

CASE STUDY

CROATIA - ZAGREB

AGGLOMERATION

3.7

3.7.1 Description of Wastewater Treatment Plant

Zagreb Urban Agglomeration (ZUA) has been founded in 2016 and includes the City of Zagreb (790,017 inhabitants) as the seat of the Agglomeration, and parts of the Zagreb county (256,689 inh.) and Krapina-Zagorje county (39,822 inh.). More specifically, the ZUA encompasses a total of 30 local government units, 11 cities and 19 municipalities. In the northern part of ZUA is the location of the WWTP Zabok, which will be built by the end 2020. This plant is owned by the public company Zagorski vodovod Ltd. The company has been founded by 26 local self-government units, is engaged in public water supply and public drainage, operates in the urban agglomeration of Zagreb and supplies water to 90,000 residents in more than

31,000 terminals. In the year 2006 Zagorski vodovod Ltd has registered the activity of public sewage and wastewater treatment and started preparations for taking over existing sewage systems in the area of Krapina-Zagorje County.

Zagorski vodovod Ltd. Is planning to build WWTP Zabok with the capacity of 36,940 PE, and will be consisted of these stages: Prior purification -separation of particles, Second stage - consisting of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface, and Third stage -which removes dissolved and suspended biological matter, as well as includes the dehydration of the sludge. The main data for WWTP Zabok is presented in the Table 3.11.

Table 3.11
The main data for WWTP Zabok

ZUA	Location	Population	WWTP size (PE)	Sludge amount (m ³ /y)	Dry matter	Total amount (t/y)
WWTP Zabok	City of Zabok	9,000	36,940	1,490	75%	1,117.5

3.7.2 Selected scenarios by REEF 2W decision support tool

The main intention for the pilot site in ZUA is to establish a pilot case and test the possibility to utilize the separately collected biowaste, as well as the sustainable usage of produced sludge. This will be the main challenge for the WTP Zabok operator in the future period. The WTP in its full capacity will be producing 1,117.5 tonnes of dehydrated sludge. The main aspects of the proposed solution are: i) Possibility to use biowaste fraction of municipal waste, ii) Anaerobic treatment - co-digestion of sludge and biowaste, iii) Utilization of biogas -CHP and biomethane, and iv) Application of digestate as a soil improver.

Besides the treatment of wastewater, one of the most important issues of the Zabok WTP is the sustainable waste management

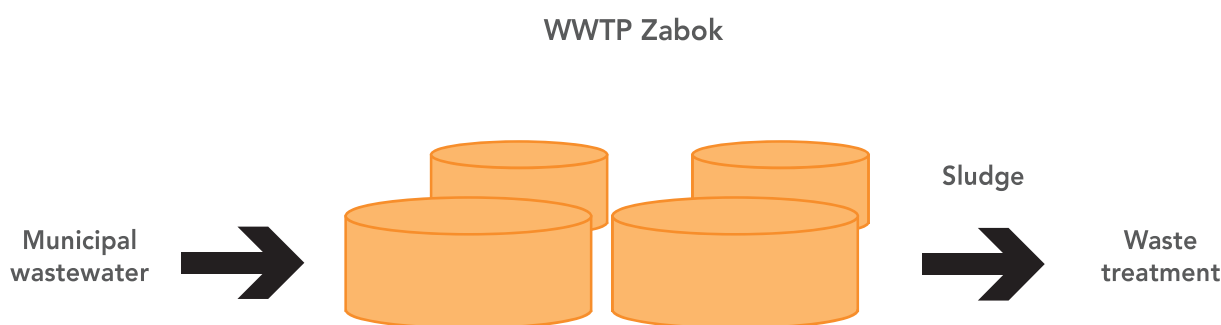
in the ZUA. The combined treatment of waste and wastewater is one of the main benefits of the proposed REEF 2W solutions. The main idea behind this proposal is to successfully utilize separately collected biowaste with current wastewater treatment. This extension will also result in a production of renewable energy.

The overview of all solutions is presented in the following scenarios:

Scenario 1: Local sludge utilization

In this scenario business as usual is foreseen, where the plant is processing wastewater and produce 1,117.5 tonnes of sludge each year. In this scenario no energy utilization will be provided. The produced sludge will be treated as a waste and will be facilitated its utilisation as a soil improver at the available local land.

Figure 3.13
Scheme of local sludge utilization



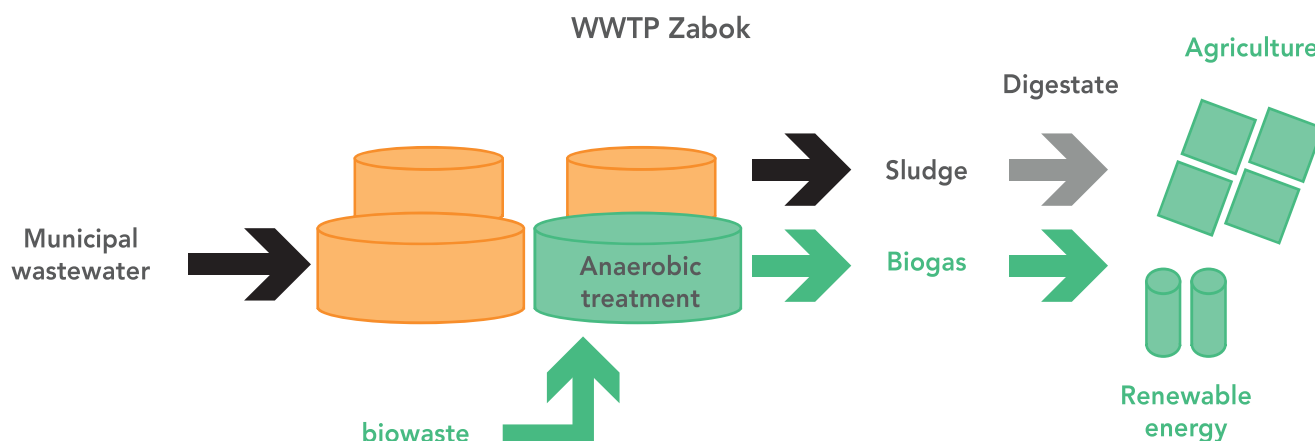
Scenario 2: Anaerobic digestion on site

This scenario is proposing the upgrade of the current facility in Zabok. The upgrade is consisted of the onsite anaerobic treatment of the sludge at the WWTP Zabok as well as

the installation of gas engine for the utilization of produced biogas. The WWTP Zabok will produce energy via cogeneration and utilise it. Also, produced sludge will be used locally.

Figure 3.14

Scheme of anaerobic digestion on-site



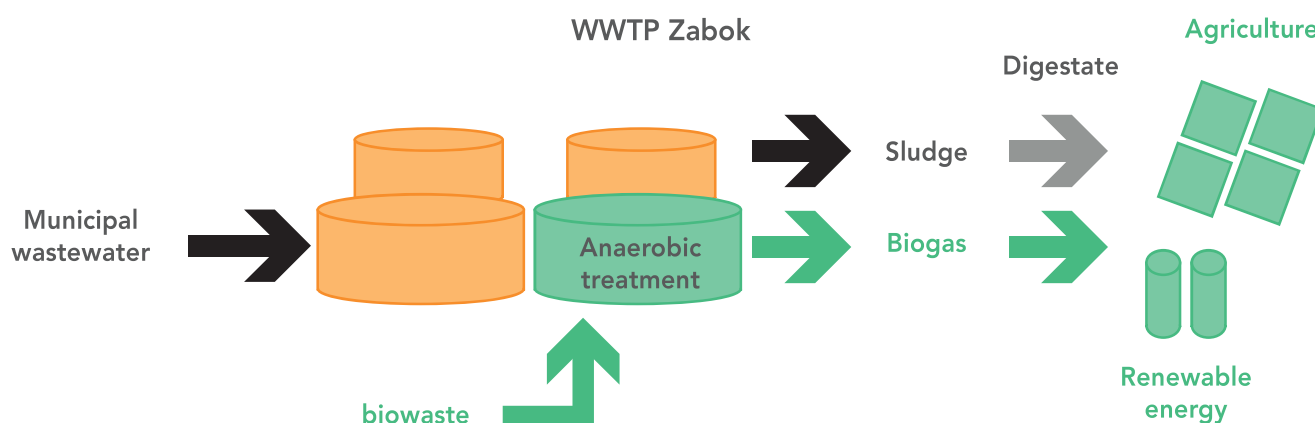
Scenario 3: Utilization of biowaste and sludge at remote biogas plant

In this scenario it is foreseen that the WWTP Zabok will be operating as in scenario 1, but the produced sludge will not be used locally for agriculture, but rather transferred to the remote biogas plant where it will be used for renewable energy production. Also, separately collected biowaste from all three

counties that are part of the Zagreb agglomeration will be transferred to the biogas plant in order to be utilised for renewable energy production (cogeneration or biofuel production). The main reason for this approach is the need to define complete energy potential of the biowaste fraction in the ZUA. This is one of the main goals of the REEF 2W project.

Figure 3.15

Scheme of utilization of biowaste and sludge at remote biogas plant



3.7.3 Results and Discussion

Energetic point of view

Table 3.12

The overview of evaluated scenarios

Scenario	Total amount (t/y)	Origin	AD	Energy utilization		Sludge management	
			Biogas potential (m3/y)	CHP (kW)	Biomethane production (t/y)	Produced sludge (t/y)	Required land (ha)
1 - Local utilization of sludge	1,117.5	Sludge	0	0	0	1,117.5	673.2
2 - Onsite anaerobic digestion	3,443.5	Biowaste/Sludge	299,650	78.7	107.9	2,280.5	1,373.8
3 - Utilization of biowaste and sludge at remote biogas plant	36,442.5	Biowaste/Sludge	3,599,550	944.9	1,295.8	18,780	11,313.3

Economic point of view

Table 3.13

Overview of overall revenue/expenditure cash flow

Scenario	REVENUE (€/y)				EXPENDITURE (€/y)	
	Energy utilization				Biowaste gate fee	Waste treatment
	Electricity	Heat	Total CHP	Biofuel		
1 - Local utilization of sludge	0	0	0	0	0	70,402.5
2 - Onsite anaerobic digestion	44,048.6	20,136.5	64,185	129,448.8	88,388	114,596.5
3 - Utilization of biowaste and sludge at remote biogas plant	529,133.9	241,889.8	771,023.6	1,555,005.6	1,342,350	1,183,140

Table 3.14**Overview of the WWTP Zabok cash flow**

Scenario	REVENUE (€/y)				EXPENDITURE (€/y)	
	Energy utilization				Biowaste gate fee	Waste treatment
	Electricity	Heat	Total CHP	Biofuel		
1 - Local utilization of sludge	0.0	0.0	0.0	0.0	0.0	7,402.5
2 - Onsite anaerobic digestion	44,048.6	20,136.5	64,185.0	129,448.8	88,388.0	114,596.5
3 - Utilization of biowaste and sludge at remote biogas plant	0.0	0.0	0.0	0.0	0.0	70,402.5

Ecological point of view

The overview of the biowaste amounts for the treatment in ZUA is presented in the Table 3.15.

Table 3.15**Overview of the biowaste**

ZUA	Total amount of produced mixed municipal waste (t)	Total potential of biowaste (t)	Expected amount of collected biowaste (t)
City of Zagreb	217,380	65,214	26,085
Zagreb County	57,621	17,286	6,914
Krapina-Zagorje County	19,388	5,816	2,326
Total	294,389	88,316	35,325

3.7.4 Conclusion

The analysis performed for the Zagreb Agglomeration case study indicates that wastewater treatment is sustainable and can be combined with the utilization of separately collected biowaste. This approach could have not only positive environmental, but also financial impact on the investigated location. The application of sludge in agriculture is already part of practice in many EU regions, and its implementation could be a solution for wastewater treatment plants. New regulations of the sludge application and its monitoring with specific reference to the environmental condition are assuring its safe application in agricultural production. According to the data, the WWTP Zabok will produce 1,117.5 t/y of sludge possible to use on 673.2 ha of agricultural land. Since the investigate area has sufficient land availability, it can be assumed that possibility of local sludge application is realistic.

The REEF 2W solution also gives a possibility to use sludge for renewable energy production, and in that sense proposed different scenarios. Besides the first proposed scenario, others are giving the overview of the plant upgrade when the separately biowaste fraction is involved in the process. This will for sure improve cash flow of the plant (scenario 2), but certain investment are expected which cannot be foreseen in detail in this stage of plant construction.

Finally, it can be concluded that the use of sludge on agricultural soils is nowadays an efficient way to sustainably treat wastes generated in wastewater treatment plants. Also plant operators will have to take into consideration the fact that sludge has energy potential which can be sustainably combined with the biowaste produced at local or broader area.