PRE-ASSESMENT FOR EVALUATING

the suitability of 15 2W plants to become REEF 2W

Made by UCT on 04/2020

D.T4.3.3

A) INTRODUCTION AND GENERAL INFORMATION

According to DT4.3.3. proposal Veolia with UCT contacted several WWTP operating companies in the Czech republic to collect data about WWTPs and for preparing the pre-assessment.

There were several sites reached based on the preselection and visited: Zlin, Olomouc, Ústi nad Labem, Liberec, Hradec Kralove and Teplice.

Teplice, Liberec are rejected absolutely limited free space on sites for new technologies and Usti nad Labem for uncommon properties of wastewater (high industrial water content).

As suitable there were Zlin, Olomouc and Hradec Kralove sites choosen.

Plant 1: WWTP Zlin

- Zlin city, east part of Czech republic, WWTP is situated in a suburban area close to industrial zones between cities Zlin and Otrokovice
- The capacity of the plant is 207000 PE, the current load is 107114 PE
- Inflow parameters:

Total real inlet flow	m^3/d	21 323
Inlet pollution (COD), mg/l	mg COD/l	603
Inlet pollution (BOD), mg/l	mg BOD/l	250
The average temperature of activation tank	°C	14.7

- Technology description:

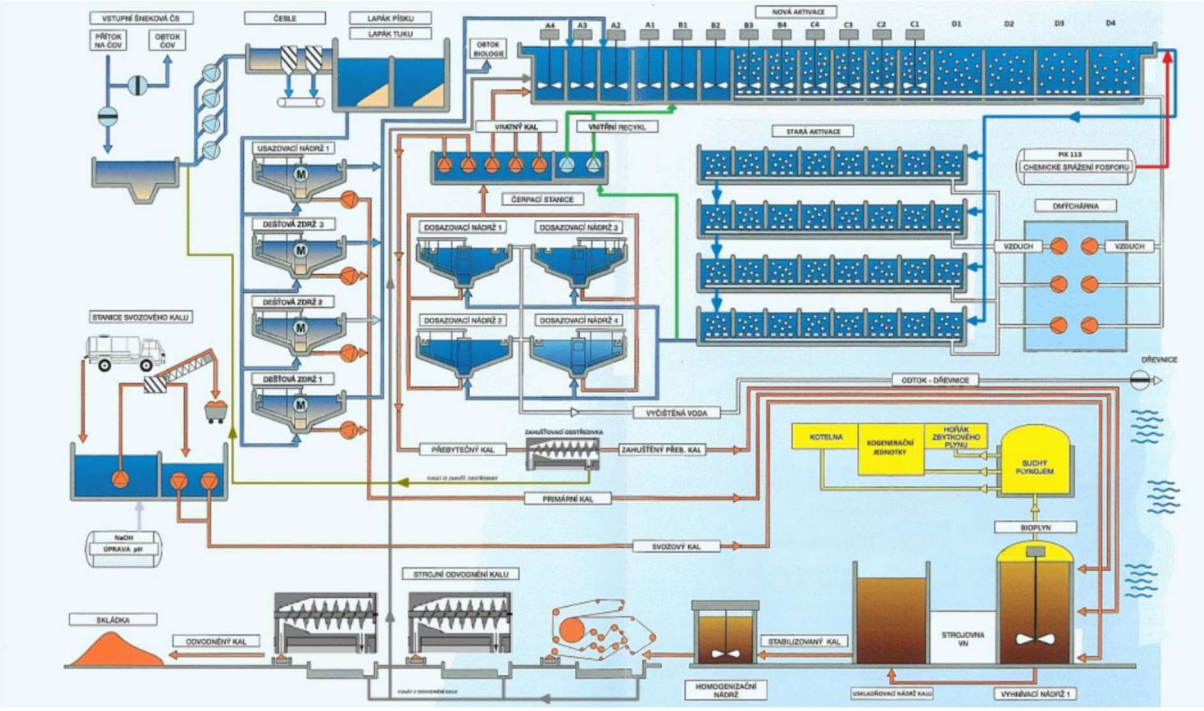
WWTP Zlin is a typical municipal mechanic-biological WWTP with primary mechanical treatment steps consisted of waste water pump station, screenings, primary sedimentation, activation with nutrient removal (optimized air distribution), round clarifiers.

The total volume of the biological treatment step: 25800 m^3, treatment efficiency:

Efficiency COD removal	%	95.3
Efficiency BOD removal	%	100
Efficiency N total removal	%	70
Efficiency P total removal	%	85

Sludge is thickened via thickening centrifuge and digested by AD. AD is first step with mesophilic digester 3800 m^3. Distillery stillage is used as co-substrate. Biogas is used in CHP unit (gas engines) 2 x 125 kWel. Sludge is dewatered by centrifuge and used in agriculture or compost producing by external companies.

Total electricity production	kWh/year	1854624
Specific electricity consumption (PE - COD WWTP inlet)	kWh/PE	23.8
Specific electricity production (PE - COD WWTP inlet)	kWh/PE	17.9
Electricity self sufficiency on the basis of biogas from WWTP	%	75.1



- Operator priority is now to change sludge disposal for more sustainable technologies. Now there are developing projects for sludge drying and incineration.
- The project is choosen for pre-assessment as a very well operated plant with a responsible operator and crew with a large amount of data about operation collected and archivated. There are also developing industrial zones close to the plant for RE projects.

Plant 2: Hradec Kralove

Hradec Kralove is the regional centre of the east-central part of the Czech Republic. It is a historical city with limited industrial development. WWTP is situated close to Elbe river about 5 km outside the city. The plant is standalone without any municipal or industrial area around It. Unique is high altitude pumping station at WWTP (due to a very deep sewer system).

- Hradec Kralove city, east-central part of Czech republic, WWTP is situated in a rural area in relatively significant distance from the city and other municipalities
- The capacity of the plant is 140000 PE, the current load is 121900 PE
- Inflow parameters:

Total real inlet flow	m^3/d	33089
Inlet pollution (COD), mg/l	mg COD/l	442
Inlet pollution (BOD), mg/l	mg BOD/l	188
Average temperature of activation tank	°C	16.0

- Technology description:

WWTP Hradec Kralove is a common municipal mechanic-biological WWTP with primary mechanical treatment steps consisted of waste water pump station (the deepest in CZ), screenings, primary sedimentation, activation with nutrient removal (optimized air distribution), round clarifiers. There is a tertiary biological N removal biofilter installed.

The total volume of the biological treatment step: 25975 m^3, treatment efficiency:

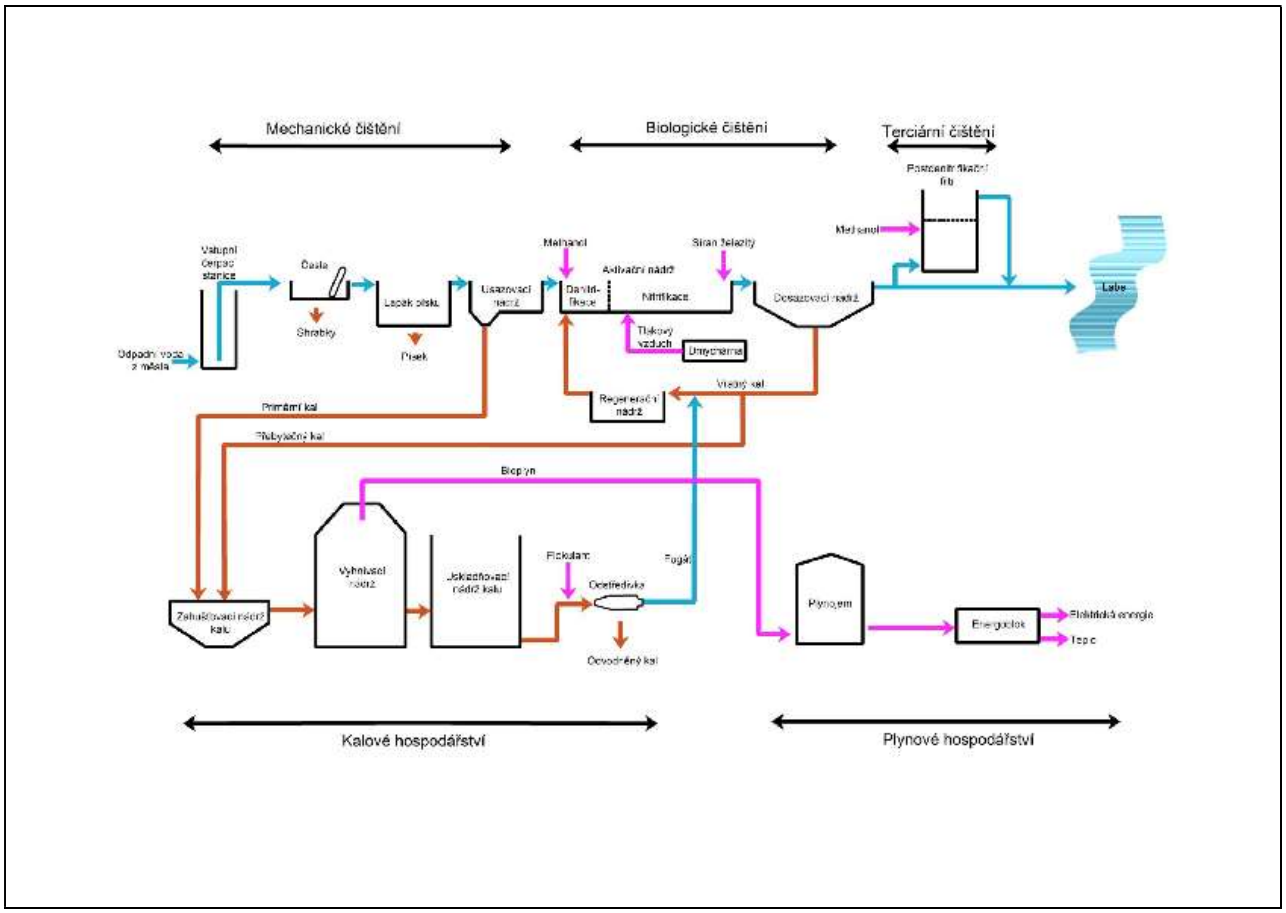
Efficiency COD removal	%	94.5
Efficiency BOD removal	%	99
Efficiency N total removal	%	76
Efficiency P total removal	%	89

Sludge is thickened via thickening centrifuge and digested by AD. AD is 2 stages with 2x mesophilic digester 4100 m^3. Glycerol by-products is used as co-substrate. Biogas is used in CHP unit (gas engines) 3 x 179 kWel. Sludge is dewatered by centrifuge and used in agriculture or compost producing by external companies.

Total electricity production	kWh/year	3092167
Specific electricity consumption (PE - COD WWTP inlet)	kWh/PE	46.4
Specific electricity production (PE - COD WWTP inlet)	kWh/PE	27.1
Electricity self-sufficiency based on biogas from WWTP	%	58.4

At the plant, there is a realized project of Hazardous waste processing plant (chemical treatment plant) for liquid waste. Pretreated water from this facility is used as a co-substrate for the anaerobic digestion (COD 50 g/l).

- Operator priority is now to change sludge disposal for more sustainable technologies. Now there are developing projects for sludge drying and incineration. Also, biomethane production is now evaluated.
- The project is selected for pre-assessment as a very well operated plant with a responsible operator and crew with a large amount of data about operation collected and archived. There is a potential-free space close to the plant for development.



Plant 3: Olomouc

WWTP Olomouc is a municipal mechanical – biological treatment plant for Olomouc city and its suburbs. It is situated at the south part of Olomouc city close to river Morava (recipient).

- Olomouc city, the central part of Moravia part of Czech republic, WWTP is situated in suburb area close to both logistic, industrial and residential areas
- The capacity of the plant is 259500 PE, the current load is 180300 PE
- Inflow parameters:

Total real inlet flow	m^3/d	27387
Inlet pollution (COD), mg/l	mg COD/l	790
Inlet pollution (BOD), mg/l	mg BOD/l	379
The average temperature of activation tank	°C	16.7

- Technology description:

WWTP Olomouc is standard municipal mechanic-biological WWTP with primary mechanical treatment step consisted of waste water pump station, screenings, primary sedimentation, activation with nutrient removal (optimized air distribution), round clarifiers.

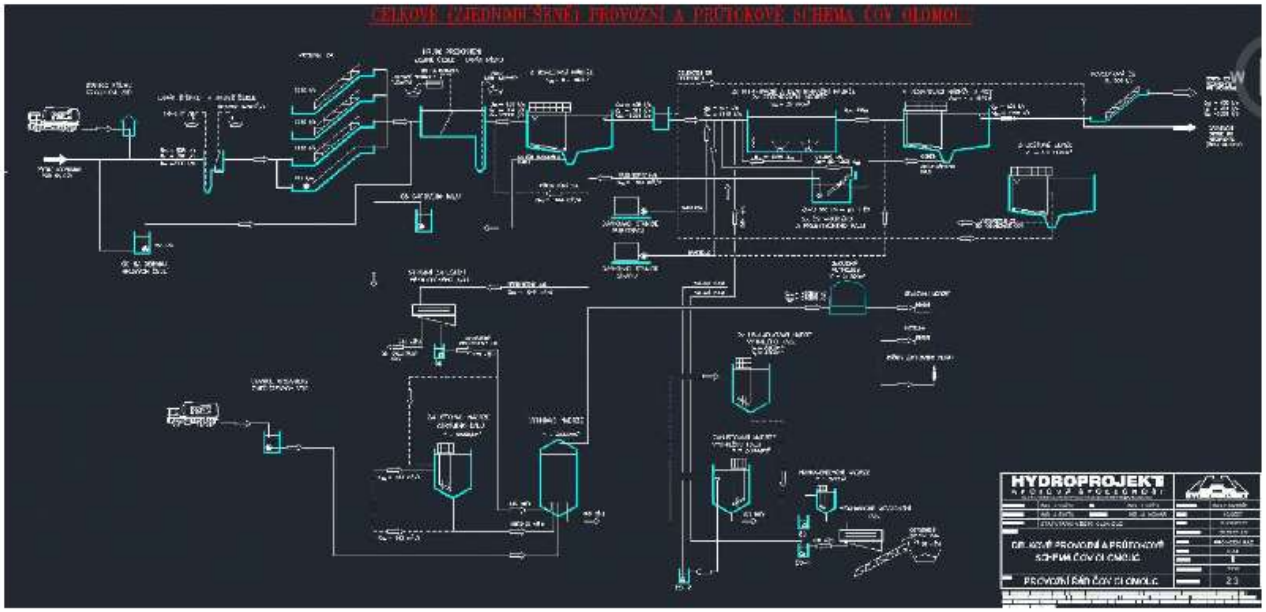
The total volume of the biological treatment step: 39 960 m^3, treatment efficiency:

Efficiency COD removal	%	96.5
Efficiency BOD removal	%	99
Efficiency N total removal	%	85
Efficiency P total removal	%	92

Sludge is gravity thickened and digested by AD. AD is first stage with 3x mesophilic digester 3200 m^3. Lecitin wastewater is used as co-substrate. Biogas is used in CHP unit (gas engines) 2 x 450 kWel. Sludge is dewatered by centrifuge and used in agriculture or compost producing by external companies.

Total electricity production	kWh/year	2650197
Specific electricity consumption (PE - COD WWTP inlet)	kWh/PE	29.0
Specific electricity production (PE - COD WWTP inlet)	kWh/PE	13.1
Electricity self-sufficiency based on biogas from WWTP	%	45.3

- Operator priority is now to replace CHP energy center and to find a new solution for biogas - CHP, boiler with sludge dryer and biomethane unit are evaluated
- The project is chosen for pre-assessment as a very well operated plant with a responsible operator and crew with a large amount of data about operation collected and archived. The current CHP unit has to be replaced immediately because of the end of engines live-cycle. Still, there is a possibility to realize other kind of biogas use, which is suitable for using REEF2W tool.



B) PRE-ASSESSMENT APPROACH (METHODOLOGY)

The first selection of the possible sites was based on the data provided by Veolia and information from the workshop made in December in Prague. We choose several WWTP in Zlin, Olomouc, Ústi nad Labem, Liberec, Hradec Kralove and Teplice for further investigations. Then we conduct a series of phone calls and videoconferences with selected sites according to which Teplice and Liberec were eliminated due to the limited free space. WWTP in Usti nad Labem was excluded after considering the specific pollution of wastewater due to industry in the region. The remaining sites agreed to participate in preassessment and data was obtained through the Data collection sheet from the Tool. The data provided from WWTPs were then used in the tool for evaluating energy efficiency. Each of the WWTPs was interested in the testing possibility of using biomethane at there sites. Therefore, we evaluated each of them in the same way, where we evaluated energy efficiency and then compared current and future situation when all biogas production was transferred in the biomethane.

C) RESULTS

ZLIN

The plant situation was analyzed by REEF2W Tool with the following results:

WWTP Description			
	Status quo	Future situation	
Plant type	Wastewater Treatment Plant		
Name of User	Zlin		
Date	2020/04/29		
Country	Czech Republic		
Treatment capacity	207000	207000	PE (*)
Connected population	107114	107114	PE (*)
Daily average of wastewater flow	21323	21323	m3/d
COD inflow concentration	603	603	mg/l
TN in influent	49,44	49,44	kgTN/m3

Substrate			
Status quo			
	Tons (t/y)	Tot. Solid (%)	Volatile (%)
Primary Sludge	24727,0	4,5	76,0
Secondary Sludge	16113,0	6,0	40,3
External Sewage Sludge	NA	NA	NA
Organic Fraction of Municipal Solid Waste	NA	NA	NA
Other	4790,0	6,9	40,0
Other	200,0	80,0	80,0
NA	NA	NA	NA
NA	NA	NA	NA

There are no changes in substrates.

Energy efficiency

WWTP Indicator

	Status quo	Future situation	
PE120	107148,1	107148,1	PE
Treatment capacity	207000	207000	PE

Electric energy consumption

	Status quo	Future situation		Standard Range		Norm. (%) Status quo	Norm. (%) Future situation
Mechanical pre-treatment	5,876	-	kWh/PE120 y	2,5	5,5	**112,5**	-
Pumping stations	4,480	-	kWh/PE120 y	1,5	3,5	**149,0**	-
Screen	1,397	-	kWh/PE120 y	0,5	1	**179,3**	-
Sand trap and primary clarifier	NA	-	kWh/PE120 y	0,5	1	**NA**	-
Mechanical-biological treatment	13,108	-	kWh/PE120 y	14,5	33	**-7,5**	-
Aeration	8,210	-	kWh/PE120 y	11,5	22	**-31,3**	-
Stirrers	2,190	-	kWh/PE120 y	1,5	4,5	**23,0**	-
Return sludge pumps	2,708	-	kWh/PE120 y	1	4,5	**48,8**	-
Miscellanious (sec. clarifier)	NA	-	kWh/PE120 y	0,5	2	**NA**	-
Sludge treatment	4,149	-	kWh/PE120 y	2	7	**43,0**	-
Thickening	1,540	-	kWh/PE120 y	0,5	1	**207,9**	-
Digestion	0,838	-	kWh/PE120 y	1	2,5	**-10,8**	-
Dewatering	1,771	-	kWh/PE120 y	0,5	3,5	**42,4**	-
Infrastructure	NA	-	kWh/PE120 y	1	4,5	**NA**	-
Heating	NA	-	kWh/PE120 y	0	2,5	**NA**	-
Misc. infrastructure	NA	-	kWh/PE120 y	1	2	**NA**	-
Tot. elect. ener. consumption	23,134	23,134	kWh/PE120 y	20	50	**10,4**	**10,4**

Initial inspection shows that plant has electric consumption inside the estimated range.

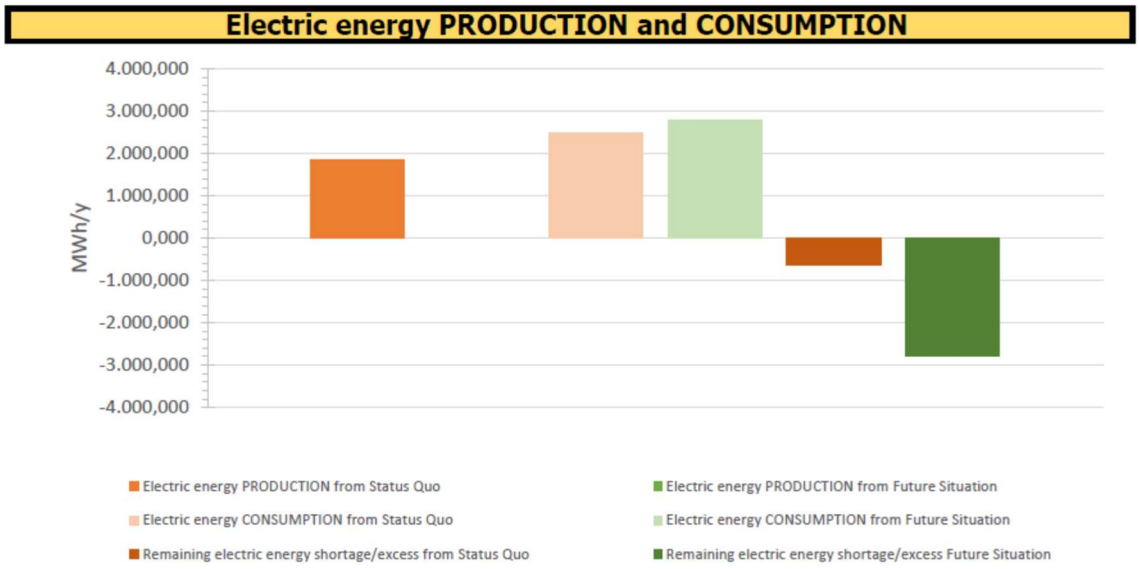
Biomethane unit installation instead of commonly operated CHP is evaluated by REEF2W tool.

Energy from waste

Anaerobic digestion

	Status quo	Future situation	
Total biogas production from AD	914789	914789	m3/y
Digestate	44732,25	44732,25	t/y
Solid fraction after solid/liquid separator	43837,61	43837,61	t/y
Liquid fraction after solid/liquid separator	894,65	894,65	t/y
CHP installed power	952,91	NA	kW
Electric energy production from CHP	1854624	NA	kWh/y
Thermal energy production from CHP	2132817	NA	kWh/y
Electric energy consumption from biogas prod.	22255,49	NA	kWh/y
Thermal energy consumption from biogas prod.	106640,85	NA	kWh/y
Electric energy consumption from Hydrolysis	NA	NA	kWh/y
Thermal energy consumption from Hydrolysis	NA	NA	kWh/y
Total biomethane production from Upgrading	NA	546129,03	m3/y
Electric energy consumption from Upgrading	NA	311028,26	kWh/y
Fraction of biogas fed into the Upgrading	NA	100,00	%
Total methane production from PtG	NA	NA	kWh/y
Input power from PtG	NA	NA	kW

Current WWTP self-sufficiency is about 74%. Biomethane unit installation causes that no energy (both thermal and electrical) for self-consumption will be produced.



Electric energy PRODUCTION from Status Quo	1854,624	MWh/y
Electric energy CONSUMPTION from Status Quo	2500,970	MWh/y
Remaining electric energy shortage/excess from Status Quo	-646,346	MWh/y
Electric energy PRODUCTION from Future Situation	0,000	MWh/y
Electric energy CONSUMPTION from Future Situation	2789,743	MWh/y
Remaining electric energy shortage/excess Future Situation	-2789,743	MWh/y

Because of no excess heat or electric energy production, there was no Spatial Assessment provided.

Environmental Assessment gives better output for CO2eq production for biomethane production.

Environment Assessment

Carbon footprint/credit for:	Status Quo	Future situation	
Imported electricity	445,98	1924,92	t CO2-eq
Imported heat	NA	NA	t CO2-eq
Aerobic treatment	961965,82	961965,82	t CO2-eq
Sludge handling	21,30	21,30	t CO2-eq
CHP engine and flare emissions	95,23	NA	t CO2-eq
Exported electricity	NA	NA	t CO2-eq
Exported heat	NA	NA	t CO2-eq
Methane slip during upgrading	NA	NA	t CO2-eq
Injected biomethane	NA	-1306,26	t CO2-eq
Sludge use	-1397,86	-1397,86	t CO2-eq
Carbon footprint scenario	**NA**	**NA**	t CO2-eq

For economic assessment, there are issues with the rentability of biomethane plant. There is significant rise of electric and heat consumption at the WWTP (no energy from CHP). These costs are not specified by REEF2W tool.

Economic Assessment		
Operating cost		
Biogas upgrading	216145,14	EUR/year
Thermal Hydrolisis	0,00	EUR/year
PtG	0,00	EUR/year
Heat pump	0,00	EUR/year
Hydroelectric microturbine	0,00	EUR/year
Photovoltaic	0,00	EUR/year
Thermal collector	0,00	EUR/year
Hybrid PV/T collector	0,00	EUR/year
Pyrolisis	0,00	EUR/year
Total operating cost	216145,14	EUR/year
Investment cost		
Biogas upgrading	644005,42	EUR
Thermal Hydrolisis	0,00	EUR
PtG	0,00	EUR
Heat pump	0,00	EUR
Hydroelectric microturbine	0,00	EUR
Photovoltaic	0,00	EUR
Thermal collector	0,00	EUR
Hybrid PV/T collector	0,00	EUR
Pyrolisis	0,00	EUR
Total investment cost	644005,42	EUR
Additional incomes		
Incomes/Expenditure - additional waste processing	0,00	EUR/year
Incomes from utilisation of heat	0,00	EUR/year
Incomes from utilisation of electricity	0,00	EUR/year
Incomes biomethane selling into the grid	472932,89	EUR/year
Incomes biomethane selling CNG	0,00	EUR/year
Indicators		
Return of the investment	2,51	Year
Aditional income	472932,89	EUR
Electrical Energy cost saving	0,00	EUR

The economic assessment gives a very good result. The return of investment is very good for RE project. The main issue is, that The Tool not validated the rise of costs of operation of the plant in case of stopping the operation of the CHP. The CHP is the best solution for the WWTP

Zlin operation. Biogas production is sufficient for all heat consumption at WWTP and 74% of electricity consumption. There is no excess biogas production for biomethane plant and replacing CHP with biomethane unit is not effective both energetically and economically.

HRADEC KRALOVE

The plant situation was analyzed by REEF2W Tool with the following results:

WWTP Description			
	Status quo	Future situation	
Plant type	Wastewater Treatment Plant		
Name of User	Hradec Králové		
Date	2020/04/01		
Country	Czech Republic		
Treatment capacity	141000	141000	PE (*)
Connected population	121876	121876	PE (*)
Daily average of wastewater flow	33089	33089	m3/d
COD inflow concentration	442	442	mg/l
TN in influent	38,45	38,45	kgTN/m3

Substrate			
Status quo			
	Tons (t/y)	Tot. Solid (%)	Volatile (%)
Primary Sludge	42653,0	4,6	67,6
Secondary Sludge	48399,0	2,4	70,8
External Sewage Sludge	NA	NA	NA
Organic Fraction of Municipal Solid Waste	NA	NA	NA
Other	9427,0	50,0	50,0
Other	1271,0	100,0	80,0
Other	231,0	22,0	90,0
NA	NA	NA	NA

There is no change for substrate composition between the status quo and the future situation.

Energy efficiency

WWTP Indicator

	Status quo	Future situation	
PE120	121877,8	121877,8	PE
Treatment capacity	141000	141000	PE

Electric energy consumption

	Status quo	Future situation		Standard Range		Norm. (%) Status quo	Norm. (%) Future situation
Mechanical pre-treatment	17,070	-	kWh/PE120 y	2,5	5,5	**485,7**	-
Pumping stations	14,537	-	kWh/PE120 y	1,5	3,5	**651,8**	-
Screen	2,534	-	kWh/PE120 y	0,5	1	**406,7**	-
Sand trap and primary clarifier	NA	-	kWh/PE120 y	0,5	1	**NA**	-
Mechanical-biological treatment	24,749	-	kWh/PE120 y	14,5	33	**55,4**	-
Aeration	16,268	-	kWh/PE120 y	11,5	22	**45,4**	-
Stirrers	1,258	-	kWh/PE120 y	1,5	4,5	**-8,1**	-
Return sludge pumps	5,855	-	kWh/PE120 y	1	4,5	**138,7**	-
Miscellanious (sec. clarifier)	1,369	-	kWh/PE120 y	0,5	2	**57,9**	-
Sludge treatment	4,154	-	kWh/PE120 y	2	7	**43,1**	-
Thickening	NA	-	kWh/PE120 y	0,5	1	**NA**	-
Digestion	1,300	-	kWh/PE120 y	1	2,5	**20,0**	-
Dewatering	2,854	-	kWh/PE120 y	0,5	3,5	**78,5**	-
Infrastructure	NA	-	kWh/PE120 y	1	4,5	**NA**	-
Heating	NA	-	kWh/PE120 y	0	2,5	**NA**	-
Misc. infrastructure	NA	-	kWh/PE120 y	1	2	**NA**	-
Tot. elect. ener. consumption	45,973	45,973	kWh/PE120 y	20	50	**86,6**	**86,6**

Initial inspection shows that plant electric consumption is in the standard range but at high value. The reason is high pumping station consumption and tertial treatment.

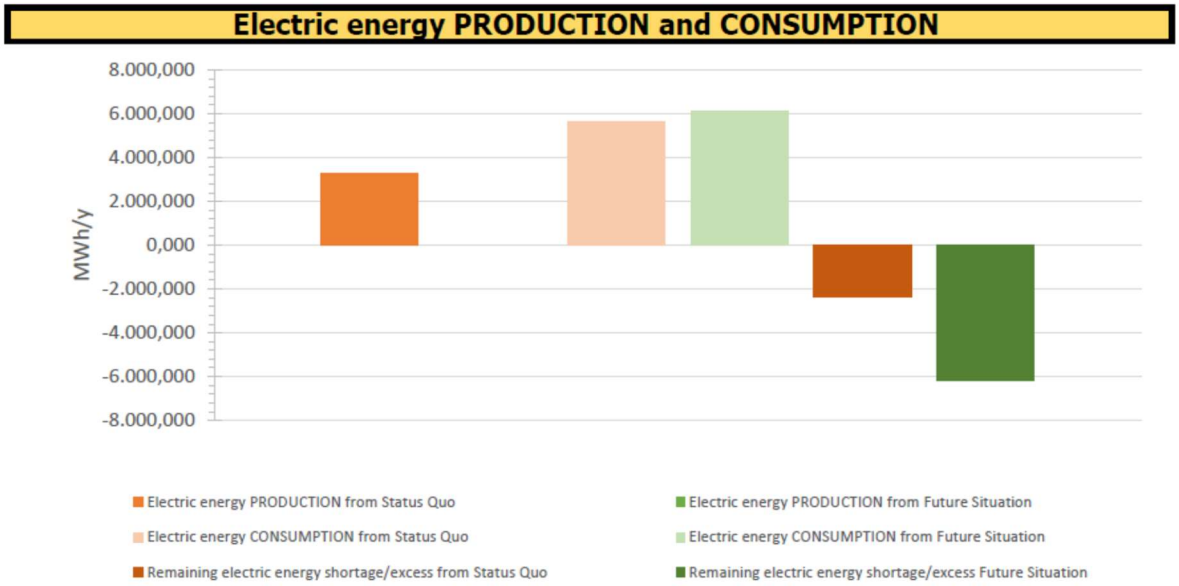
Biomethane unit installation instead of commonly operated CHP is evaluated by REEF2W tool.

Energy from waste

Anaerobic digestion

	Status quo	Future situation	
Total biogas production from AD	1604650	1604650	m3/y
Digestate	100055,42	100055,42	t/y
Solid fraction after solid/liquid separator	98054,31	98054,31	t/y
Liquid fraction after solid/liquid separator	2001,11	2001,11	t/y
CHP installed power	1671,51	NA	kW
Electric energy production from CHP	3297000	NA	kWh/y
Thermal energy production from CHP	4582969	NA	kWh/y
Electric energy consumption from biogas prod.	39564,00	NA	kWh/y
Thermal energy consumption from biogas prod.	229148,45	NA	kWh/y
Electric energy consumption from Hydrolysis	NA	NA	kWh/y
Thermal energy consumption from Hydrolysis	NA	NA	kWh/y
Total biomethane production from Upgrading	NA	957976,05	m3/y
Electric energy consumption from Upgrading	NA	545581,00	kWh/y
Fraction of biogas fed into the Upgrading	NA	100,00	%
Total methane production from PtG	NA	NA	kWh/y
Input power from PtG	NA	NA	kW

The current WWTP self-sufficiency is about 58,4%. Biomethane unit installation causes that no energy (both thermal and electrical) for self-consumption will be produced.



Electric energy PRODUCTION from Status Quo	3297,000	MWh/y
Electric energy CONSUMPTION from Status Quo	5642,679	MWh/y
Remaining electric energy shortage/excess from Status Quo	-2345,679	MWh/y
Electric energy PRODUCTION from Future Situation	0,000	MWh/y
Electric energy CONSUMPTION from Future Situation	6148,696	MWh/y
Remaining electric energy shortage/excess Future Situation	-6148,696	MWh/y

Because of no excess heat or electric energy production, there was no Spatial Assessment provided. There are also no development, industrial or residential areas as energy consumers in the distance to 3 km from WWTP.

Environmental Assessment gives better output for CO2eq production for biomethane production.

Environment Assessment

Carbon footprint/credit for:	Status Quo	Future situation	
Imported electricity	1618,52	4242,60	t CO2-eq
Imported heat	634853,50	635872,30	t CO2-eq
Aerobic treatment	1160948,25	1160948,25	t CO2-eq
Sludge handling	76,24	76,24	t CO2-eq
CHP engine and flare emissions	167,04	NA	t CO2-eq
Exported electricity	NA	NA	t CO2-eq
Exported heat	NA	NA	t CO2-eq
Methane slip during upgrading	NA	NA	t CO2-eq
Injected biomethane	NA	-2291,35	t CO2-eq
Sludge use	-5003,24	-5003,24	t CO2-eq
Carbon footprint scenario	**1792660,31**	**1793844,79**	t CO2-eq

For economic assessment, there are issues with the rentability of biomethane plant. There is significant rise of electric and heat consumption at the WWTP (no energy from CHP). These costs are not specified by REEF2W tool.

Economic Assessment		
Operating cost		
Biogas upgrading	368832,94	EUR/year
Thermal Hydrolisis	0,00	EUR/year
PtG	0,00	EUR/year
Heat pump	0,00	EUR/year
Hydroelectric microturbine	0,00	EUR/year
Photovoltaic	0,00	EUR/year
Thermal collector	0,00	EUR/year
Hybrid PV/T collector	0,00	EUR/year
Pyrolisis	0,00	EUR/year
Total operating cost	368832,94	EUR/year
Investment cost		
Biogas upgrading	1009065,04	EUR
Thermal Hydrolisis	0,00	EUR
PtG	0,00	EUR
Heat pump	0,00	EUR
Hydroelectric microturbine	0,00	EUR
Photovoltaic	0,00	EUR
Thermal collector	0,00	EUR
Hybrid PV/T collector	0,00	EUR
Pyrolisis	0,00	EUR
Total investment cost	1009065,04	EUR
Additional incomes		
Incomes/Expenditure - additional waste processing	0,00	EUR/year
Incomes from utilisation of heat	0,00	EUR/year
Incomes from utilisation of electricity	0,00	EUR/year
Incomes biomethane selling into the grid	565623,55	EUR/year
Incomes biomethane selling CNG	0,00	EUR/year
Indicators		
Return of the investment	5,13	Year
Aditional income	565623,55	EUR
Electrical Energy cost saving	0,00	EUR

The CHP is the best solution for WWTP Hradec Kralove operation. Biogas production is sufficient for all heat consumption at WWTP and 58,4% of electricity consumption. There is no excess biogas production for biomethane plant and replacing CHP with biomethane unit is not effective both energetically and economically.

OLOMOUC

The plant situation was analyzed by REEF2W Tool with following results:

WWTP Description			
	Status quo	Future situation	
Plant type	Wastewater Treatment Plant		
Name of User	Olomouc		
Date	2020/04/01		
Country	Czech Republic		
Treatment capacity	259500	259500	PE (*)
Connected population	180295	180295	PE (*)
Daily average of wastewater flow	27387	27387	m3/d
COD inflow concentration	790	790	mg/l
TN in influent	61,8	61,8	kgTN/m3

Substrate			
Status quo			
	Tons (t/y)	Tot. Solid (%)	Volatile (%)
Primary Sludge	79546,0	3,4	74,9
Secondary Sludge	45494,0	5,4	67,9
External Sewage Sludge	NA	NA	NA
Organic Fraction of Municipal Solid Waste	NA	NA	NA
Other	1050,0	100,0	92,0
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

There are no changes for substrates in comparison to the status quo and future situation.

Energy efficiency

WWTP Indicator

	Status quo	Future situation	
PE120	180297,8	180297,8	PE
Treatment capacity	259500	259500	PE

Electric energy consumption

	Status quo	Future situation		Standard Range		Norm. (%) Status quo	Norm. (%) Future situation
Mechanical pre-treatment	3,682	-	kWh/PE120 y	2,5	5,5	**39,4**	-
Pumping stations	NA	-	kWh/PE120 y	1,5	3,5	**NA**	-
Screen	3,682	-	kWh/PE120 y	0,5	1	**636,5**	-
Sand trap and primary clarifier	NA	-	kWh/PE120 y	0,5	1	**NA**	-
Mechanical-biological treatment	17,052	-	kWh/PE120 y	14,5	33	**13,8**	-
Aeration	13,618	-	kWh/PE120 y	11,5	22	**20,2**	-
Stirrers	2,138	-	kWh/PE120 y	1,5	4,5	**21,3**	-
Return sludge pumps	1,296	-	kWh/PE120 y	1	4,5	**8,4**	-
Miscellanious (sec. clarifier)	NA	-	kWh/PE120 y	0,5	2	**NA**	-
Sludge treatment	2,850	-	kWh/PE120 y	2	7	**17,0**	-
Thickening	1,288	-	kWh/PE120 y	0,5	1	**157,5**	-
Digestion	0,500	-	kWh/PE120 y	1	2,5	**-33,3**	-
Dewatering	1,063	-	kWh/PE120 y	0,5	3,5	**18,8**	-
Infrastructure	NA	-	kWh/PE120 y	1	4,5	**NA**	-
Heating	NA	-	kWh/PE120 y	0	2,5	**NA**	-
Misc. infrastructure	NA	-	kWh/PE120 y	1	2	**NA**	-
Tot. elect. ener. consumption	23,585	23,585	kWh/PE120 y	20	50	**11,9**	**11,9**

Initial inspection shows that plant has low electric consumption at the expected range.

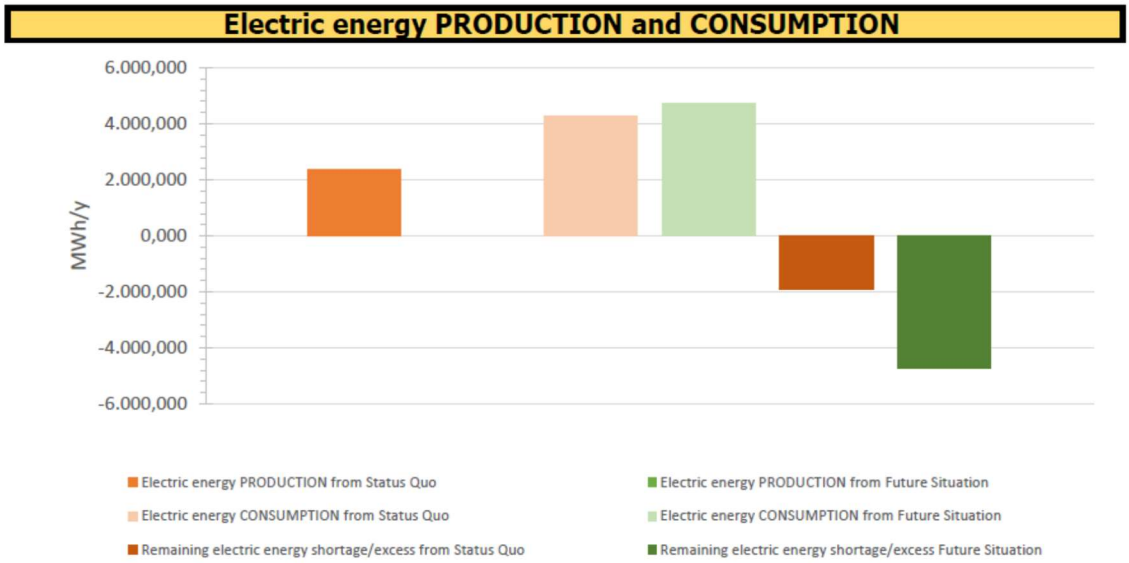
Biomethane unit installation instead of commonly operated CHP is evaluated by REEF2W tool.

Energy from waste

Anaerobic digestion

	Status quo	Future situation	
Total biogas production from AD	1355895	1355895	m3/y
Digestate	124462,93	124462,93	t/y
Solid fraction after solid/liquid separator	121973,67	121973,67	t/y
Liquid fraction after solid/liquid separator	2489,26	2489,26	t/y
CHP installed power	1412,39	NA	kW
Electric energy production from CHP	2368455	NA	kWh/y
Thermal energy production from CHP	4425858	NA	kWh/y
Electric energy consumption from biogas prod.	28421,46	NA	kWh/y
Thermal energy consumption from biogas prod.	221292,90	NA	kWh/y
Electric energy consumption from Hydrolysis	NA	NA	kWh/y
Thermal energy consumption from Hydrolysis	NA	NA	kWh/y
Total biomethane production from Upgrading	NA	809469,32	m3/y
Electric energy consumption from Upgrading	NA	461004,30	kWh/y
Fraction of biogas fed into the Upgrading	NA	100,00	%
Total methane production from PtG	NA	NA	kWh/y
Input power from PtG	NA	NA	kW

Current WWTP sef-sufficiency is about 45,3%. Biomethane unit installation causes, that no energy (both thermal and electrical) for self-consumption will be produced.



Electric energy PRODUCTION from Status Quo	2368,455	MWh/y
Electric energy CONSUMPTION from Status Quo	4280,671	MWh/y
Remaining electric energy shortage/excess from Status Quo	-1912,216	MWh/y
Electric energy PRODUCTION from Future Situation	0,000	MWh/y
Electric energy CONSUMPTION from Future Situation	4713,254	MWh/y
Remaining electric energy shortage/excess Future Situation	-4713,254	MWh/y

Because of no excess heat or electric energy production, there was no Spatial Assessment provided.

Environmental Assessment gives better output for CO2eq production for biomethane production.

Environment Assessment

Carbon footprint/credit for:	Status Quo	Future situation	
Imported electricity	1319,43	3252,15	t CO2-eq
Imported heat	NA	NA	t CO2-eq
Aerobic treatment	1544421,40	1544421,40	t CO2-eq
Sludge handling	52,04	52,04	t CO2-eq
CHP engine and flare emissions	141,15	NA	t CO2-eq
Exported electricity	NA	NA	t CO2-eq
Exported heat	NA	NA	t CO2-eq
Methane slip during upgrading	NA	NA	t CO2-eq
Injected biomethane	NA	-1936,14	t CO2-eq
Sludge use	-3415,04	-3415,04	t CO2-eq
Carbon footprint scenario	**1542518,97**	**1542374,40**	t CO2-eq

For economic assessment, there are issues with the rentability of biomethane plant. There is significant rise of electric and heat consumption at the WWTP (no energy from CHP). These costs are not specified by REEF2W tool.

Economic Assessment

Operating cost		
Biogas upgrading	314797,80	EUR/year
Thermal Hydrolisis	0,00	EUR/year
PtG	0,00	EUR/year
Heat pump	0,00	EUR/year
Hydroelectric microturbine	0,00	EUR/year
Photovoltaic	0,00	EUR/year
Thermal collector	0,00	EUR/year
Hybrid PV/T collector	0,00	EUR/year
Pyrolisis	0,00	EUR/year
Total operating cost	314797,80	EUR/year
Investment cost		
Biogas upgrading	889383,23	EUR
Thermal Hydrolisis	0,00	EUR
PtG	0,00	EUR
Heat pump	0,00	EUR
Hydroelectric microturbine	0,00	EUR
Photovoltaic	0,00	EUR
Thermal collector	0,00	EUR
Hybrid PV/T collector	0,00	EUR
Pyrolisis	0,00	EUR
Total investment cost	889383,23	EUR
Additional incomes		
Incomes/Expenditure - additional waste processing	0,00	EUR/year
Incomes from utilisation of heat	0,00	EUR/year
Incomes from utilisation of electricity	0,00	EUR/year
Incomes biomethane selling into the grid	477939,82	EUR/year
Incomes biomethane selling CNG	0,00	EUR/year
Indicators		
Return of the investment	5,45	Year
Aditional income	477939,82	EUR
Electrical Energy cost saving	0,00	EUR

The CHP seems to be an optimal solution for WWTP Olomouc operation. Biogas production is sufficient for all heat consumption at WWTP and 58,4% of electricity consumption. There is

no excess biogas production for biomethane plant and replacing CHP with biomethane unit seems to be not effective enough both energetically and economically.

Now the municipality has to take a decision on further biogas utilization. The presented pre-assessment was performed using the REEF2W tool and elaboration of a feasibility study can be used as a crucial basis for the selection of an optimal and sustainable solution.

D) CONCLUSION

There were three large municipal WWTP operated by Veolia chosen for preassessment. At these plants, there were long-time multiple parameters benchmarking provided, so there are operational data available. Plants are mechanical/biological WWTPs with anaerobic digestion step. Biogas is used for electricity and heat production by CHP (gas engines).

Plants are evaluated by REEF2W Tool and the possibility of installing the biomethane production unit was validated.

All three plants have electric consumption in the range expected by the REEF2W tool. Power consumption at Zlin and Olomouc Plant is significantly lower than at Hradec Kralove. The reason is higher pumping consumption at Hradec (high altitude of pumping) and tertiary treatment.

Biomethane unit has a better environmental impact but economically is often better to use CHP because the produced energy is used for self-consumption of WWTP.

At Olomouc plant, now the further biogas utilization is evaluated. It is necessary to replace old CHP engines. Evaluated solutions were boiler connected to sludge dryer, biomethane unit, and new CHP.

As the most promising plant for performing a feasibility study (D.T4.3.5.) was finally selected WWTP Olomouc, because of the high interest of the municipality of Olomouc city and the utility Moravská vodárenská a.s., which is the operator of the plant.