D.T2.1.1 REASONS/CONDITIONS LEADING TO THE CHOICE OF THE 5 PILOTS

Germany

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1. Objective of the task:

In DT2.3.1, the pilot locations were selected. The main objective of this deliverable (D.T.2.1.1) is to identify the leading reasons for selecting the pilot locations, in this case the WWTP in Prague.

The deliverable draws on four deliverables finalised in Work Package 1.

- D.T1.2.1: Base line analysis of the current situation in the targeted utility companies/ territories
- D.T1.2.2: Relevant models highlighting integration and combination of technologies
- D.T1.2.3: Guiding document to demonstrate the benefits of implementation of REEF 2W plants
- D.T1.4.1: Detailed description of the methodology and criteria for location suitability

The deliverable is divided into three parts. First, an overview is provided about the initial situation at Central Prague WWTP (PCWTP), including the technological setup and its suitability. This is followed by an overview of the planned technological upgrade in the context of Reef2 W and the benefits accruing from it. The last part analyses the leading conditions including socio-economic and institutional aspects that qualified the WWTP for selection in Reef2W.

2. Initial Situation at the pilot side

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

The WWTP Schönerlinde is a part of Berlin's Water Works (Berliner Wasserbetriebe – BWB), which provides 3.7 million people in Berlin and Brandenburg with drinking water, as well as collection and advanced biological wastewater treatment. The wastewater in Schönerlinde 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 2 gives an overview of the treatment process at Schönerlinde sewage treatment plant. The following technical dates are from the information sheet of BWB (BWB, 2017a).

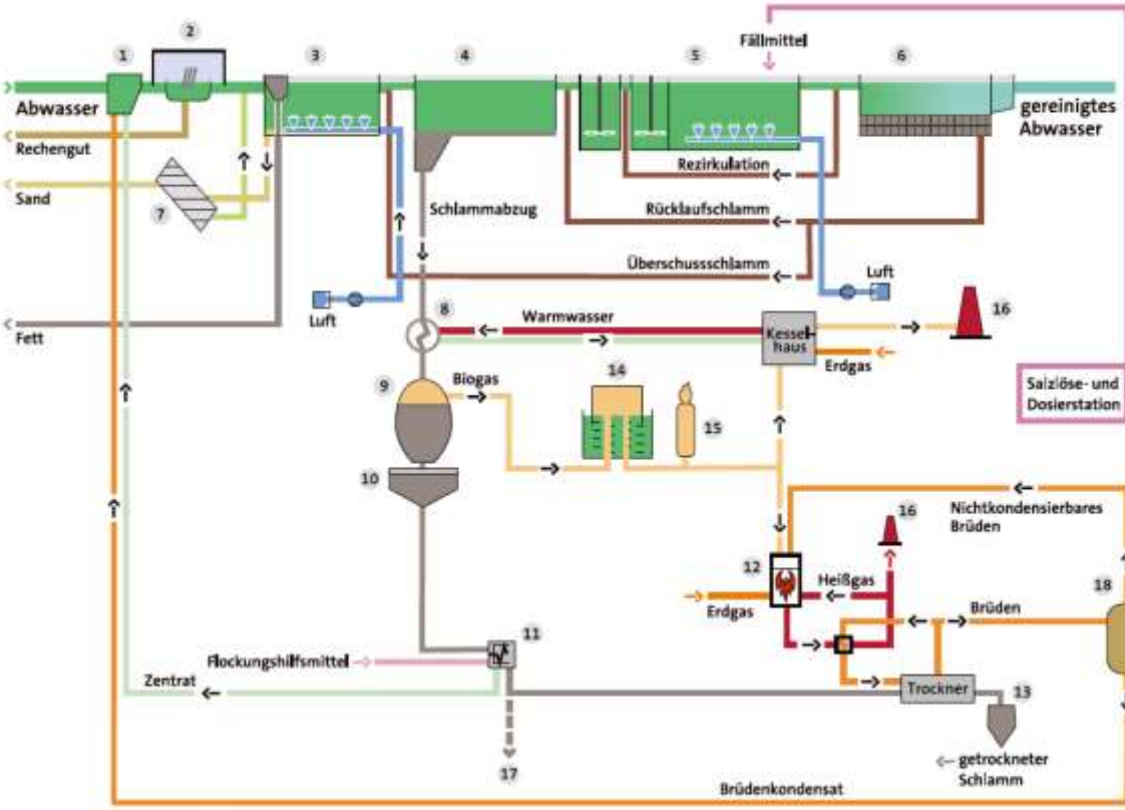

Figure 2: Process scheme of wastewater treatment in Schönerlinde (BWB, 2017a)

Treatment capacity:

The daily capacity amounts to 105,000 cubic meters per day wastewater (dry weather), which equates to approx. 850,000 PE (based on BOD5 value).

Energy consumption and production:

In 2016 WWTP Schönerlinde 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).

3. Technological Upgrade

The integrated approach envisioned in Reef 2W encompasses a wide range of technological steps and processes. Except the enrichment of sludge through bio-waste to enhance biogas yields, many of them are realized at Schönerlinde. Steps will be established to increase the biogas yield through hydrolysis and to convert biogas into bio-methane. Additionally, facilities will be installed to take lower-value electricity from the grid turning it into hydrogen, which will be used together with carbon dioxide from biogas upgrading for producing further bio-methane.

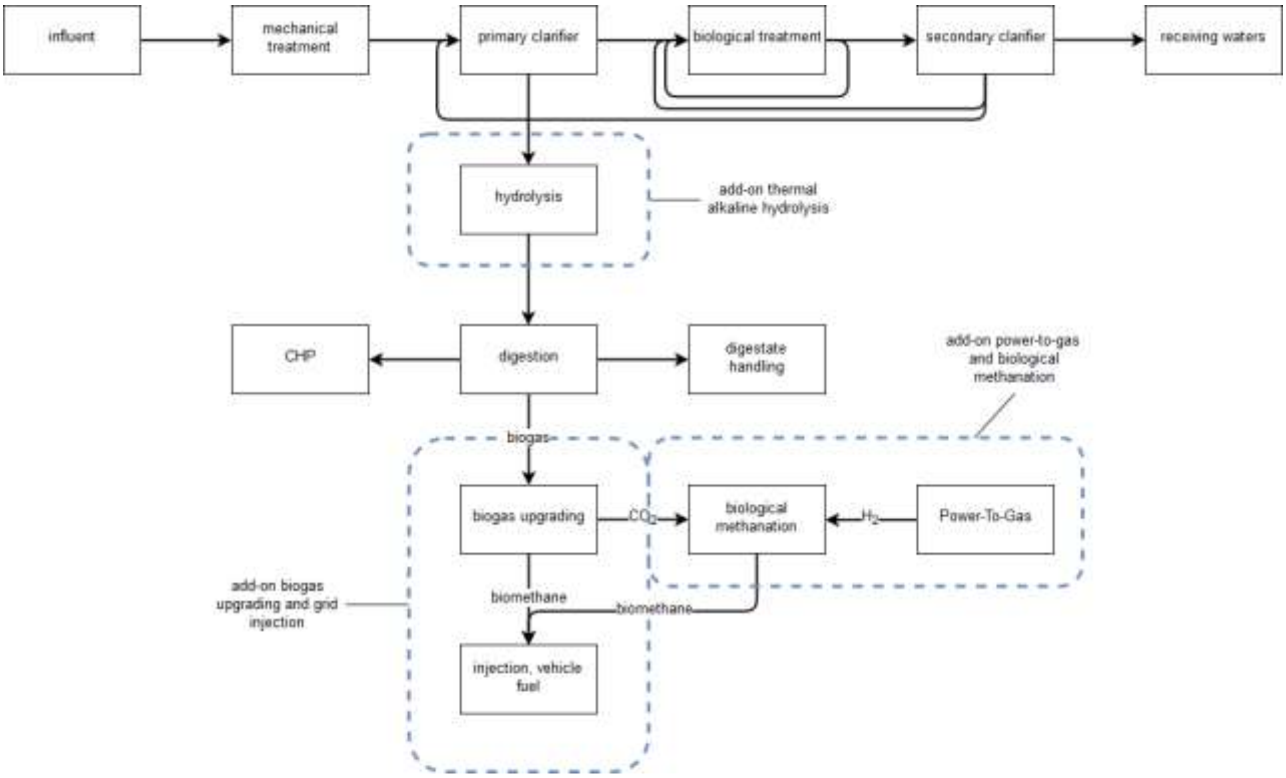

Figure 3: schemata of the new pilot site including the new REEF 2W technologies

a) **Thermal Hydrolysis**

The new pilot site will incorporate a thermal hydrolysis stage which will receive a part or the complete flow of the separated sludge from the primary clarifiers to increase the biogas yield during anaerobic digestion and reduce the overall digestate.

b) **Biogas Upgrading**

A biogas upgrading unit will receive the biogas produced during anaerobic digestion and upgrade it into bio-methane. Only a small footprint is needed even in the case of upgrading the full biogas stream.

c) **Electrolysis Unit**

The electrolysis unit will use electrical energy from the grid during low demand times or during surplus of renewable energies and produces a stream of hydrogen. The inevitably simultaneously formed oxygen stream will be fed into the biological treatment of the wastewater or can be used for the prospective ozonisation step as fourth treatment stage.

d) **Grid Injection**

Hydrogen produced in the electrolysis stage and the carbon dioxide stream from biogas upgrading will be injected into a biological methanation unit producing high quality bio-methane. The vessel and its accessories only have a small footprint.

Additionally, a grid injection site and required pipelines will be installed. This site is owned and operated by the grid owner who will also be responsible for calorific adjustment, odoration, compression and pressure control.

The hydrolysis stage and biogas upgrading can be independently operated and toggled on or off. The electrolysis/methanation stage needs the running biogas upgrading module as CO2 source and for the grid injection.

4. Expected Benefits

Space:

The entire spatial footprint needed for the intended REEF 2W technologies is low as for each of the stages an area equating a few shipping containers is needed. The large territory on which the WWTP Schönerlinde is situated easily allows accommodating the REEF 2W technologies.

Increased biogas yield

The hydrolysis step can enhance the biogas yield, up to 50% according to PONDUS company's plant reference list. A realistic value is expected to be approximately 20-30%, if the secondary sludge stream is treated.

Biomethane production

With biogas upgrading the sewage gas will be converted into the superior and more versatile product bio-methane. Quality requirements for grid injection will be met. Since the produced biomethane originates from renewable resources, it can be marketed as such.

Grid stabilization

The electrolysis unit can act to stabilize the electricity grid during low demand times or times when the production by renewable energy sources (e.g. solar, wind) surpasses demand and would otherwise be shut off. The harvested energy can be stored in the form of gases such hydrogen or biomethane after methanation. The side product oxygen generated during electrolysis can be fed into the biological treatment process as a substitute for ambient air. Due to the oxygen content of 100% as opposed to 21% it is possible to save on aeration cost. Alternatively the oxygen can be used during the prospective ozonisation step to save on energy intensive ozone production.

The downside of implementing upgrading biogas for injecting into the public grid is the reduced/omitted local production of electrical energy in the CHP units. The missing energy has to be purchased from the public grid. Because the major part of electrical energy demand of the Schönerlinde WWTP is covered by the wind turbines, this will not be a substantive obstacle.

5. Key Selection Criteria

Suitable size of plant and utility

Scale played a crucial role in selecting Schönerlinde. BWB provides 3.7 million people in Berlin and Brandenburg with drinking water, as well as collection and advanced biological wastewater treatment. It is Germany's largest water and wastewater company. The importance arising from its size means that the company can devote sufficient resources to the project, but also has internal expertise to engage in the project. The WWTP Schönerlinde itself is one of the important wastewater treatment plants for the water cycle in Berlin with a treatment capacity of 105.000 cubic meters per day (dry weather). In the upcoming years the installation of an ozonisation unit as fourth treatment step is planned. This unit can profit from synergy effects with the electrolysis unit by using the oxygen stream.

Good basis for collaboration

KWB's mandate is to foster science, development and water management of the water sector. The water and wastewater company, Berliner Wasserbetriebe (BWB), is one among two shareholders of Kompetenzzentrum Wasser Berlin (KWB). KWB has therefore by nature a good relationsship to the utility at Schönerlinde, which is a key pre-condition for a project such as Reef 2W. It guarantees willingness of the wastewater utility to cooperate for the tool development, training events and other elementary parts of the project to a high degree.

Innovative utility

BWB has always been progressive in experimenting with energy self-supply of its water and wastewater infrastructures. Currently, 70 percent of the energy required to operate its six wastewater treatment plants is generated from biogas and sludge. At Schönerlinde, BWB installed three wind turbines, each with an output of two megawatts in 2012. 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). This innovative spirit was a key criteria in choosing Schönerlinde among WWTPs in Berlin.

Suitability of Technological Setup

Without certain minimum technological setup in place, undertaking a comprehensive upgrading of wastewater-to-energy technologies like the one being pursued at Schönerlinde is impossible. In Schönerlinde, many of the technological pre-conditions exist that allow to establish and test Reef 2W solutions – from biogas upgrading over Power2Gas technologies and grid-injection. This is not always the case. Many WWTPs in Europe do not even have AD facilities.