generally requiring subsidisation (Edwards et al., 2015). National support schemes (e.g. feed-in tariffs) form the key financial mechanism to drive renewable energy developments in the EU. However, these are still ineffective in many member states, for example due to low or reduced subsidies (Kampman et al., 2016). At the same time, the EU legislation and policies upon which the support schems are based are yet not sufficiently linked to sustainability criteria, as argued above. Furthermore, Green Public Procurement (GPP) for WWTPs currently apply only to EE, but not to producing RE (Loderer and Hananel, 2018).

Grid injection of bio-energy

If not used for self-supply in on-site CHP plants, WWUs have several options to bring bioenergy to the market: As biogas or biomethane via the gas network; as heat via the district heating network; or as electric power via the electric grid. Arguably, a range of barriers apply to each of these options. Generally, decentralized energy forms – such as wastewater-to-energy solutions – lack a common EU framework that explicitly supports them. Across member states + small market entrants providing distributed energy (DE) still face various challenges, including a lack of explicit incentives in planning and operations of networks, high connection charges, or high trading fees (Ropenus and Skytte, 2005). Another specific example concerns cross-border trade of biomethane, which is hindered substantially by national quality standards, which lack harmonisation (Kampan et al., 2016).

4. Overview on legal and policy situation in Croatia

4.1. National Level:

Waste management in the Republic of Croatia is stipulated by the Act on Sustainable Waste Management (OG No. 94/13 and 73/17). This Act defines measures for prevention and reduction of adverse impacts on human health and the environment

resulting from waste management and operations. These aim at reducing the overall quantity of produced waste, as well as recovering resources from waste.

The governing legislation for the waste management in Croatia is the following:

- The Environmental Protection Act (OG No. 80/13, 153/13, 78/15)
- Act on Sustainable Waste Management (OG No. 94/13, 73/17)
- Waste Management Strategy of the Republic of Croatia (130/05)
- Waste Management Plan in the Republic of Croatia for the period 2017-2022 (OG No. 3/17)
- Ordinance on Municipal Waste Management (OG No. 50/17)

EU legislation requires that the amount of organic material in municipal waste being disposed of at landfills in the Republic of Croatia is reduced by 65 % until 2020 compared to 1997 levels. The main objectives defined in the Waste Management Plan (OG No. 3/17) for the period 2017 to 2022 are therefore to increase the fraction of separately collected waste and to reduce the share of biodegradable waste in municipal waste. The Act on Sustainable Waste Management sets out the following objectives to reduce gaseous effluents being emitted from disposed waste with high shares of biodegradable components:

- By 2012 the share of biodegradable municipal waste deposited to landfills must be reduced to 75% of the mass share of biodegradable municipal waste generated in 1997;
- By 2015 it must be reduced to 50% of the mass share generated in 1997;
- By 2020 it must be reduced to 35% of the mass share generated in 1997.

The mandatory obligation to implement separate collection intends to use therewith increased bio-waste yields in composting, anaerobic digestion and incineration with energy recovery. The law also defines the priority order of waste management. Prevention of waste comes first in this order. The implementation of the measures stipulated by bio-waste-related legal provisions is likely to increase the cost of waste disposal, which, from an economic point of view, justifies to avoid producing waste in the first place.

Measured by their authority and thematic mandates, the following institutions are the most important actors in the waste management sector in the Republic of Croatia:

- The Croatian Parliament and the Government of the Republic of Croatia are State Authority Bodies. The key role of the Parliament is to adopt waste-related legislation and national strategies such as the Waste Management Strategy of the Republic of Croatia. The Government adopts the Waste Management Plan and its implementing legislation (such as decisions to be made or annual reports), but also proposes relevant legislation and strategies to the Parliament. Another key mandate of the Government is to ensure framework conditions for and prescribe measures to manage hazardous waste, including incineration.
- The Ministry of Environment and Nature Protection is a State Administration Body and is mainly responsible for preparing new legislation and standards (e.g. the National Waste Management Strategy and National Waste

Management Implementation Plan), implementation of measures (especially for hazardous waste management), supervision and enforcement of secondary legislation, monitoring the Croatian Environment Agency and Environmental Protection and Energy Efficiency Fund, etc.

- The Environmental Protection and Energy Efficiency Fund is an extra-budgetary institution owned by the Republic of Croatia, its purpose being to finance environmental protection programs and projects. The fund also functions as a regulatory institution, among others imposing fines in the context of pollution offenses related to hazardous and non-hazardous industrial waste.
- The Croatian Environment Agency (CEA) is a public institution established by the Government, primarily collecting processes and providing data required for the efficient implementation of the environmental protection policy.
- The Counties and the City of Zagreb are regional self-governing bodies which are responsible for managing all types of waste in their respective jurisdiction. They also develop and provide waste management plans. Furthermore, they gather and submit data on waste. The counties' state administration offices issue permits for non-hazardous waste management.
- At local level, towns and municipalities are self-governing bodies responsible for managing municipal waste, preparing waste management plans and determining locations for waste disposal or recycling yards in spatial plans for their respective areas. Municipal waste is managed by the public utility services.

Other actors involved in waste management are private companies that are registered and entitled to carry out the collection and transport, recovery and/or disposal of waste, as well as consulting firms or other professional and non-governmental organisations.

4.2. Federal Level and Municipal Level:

Counties and cities in Croatia implement laws and can decide how they interoperate the adapted legislation. Regarding the waste management in Croatia, separate collection of waste and charging of waste collection services by amount have become mandatory in Croatia when the Decree on the Management of Municipal Waste came into force on November 1, 2017.
Subsequently, every local self-government in Croatia had to decide on how to provide public services for the collection of mixed and biodegradable municipal waste while complying with the above mentioned Ordinance. Non-compliance with this regulation implies fines pursuant to the Law on Sustainable Development. This also concerns the Croatian Government if it breaches EU waste directives.

The EU Waste Framework Directive and Act on Sustainable Waste Management require that by 2022 50 % of municipal waste is re-treated and recycled, compared to 18 % as of now.
In January 2018 the government of Zagreb adopted a legislative amendment concerning the public service to collect mixed municipal waste and biodegradable municipal waste in Zagreb. According to it, the waste management company (ZCH) is

responsible to implement source-separation of bio-waste, which ZCH is expected to begin in 2018.

5. Main legal and policy barriers in Croatia

The lack of national support schemes is the main barrier impeding the development of EE and RE measures in WWTPs. Additionally, waste management is another large challenge facing Croatia's environmental sector. To obtain EU standards, for example recycling targets, is a demanding task for the government. An analysis carried out in the context of the National Waste Management Plan estimates that the organic share in household waste is 37 %. According to the Waste Management Plan, the municipal waste management system will focus on introducing separate collection of municipal waste, which implies to build the necessary infrastructure: at the origin waste creation, via recycling yards, on public surfaces and through implementing the regulations for special categories of waste (packaging waste, waste tires, etc.).

Separately collected bio-waste will be taken for material recovery in facilities for biological (aerobic or anaerobic) treatment of separately collected bio-waste (composting plant or anaerobic digestion), in order to produce compost or digestate and biogas.

Beside the Sustainable Waste Management Act, the Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (OG 3/17) also defines the quantitative targets and deadlines for increasing the amount of separately collected and recycled waste but also the quantitative targets related to the reduction of biodegradable municipal waste disposed to landfills are established. By the end of 2020, the share of biodegradable municipal waste disposed of in landfills must be reduced to 35% compared with 1997 levels.

Strategic guidance for solid waste management

Poor management of waste is among the main challenges the City of Zagreb confronts. Currently, the main portion of municipal waste is disposed of at the landfill site Jakuševec. In the last couple of years systematic actions have been undertaken to increase the quantity of separately collected waste. However, the absence of strategic documents providing waste management concepts or practical guidance for separate waste collection constitutes a serious barrier. To produce bio-energy at the Zagreb WWTP, exploring aspects around the utilization of bio-waste plays a key role. Therefore improving the separate waste collection system is one of the first and necessary steps to be taken for the City of Zagreb.

Low financial Support for bio-energy production

The key driver for encouraging the application of biogas for electricity generation, as well as for co-fermentation technologies, is incentives. In Croatia, these mainly come as feed-in tariffs, which depend on the type of feedstock, plant size and capacity for electricity generation. The WWTP in Zagreb is currently receiving feed-in tariff for RE production. However, the FIT system was suspended in 2015. Hence there is currently no

support scheme promoting RE production in Croatia. The wholesale prices of electricity in Croatia have been moving around 36-40 EUR/MWh in the past few years, according to the Croatian Energy Regulatory Agency (HERA) Annual Report from 2016. The regulated buy-off price at which the suppliers purchase electricity according to the Tariff system for the generation of electricity from RE sources was continuously higher (around 70 EUR/MWh). This made grid injection more attractive than self-supply from economic point of view. However, this is only relevant for RE producers who applied prior to 2015 for subsidies by the FIT system.

Unsustainable sludge management

Another main barrier faced by the WWTP in Zagreb relates to disposal of sludge, which is still done without making use of its resource recovery potential. Various solutions for the treatment and final disposal of sludge at the WWTP in Zagreb have been considered and studied for several decades now. However, the city of Zagreb has not finally decided on and issued legal provisions for disposing sludge in a sustainable way. This is why sludge is still mostly landfilled in the vicinity of the WWTP at present. Restrictions such as prohibitions to apply sludge in agriculture during certain times or health concerns have led to a ban of sludge application in agriculture in Croatia. Plans for an incinerator in the city's area of Resnik were abandoned by the Zagreb's authorities due to public opposition.

Discrimination of small energy providers

Small energy providers, such as WWTPs, which are willing to gain grid access and sell energy must pay high connection costs because WWTPs in Croatia are mostly build outside the urban area. These WTTPs do often not have access to the existing electricity network. To gain access, additional infrastructures are required, the costs of which operators have to bring up themselves. These additional costs lower the ability to feed surplus energy into the market in a way that is financially sustainable.

6. Drivers and existing approaches to overcome barriers in Croatia

Croatia currently lacks a nationwide public support scheme which supports RE production in WWTPs. The fixed feed-in tariffs, which were in place, acted as the most important driver. Stipulated in the Croatian Electricity Act, they guaranteed WWTP operators a fixed price, which had to be above that of the market. Every producer, who held the status of "qualified producer" and has signed a formal agreement with the Croatian Energy market Operator (HROTE) had the right to receive this incentive depending on the type of RES technology and power output of his RES-E plant, as is defined in the Tariff System (OG No.100/15).

Feed-in tariffs were paid depending on the size of the installation and its efficiency. Defined quotas for guaranteed purchase of electricity until 2020 are 70MW for biogas (including waste gas and gas from wastewater treatment plants). New law introduced

feed-in premiums (FIP) but has still not been implemented due to numerous undefined by laws.

In January 2018 City of Zagreb adopted the Decision on the manner of performing the public service of collecting mixed municipal waste and biodegradable municipal waste and services related to public service in City of Zagreb which should be a good start for further utilization of biowaste within the WWTP in Zagreb. City of Zagreb is currently in phase of preparing of the local Waste management plan which is pre-requisite for introducing a source separated bio-waste system. As already mentioned, the plan should be finalized in the next period.

7. Appendix I: Questionnaire for Legal and Policy Barrier Analysis

This questionnaire is intended for gathering primary and secondary data needed to accomplish D2.4.1. There is no obligation to use it, but you may find it useful drawing on all or several of the proposed guiding questions.

- Conduct 5-10 interviews with experts such as utility staff or policy makers and other experts, separately or in focus groups;
- Adjust questions according to the type of interviewed respondent, characteristics of the treatment facility and utility and country context.

Legal and Policy Barriers in Country X

1. How conducive is the legal and policy framework in supporting the implementation of EE and RE measures in the WWTP(s) of your country?

2. Can you outline and describe in detail the most significant legal and policy barriers, differentiating between the main ways for exploiting energy from wastewater where relevant (such as improving operational energy efficiency or generating electricity and heat from biogas)?

3. Can you identify the political level(s) at which legal and policy barriers may be most severe (EU/International, national, federal and local)?

4. Does the legal and policy situation support or impair interventions for exploiting waste heat more than electricity or vice versa? If so, what barriers apply?

5. Which legal and policy barriers constrain WWUs from using surplus heat and electricity for self-supply?

6. What legal and policy barriers impede supplying waste heat or electricity to the market in your country? For example, regulations may prohibit WWUs from

entering business other than managing wastewater while low subsidies for RE might constrain them to gain financial sustainability.

7. What legal and policy barriers particularly apply for integrating systems of solid waste and wastewater to use organic substrates for enrichment of sludge in the co-fermentation process?

Policy and legal drivers and approaches to overcome barriers in Country X

8. Can you outline and describe the most significant legal and policy drivers, differentiating between the main ways for exploiting energy from wastewater where relevant?
9. What governmental or private sector actors do you consider most critical for improving the legal and policy framework for wastewater-to-energy systems?
10. What actor-based instruments (such as a central agency to coordinate interventions with respect to energy-related matters or specific funding or educational programmes) have been established to promote wastewater-to-energy systems?
11. Are you aware of legal and policy interventions that are currently being planned or already under way to overcome the main barriers you mentioned above (e.g a revision of the sludge ordinance or law with respect to CHP?)

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