D.T 4.3.5 – ADDITIONAL 3 FEASIBILITY STUDIES ON BEHALF OF THREE NEW PA

Project Title: REEF2W Increased renewable energy and energy efficiency by integrating, combining and empowering urban wastewater and organic waste management systems

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1. Introduction

This deliverable aims to analyze the energy efficiency and the potential to produce renewable energy in the WWTP Plzeň. This feasibility study was added due to the high interest of the WWTP Plzeň to implement new technologies in the existing wastewater treatment and management. Implementing the first part of the feasibility will allow us to understand how much energy the WTTPs currently use and the efficiency level. Furthermore, it will provide a quantitative understanding of the potential to increase energy outputs. In the (fictive) technological upgrades defined for each pilot, these include measures to optimize existing processes and to install new technologies that produce renewable energy

2. Background

2.1. The Integrated Sustainability Assessment

The Integrated Sustainability Assessment (ISA) methodology is used to systematically assess technical innovations for energy optimization of wastewater treatment plants (WWTPs) on different sustainability criteria. The instrument allows for making predictions about potentials to improve energy performance, the technical feasibility, or the REEF 2W solutions' environmental sustainability. For more detailed information, please check DT.1.4.1-3.

The REEF 2W tool, which was developed as an Excel spreadsheet and online tool, comprises five core steps:

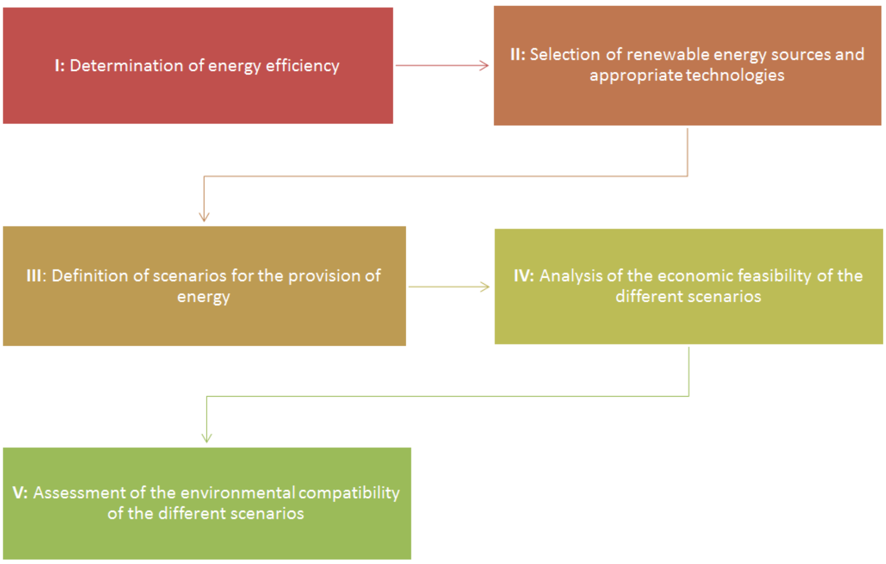


Figure 1: The five steps of the ISA method

I: Energy efficiency is determined through a comparative analysis that measures current energy consumption against recognized efficiency standards. This benchmarking shows the optimization potential for heat and electricity savings.

II: Suitable technologies are selected through a potential analysis that compares different renewable energy sources. The project's emphasis is set on improving heat and biogas yields while increasing the efficiency of subsequent uses such as biogas upgrading.

III: Different scenarios demonstrate how excess energy can be used for self-supply of the WWTP and feed-in into the gas, electricity and heat grid. These consider the amount of available surplus energy, energy consumption and energy demand of neighbouring settlements, and existing grid infrastructures.

IV: The economic feasibility assessment of planned measures will be carried out through a life-cycle cost analysis incorporating generated revenues from energy savings and sales and investment and maintenance costs.

V: Life Cycle Assessment (LCA) focusing on CO_2-reduction potentials is carried out for each scenario to assess the environmental impacts.

2.2. The Expected Benefits

The implementation of REEF2W technologies entails several advantages from an energetic, economic and environmental point of view.

Energy optimization	Economic feasibility	Environmental sustainability
Additional process steps such as thermal hydrolysis or co-fermentation with organic substances increase biogas yields. **Additional heat production is achieved by heat pumps in the sewer.** **More efficient utilization of biogas is achieved by Combined Heat and Power or biogas upgrading.** **More efficient energy consumption increased energy yields, and storable biomethane production increase system security and flexibility.**	Energy savings and self-supply of energy and heat lead to a **reduction in operating costs**. Sales of excess heat, electricity and biomethane allow for **additional revenues**. Reduced sewage sludge volumes **reduce disposal cost**s, especially where cost-intensive waste incineration is the only option. Optimized economics of wastewater treatment plants lead to **financial savings for municipalities.**	Energy savings and reduced use of fossil fuels result in a **lower CO_2-footprint** of WWTPs. Biogas obtained from sewage is **more environmentally friendly biogas** compared to crop-based feedstocks. Recycling organic waste in sewage treatment plants **replaces the CO_2-intensive disposal on landfills.** The wastewater sector increases its **contributions to a sustainable energy transition** and **climate protection.**

3. Description of a pilot site (WWTP Plzeň)

3.1. Characteristics and description of the WWTP

WWTP Plzeň is a conventional mechanical-biological WWTP with thermophilic anaerobic sludge stabilization. The biological process includes nitrification and denitrification and increased biological phosphorus removal (R-AN-D-N system) and consists of a pre-regeneration tank connected to four lines operating in parallel. Each of this line has four sections - anaerobic (AN), denitrification (D) and nitrification (N I and N II). Submersible mixers ensure the homogenization of the contents of section AN, D and N I. The sections D and N I are equipped with an aeration system and can alternatively be operated in anoxic or oxic mode. Regeneration and nitrification N II is fitted with a fine-bubble aeration system.

After intensification in 2011, the design capacity of the WWTP is 427,917 PE. A significant part of inflowing wastewater consists of industrial wastewater from the brewery Plzeňský prazdroj, a.s. with a maximum of about 50% of the volume inflow.

Screw pumps pump wastewater for rough mechanical pre-treatment, which consists of screens and a gravel trap. The primary sludge is then settled in two settling tanks (UN). Pre-treated wastewater flows to the biological treatment line. During rainy events at a flow rate exceeding the biological stage's capacity (1.47 m^3/s), rainwater flows into the rainwater-accumulation tank (11,000 m3). When the rainwater tank is filled, the pre-treated wastewater flows behind the UN into the recipient.

Part of the pre-treated wastewater is fed to the AN sections, where after mixing with the reversible activated sludge, biological phosphorus removal takes place under anaerobic conditions. The remaining part of the pre-treated wastewater flows into the denitrification zones, where it is mixed with a mixture of wastewater and sludge from AN simultaneously as the internal recirculation mixture from the effluent from the nitrification zones. Furthermore, the activating mix flows into the nitrification sections, where nitrogenous pollution is removed.

The depth of the activation tanks is 5.9 m, of which 4.9 m of the water column.

The activated sludge is separated from the purified water in four settling tanks, and then part of it is pumped into the regeneration tank. The excess sludge is pumped for machine concentration on three centrifuges.

3.2. Sludge management of WWTP

The sludge management of the Plzeň WWTP includes the thickening of primary and excess sludge, digestion tanks, mechanical dewatering of digested sludge with subsequent biogas management and electricity production in cogeneration units.

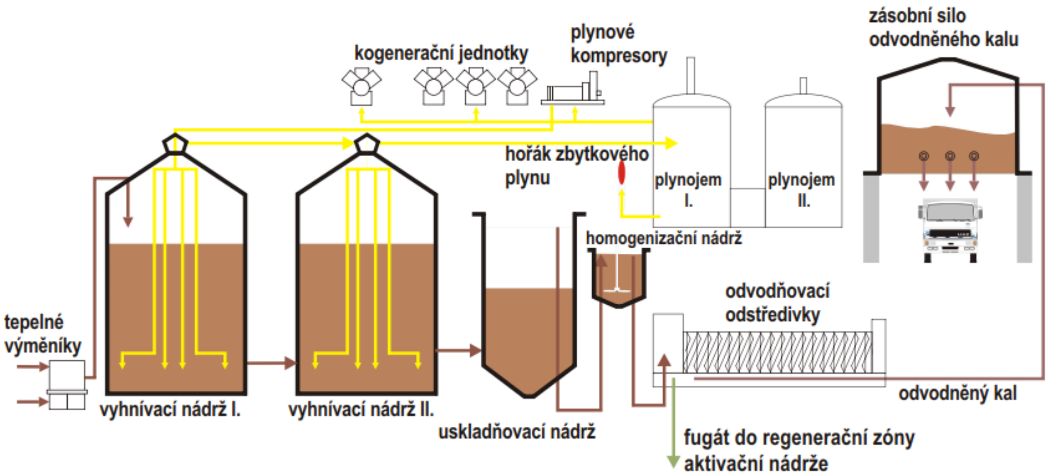
The primary sludge from the settling tanks is pumped into the gravity thickeners. The gravity thickener is a circular reinforced concrete tank partially sunk below ground level (approx. 3.5 m), and the height above the ground is 3.6 m. The inner diameter of the tank is 16.5 m. After thickening, the primary sludge is periodically pumped into the anaerobic digester I (AD I). The pumps are usually operated in manual remote control mode; in this mode, the pump's operation is not blocked either from the minimum level in gravity thickener or from the maximum level in AD I. The supernatant from gravity thickeners is collected by overflow channels and is led before AN.

Excess sludge is pumped into the sump before the thickening centrifuge. The three thickening centrifuges are located in the sludge dewatering engine room together with the dewatering centrifuges. Excess sludge pumps are preferably operated in automatic mode - the operation is controlled by the liquid level in the suction sump of the centrifuge feed pumps. It is possible to add flocculant to the centrifuges to increase the efficiency of thickening.

Anaerobic stabilization of sludge occurs at a temperature of 52 - 56 ° C in a pair of anaerobic digestion tanks of the 1st and 2nd stage. Both tanks have the same equipment, and therefore their order can be reversed. The mixing of the tanks is ensured both by biogas and by circulation pumps. The anaerobic sludge is heated via a water-sludge exchanger. The thickened sludges are pumped to the sludge heating circuit of the 1st stage digestion tank, where they are mixed with the heated digested sludge. From the 1st stage tank, the sludge is transferred to the 2nd stage digestion tank, where the anaerobic stabilization process occurs. The biogas produced during digestion is drawn from the upper part of both tanks into a pair of gas tanks, which serve as a biogas storage tank. Compressed biogas is used to homogenize and mix digesters' contents, and the rest of daily biogas production is used to produce heat (approx. 60 % efficiency) and electricity (approx. 30% efficiency) in cogeneration units.

The digested sludge is transferred from the digestion tanks to an open storage tank serving as a storage tank for further mechanical sludge dewatering with polymeric flocculant on dewatering centrifuges.

The dewatered sludge is fed and stored into the sludge silo by a system of screw conveyors, and when necessary, emptied into the delivered truck and transported for subsequent use.



3.3. Biogas management of WWTP Plzeň

All biogas generated at the Plzeň WWTP is currently burned in 4 cogeneration units. The produced energy is primarily consumed in the premises of the Plzeň WWTP. The surpluses are supplied to the distribution network to the contractual partner. The so-called green bonus supports all produced energy from cogeneration units based on the date of commissioning.

Three cogeneration units (470 kW) were put into operation in 1996, and at the end of 2021, the support of green bonus on electricity produced in these units will be terminated. The fourth cogeneration unit (698 kW) was put into operation in 2012, and the support of the green bonus is planned till the end of 2027.

Biogas production fluctuates considerably during the year and depends on the load of the treatment plant and the production of primary and excess sludge. The changes in production of biogas are also reflected by the production in the Pilsen brewery.

3.4. Data availability and quality

Veolia collects a detailed operational data pool for all large WWTP's operated (up to 600 parameters per plant). However, the Plzeň WWTP is not managed by Veolia.

There are available data about the quality and efficiency of the treatment process in all necessary indicators (influent/effluent quality, treatment process parameters, chemicals consumption, etc.) for evaluating WWTP Plzeň. Data are also available about energy (heat and electricity) production, consumption (electricity) and sludge production and quality. Part of the data is generally confidential, but there are enough to evaluate the pilot's calculations and REEF 2W TOOL.

4. Application of renewable energies and associated energy output improvements

In the REEF 2W tool, the following technologies were implemented:

- Renewable energy technologies such as photovoltaic power plant, solar thermal power plant, hydropower plant and hybrid collectors
- Thermal hydrolysis
- Power-to-gas
- Biogas upgrading
- Co-fermentation
- Heat pump
-

The use of these technologies allows WWTPs to generate a significant amount of energy, which they can use on-site to the extent that they become self-sufficient and supply excess power to the network. From a technical point of view, it is possible to integrate several considered technologies into the Pilsen WWTP. However, the plant operator is very interested in two of these options: biogas treatment and thermal hydrolysis technology. Therefore, these two technologies were evaluated in this feasibility study.

4.1. Thermal hydrolysis

Thermal hydrolysis (TH) of sludge is now a very well described process. The principle is based on the fact that high temperatures and pressure on the cells disrupt the cell's solid cellular components and hydrolyzes proteins, carbohydrates, fats, and other macromolecules secreted from the cell. Simply put, thermal treatment breaks cell walls and exposes proteins to biodegradation. However, due to thermal treatment, they can dissolve, or other compounds that are not biodegradable may also be formed.

The degree of positive and negative effects of thermal hydrolysis of sludge also differs according to the thermal hydrolysis arrangement itself.

In general, the following positive effects of thermal sludge hydrolysis can be summarized:

• Increasing biogas production.

• Reduction of sludge for disposal due to more profound decomposition of organic matter.

• Reduction of sludge volume for disposal due to better sludge dewaterability.

• Volume reduction of anaerobic digesters.

• Sludge sanitation.

The first 3 positive effects are related to the improved removal efficiency of organic matter in the digestion tank.

4.2. Biogas upgrading

Using the energy in wastewater by burning biogas from anaerobic digesters in a CHP unit allows wastewater facilities to generate and cover some or all of their electricity and heat demand. However, there is an excess of heat energy, especially in summer, due to a lower heat demand of the WWTP resulting from weather conditions. Heat is usually produced in excess at a WWTP, but most of the time, the excess is lost due to the location of WWTPs, which are too far away from potential external consumers. Therefore, a complete upgrading of the digester gas and feeding into natural gas pipelines make it possible to use the biomethane regardless of location and time. The produced biomethane during biogas upgrading is gas from renewable resources with the same quality as natural gas and thus can replace it by providing a carbon-neutral form of energy. It is possible to produce fuel quality biomethane for an existing CNG fleet. Producing the biomethane and biofuel can enhance the image of the operator. It may set trends for the main biogas utilization with a higher technical standard than simply burn biogas in CHPs.

For the purposes of treatment of biogas generated in anaerobic fermentation processes, especially at wastewater treatment plants ("WWTP"), but also biogas plants or gas landfills, the following technologies are widespread in operation around the world:

• Physical absorption - is performed by selective dissolution of biogas components in scrubbing liquids.

• Chemical absorption - this method can be used to remove H_2S from biogas. It is performed with organic solvents or anhydrous salts.

• Adsorption - this method can also be used to remove H_2S from biogas. T It is performed using highly porous solids - sorbents or activated carbon. This method is complicated and expensive due to the need to regenerate the sorbent.

• Pressure Swing Adsorption (PSA) - used in combination with adsorption to remove H_{2O}, H_2S and NH3 from biogas. The technology, therefore, includes compressors, chambers, adsorption units. Before starting cleaning with this method, it is necessary to dewater the biogas.

• Separate condensation by compression - this method can remove CO_2 from biogas. The basis of the technology is compression and decompression.

• Freezing systems - cryogenic technology - this method can be used to remove H_2O from biogas. The technology is industrial refrigeration equipment.

• Biodegradation - this method can be used to remove H_2S from biogas. After dissolving in water, microorganisms of the species Thiobacillus and Sulfolobus are used in the presence of oxygen. The output is elementary sulphur and H_2O.

• Molecular sieves (filters) - this method can be used to remove H_2O, CO_2 and H_2S from biogas. Molecular sieves (filters) are used. The method is simple, but it is necessary to perform periodic regeneration of molecular sieves.

• Membrane separation - this method is used to purify gas from CO_2, H_2S and N_2. The above overview shows a wide range of possibilities for the separation of partial components from biogas. However, not all methods are applicable for the purification of raw biogas to natural gas level, as raw biogas contains a broader range of gases that need to be removed.

4.2.1. PSA technology – molecular sieves

Van der Waals forces are used to separate CO_2, which bind CO_2 molecules to the surface of a highly porous solid (usually activated carbon). Adsorption takes place at elevated pressure and desorption (absorbent regeneration) at reduced pressure. The pressure conditions in the adsorber thus change repeatedly. In order to produce biomethane smoothly, several adsorbers are usually installed in parallel - each time, the adsorber is in a different part of the process.

The sulfur-free biogas (pre-treated by activated carbon filter) is compressed to approx. 0.4 - 0.7 MPa and cooled to 10 - 20 ° C and the condensed water is separated off. The biogas thus purified is fed to an adsorber, which contains a so-called molecular sieve formed by very finely ground carbon in extruded form. This absorbent captures CO_2 and the residual content of H_2O and H_2S, and a small amount of methane, biomethane with a methane concentration of 95-98 %, emerges from the upper part of the filter. After saturation of the adsorber, the feed biogas feed is switched to the second set of regenerated filters, and the spent molecular sieve must be regenerated. Thus, the technology is not continuous, but the continuous operation is achieved by arranging more networks in series.

4.2.2. PWA technology – washing by water

The technology uses different solubilities of undesirable components of biogas (CO_2, H_2S, NH_3) compared to methane at different temperatures and pressures (at a pressure of 1 bar and 25 ° C) CO_2 has 25 times more solubility than methane, H_2S almost 80 times and NH_3 more than 20 thousand times. As it passes through the working medium at elevated pressure, the process liquid is saturated with undesired impurities, while methane passes through and increases its proportion in the exhaust gas. Water is most often used as a working medium (solvent).

The raw biogas is compressed and cooled in two stages and enters the bottom of the absorption column at a temperature of approx. 15 ° C and a pressure of 0.3 - 0.7 MPa. Water is injected into its upper part, which traps the mentioned unwanted gases in the countercurrent shower and the resulting gas leaves with 95 - 98% methane content. The disadvantage of the process is that it does not remove other components, i.e. N_2 and O_2. The column is filled inside with a highly porous material with a large inner surface for higher process efficiency. Water from the bottom of the column is pumped into the expansion vessel. From there, after releasing to atmospheric pressure, to the desorption column, where the dissolved gases are released by means of a countercurrent air and with it leave the atmosphere.

Organic solvents (Genosorb, Selexol) based on polyethene glycol can also be used instead of water for better absorption properties. While maintaining the same absorption capacity, the device reaches much smaller dimensions. The sulfur content of the raw biogas must be less than 300 ppm / Nm3. Above this value, desulphurization is necessary again as a pre-treatment to the technology itself.

4.2.3. Membrane separation

Membrane separation uses different permeabilities of individual components in the biogas mixture through a thin membrane. The material for the construction of membrane screens is most often polymers. CO_2 and the residual content of H_2S and water vapor (perm) pass more quickly through the membrane. Most of the methane remains in front of the membrane and leaves on the pressure side (retentate). The proportion of methane in the retentate depends on the membrane material used, its age and also on the pressure level. Under optimal conditions, the cleaning process takes place at a pressure of 0.7 - 0.9 MPa and 97 - 98% methane content is achieved. Two-stage and multi-stage separation allows higher purification rates and lower methane losses. In addition to the classic "dry" method of membrane treatment, there is also an alternative treatment method with the so-called "wet membrane", verified, for example, at the Prague WWTP. Still, with the conclusion that to achieve the required degree of separation, the technology would have to be implemented in two stages.

4.3. Concluding remarks

The first part of the tool (EE) can provide easy and rapid performance analysis. For the evaluation of this part, it is vital to use good quality and actual data from a WWTP. However, detailed information regarding individual process steps and equipment such as pumps, motors and screens are often not available for comparison. However, the tool can also work with the simplified energy performance of the WWTP and gas production and consumption. The result of the first part of this analysis shows that the Pilsen WWTP's energy consumption is in the specified energy range, and many indicators are on the better side of this range. It is also quite interesting to observe that the calculated amounts of biogas correspond with real production.

The second part of this analysis compared and evaluated the combination of different renewable energy technologies. Although Pilsen did not show interest in other than previously mentioned technologies, other possibilities were marginally tested during the tool's presentation. The result indicates that a solar plant could improve electrical energy self-sufficiency but in minimal scale. Two other renewable technologies (solar thermal and hybrid) increase the thermal energy generation, but WWTP has already enough heat. The integration of renewable energy technologies can improve the energy self-sufficiency of WWTP but not in current status with CHP biogas utilization. The same applies to heat pumps, where, besides, the height difference is inappropriate. The implementation of co-fermentation in the Czech Republic is currently complicated (see the deliverable on legal barriers). And at present, the treatment plant does not have enough renewable energy sources to use power to gas technology.

Thermal hydrolysis can boost biogas production and so energy production. Upgrading of biogas to biomethane allows the highest efficiency levels to be achieved, both in electricity production and indirect heat utilization. In the case of biogas upgrading technologies, the tool favoured membrane technology. We can note that in large installations, PWA and PSA are still fully competitive to membrane technologies.

Comparing the result of both parts of the tool indicates that the integration of renewable energies could lead to the WWTP's energy neutrality. Besides, energy neutrality can be reached by increasing energy production using new technologies such as thermal hydrolysis.

The results gained by using the developed tool are acceptable and sufficient for the first analysis. However, the results are insufficient for detailed planning and analysis, as the tool cannot assess all local conditions (river valley WWTP position, urban regulations etc.).

5. ISA of REEF 2W for WWTP Plzeň

This chapter will compare possible scenarios for the implementation of selected REEF2W technologies at the wastewater treatment plant in Pilsen

- Status Quo of WWTP Pilsen before implementing REEF 2W solutions
- REEF 2W I – implementation of Thermal hydrolysis
- REEF 2W II – implementation of Biogas upgrading

5.1. General indicator evaluation

Table 5.1: General indicators used for the pre-assessment

Sustainability criteria	General indicator	Measurement	Categories	Status Quo	REEF 2W I	REEF 2W II
Availability of excess energy (Software tool N.1)	Electric excess energy provision	Difference between electric energy production and consumption in kWh	> 0 ≤ 0	≤ 0	≤ 0	≤ 0
	Thermal excess energy provision	Difference between thermal energy production and consumption in kWh	> 0 ≤ 0	> 0	> 0	≤ 0
	Excess digester gas provision	Difference between digester gas production and consumption in m³	> 0 ≤ 0	≤ 0	≤ 0	> 0
Availability of energy consumers (Software tool N.2)	Excess electricity demand	Electricity demand in the vicinity of the WWTP and in kWh	> 0 = 0	> 0	> 0	> 0
	Excess heat demand	Heat demand in the vicinity of the WWTP and in kWh	> 0 = 0	= 0	= 0	= 0
	Excess digester gas demand	Digester gas demand in the vicinity of the WWTP and in kWh	> 0 = 0	= 0	= 0	> 0

Table 5.1 shows that evaluated WWTP has actually excess of heat (in some periods of the year) and part of biogas is burnt in flares. Balance of other energy sources such as electricity is negative.

Implementing biomethane production the surplus heat production for which no demand exists will be eliminated. However, biomethane will be produced which can be beneficially used for gas grid injection or as fuel in public transport.

5.2. Specific indicator evaluation

Table 5.2: Specific indicators used for ISA and their weights

Sustainability criteria	Indicator	Measurement	Categories	Graduation	Status Quo	REEF 2W I	REEF 2W II	Weight
Environmental context	CO_2 emissions reduction for consumed electric energy (internal and external)	%	> 0 = 0	A C	C 0.69	C 0.69	C 0.62	0,1
	CO_2 emissions reduction for consumed gas (internal and external)	%	> 0 = 0	A C	C 0	C 0	A 0,33	0,1
	CO_2 emissions reduction for consumed thermal energy (internal and external)	%	> 0 = 0	A C	A 1	A 1	C 0	0,1
	Share of renewable electricity (internal and external)	%	> 100 100-40 <40	A B C	B 80	B 85	C 0	0,2
	Share of renewable thermal energy (internal and external)	%	> 100 100-40 <40	A B C	A 100	A 100	C 20	0,2
	Share of renewable gas (internal and external)	%	> 100 100-40 <40	A B C	B	B	A	0,4
	Sludge production change	Delta t DM / year	<0 0 >0	A B C	B	A	B	0,2
Social context	Affordable energy	%	Lower Same (+- 10 %) Higher	A B C	B	B	B	0,2
	Number of applied technologies for electric energy provision (*Resilience*)	Quantity	3 1-2 0	A B C	C	C	C	0,1

Sustainability criteria	Indicator	Measurement	Categories	Graduation	Status Quo	REEF 2W I	REEF 2W II	Weight
	Number of applied technologies for thermal energy provision (*Resilience*)	Quantity	3 1-2 0	A B C	B	B	C	0,1
	Additional employment	Change of employment, job creation or loss	<0 0 >0	A B C	B	B	B	0,2
	Local environmental welfare	Indication of local welfare change	Positive Neutral Negative	A B C	B	A	A	0,4
Economic context	Return of Investment (ROI)	Years	<3 3-10 >10	A B C	A	C	B	0,5
	Additional income	€	>0 0 <0	A B C	B	B	A	0,3
	Energy costs saving	€	>0 0 <0	A B C	B	B	C	0,2
Technical context (energetic & spatial)	Degree of electric self-sufficiency	Ratio between electric energy production and consumption in %	>75 25-75 <25	A B C	B	B	C	0,2
	Degree of thermal self-sufficiency	Ratio between thermal energy production and consumption in %	>100 20-100 <20	A B C	A	A	C	0,2
	Degree of externally usable excess heat	Ratio between heat production and consumption in %	> 0 0	A C	C	C	C	0,1

Sustainability criteria	Indicator	Measurement	Categories	Graduation	Status Quo	REEF 2W I	REEF 2W II	Weight
	Degree of usable excess gas	Ratio between gas production and consumption in %	> 0 0	A C	C	C	A	0,1
	Electric energy consumption at WWTP	kWh/PE_{120}.a	< 20 20 - 50 > 50	A B C	B	B	B	0,1
	Thermal energy consumption at WWTP	kWh/PE_{120}.a	<30 > 30	A C	A	A	C	0,1
	Electric energy generation at WWTP (with anaerobic stabilisation)	kWh/PE_{120}.a	>20 10-20 <10	A B C	B	B	C	0,1
	Electric energy generation at WWTP (with aerobic stabilisation)	kWh/PE_{120}.a	>0 0	A C	NA	NA	NA	0
	Thermal energy generation at WWTP (with anaerobic stabilisation)	kWh/PE_{120}.a	>40 20-40 <20	A B C	B	B	C	0,1
	Thermal energy generation at WWTP (with aerobic stabilisation)	kWh/PE_{120}.a	>0 0	A B	NA	NA	NA	0

5.3. Suitability of indicators

In the evaluation of WWTP Plzeň, all indicators were used, except for "Electric and thermal energy generation at WWTP with aerobic stabilization". These two indicators are alternatively used when anaerobic digestion could not be used, which is not the WWTP case. Calculation of values for final indicators evaluation was done partly using REF 2W tools, partly by using real data from WWTP.

5.4. Multi-criteria decision analysis (MCDA)

To have detailed information about specific parts of ISA (social, environmental, economic and technical) are calculated separately to be used by decision-makers for their own analysis and decision. The following formula was used for the evaluation of each criterion.

$$CI_{s,en,ec,tech} = \sum_{i=1}^{n} w_i \, u_i$$

where CI is the composite index of the ISA for the social, environmental, economic and technical segment, w is the value of indicator and u is the weight of indicator.

The result of each ISA criterion is shown in the following table

5.3.

Table 5.3.: The result of multi-criteria decision analysis

Criterion	Composite Index (Status Quo)	Composite Index REEF 2W I	Composite Index REEF 2W II
Environmental	3,3	2,7	3,1
Social	2,6	1,8	2
Economic	2	4	2,8
Technical	2,4	1,8	2,7

Considering the comprehensive environmental, social, economic and technical analysis, the REEF 2W technology – introduction of biomethane production - is beneficial for the selected WWTP. As shown in Table 5.3, the REEF 2W scenario has the better composite index in three categories for thermal hydrolysis and in two in the case of biomethane. This means that implementing the proposed REEF 2W solution could bring additional benefits in these fields.