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Heating and Cooling with Renewable Energy from Wastewater

A Large-Scale Case Study from Vienna

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Abstract. Energy from wastewater is recognized as a renewable energy source and can add a valuable contribution to the EU's path to decarbonization. With modern heat exchangers and heat pumps, buildings and districts can be supplied with energy for heating, cooling and water heating. Based on the successful results of the implementation in Vienna Blumental, another project in Vienna has been rolled out: The Vio Plaza building complex will be supplied with energy from wastewater for heating (1.2 MW) and cooling (6 MW). This article presents the case study at Vio Plaza, gives a detail description of the system design and delivers first-hand information about operation of the installed system. Special focus is put on the innovative monitoring system and resulting monitoring data, which prove the good operation of the system. Based on these results, further knowledge about these systems will be gained to support the increasing implementation of this technology.

Keywords: Energy from Wastewater, Decarbonization, Building Sector, Heating and Cooling, Monitoring

1. Introduction

Since 2018, the EU recognizes energy from wastewater as a renewable energy source and thereby its valuable contribution to the achievement of the climate goals [1]. Space and water heating require ~75 % of the energy consumption, which today is mostly covered by non-renewables [2]. Energy from wastewater is available all year round and can be tapped with modern heat exchangers and heat pumps. Still, wastewater in Austria is relatively unused in this regard and thus offers great potential for decarbonizing heating and cooling.

The research project ThermaFLEX has proven that the technology for heat recovery from wastewater is ready for up-scaling. Within the project, a demonstration has been implemented at the headquarters of "Wien Kanal" in Vienna Blumental. For the project, an innovative system combination of in-sewer heat exchangers, heat pumps and monitoring has been installed in 2021 to cover the building's heating and cooling demand. One of the main findings of this project is the importance of smart monitoring to ensure smooth operation, survey the influence of the system on the sewage and increase the overall efficiency [3, 4, 5].

These important results have been directly transferred and rolled out to a new project, which has been put in operation beginning in December 2023 to February 2024: The Vio Plaza Center in Vienna. Energy from wastewater is one of the main sources for renewable heating and

exclusive source for cooling for a whole building complex with mixed use on an area of 22 000 m² and currently the largest project for energy from wastewater from sewer in Austria!

2. Case Study Vio Plaza

Vio Plaza is a building complex combining uses such as office spaces, retail and living (~3500 people) in Vienna, Austria (Figure 1). Central part of the project is the use of wastewater energy for heating and cooling. The operation of the system is done by “Wien Energie” as a contractor. Due to the high wastewater energy potential at the project site, the complete cooling requirement of up to 6 MW power can be covered by the heat exchanger system. On the heat side, the base load of 1.2 MW power is supplied from the sewer, the peak load in winter is covered by district heating. This means that this system can be operated very economically with renewable energy, which significantly reduces the future operation costs of the building compared to conventional fossil fuels.

The novel aspect of this case study is the size of the building complex, heated and cooled with wastewater. With this scale, the energy from wastewater at Vio Plaza is currently the largest facility of its kind in Austria.

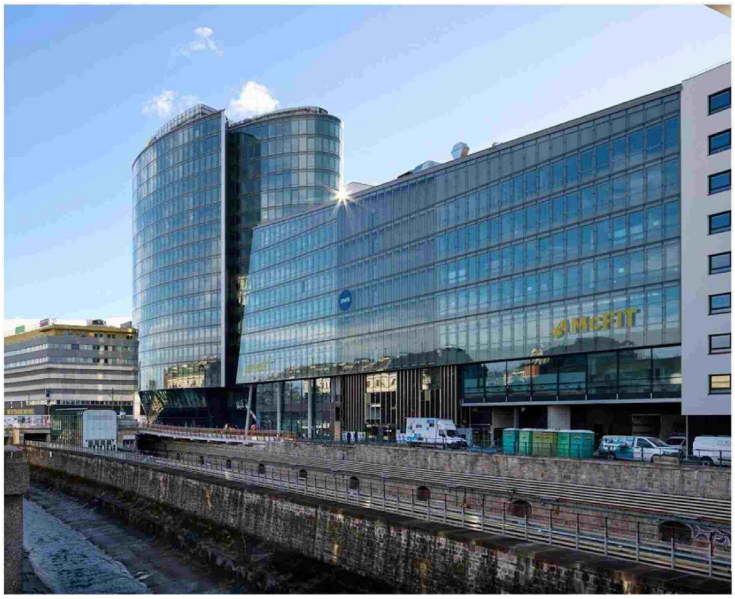

Figure 1: *Newly constructed building complex Vio Plaza with energy supply from wastewater (Wiedemann/Rabmer GreenTech GmbH).*

3. System Description

3.1 Heat exchangers and heat pumps

The planning and construction of the energy from wastewater system was conducted by Rabmer in cooperation with the company Uhrig. The trenchless construction through assembly manholes was finished within two months. The main sewer is split into two lines to facilitate operation and maintenance, as well as to increase yields (Figure 2). Each sewer has a dimension of 1000 x 2250mm and is equipped with 185m of Therm-Liner heat exchangers (Figure 3).

For subsequent temperature adjustment for heating and cooling, “Wien Energie” is operating the heat pumps. In total, 3 cooling units and 1 heat pump were installed.

Figure 2: *Construction of two parallel sewer lines (Wiedemann, Rabmer GreenTech GmbH).*

Figure 3: *Installation of the heat exchangers in the sewer lines (Rabmer GreenTech GmbH/Uhrig).*

3.2 Monitoring System

Based on the results of the ThermaFLEX project, the same innovative monitoring system was installed to survey the energy production and the impact on sewer operation. The system provides information on the conditions in the sewer as well as on energy production. The sensors were installed both in the sewer lines and in the return and flow lines to the heat pumps (Table 1). Based on these measured parameters, the following parameters are additionally calculated: temperature difference in the sewer lines and in the heat transfer medium, pressure difference in the heat transfer medium, discharge, and energy output.

The monitoring system is directly connected to the control system of the energy center and is crucial for controlling heating and cooling of the Vio Plaza Center. The data is continuously available for the operator and Rabmer. This makes it possible to monitor operation in the sewer as well as to ensure optimal energy production.

Table 1: *Measured parameters for monitoring system in Vio Plaza.*

Parameter	**Sewer 1**	**Sewer 2**	**Supply Pipe**	**Return Pipe**
Temperature	before and after heat exchanger	before and after heat exchanger	x	x
Flow velocity			x	
Water level	x	x		
Pressure			x	x

Figure 4: *Installed monitoring sensor in the sewer (left) and return and flow pipes to the heat pump (right) (Rabmer GreenTech GmbH/Uhrig, Wiedemann).*

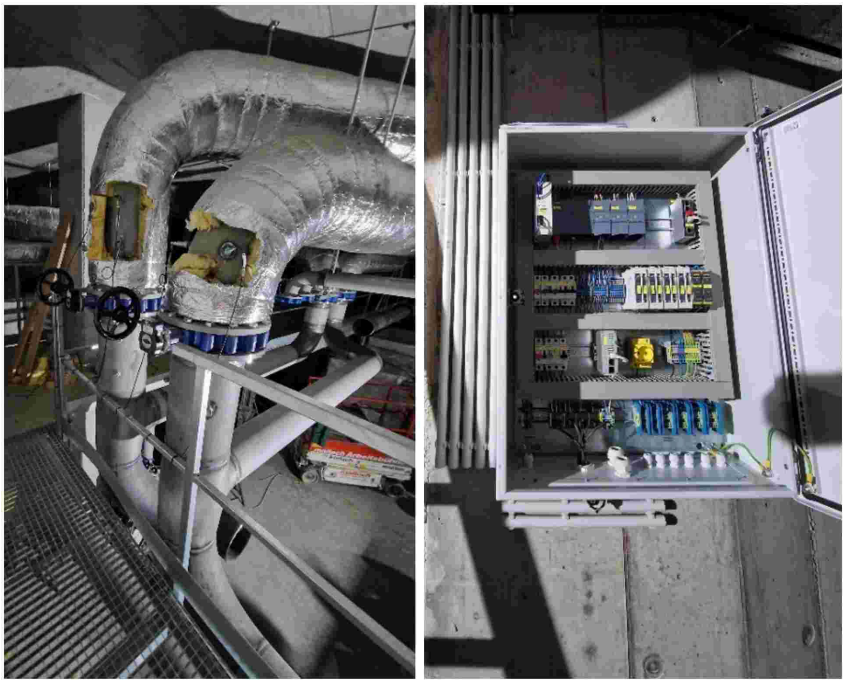

Figure 5: *Installed sensors in the return and flow pipes to the heat pump (left) and the heart of the monitoring system: the switch cabinet (right) (Wiedemann, Rabmer GreenTech GmbH).*

4. Results

The energy from wastewater recovery and the monitoring system are in operation since January 2024. The trial operation was successfully completed in the beginning of January. Since then, monitoring data was continuously collected. As an example of the operation in cooling mode, monitoring data between the 14th and 26th of February 2024 are presented. It is important to mention that the system is currently not running in its maximum potential of providing 6MW cooling power (at the heat exchanger) but in a partial load.

The monitoring data during the commissioning shows that the operation of the heat exchangers and heat pumps work as planned. The wastewater temperatures are not exceeding the threshold values agreed on by the building owner and the sewer operator.

The temperatures in the two sewer lines (Figure 6 and Figure 7) show that the temperatures after the heat exchangers are slightly higher than at the beginning of the heat exchanger. This indicates the cooling operation of the system and the input of heat into the wastewater.

The temperatures of the heat transfer medium in the supply and return pipe (Figure 8) shows again the cooling mode. The heat transfer medium at the outflow of the heat exchanger (return pipe) is cooler than the medium in the supply pipe. This is further visible in the temperature difference.

The monitoring data shows several days of normal operation of the system (14th to 24th of February). On the 24th, the system is shut down and does not provide cooling for the building. In the data, this is visible by the equalization of the temperatures in the heat transfer medium and therefore in the temperature difference of the heat transfer medium going towards zero (Figure 8). Additionally, this effect can be seen in the wastewater temperatures in both sewer lines (Figure 6 and Figure 7).

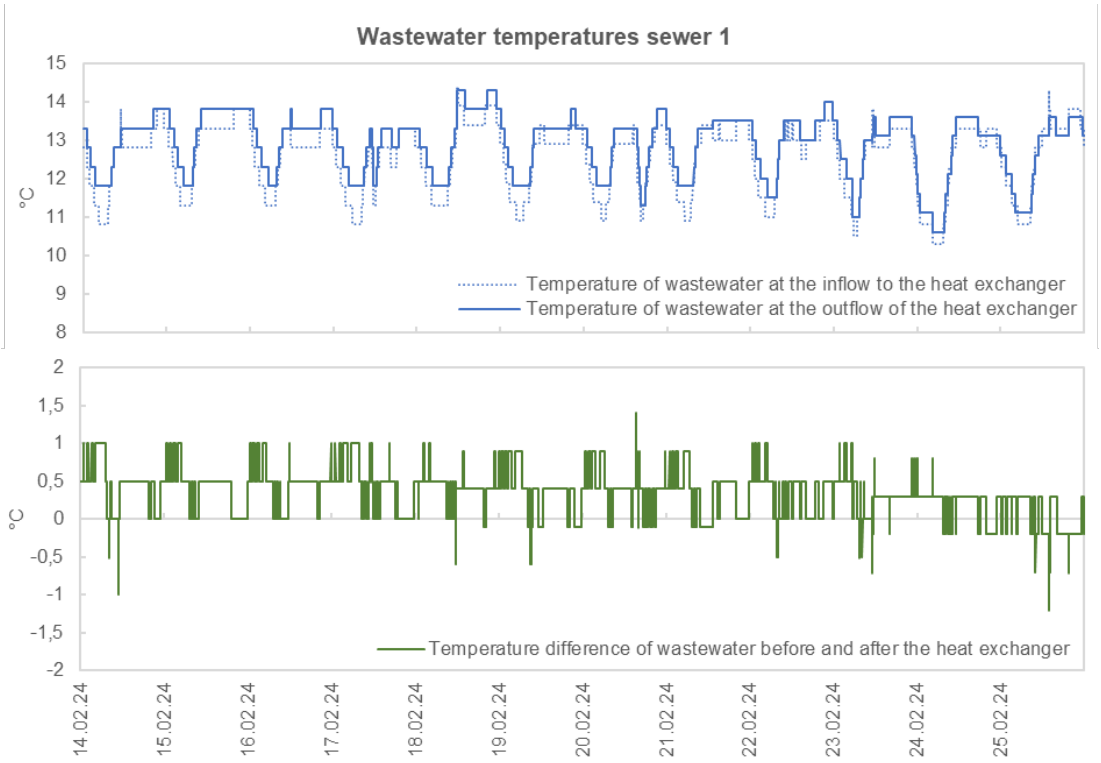

Figure 6: *Temperatures of the wastewater in sewer 1 at Vio Plaza (Rabmer GreenTech GmbH).*

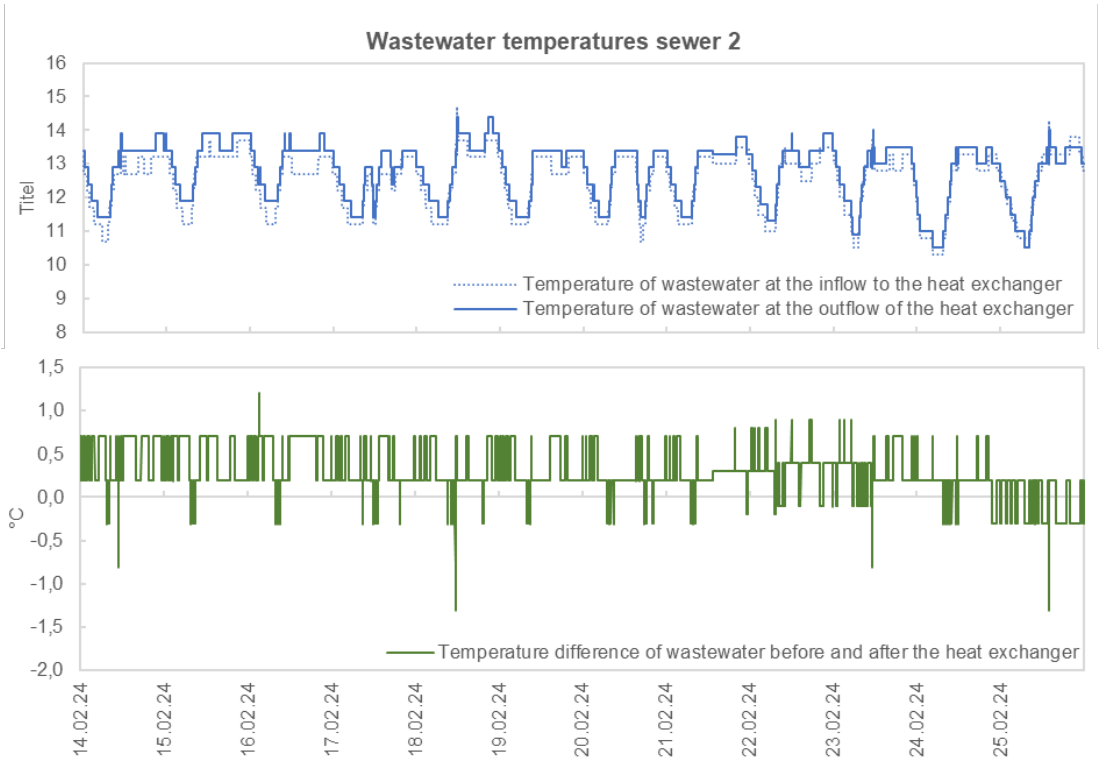

Figure 7: *Temperatures of the wastewater in sewer 2 at Vio Plaza (Rabmer GreenTech GmbH).*

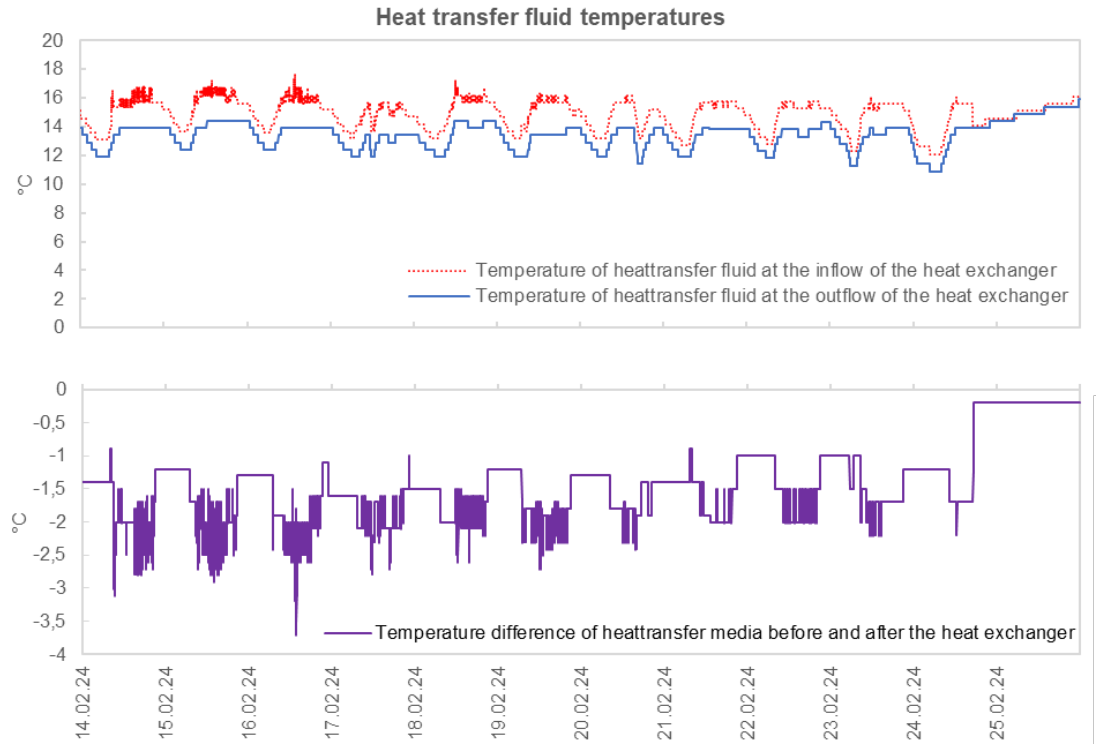

Figure 8: *Temperatures of the heat transfer medium at Vio Plaza (Rabmer GreenTech GmbH).*

The monitoring system acts as a control element to ensure, the boundary conditions and limit values from the sewer operator are not exceeded. Thereby, the monitoring system provides security for the sewer operator in regard to warming and cooling of the wastewater after the

heat exchanger, water level control and subsequently the operation of the wastewater treatment plant. The monitoring system also provides important information for the operation of chillers and the heat pump, such as flow rate, temperature spread etc.

5. Conclusions

Heating and cooling of Vio Plaza Center based on wastewater is currently the largest facility of its kind from sewer in Austria and therefore has a lighthouse function for the region. The monitoring data shows that such systems can be operated without problems and can be controlled precisely to avoid exceeding threshold values and operated according to the Austrian working tool ÖWAV-AB 65 [6]. The findings from this large-scale project are important for the roll-out of future projects in municipal and industrial sewers and can be used to gain important information for energy spatial planning.

The article aims at validating this technology for the use of energy from wastewater for bigger building complexes and foster the acceptance of this (in Austria and Europe) still often critically viewed renewable energy source.

Data availability statement

The data used in the paper is restricted as it includes third-party data. The data presented here serve to illustrate the monitoring system. More detailed monitoring and operational data cannot be presented in the context of this publication.

Author contributions

FP: Conceptualization, Data curation, Formal analysis, Validation, Writing – original draft; RW: Conceptualization, Project administration, Resources, Supervision, Validation, Writing – review & editing. DI Flora Prenner; Dr. Rainer Wiedemann Rabmer Greentech GmbH, Bruckbachweg 23, 4203 Altenberg E-Mail: flora.prenner@rabmer.at; rainer.wiedemann@rabmer.at, Key activities: Technical manager for energy from wastewater projects.

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Competing interests

The authors declare that they have no competing interests.

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