Interreg CENTRAL EUROPE

European Union European Regional Development Fund

REEF 2W

DT 1.2.1

BASE LINE ANALYSIS OF THE CURRENT SITUATION IN THE TARGETED UTILITY COMPANIES/ TERRITORIES

30/11/2017

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1. INTRODUCTION

LP collected the baseline analysis prepared by multi-utilities PPs in their respective territories in order to better monitor and assess the level of innovativeness that will be achieved by the project.

Scope of the project is to identify the best strategies and applicable technologies to improve the energy efficiency in the wastewater and waste treatment platforms.

The project will focus on the 5 pilots involved, developing tools able to identify the better path for the best possible results taking in consideration all the relevant aspects: technical viability, investment costs, management cost, social acceptance, and framework legislation, without negative effects for the environment.

Each of the 5 pilots have different starting situations, some of them are already well-structured, others just at the beginning of their pathway.

Even the final point for each pilot will be decided according to the different local situations, particularly the available subsidies for electricity or biofuel production and the political approach of the communities with their higher or lower interest for the use of renewable energies and for the contribution they can give to the problem of greenhouse gasses emissions and related climate change.

In this framework, deliverable DT 1.2.1 shows the starting point of each pilot defining the current situation of the partner utilities and for their territories.

2. DESCRIPTION OF THE TEMPLATE FOR THE BASELINE ANALYSIS

A template has been developed (annex 1) to collect the relevant information useful to properly describe the actual situation of the pilot sites.

The template considers not only the technological aspects of the pilots, but also the information regarding the geographical, social and legal framework of the pilot locations.

This wider approach has been decided with the scope to gather basic information also useful for the development of other parts of the project.

Information reported in the next paragraphs was provided by each partner filling in the template.

3. PILOT SITE MONTEFELTRO SERVIZI

The High Valmarecchia, crossed by the river of the same name, is enclosed between Tuscany, the Marche, the Republic of San Marino and Emilia-Romagna of which it is part.

The valley goes from the central Apennine to Rimini, in the heart of the Romagna Riviera, ranging from soft clay hills to sandstone and limestone spikes that rise here and there. It has always been a disputed territory and has a monumental and art heritage among the most singular in Italy, rich in some of the most beautiful fortresses, of boroughs with walls and towers, beautiful churches, small and great stories, linked to fights that saw the big families of Montefeltro and Malatesta antagonistic.

The High Valmarecchia is the ancient heart of Montefeltro: meta and stay since ancient times of famous men, from Dante to San Francesco, from Cagliostro to Ezra Pound; has recently reinforced its tourist attractiveness.

High Valmarecchia offers varied natural landscapes, dense woods, habitat of a rich and characteristic fauna, all enriched by sudden panoramic balconies, where the gaze is lost on the horizon, until you can see the sea. The Natural Park of Sasso Simone and Simoncello, of 4847 hectares, is located in the provinces of Rimini-Pesaro and Urbino, representing the 50% of Pennabilli's municipal territory.

By law no. 117 of August 3, 2009 the municipalities of Casteldelci, Maiolo, Novafeltria, Pennabilli, San Leo, Sant'Agata Feltria and Talamello from the Marche Region were aggregated to the Emilia-Romagna Region, within the province of Rimini, pursuant to Article 132, second paragraph, of the Italian Constitution.

Short description of the municiplities of the Valmarecchia

CASTELDELCI
surface area km^2: 49,21

altitude: 436 – 1355

inhabitants: 460

MAIOLO
surface area km^2: 24,40

altitude: 212 – 950

inhabitants: 830

NOVAFELTRIA

surface area km^2: 41,78

altitude: 164 – 883

inhabitants: 7.126

PENNABILLI

surface area km^2: 69,66

altitude: 298 – 1375

inhabitants: 2.850

SAN LEO

superficie in kmq: 53,32

altitude: 122 – 787

inhabitants: 2.945

SANT'AGATA FELTRIA

surface area km^2: 79,30

altitude: 174 – 961

inhabitants: 2.130

TALAMELLO

surface area km^2: 10,53

altitudine: 213 – 861

inhabitants: 1.088

Montefeltro Servizi S.r.l is a public company (in House) with share capital of Euro 119,000.00, owned by the 7 municipalities that are its members.

The administrative headquarters are located in the municipality of Novafeltria in Piazzale Kennedy, while there are three operating venues:

- one located in Novafeltria, in via della Stazione we have a garage for all the trucks and operating machines;

- two located in the municipality of Maiolo in Cavallara: the Inter-municipal Environmental Center and the trans-shipment Center.

The Company carries out the following services:

- Environmental hygiene;
- Collection of urban solid waste unsorted and differentiated;
- Management of the Inter-municipal Environmental Center;
- Cemetery Services;
- Public announcements;
- Management of public parks.

The Company consists of a sole Director and 25 employees, of which 4 administrative / technical and 21 operators with different tasks.

The Company carries out its activities in the territory of the 7 Municipal Members which reaches an area of 328,26 Kmq with 17.374 inhabitants, representing 40% of the territory of the Province of Rimini and 5% of the total population of the Province.

The undifferentiated and differentiated collection is managed by Montefeltro Servizi on 6 Municipalities out of the total 7 of the High Valmarecchia; Novafeltria, San Leo, Talamello, Pennabilli, S. Agata Feltria and Casteldelci, while the municipality of Maiolo performs it internally, for economic reasons.

Collection of the undifferentiated fraction is carried out through road harvesting while for differentiated collection two systems are adopted: road harvesting through the proximity system and direct delivery to the Inter-municipal Environmental Center, to which citizens of all municipalities can directly confer.

3.1. NATIONAL AND LOCAL WASTE MANAGEMENT LEGISLATION

D. Lgs.. April 3, 2006, no. 152 on "Environmental Standards";

D.L. 18 October 2012, n. 179, converted from l. December 17, 2012, no. 221 on "Further urgent measures for the growth of the country", art. 34, paragraph 20;

D.L. August 13, 2011, no. 138, converted, with modifications, in l. September 14, 2011, no. 148, on "Further urgent measures for financial stabilization and development", art. 3-bis;

LR Emilia Romagna, September 6, 1999, no. 25 "Delimiting optimal territorial spheres and disciplining the forms of cooperation between Local Authorities for the Integrated Water Service and the Urban Waste Management Service";

LR Emilia Romagna 23 December 2011, no. 23 on the "Territorial organization rules for the functions of the local public services of the environment", the Territorial Agency of Emilia Romagna for water and waste services (ATERSIR), composed of the municipalities themselves, which are included in the social quotas; in the management of these local public services of economic significance ATERSIR has the function of establishing the best possible territorial areas of reference, establishing its management through trust, determining costs.

LR Emilia Romagna No.16 of 5 October 2015 "Provisions to support the circular economy, the reduction of urban waste production, the re-use of end-of-life goods, differentiated collection and amendments to Regional Law no. 31 (Special Discipline Disposal Scheme for Waste Disposal) "art. 9 and 10 Regional Law Amendment 23 December 2011, n. 23.

WASTE SERVICE

The Integrated Waste Management Service (SGRU) consists of a range of activities to optimize waste management, including road sweeping activities and must be managed in accordance with principles of efficiency, cost-effectiveness, transparency, technical and economic feasibility and in compliance with national and EU standards.

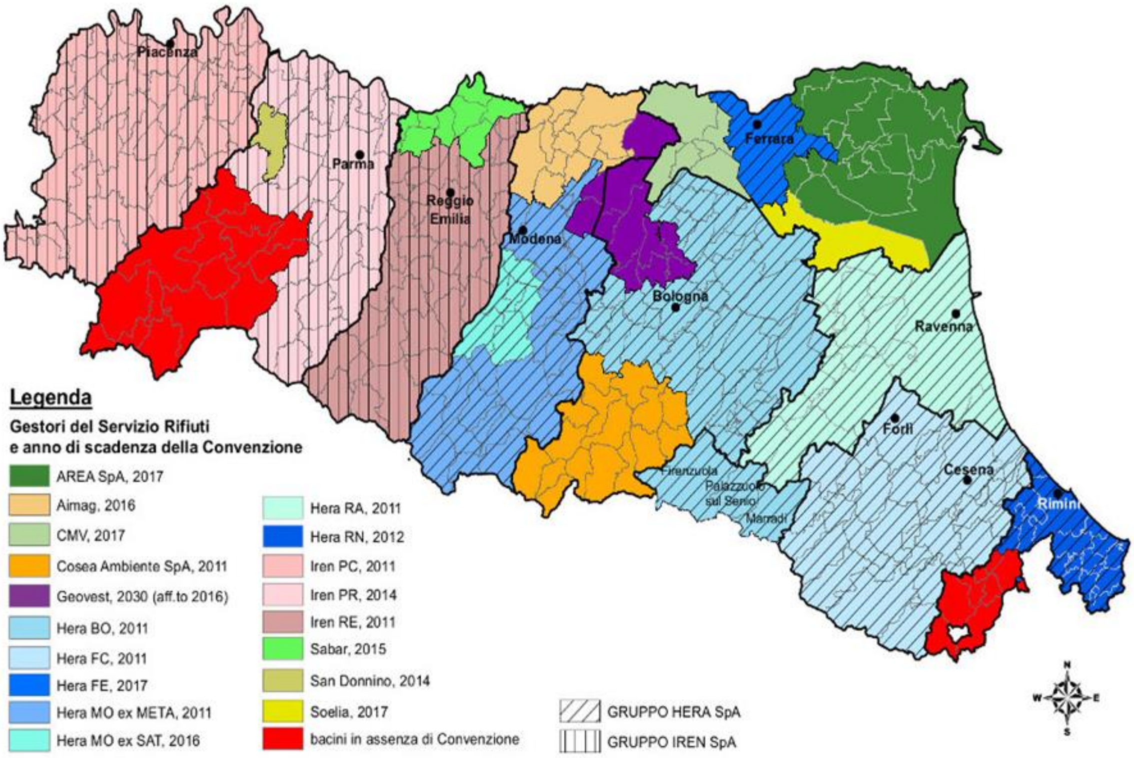
The Integrated Waste Management Service is organized, as envisaged by Legislative Decree 152/2006 "Uniform Text of the Environment" based on the best territorial areas identified by each Region, together with the definition of the specific sphere of government. Government of the area that the Emilia Romagna Region, with Regional Law no. 23/2011 has entrusted to ATERSIR, which, in compliance with national and EU legislation on the reliance of local public services of economic importance, provides, distributes and manages the integrated waste management service.

The functions of ATERSIR relate in particular to the organization of the services, the choice of the management form, the determination of the tariffs to the users in matters of competence, the management and its control.

Waste management takes place in accordance with the hierarchy enshrined in the EU Directive 98/2008 / EU, aiming to identify, in order of priority, the best environmental option.

Since the approval of Regional Law no. 25 of 1999 and until December 31, 2011 the system of regulation and organization of the integrated water service and integrated waste management service in Emilia-Romagna was mainly based on the provincial-level action at the nine Agencies Territorial Optimal, special forms of cooperation between local authorities. Each agency operates on the basis of a convention concluded between all the municipalities of each province and the province.

With L.R. 23/2011, the Emilia-Romagna Region has identified a single optimal territorial area comprising the entire regional territory (and possibly in special cases also external communes adjacent to the regional border) by reassigning the functions of provincial agencies to a new public body with autonomy administrative, accounting and technical services, the Emilia-Romagna Territorial Agency Water and Waste Services (ATERSIR).



The red area at south east of the map is the area served by Montefeltro servizi.

3.2. AMOUNT OF MUNICIPAL SOLID WASTE COLLECTED AND PRUNINGS COLLECTED

As for the collection of organic waste, it is currently carried out in 3 Municipalities out of seven and precisely Novafeltria, Talamello and San Leo.

Within a few days, Sant'Agata Feltria will also begin collecting the organic fraction experimentally and will become official from 01/10/2017.

The table below shows the quantities collected annually; it shows a steady increase in waste collected both for organic and for garden pruning and mulching.

Differentiated wastes			
Tipology of waste	CER code	Year	quantity KG
Organic Fraction	200108	2011	150.019
Pruning	200201	2011	1.452
Total KG.			**151.471**

Organic Fraction	200108	2012	193.179
Pruning	200201	2012	2.307
Total KG.			**195.486**
Organic Fraction	200108	2013	231.610
Pruning	200201	2013	15.960
Total KG.			**247.570**
Organic Fraction	200108	2014	258.119
Pruning	200201	2014	94.370
Total KG.			**352.489**
Organic Fraction	200108	2015	253.407
Pruning	200201	2015	133.080
Total KG.			**386.487**
Organic Fraction	200108	2016	312.292
Pruning	200201	2016	195.001
Total KG.			**507.293**

Annual costs for the waste disposal during the year 2017.

- cost for organic fraction 90,00 euro/ton
- costs for pruning 35,00 euro/ton

Organic fraction is processed in the composting platform of Sogliano al Rubicone.

4. PILOT SITE SCHÖNERLINDE BERLIN

4.1. GENERAL DESCRIPTION OF THE AREA

Berlin is the capital and the largest city of Germany with a population of approximately 3.7 million1. Berlin's population is still growing in a fast pace, being an attractive destination for migrants. The water supply and wastewater treatment play an important role in this mega-city in providing a sustainable and safe water supply for its residents. Berlin is served by one of the largest water and sewer companies in Germany Berliner Wasserbetriebe (Berlin Water Works – BWB), which provides 3.7 million people in Berlin and Brandenburg with drinking water, as well as collection and advanced biological wastewater treatment.

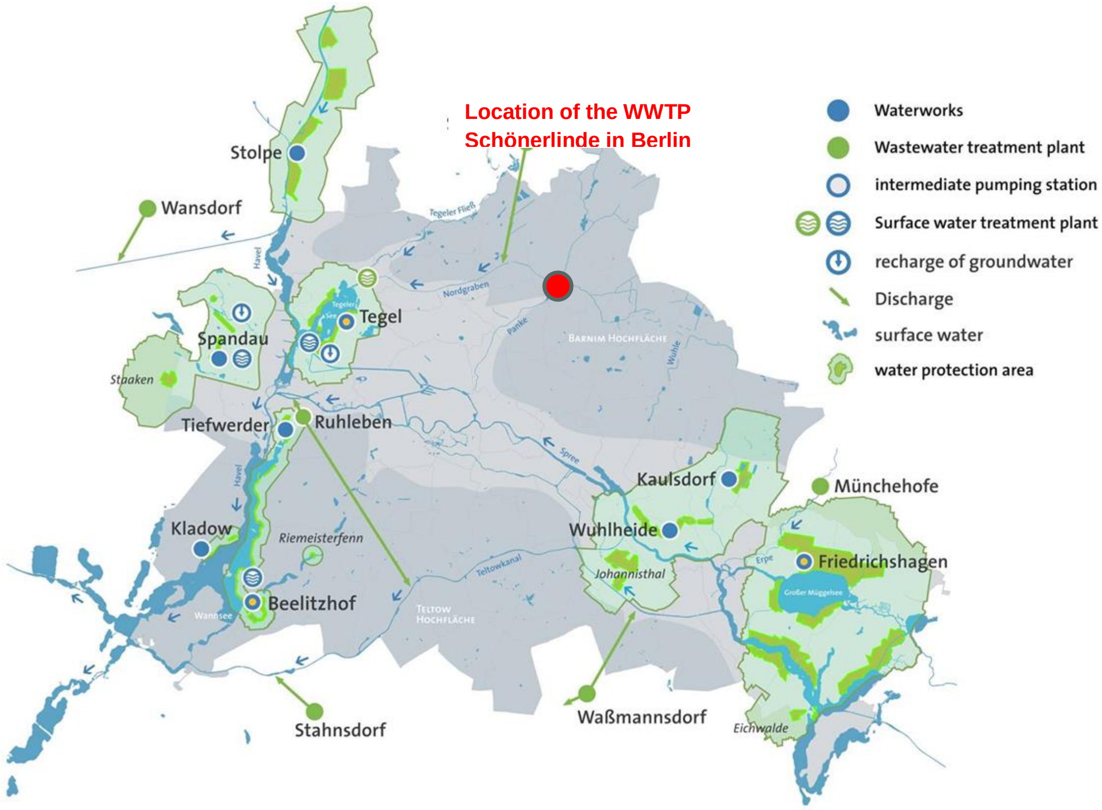


Figure 1: The location of Schönerlinde sewage treatment plant in Berlin (Source: BWB)

[1] Source: "Boom hält an. Berlin zählt mehr Einwohner.". Amt für Statistik Berlin-Brandenburg (in German). https://www.morgenpost.de/berlin/article211682483/Boom-haelt-an-Berlin-zaehlt-mehr-Einwohner.html

Around 245 million cubic metres of wastewater were treated at 6 sewage treatment plants in 2016 by BWB. This wastewater is transported by 160 pumping stations through a total of 9,710 kilometres of sewer networks and 1,181 kilometres of force main networks (Gnirss, 2017). With the growth of the city, a semi-closed urban water cycle has been established in parts of the city area and its surroundings. At some bank filtration sites the surface water is strongly influence by treated domestic wastewater. The demonstration site WWTP Schönerlinde sewage treatment plant is in operation from 1985 and located in the north of Berlin in Wandlitz, OT Schönerlinde (Figure 1). The effluent from the wastewater treatment plant in Schönerlinde is released into the Nordgraben channel that confluences with the river Tegeler flow. The tegel lake water is used for bank filtration and artificial groundwater recharge. The treated wastewater portion is close to 50% in the winter period and 33% in the summer half year (Jekel and Gruenheid, 2008). Thus, The WWTP Schönerlinde is one of the important wastewater treatment plants for the water cycle in Berlin with a treatment capacity of 105.00 cubic meters per day (dry weather). Figure 2 shows the aerial view of this plant with three wind turbines.

Figure 2: Aerial view of wastewater treatment plant Schönerlinde in Berlin, Germany (source: BWB, Simanzik)

The BWB has always been progressive when trying to generate its own energy. Currently, 70 percent of the energy required to operate its six wastewater treatment plants is generated from biogas and sludge. In 2012 BWB installed three wind turbines, each with an output of two megawatts at the wastewater treatment plant

Schönerlinde. While the cost of installing the turbines was EUR 11 million each, the three wind turbines combined produce 80-90% percent of total energy required to run the plant, saving BWB significant energy cost (Brears, 2017). Due to exceeding of limit values for heavy metals under the Sewage Sludge Ordinance in the sludge from all sewage treatment plants, all generated sewage sludge at BWB is disposed by co-incineration or mono-incineration (Franzke, 2011). In order to utilize the thermal energy of sludge completely and recover more phosphorus in accordance with the new sewage sludge ordinance, the BWB will start the construction of a mono-incineration plant in 2022 (BWB, 2017b).

4.2. LEGAL FRAMEWORK

The Schönerlinde sewage treatment plant is owned by the Berliner Wasserbetriebe (BWB). BWB is a public law corporation, is the largest company in the field of water supply and wastewater treatment in Germany with a long tradition. Since the treated wastewater is discharged into the Berlin rivers, the Berlin water authority is responsible for the discharge licence and water quality. The sewage treatment plant is located in Brandenburg, so the land Brandenburg has the permission for operation. The authoritative law for air quality control in the unit of sludge drying is the Federal Immission Control Act (Bundes-Immissionsschutzgesetz, BImSchG).

4.2.1. NEW SEWAGE SLUDGE ORDINANCE IN GERMANY HAS ENTERED INTO FORCE

The German Sewage Sludge Ordinance of 1992 has been amended in order to return the valuable constituents of sewage sludge (phosphorus) to the economic cycle more intensively. The Ordinance on the Reform of Sewage Sludge Utilisation of 27 September 2017 entered into force on 3 October 2017 (BMUB, 2017). The new ordinance will make phosphorus (P) recovery from sewage sludge obligatory, for WWTP larger than 50,000 person equivalents (p.e.) will have to recover the phosphorus if the sludge contains more than 2% phosphorus /DS (dry solids) or have to incinerate the sludge in mono-incinerators.

4.2.2. SEWAGE SLUDGE DISPOSAL IN BERLIN

Due to exceeding of limit values for heavy metals under the Sewage Sludge Ordinance in the sludge from all sewage treatment plants, it is not possible to transfer it to agricultural areas. The addition of sewage sludge, together with other organic materials into plants for composting was carried out for partial quantities until mid-2002, however, this was discontinued due to the aforementioned limit value excesses. Landfilling of the sewage sludge without further pre-treatment has been prohibited for legal reasons (Technical Directive on Municipal Waste/German Waste Storage Ordinance 2001/Landfill Directive 2009) since 2005.(Franzke, 2011)

The disposal methods for sewage sludge in Berlin currently used by Berliner Wasserbetriebe are mono-incinerated in the sludge incineration plant in Ruhleben, as a secondary fuel in power plants (thermal recycling) or in a cement works nearby Berlin (material and thermal recycling). A new mono-incineration plant is under construction.

4.2.3. GERMAN LEGAL FOR ENERGY PRODUCTION AND CONSUMPTION AT THE WASTEWATER TREATMENT PLANT

The legal framework of energy management in Germany is highly complex. For the wastewater sector, five main laws are relevant for energy production and consumption at the wastewater treatment plant (WWTP)(Ravn et al., 2017):

- Energiewirtschaftsgesetz – EnWG ((EnWG, 2017)) (Energy Economy Law)
- Erneuerbare-Energien-Gesetz – EEG ((EEG, 2017)) (Renewable Energy Sources Act)
- Kraft-Wärme-Kopplungsgesetz – KWKG ((KWKG, 2016)) (Combined Heat and Power Act)
- Stromsteuergesetz – StromStG ((StromStG, 2016)) (Electricity Tax Law)
- Energiesteuergesetz – EnergieStG ((EnergieStG, 2017)) (Energy Tax Law)

Whereas the EnWG regulates the general energy market (e.g. consumption and production of energy, sales, grid management, etc.), the EEG is focused on the promotion and management of RE in form of rules for grid supply, subsidies for RE, and taxes for other energy sources to cover the societal cost of the energy transition. For combined heat and power (CHP) generation, the KWKG regulates subsidies for energy from CHP units to promote this very efficient use of energy sources at smaller scale. The StromStG regulates the taxable use of electricity, also including the waiving of electricity tax for self-consumption. Sewage gas is also a combustible gas according to the EnergieStG, but is currently freed from this tax. (Ravn et al., 2017).

There are three routes energy valorisation at WWTPs:

(1) production of electricity at the WWTP for self-supply and for grid supply

(2) odu self-s of heat for external supply

(3) se heat fo of biomethane for grid injection or as biofuel for vehicles

For Germany, covering WWTP electricity demand with self-supply seems the most economical option due to the high electricity price in the market, which can be avoided with self-supply. The market price is more than 170 €/MWh, which is mainly determined by taxes and fees (80%) and only partially by the market price (20%). Self-supply is an attractive option to avoid these significant costs by producing electricity on –site to cover the demand of the WWTP, for example in a CHP unit. For grid supply of electricity, subsidy schemes have been reduced in recent revisions of the RE energy laws, so that this route is becoming less attractive. Potentials in heat sale are heavily depending on local conditions (demand) and availability of heating grids (e.g. district heating) nearby. Bio methane production may be a viable option for the future due to the constant prices at the gas market and the rising demand of "green" gas for policy targets in the heating and transport sector. (Ravn et al., 2017).

4.3. THE MOST IMPORTANT STAKEHOLDERS

The most important stakeholder to improve the energy efficiency and renewable energy resources production is finally the customer. The following stakeholders determines the improvement of energy and efficiency / energy production through renewable energy:

- Climate Protection Agreement BWB – Senate of Berlin
- Guide values e.g. the DWA (German Association for Water, Wastewater and Waste)
- Benchmarking of sewage treatment plants (Schönerlinde participates in Germany-wide comparison)

- BWB company

4.4. TECHNOLOGICAL DESCRIPTION

The wastewater in Schönerline is treated by mechanical and biological processes with biological phosphate elimination in combination with nitrification and denitrification. The sewage sludge is digested in digesters with mesophilic digesting at approx. 35°C and subsequently drained in centrifuges. Figure 3 give an overview of the treatment process at Schönerline sewage treatment plant. The following technical dates are from the information sheet of BWB (BWB, 2017a).

4.4.1. TREATMENT CAPACITY:

105,000 cubic meters per day wastewater (dry weather), approx. 850,000 population equivalent (based on BOD5 value)

Mechanical treatment:

Five rake screens remove 1.5 tons of screenings from the wastewater daily. Three aerated double grit chamber classifier approximately two tons of sand per day. Eight rectangular sedimentation tanks are available as Pre-treatment tanks with a total volume of 14,800 cubic meters.

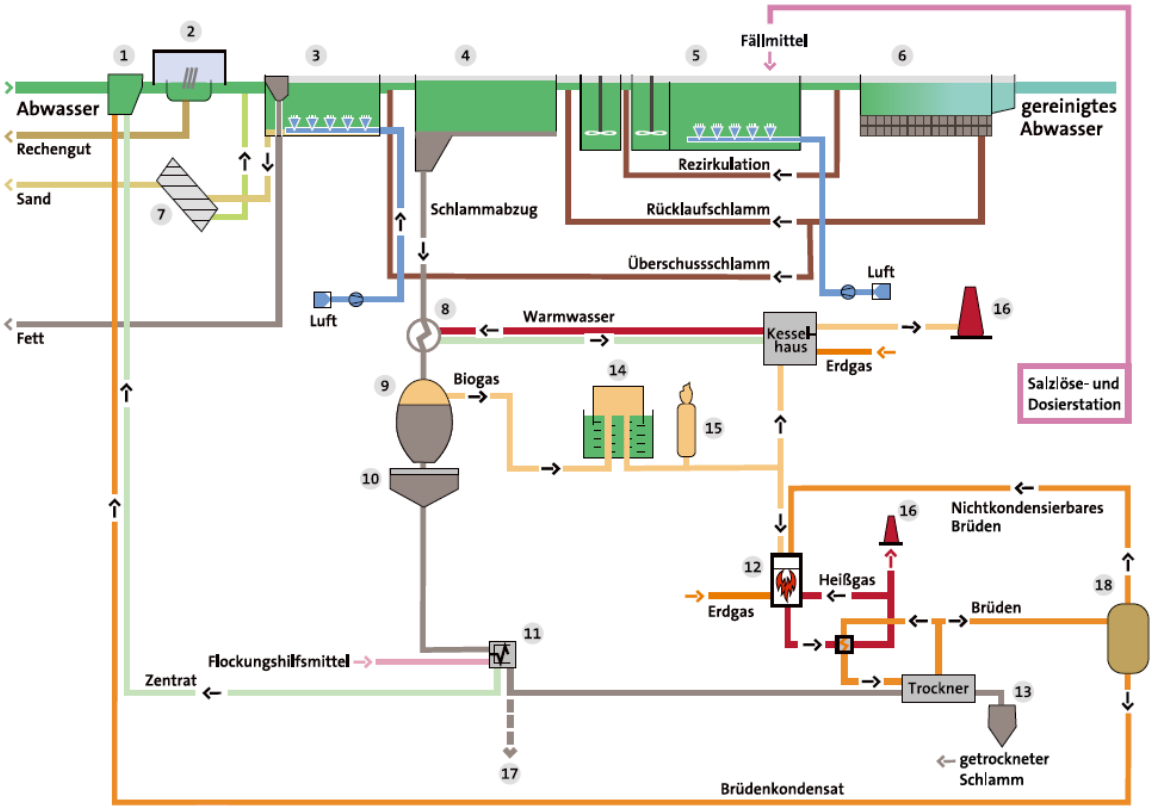


Figure 3: Process scheme of wastewater treatment in Schönerlinde (BWB, 2017a)

Biological purification:

The aeration tanks consist of eight basins as anaerobic zone, as well as fourteen basins as anoxic and aerobic zone. These have a total volume of 130,500 cubic meters. Aeration systems installed in the activated sludge tank consists of membrane aerators as well as ceramic aerators. As clarification serve twelve rectangular tanks with a total volume of 42,660 cubic meters and two round basins with a total volume of 10,500 cubic meters. Table 1 give the key operation parameters at Schönerlinde sewage treatment plant.

Table 1: operation parameters of Schönerlinde sewage treatment plant (Miehe, 2010)

Parameters	Value	Unit	Parameters	Value	Unit
sludge age	17.8	d	hydraulics retention time (HRT)	22.8	h
sludge load	0.09	kg BOD_5/(kg DM•d)	Flocculants doses	13.7	mg Fe^{2+}/L
volumetric load	0.34	kg BOD_5/(m^3•d)	Oxygen concentration in in activated sludge	2.1	mg O_2/L

			basin		
dry matter in activated sludge basin	3.7	g/L	wastewater temperature	18.9	˚C

Sludge treatment and disposal:

The sewage sludge is stabilized and sanitized by mesophilic fermentation in four digesters with a total volume of 32,000 cubic meters. Three decanter centrifuges are used to dewater the sewage sludge, in order to achieve continuous operation and essentially keep the sludge in a closed system, due to odours. A dry mass content of 26-27% is achieved after the drainage centrifuges. Three drying lines are used for the sludge drying to reach approx. 94 % dry matter content (complete drying, using drum dryers). In total, a sludge volume (dry mass) of approx. 12,100 ton was generated in this sewage treatment plant. 93% of the sewage sludge (partly dried) in the Schönerlinde sewage treatment plant is used as a secondary fuel in power plants (thermal recycling), in a cement works nearby Berlin (material and thermal recycling) and 7% incinerated in the sludge incineration plant of the sewage treatment plant Ruhleben (Franzke, 2011; Kabbe et al., 2014). The internal price of sludge disposal in Ruhleben is approx.100 Euro per ton dry sludge. Cost for disposal in co-incineration plants is between 45 and 70 Euro per ton treated sludge.

Biogas utilization:

The produced biogas is stored in two gas containers and used for drying the sewage sludge, for heating purposes and for power generation.

Energy consumption and production:

In 2016 WWTP Schönerline has a total energy consumption of 22,173,370 kWh and among them 8,283,508 kWh is generated from biogas and sludge (Schwieger, 2017). Based on the values of measuring devices, connection values and operating hours, the following energy consumption of the individual processes were estimated from the WWTP operator (Schwieger, 2017):

- mechanical cleaning 3%,
- biological purification 69.1%

- Sludge utilization (digestion, drainage, drying) 15.5%
- superior 8.9%
- rest 3.5%

4.5. SOCIAL SITUATION

The WWTP Schönerlinde has good relationship with their neighbor farms (livestock pigs/cows). The wastewater treatment plant also opens its doors to the public. The last "Open Door Day" was on August 2017 and more than 600 people visited this plant on that day. The wastewater treatment plant had sometimes received odor complaints. The plant is trying to reduce and control odor emissions and hat already done some research projects to reduce odor from the plant. (Schwieger, 2017)

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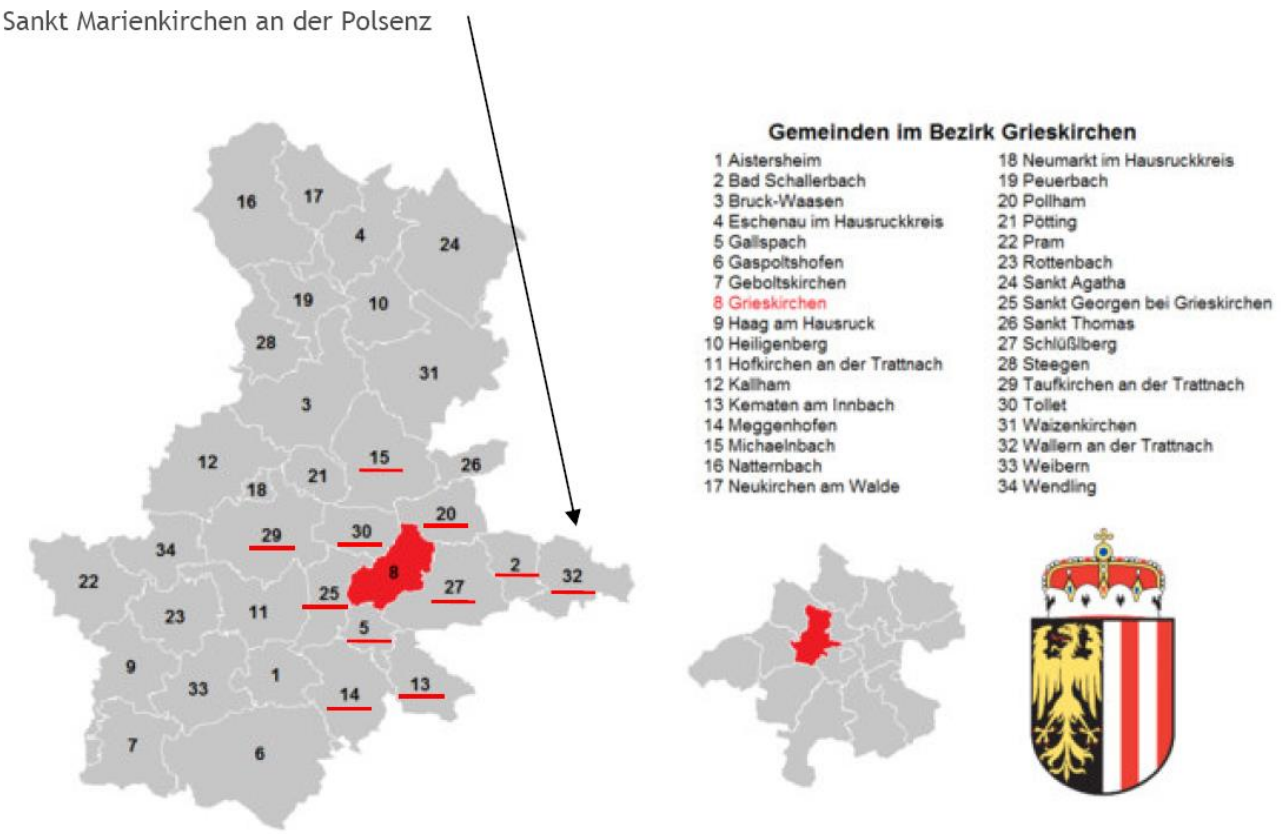
5. PILOT SITE RHV TRACNACHTAL

The RHV-Trattnachtal is situated in n Upper Austria in the district of Grieskirchen. 12 communities out of 32 treat their wastewater in the sewage plant.

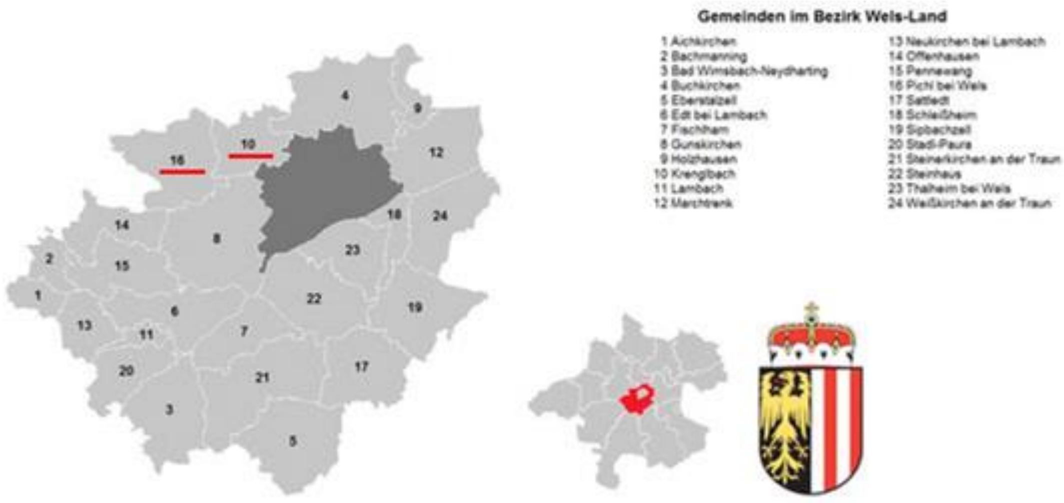
02 Bad Schallerbach	05 Gallspachh	08 Grieskirchen	13 Kematen am Innbach
14 Meggenhofen	15 Michaelnbach	20 Pollham	25 Sankt Georgen bei Grieskirchen
27 Schlüßlberg	29 Taufkirch hen	30 Tollet a.d.Trattnach	32 Wallern a an der Trattnach

And one community form the district of Eferding is also connected to the sewage plant. Sankt Marienkirchen an der Polsenz



Additionally 2 communities from the district Wels Land (directly in the south of Waallern an der Trattnach) are connected with the sewage plant.

10 Krenglbach 16 Pichl be i Wels

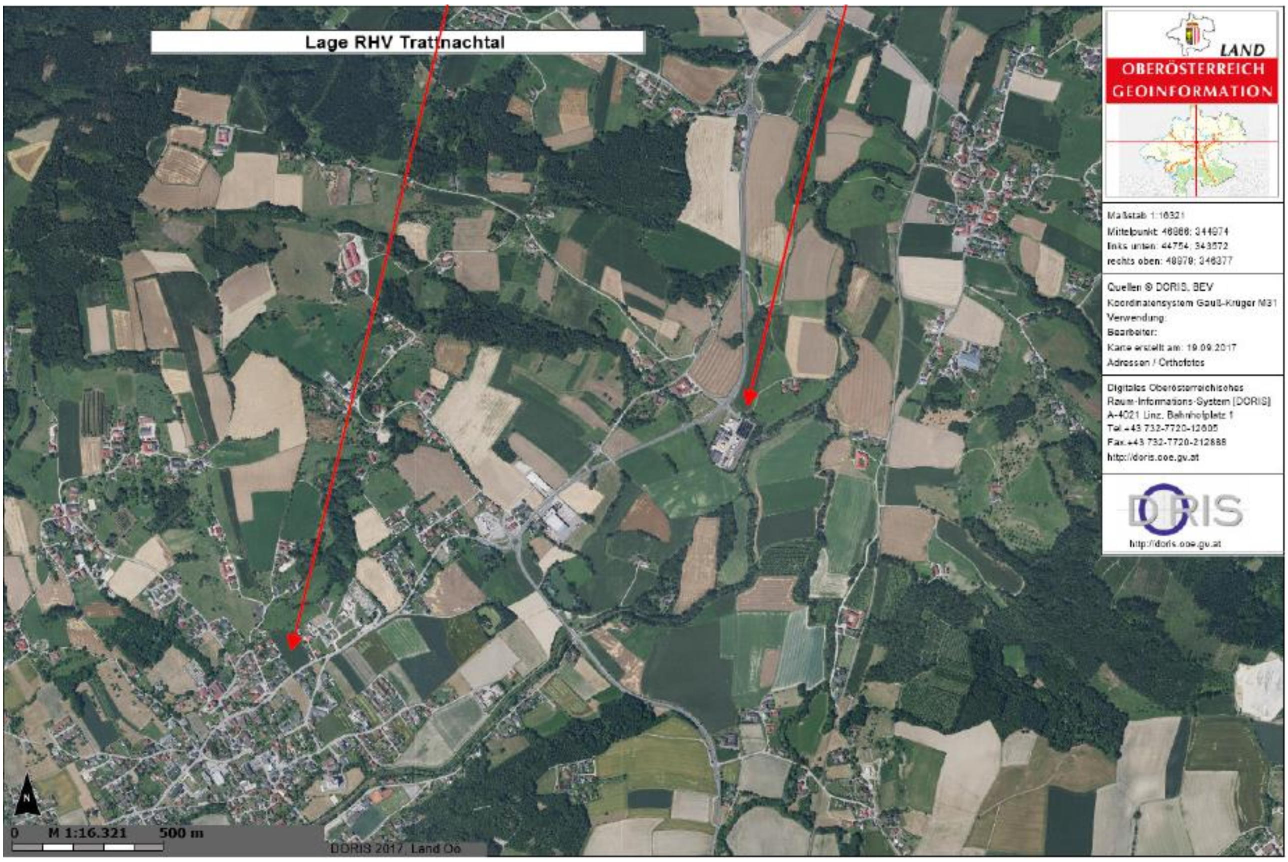


Overview of the RHV-Trattnachtal m members

	Population equivalent	% EW	Year of participation	
Grieskirchen	18.500	24,99%	1974	founding member
Bad Schallerbach	11.000	14,86%	1974	founding member
Pichl	8.500	11,48%	1979	
Gallspach	6.500	8,78%	1974	founding member
Schlüßlberg	6.000	8,10%	1974	founding member
Wallern	5.000	6,75%	1974	founding member
Krenglbach	4.500	6,08%	1974	founding member
Taufkirchen	3.000	4,05%	1977	
St. Marienkirchen	3.000	4,05%	1995	extraordinary member
Kematen	2.500	3,38%	1979	
St. Georgen	1.750	2,36%	1979	
Tollet	1.500	2,03%	1979	
Pollham	1.100	1,49%	1995	extraordinary member
Meggenhofen	1.100	1,49%	1998	
Michaelnbach	90	0,12%	1991	
	74.040	**100,00%**		

5.1. LOCATION OF THE TREATMENT PLANT

The treatment plant is situated in Wallern an der Trattnach, Parzham3, directly next to the B134.



5.2. RELEVANT INFRASTRUCTURES

The plant is connected to the natural gas grid and to the electrical grid. The maximum natural gas consumption is 90m3/h, the connection to the electricity grid is via a 1250 KVA Trafo. Currently the plant does not need any natural gas because there is enough heat for the own demand. Same situation with the electricity, the plant produces more electricity than needed, so it is delivering electricity (up to 500kW) to the grid. Only in rare occasions the electricity from the grid is needed to run the plant.

5.3. POPULATION INVOLVED LOCAL ADMINISTRATION INVOLVED

As shown before waste water of around 70.000 inhabitants can is treated in the sewage plant. Due to the fact, that there are also some food processing companies in the area, the e share of the agro industries is around 40% of the w waste water, and 60% is coming from the population.

The plant is mainly controlled by the government of Upper Austria situated in Linz. They are responsible for all regulations concerning waste water and waste.

Additionally the district government in Grieskirchen is responsible for the veterinary control of the biogas plant. The community of Wallern an der Trattnach is responsible for the fire prevention regulations. Last but not least the aspects of industrial safety and industrial medicine are supervised by the state owned AUVA situated in Linz.

5.4. DESCRIPTION OF THE SERVICES PROVIDED

The RHV Trattnachtal provides t the following services:

- Processing of dry well content
- Processing of waste water
- Processing of organic waste
- Production of electricity (surplus to the grid)
- Production of heat (one neighbor house heated)
- Production of steam (internal use only)

5.5. LEGAL FRAMEWORK

5.5.1. RHV CORPORATE STRUCTURE

The RHV Trattnachtal is organized as a public union with 13 members. The Biogas Trattnachtal was founded as a private limited company with the RHV-Trattnachtal as 100% shareholder of the company. It would also be possible to run t the biogas plant within the RHV-Trattnachtal.

5.6. NATIONAL AND LOCAL LEGISLATION FOR WASTE AND SLUDGE DISPOSAL

The RHV-Trattnachtal has to fulfil mainly two different legislations:

- Wastewater law the sewage e plant
- Waste law concerning the b biogas plant
- Animal by products law concerning sanitation and pest control of the incoming waste
- The use of the sewage sludge as fertilizer is regimented in the Upper Austrian sewage sludge decree

5.7. TECHNOLOGICAL DESCRIPTION

5.7.1. DESCRIPTION OF THE COLLECTION SYSTEM OF WASTE

The biogas plant has no own trucks for the collection of waste or disposing sewage sludge. We totally rely on transport companies who are specialists in the fields of waste collection and sludge disposal. The normal way of the waste into our plant looks like this:

1. Prior phone call or e-mail from a transport company concerning the delivery of a certain waste (defined by specific key number) and with known weight or volume.
2. Specification of the waste fee per ton or m3
3. Delivery of the waste to o the plant
4. Storing the liquid waste e in tanks or if solid in the sludge hall
5. Feeding of the biogas plant

5.7.2. INPUT AT THE TREATMENT PLANT

The biogas plant has the permission to treat up to 16.800t of organic waste. There is no fixed share of tons per waste, so the plant is free to take different the waste that is available. 2016 the biogas plant treated the following waste numbers:

Waste	Key Number	Tons per year	Info
biodiesel remains	92203	2.628,18	Biodiesel production
biowaste/foodwaste	92450	2.087,73	Pres sorted and shredded
gut press liquid	92406	1.084,81	Slaughter house
flotation tailings	92504	1.801,79	Slaughter house
anaerobic digestate	92506	26,78	
sewage sludge	92201	2.575,49	From o other sewage plants
dairy waste	92425	844,50	
rumen content	92409	897,50	Slaughter house
Divers	92122	82,60	
used cooking oil and fat	92403	1.912,21	Restaurants
glucose sludge	92501	1.626,00	
Total		15.567,59	

All material was liquid with the exception of sewage sludge and rumen content (app. 3.500t out of 15.500t)

5.7.3. DESCRIPTION OF THE TECHNOLOGIES USED

The used technique is mainly defined through the installed infrastructure of the sewage plant. The sewage plant consists of:

Parts of the sewage plant:

- Preliminary sedimentation (1 x 1000m3)
- Aeration (2 x 2000m3)
- Final sedimentation (4 xx 1900m3)
- Digesters (2 x 2000m3)
- Gas storage (800m3)
- Sludge press and sludge e hall New built parts of the biogas plant:
- Receiving station (pump p and macerator)
- Storage tanks (3 tanks w with 120m3. 150m3 and 250m3)
- Sanitizing unit (2 x 7 m m3)
- Bio filter
- Flare
- 2 x 360 kWel MAN units

The sludge of the preliminary sedimentation and the discharged sludge from th he final sedimentation are pumped into the digesters. Per day an average amount of 120m3 sludge with ap. 3% dry matter is digested. The waste is stored in n tanks (if liquid) or in the sludge hall (if solid). Depending on the sanitizing rules, bio-and slaughterhouse waste has to be sanitized according to o the EU-regulation: >70°C for min. 60 minutes and < 12mm particle size. All other material may be e pumped into the digester without any heat treatment.

Additionally to the 120m3 sludge a day, an average amount of 50m3 waste is pumped into the digesters. Solid material is re-liquified, by inserting it into the thickener, where e the sludge is stored before being pumped into the digesters. With the aid of a powerful stirring unit t the solids are mixed with the liquid to end up as a thick (up to 10-15%) paste, which can be pumped d.

The digester can only handle m material with no-or little-dry matter, because th he stirring unit is too weak for a strong mixing effect t. Additionally the digester has only a small surface on top, so swimming layers are hard to handle. So it is better for our plant to digest liquids with a high COD and a low dry matter content. Sewage sludge can also be treated, because it has a small particle size, which does not cause swimming layers.

5.7.4. ENERGY CONSUMPTION O OF THE PROCESS, POSSIBLY BY SECTION

The biogas process needs heat a and electricity. Both can be delivered form the installed CHP. The sanitizing heat of >70°C can be u used for the digester heating, so it is no real loss of energy. The digesters are heated up to 45-48 8°C, because the biological process is speeding u up with increasing heat level and we can produce enough heat energy to do so.

The electric consumption of the biogas plant is about 4.000 kWh per month. This is the electricity for all devices belonging to the biogas plant (storage tanks, bio filter, flare, sanitation unit).

The heat demand of the sanitation unit is about 13,5 MWh per month, with 80 M MWh per digester per month the heat demand of the d digesters is by far higher. Before the biogas plant was built, the digesters had to be heated with natural gas in the winter season, because the energy gained from the pure sludge was neither enough for heating, nor for the electricity demand of the sewage plant.

The sewage plant has a monthly electricity consumption of ap. 200.000 kWh.

5.7.5. ENERGY PRODUCED, IF A ANY, FROM THE TREATMENT PROCESS

During 2016 the biogas plant produced 33.744.460 kWh of electricity and 2.818.272 kWh h heat + steam. The sewage plant needed 2.040.970 kWh for the process, 1.754.730 kWh of electricity were sold to the grid. Over 90% of the heat was u used on site, ap. 10% could not be used.

5.7.6. USE OR WAY OF DISPOSAL OF THE TREATED MATERIAL

The mixture of waste (<50%tot) a and sludge (>50%tot) are still considered to be sludge, so the remaining pressed sludge is still considered as sewage sludge. Its use as fertilizer is allowed according to the Upper Austrian sewage decree. 2016 we produced ap. 3.800t of sewage sludge with ap. 35% dry matter. From October to

April w we have to store the sludge in a hall, because it is not allowed/it is not possible to apply sewage sludge e during winter season.

5.7.7. COSTS OF THE DISPOSAL / PRICE OF THE COMPOST

We pay 35€ per ton of sewage sludge for the agricultural use as fertilizer, compost and incineration would cost 50-70€ per ton.

5.8. WASTEWATER GENERATED AND TREATMENT TECHNOLOGIES

The wastewater from the press is treated in the sewage plant. Depending on the e ingredients of the waste the remaining wastewater r can have a high ratio of Nitrogen, Natrium or C Chlorine. Especially Nitrogen can put the aeration under a high stress level, depending on its degree e of capacity utilisation. In a worst case scenario, the aeration cannot degrade the additional nitrogen in n a proper way, so an additional nitrogen removal would be necessary. Since we stopped the fermentation of blood we do not need any additional nitrogen removal like ammonia-stripping anymore.

5.9. SOCIAL SITUATION

5.9.1. IMPACT ON THE TERRITORY

The impact on the territory is m mainly, that a high share of the treated waste is c coming from the surrounding area, so the transport is relatively short. Instead of using external fossil power the sewage plant and the biogas plant produce a surplus of heat and electricity, which can/ /could be used in the neighborhood. The produced sludge used as fertilizer can replace fossil mineral fertilizer and is a perfect example of closed circle e economy. It is also important to say, that the u use as fertilizer is the only possible way till today, to r return the phosphor to the soil, where it is needed, without using further guano-phosphor from abroad.

5.9.2. GENERAL ACCEPTANCE O OF THE PLANT FROM THE POPULATION

As long as the plant doesn’t generate odor problems, the acceptance of the neighborhood is OK. Due to the fact that we treat human excrement and urine combined with diverse organic waste, none of our neighborhoods is too interested in that and only school-classes come to visit t the plant.

5.9.3. COMPLAINTS ABOUT ODOURS OR OTHER ASPECTS

The sewage plant itself can produce odor throughout the year. The additional digestion of waste can severely increase the odor of t the sewage plant, especially if slaughterhouse waste is on site and the bio filter is not planned and operated properly. This is a big threat to the site, because odor can lead to massive complaints and the threat of closing the site.

5.10. PHOTOGRAPHIC DOCUMENTATION OF THE SEWAGE PLANT

For better understanding of the written text, a photo documentation of all mentioned facilities is enclosed.

Fig. 1 primary sedimentation tank

Fig. 2 aeration basin

Fig. 3 Secondary sedimentation tank

Fig. 4 Sludge hall

Fig. 5sludge storege tank prior processing

Fig. 6 Digestors

Fig. 7 Sanitizing Unit

Fig. 8 Waste storage tank

Fig. 9 Biofilter

6. PILOT SITE PRAGUE

6.1. GENERAL DESCRIPTION OF THE AREA

6.1.1. GEOGRAPHICAL DESCRIPTION OF THE SERVED AREA

Prague is situated in central part of Czech republic. It is the capital of Czech rep. and city area is placed on river Vltava and hilly country around.

Zlin is the district city of the Zlin region in east part of Czech republic. Its population is about 75.000 inhabitants. Its well known by long time industrial history connected to Baa shoe company and rubber industry.

6.1.2. LOCATION OF THE TREATMENT PLANT

Prague central WWTP is situated at river island at northern part of the city.

Zlin WWTP is situated south-west part of Zlin suburbs.

Relevant infrastructures in the area

Central Prague WWTP is large site with capacity of 1.641.000 PE, WWTP is mechanical-biological system with thermophilic anaerobic digestion of sludge.

Main Zlin WWTP is Malenovice plant. Its mechanical-biological treatment plant with capacity of 200.000 PE.

6.1.3. POPULATION INVOLVED, LOCAL ADMINISTRATIONS INVOLVED

Prague population is 1280500 inhabitants.

Zlin population is 75100 inhabitants.

6.1.4. DESCRIPTION OF THE SERVICES PROVIDED

Veolia is main operator of WW sewer system and WWTP plant in Prague via company PVK a.s.

Veolia operates Zlin city water system via company Moravska vodarenská a.s.

6.2. LEGAL FRAMEWORK

6.2.1. CORPORATE STRUCTURE OF THE PARTNER UTILITY

VEOLIA ČESKÁ REPUBLIKA a.s. is joint-stock company 100% owned by VEOLIA CENTRAL & EASTERN EUROPE, S.A.

6.2.2. NATIONAL AND LOCAL LEGISLATION FOR WASTES AND SLUDGE MANAGEMENT AND DISPOSAL

6.2.2.1. Solid / Liquid organic (urban) waste usage in WWT /digestion process

Waste can be used as substrate only if the plant have permit to operate with wastes (due to Czech law 185/2001 Sb. with later changes). For big plants there is also necessary to have IPPC authorization. Liquid wastes are sometimes processed as concentrated wastewater (in this case is waste legislation evaded). Special veterinary legislation connected to EU legisltation 1069/2009 EP is required for food and other wastes contains animal products and by-products (meat) – especially hygienisation.

6.2.2.2. Renewable energy (electricity or heat) production / feeding energy into the grid

There was operational subsidy till 2013 which guaranteed prices for electricity for 15 to 20 years of operation. This kind of subsidy was stopped in 2013. Now there is problematic subsidy for heat from CHP utilisation (not long-time guaranteed) and biomethane to grid subsidy (not exactly specified).

biogas plant – agricultural (no waste, similar to NAWARO)	AF1 to 2012	0,15	EUR/kWh
biogas plant waste	To 2012	0,13	EUR/kWh
biogas plant waste + agricultural to 550 kWel	2013	0,13	EUR/kWh
biogas	after 2013	0	no subsidy
biogas - heat from cogeneration, waste processing	2017	30,74	EUR/GJ
biogas - WWTP anaerobic digestion	2003	0,13	EUR/kWh
biogas - WWTP anaerobic digestion	2004 - 2005	0,10	EUR/kWh
biogas - WWTP anaerobic digestion	2006-2012	0,11	EUR/kWh
biogas - WWTP anaerobic digestion	2013	0,08	EUR/kWh

Biometane injected to grid have to achieve parameters specified by Czech technical norm CSN 656514 which is similar to EU TC408.

Most important legal/policy amendments to improve the energy efficiency and renewable energy resources production during wastewater treatment along the urban waste/wastewater treatment nexus should be a change in WWTP sludges legislation, with the end of municipal waste landfilling

Most important stakeholders:

- Public authorities and administrative bodies: Ministry of Environment, Ministry of Agriculture, Ministry of Industry

- Policy and decision makers: Ministry of Environment, Ministry of Agriculture, Ministry of Industry, state owned company CEZ
- Public institutes: Ministries + few expert committees (university and private members)
- Privately owned entities: Big waste companies and groups (AVE CZ, FCC, Marius Pedersen, SITA, Veolia,
- Influential individuals:

6.3. TECHNOLOGICAL DESCRIPTION

6.3.1. DESCRIPTION OF THE COLLECTION SYSTEM OF WASTE, METHOD USED:

Sewer system, no changes in both cases

- Input at the treatment plant

Prague – no changes, project deals with biogas utilisation

Zlin: common sludge production – 5000 t, reduction by 3500 ton

- Description of the technologies used at the moment

Prague: common CHP, 3 x 0,95 + 2 x 1,25 Mwel CHP

Zlin: dewatering by centrifuge and landfilling

- Energy consumption of the process, possibly by section
- Energy produced, if any, from the treatment process

Prague: anaerobic digestion of WWTP sludge

Biogas production (Nm3/year)	18 066 974
Electricity production (kWh/year)	32 029 000
Plant self sufficiency	75 %
Biogas for other purposes (Nm3/year) (now burned on flares)	1 150 000
Methane content of raw biogas	61 %

Zlin: anaerobic digestion of WWTP sludge

Biogas production (Nm3/year)	1026585
Electricity production (kWh/year)	1823719
Plant self sufficiency	80 %
Methane content of raw biogas	63 %

- Use or way of disposal of the treated material

Prague: water discharge to river, biogas CHP, sludge – landfill, agriculture

Zlin: water discharge to river, biogas CHP, sludge – landfill, agriculture

Costs of the disposal / price of the compost

Approx.30 EUR/t for sludge

- Wastewater generated if any, way of treatment

6.4. Social situation

- Impact on the territory

positive on both cases

- General acceptance of the plant from the population

Prague – long time difficulties with odors, not affected by biomethane technology

- Complaints about odours or other aspects

7. PILOT SITE ZAGREB ZCH

7.1. GENERAL DESCRIPTION OF THE ZAGREB AREA

City of Zagreb is the largest city in Croatia with approximately 800,000 inhabitants and a density of 1,200 inh/km². With the surrounding areas, total population of the City is around one million of inhabitants. Food and beverage processing is traditional and one of the most important local branches of industry, and it achieves the highest total revenue and employs the most people. Municipal wastes in the city of Zagreb are managed by a company "Zagrebački holding d.o.o., Podružnica Čistoća" (ZCH). It is a city company whose purpose is the realization of public cleaning service, collection, transportation, treatment and disposal of municipal waste within the city of Zagreb. For the processes of treatment, recovery and disposal landfill site Jakuševec – Prudinec is in use.

Figure 1. Location of city of Zagreb

Figure 2. ZCH waste collection trucks

Figure 3. . Landfill "Jakuševec

As in any other EU country, largest portion of mixed municipal solid waste (MSW) is biowaste. It is mostly kitchen and green waste with an average of 30 percent of total amounts. The main figures regarding waste management in the City of Zagreb are shown in table 1.

Table 1. Main figures regarding the waste management in the City of Zagreb (ZCH 2015)

City of Zagreb	
Amount of collected municipal solid waste in 2015 (t)	215,373
Potential amount of municipal biowaste in 2015 (t), 30% of total amounts	64,612
Amount of collected biowaste by ZCH in 2015 (t)	4,674

In the City of Zagreb, ZCH is certain amounts of the kitchen of waste collecting from a number of restaurants and hotels, and delivering to the composting plants where it is mixed with the garden waste collected from public areas. Larger waste producers including food and beverage industry and shopping malls are also separating biowaste, as well as market places in the City (total number of markets in the City is 18). These actions have led to the increase of total biowaste amounts sent to the composting plant (figure 4). The overview of all biowaste categories collected in the City of Zagreb is presented in table 2.

Figure 4. Increase of collected biowaste in the City of Zagreb (2007-2014)

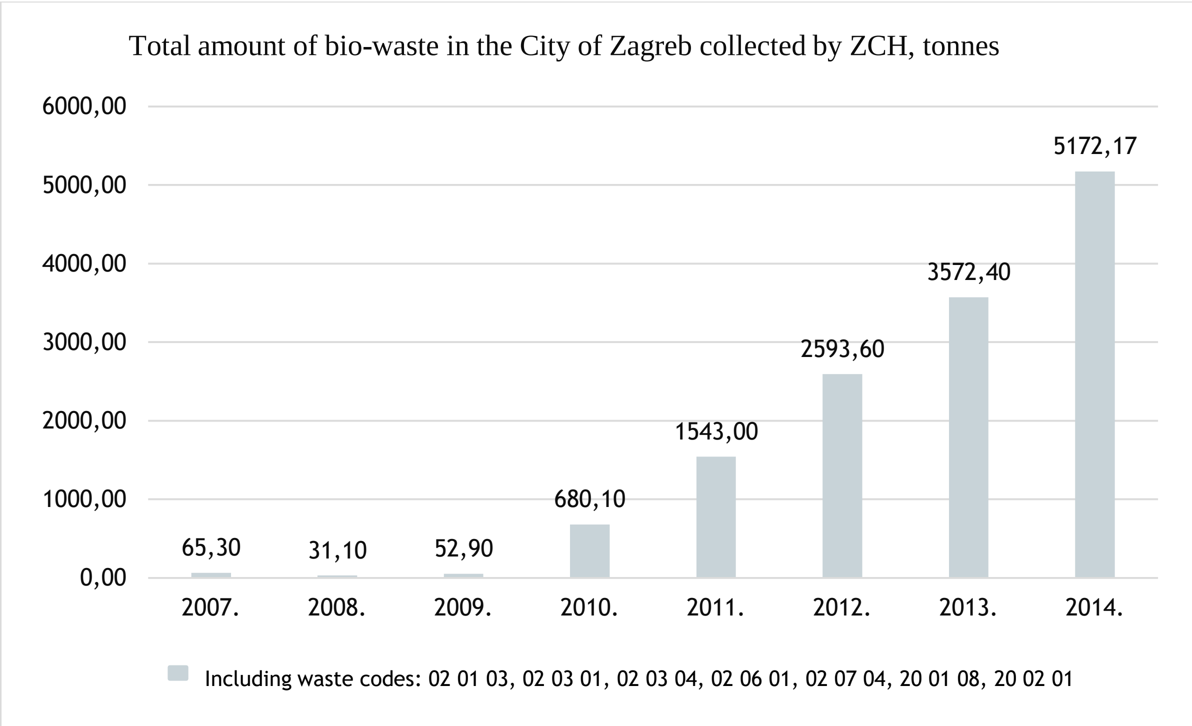


Table 2. Total amounts of biowaste by waste codes in the City of Zagreb collected by ZCH and other waste management companies in 2013

Waste code	Waste description	Amount of waste (t)
02 01 03	plant-tissue waste	66.32
02 01 06	wastes from forestry	58.00
02 03 01	sludges from washing, cleaning, peeling,	197.84

	centrifuging and separation	
02 03 04	materials unsuitable for consumption or processing	1,939.92
02 03 99	wastes not otherwise specified	41.80
02 06 01	materials unsuitable for consumption or processing	1.54
02 07 01	wastes from washing, cleaning and mechanical reduction of raw materials	32.62
02 07 04	materials unsuitable for consumption or processing	1,504.42
02 07 05	sludges from on-site effluent treatment	4.56
02 07 99	wastes not otherwise specified	10.08
20 01 08	biodegradable kitchen and canteen waste	158.22
20 01 25	edible oil and fat	380.20
20 02 01	biodegradable waste	1,940.41
Total		**6,335.93**

As mentioned before, the significant portion of above presented quantities is from marketplaces within the city area. Having in mind the total potential of produced biowaste in the city, these amounts are still not that significant and complete biowaste collection needs improvement. Over the past five years various projects were prepared and actions conducted in Zagreb in which particular attention has been paid to the biowaste collection improvement linked with legal obligations Croatia has regarding the decrease of biodegradable waste landfilling. In addition, over the years ZCH has performed many surveys and inquiries regarding the potential of biowaste in the City from different waste producers. Table 3 shows an estimation on possible quantities of biowaste in Zagreb suitable for anaerobic digestion and biogas production.

Table 3. Total estimated quantities of biowaste in the City of Zagreb

Input	Amount, t/year
Biowaste from shopping centers and households	5,000
Biowaste from kitchens and restaurants	10,000
Market biowaste	3,000
Industrial biodegradable waste (brewery, diary, food processing)	1,500
Expired milk & eggs	500
TOTAL	**20,000**

An estimate provided in the table above can outline the expected potential in the City, combining industrial biodegradable waste, biowaste from restaurants, expired products and biowaste from shopping centres and citizens, which are all included in this project.

7.2. LEGAL FRAMEWORK

7.2.1. LEGAL FRAMEWORK IN THE EU

At the moment on EU level there are two main legislations regarding the waste management:

- Landfill directive(1999/31/EC),
- Waste Framework Directive (2008/98/EC)

7.2.1.1. Landfill Directive

In this directive biodegradable waste is defined as a type of waste capable of ongoing anaerobic or aerobic composition, such as food and garden waste or paper. The Directive sets objectives for the reduction of biodegradable waste sent to landfills, with the following target: "biodegradable municipal waste going to landfills must be reduced to 35 % of the total amount (by weight) of biodegradable municipal waste produced in 1995". It is likely that coming Directives will progressively ban the landfilling of biodegradable waste.

7.2.1.2. Waste Framework Directive (WFD)

The WFD sets definitions for several waste-related terms and lays general principles for the organisation of waste management. In this directive biowaste is defined as a "biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants". It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood. It also excludes those by-products of food production that never become waste. It is a step forward to more precise definition of biowaste comparing with the Landfill directive.

In addition, article 5 provides a definition for by-products, a term that is widely applied to organic outputs from food and beverage (FAB) industry. It is defined as "a substance or object resulting from a production process" whose "primary aim (is) not the production of that item" and that "may be regarded as not being waste (…) only if the following conditions are met:

(a) Further use of the substance or object is certain;

(b) Substance or object can be used directly without any further processing other than normal industrial practice;

(c) Substance or object is produced as an integral part of a production process; and
(d) Further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts."

Among the principles set by the WFD, the most important one is the above mentioned waste management hierarchy that establishes a priority order for waste management. The hierarchy is presented in the table 4, along with examples of applications for biowaste.

Table 4. Waste management hierarchy and management options for organic residues

Step in the hierarchy	Example of actions (treatments)
Prevention	• Direct avoidance (modification of processes…) • Redistribution of non-compliant products to food banks
Preparation for reuse	• This concerns mainly by-products used as animal feed, sent to rendering or used in other industrial uses
Recycling	• Composting; • Anaerobic digestion; • Deconditioning; • Landspreading;
Other recovery	• Incineration with energy recovery • Co-incineration
Disposal	• Incineration without energy recovery; • Landfilling.

The Directive also states that Member States must encourage the separate collection of biowaste for composting or anaerobic digestion and ensure the use of environmentally safe materials produced from biowaste. The Circular Economy Package, adopted by the European Commission in December 2015, includes revised legislative proposals on waste, amongst which is the WFD. Among the main elements of the proposals to amend EU waste legislation are:

- Gradual limitation of the landfilling of municipal waste to 10% by 2030;
- Greater harmonisation and simplification of the legal framework on by-products and end-of-waste status;
- New measures to promote prevention, including food waste, and its re-use.

7.2.2. NATIONAL/ LOCAL FRAMEWORK

Croatia / City of Zagreb

Waste management in the Republic of Croatia is prescribed by the Act on Sustainable Waste Management (OG No. 94/13 and 73/17). This Act lays down measures for the prevention or reduction of adverse impacts of waste on human health and the environment by reducing amounts of waste generated and/or produced, and regulates the management of waste which includes no operation posing a risk to human health and the environment and involves the use of valuable properties of 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)

The Republic of Croatia has to divert 65% of biodegradable municipal waste of the total amount (by weight) of biodegradable municipal waste produced in 1997 from landfills by the end of 2020 according to EU legislation. Therefore, the main objectives defined in the Waste Management Plan in the Republic of Croatia for the period 2017 to 2022 is to increase the amount of separately collected waste fraction and to reduce the share of biodegradable waste in the municipal waste. According to the "Act on Sustainable Waste Management" and in order to reduce gaseous effluents emitted into the environment resulting from the disposal of waste containing a high share of biodegradable components, the following objectives are set:

- 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 law also stipulated the obligation of separate collection of biowaste in order to be used in composting, anaerobic digestion and incineration with energy recovery. The law defines the order of priority of waste management with the advantage primarily on the prevention of waste generation. The implementation of the measures arising from the provisions of national legislation in the field of biodegradable waste is likely to affect the cost of waste disposal and to assume that in order to rationalize costs one should intensely consider the possibility of preventing its occurrence. The City of Zagreb produces around 250,000 tonnes of municipal solid waste per year, which is mostly being landfilled (92.6% in 2011) at the landfill site Jakuševec-Prudinec. Recently the life span of this landfill site has been extended even though most of the landfilled waste is biodegradable (paper, cardboard, kitchen and green waste – approx. 62%). At the moment, city of Zagreb does not have a local Waste management plan, it should be finalized in the next period.

In Croatia, the most important and most dominant supporting scheme is fixed feed-in tariffs scheme which provide a fixed price which is above the market price for RES according to the Croatian Electricity Act. Every producer, who holds the status of "qualified producer" and has signed a formal agreement with the Croatian Energy market Operator (HROTE) has the right to receive an 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 tariff differentiated by size of the installation and efficiency. Qutoas for guaranteed purchase of electricity until 2020 are 70MW for biogas (including waste gas and gas from wastewater treatment plants). Unfortunately, Croatia still lacks of an effective waste management system but also the incentive system which would encourage more effective and more efficient waste management system.

The most important stakeholders in the Republic of Croatia regarding the waste management responsibilities are the following institutions:

- Croatian parliament and the Government of the Republic of Croatia are State Authority Bodies. The key role of the Parliament is to adopt the relevant 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, but also proposes relevant legislation and strategies to Parliament. One of the key roles of the Government is to ensure the conditions and prescribe the measures for hazardous waste management and for the incineration of waste.
- The Ministry of Environmental and Nature Protection (www.mzoip.hr) is a State Administration Body and it is mainly responsible for preparing new legislation and standards, preparation of the National Waste Management Strategy and National Waste Management Implementation Plan, implementation of measures (especially for hazardous waste management), supervision and enforcement of laws of secondary legislation, monitoring the Croatian Environment Agency and Environmental Protection and Energy Efficiency Fund, etc.
- The Environmental Protection and Energy Efficiency Fund (www.fzoeu.hr) is an extra-budgetary institution owned by the Republic of Croatia with

purpose to finance environmental protection programmes and projects. The Fund collects different environmental charges for burdening the environment with hazardous and non-hazardous industrial waste.

- The Croatian Environment Agency (www.azo.hr) is public institution established by the Government which primarily collects processes and provides data required for the efficient implementation of the environmental protection policy. The CEA is responsible to provide reliable and comparable waste data and information to decision makers and general public.
- The Counties and the City of Zagreb are regional self-government units which are responsible for managing all types of waste in their respective areas, issuing waste management plans for their respective areas. Furthermore, they are gathering and submitting data on waste and the state administration offices in the counties issue permits for non-hazardous waste management.
- Towns and municipalities are local self-government units that are responsible for managing municipal waste, preparing waste management plans and determining locations in spatial plans for their respective areas. Municipal waste is encompassed by the public utility services.
- Other stakeholders involved in waste management are companies registered and licensed for the collection and transport, recovery and/or disposal of waste, consulting firms or other professional and non-governmental organisations.

7.3. TECHNOLOGICAL DESCRIPTION

7.3.1. CITY OF ZAGREB – WASTE MANAGEMENT

As described before, ZCH (branch Čistoća) is public-owned company in charge of the waste management in the City of Zagreb. Total number of employees is around 1,500. Besides the ZCH, a few other companies are allowed to collect only industrial waste within the city area.

Mixed municipal waste (MSW) is collected two times per week, in some areas it is six times (city center). Biowaste from households is collected once a week, and from industrial producers it is usually collected on demand. Following tables are presenting the current infrastructure of ZCH regarding the waste management in the City of Zagreb.

Table 5. Number and volume of containers/tanks for collecting of municipal waste

Container/tank volume (l)	Number of containers
1,100	13,335
80	370
120	64,632
240	28,584

Table 6. Number of containers/tanks for biowaste collection in city of Zagreb

Container/tank volume (l)	Number of containers/tanks
1,100	158
120	1,769
240	88

Table 7. Vehicle fleet in ZCH by vehicle type

Vehicle type	Number of vehicles
Special vehicles for household/industrial waste collection	100
Special vehicles for bulky waste	45
Special vehicles for cleaning and washing	64
Special vehicles for HW transport	2
Pick up and personal vehicles	36
Other	8
Total	**255**

7.3.2. CITY OF ZAGREB – WASTE WATER TREATMENT PLANT

Zagrebačke otpadne vode d.o.o. (ZOV)/ Zagreb wastewater Ltd./ founded in Zagreb in 1998, is responsible for design, financing, construction and operation of the Central wastewater treatment plant Zagreb (CWWTZ) and related infrastructure. The CWWTZ project is the first concession for a wastewater treatment plant in Croatia that enabled the City of Zagreb to harmonize and comply with the environmental standards of European Union in the field of environmental and water protection. Pursuant to the Concession Agreement between the City of Zagreb and ZOV, ZOV designed and completed the construction of CWWTZ in 2007, and now, through its sister company Zagrebačke otpadne vode-upravljanje i pogon d.o.o./Zagreb wastewater-management and operation Ltd. is responsible for the management and operation of the facilities and regular maintenance.

The process of the wastewater treatment is mechanical and biological with total capacity of 1.2 mil ES and demand of 27.790 m3/h (BOD 90.000 kg/day).

Figure 4. Wastewater treatment plant in Zagreb (source: www.zov.hr)

7.4. SOCIAL-ECONOMIC BENEFITS AND ENVIRONMENTAL IMPACT

Poor management and disposal of waste are one of the main challenges for the City of Zagreb. Having in mind the potential of biowaste in the City (table 3). It is obvious that the increase of employment rate should be considered. Furthermore, the circular approach of waste management in the City will trigger development of industrial activities in many sectors and help improving its acceptance by the citizens, so called effect NIMBY (Not in my backyard). Nevertheless, it has been stated before that implementation of proposed actions will definitely have a positive impact to the environment. Due to the actions in waste management, the main benefits to the environment will be:

- Reduction of GHG emissions and renewable energy production,
- More efficient use of resources,
- Reduction of landfill usage,
- Improvement of recycling and recovery technologies.

In order to give more precise socio-economic overview, a SWOT analysis is presenting positive and negative impacts of current waste management and presented below (tables 8).

Table 8. SWOT analysis for Zagreb

Favourable to introduce separate biowaste collection	**Unfavourable to introduce separate biowaste collection**
Strengths **– Already a well-established system of waste collection through City company (Čistoća)** **– General population willing to do certain changes in their waste management behaviour** **– General knowledge on separate biowaste collection presented to key stakeholders during previous pilot projects** **- City government aware of legal obligations and constraints regarding waste management** **- Strong NGO community pushing advanced waste management schemes**	***Weaknesses*** **– No strategic documents for proposed waste management concepts** **– Lack of communication between national regional and local stakeholders in waste management procedures and plans** **– Lack of advanced financing opportunities for different concepts** **– NIMBY effect regarding the waste management facilities**
Opportunities **- Decreasing the pressure on City landfill site and solving part of the City's waste management issues** **– Creating new "green" job through the new advanced waste management concepts** **– Sustainable waste management concepts that are in line with the EU long term guidelines** **– New positive dimension for the City (green City) on an EU and national level** **– Positive impact on achieving national goals on renewable energy sources in the transport sector and the reduction of GHG emissions**	***Threats*** **– Lack of concrete obligations from national and local stakeholders** **– Strategic waste management documents and framework stalling** **– Increase of prices for communal services as a result of establishing new and advanced waste management system** **– Lack of commitment from the general population after establishing new and advanced waste management system** **– NIMBY effect on the regional and local level**

8. CONCLUSIONS

The framework deriving from the analysis of the situation of the 5 pilot sites shows a rather varied situation by plant size and by local regulatory framework.

From the size analysis pilot sites cover a quite large range of situations, with the smallest site in Italy involving about 17.000 inhabitants in a mountainous territory of 328 sq km to the largest in Berlin with a population served of 3.5 million and a surface area covered of 892sq km.

Also from the technological point of view there are several differences with plants very well developed and integrated in the waste and water cycle addressed to the next future technologies and plants just starting the process of energy efficiency of the site.

Also the legal framework determine different situations. Although all the countries have to respect the European directives regarding the waste and water management the application of these directives in the different countries show a different situation. In addition to this in some of the country local authorities can develop a local legislation with, in some case, different rules and this will affect the decisions of the plant managers regarding the technologies to implement.

In this quite complex framework the development of the REEF 2W tools will try to satisfy the requests of the different pilots. For this large panorama of situations already present in the project partner the tool should be enough robust to be used in many other different situation in Central Europe where the need of EE or RES in the WWTPs will be implemented.

9. ANNEX 1

COLLECTION DATA FOR PILOT SITE DESCRIPTION

23/07/2017

GENERAL DESCRIPTION OF THE AREA:

- Geographical description of the served area
- Location of the treatment plant
- Relevant infrastructures in the area
- Population involved, local administrations involved
- Description of the services provided

LEGAL FRAMEWORK

- Corporate structure of the partner utility
- National and local legislation for wastes and sludge management and disposal
  - What are specific legal/policy incentives or barriers regarding the EE and REs in wastewater treatment plants, with regard to:
    - Solid / Liquid organic (urban) waste usage in WWT /digestion process
    - Renewable energy (electricity or heat) production / feeding energy into the grid
  - What would be the most important legal/policy amendments to improve the energy efficiency and renewable energy resources production during wastewater treatment along the urban waste/wastewater treatment nexus?
  - Who are the most important stakeholders?
    - Public authorities and administrative bodies:
    - Policy and decision makers:
    - Public institutes:
    - Privately owned entities:
    - Influential individuals:

TECHNOLOGICAL DESCRIPTION

- Description of the collection system of waste, method used
- Input at the treatment plant
  - Total ton of wastes per year, ton of the different fractions including sludge, if any, and any other waste material
- Description of the technologies used at the moment
- Energy consumption of the process, possibly by section
- Energy produced, if any, from the treatment process

- Use or way of disposal of the treated material
- Costs of the disposal / price of the compost
- Wastewater generated if any, way of treatment

SOCIAL SITUATION

- Impact on the territory
- General acceptance of the plant from the population
- Complaints about odours or other aspects