Energy from Wastewater with UHRIG Therm-Liner
Frequently asked questions

1. General

1.1 Why obtain energy from wastewater?

Wastewater is an energy source that is available constantly and in large volumes. Every day, millions of households, plus commercial and industrial concerns, pour vast quantities of heating energy down the drain in the form of wastewater. This energy can be recovered using wastewater heat exchangers and used. This makes economic and ecological sense and can boost climate protection and energy transition considerably. Buildings can be both heated and cooled using energy from wastewater. This form of energy is already competitive. Heat from wastewater is CO_2-free and represents a major opportunity for energy transition in the heating market. In Germany alone, up to 14 % of the demand for heat in buildings can be met with energy from wastewater. Wastewater is an energy source that has major potential in urban areas in particular. Because wherever there are lots of people, there is also a great deal of wastewater and a high demand for energy. Supply and demand fit perfectly.

1.2 Where and how can energy be obtained from wastewater?

Basically, energy can be obtained from wastewater at three points. Firstly, “in-house”, secondly from the public sewer network and thirdly at sewage treatment plants. With the UHRIG Therm-Liner, we extract energy mostly from the public sewer network, as the volumes of energy are large here and there are many possible energy users nearby. The quantities of energy that can be recovered in an individual building from the wastewater are very small and so extraction would generally be uneconomical. The quantities of energy at sewage treatment plants are very large but after they have been extracted, they need to be taken to potential users. The concept of recovering energy from the sewer network is therefore a decentralised approach that aims to bring source and users together directly. This is the approach we pursue.

1.3 What is the target group for energy from wastewater?

Heating and cooling with energy from wastewater are possible in any building with a power requirement of around 50 kW or more. That is around 15 residential units. The largest system constructed to date has a heat extraction rate of 2.1 MW and supplies a district with over 450 residential units plus commercial users. Commercial buildings are also easily heated and cooled using wastewater energy. The aim is that energy from wastewater will reach a temperature of 35 to 55 °C using heat pump technology. However, there are now also many projects when energy is stored at a higher temperature. It is always a question of competition and the next best option. Wastewater heat is also particularly suitable for storage in local authority or municipal heat networks. These local and district heating networks can be both cold and hot networks.

1.4 How does energy extraction from wastewater using the Therm-Liner work?

The Therm-Liner heat exchanger is a stainless-steel module with integrated water cycle. We can install our modules in any sewer at all with a nominal diameter of at least 400 mm. The water in the module is colder than

the wastewater in the sewer, so that the water in the module is warmed by the wastewater flowing over the module. This means that a heat transfer take place, although the wastewater and the water in the module are not in contact. The heat is transmitted via the stainless steel. The water, which is now heated, flows from the module through a pipe to the heating plant and forms the forward and return flow to the heat pump. Using a small amount of power, the heat pump makes the energy extracted from the sewer usable. A kWh of heat generated in this way consists of 75 % energy from wastewater, with only 25 % from electricity – this is energy efficiency and climate protection in action.

1.5 Is wastewater a reliable source of energy?

Yes. Wastewater has an average temperature of 10 to 12 °C in winter and 17 to 20 °C in summer. This temperature represents thermal energy that can be used to heat buildings in winter and cool them in summer. Wastewater is a completely underestimated, renewable energy source that can make a significant contribution to climate protection in the heating market. In addition: The level of wastewater can be calculated and forecast precisely over decades, which means that the use of wastewater for energy offers a high degree of reliability. What is particularly attractive is the fact that the temperature of wastewater recovers again very quickly even after large quantities of energy have been extracted. This is due firstly to the inflow of new wastewater into the sewers and secondly to the constant uptake of ambient warmth from the ground. It is therefore possible to install a large number of plants to extract energy from wastewater in a sewer network. The only thing that is important is that the plants must be a certain distance apart. The rule of thumb is: After a wastewater heat recovery plant, a “recovery line” around two to three times the length of the plant itself should be incorporated. If a wastewater energy recovery plant is 100 m long, then another plant can be installed around 200 to 300 m afterwards.

1.6 How much does energy from wastewater cost?

Depending on the background conditions on site, the investment costs for recovering energy from wastewater using UHRIG’s Therm-Liner are around €500 to €1,000 per kW heat exchanger output. These costs include the production and installation of the heat exchangers including pipework to the drain.

At locations where the conditions are good, energy from wastewater provides heat production costs of around 7 to 8 cents per kWh heat output. This is a full cost analysis of the complete technology. It includes

- ► Capital costs of the Therm-Liner including connecting pipes and house connection
- ► Capital costs of the heat pump
- ► Pump and heat pump electricity
- ► Cost of maintenance and repairs

The above amount is often compared with the pure procurement costs, such as gas tariffs. People often forget that these do not cover the capital costs of heating and the infrastructure.

Many projects are now realised on a contracting basis, with the end customer being offered a fixed price in cents/kWh for heat or cold. This ensures transparency and good price stability. Customers, therefore, if they wish, have nothing to do with the operation or purchase of the plant. Instead, they are provided with heat and/or cold in a “worry-free” package at a fixed price.

1.7 Where are the conditions good for the use of energy from wastewater?

Good locations for obtaining energy from wastewater are to be found in cities and conurbations, and also in smaller towns and villages that are close to sufficiently large wastewater collectors. Ultimately, the same questions need to be asked with every property project when considering the option of using heat from wastewater. Firstly: Where is the nearest public sewer network? Secondly: How much wastewater does it carry? Thirdly: What is the temperature of the wastewater? Some sewer network operators now provide energy maps online that you can use to check any particular location in seconds yourself. Other sewer network operators will provide this information on request. You can talk to us at any time if you want to check a location. Important: Heating and cooling with energy from wastewater is already competitive today without any subsidy. Up to 14 % of the requirement for heat in buildings in Germany can be met with energy from wastewater. In Germany energy from wastewater meets all the requirements of the Building Energy Act (GEG). In new buildings, renewable energies must be used at least proportionally to cover the heat demand. For existing buildings, the use of renewable energies is encouraged through subsidies.

1.8 In what sewers can energy be obtained from wastewater?

UHRIG's Therm-Liner can be installed both in existing sewers and in new ones. The basic requirement is that the sewer dimension is at least 400 mm. Smaller sewers do not carry enough wastewater and the installation of the plant becomes complicated because of the size. Alongside classic gravity sewer systems there are also wastewater pressure pipes which cannot be walked through. Wastewater heat can also be recovered in pressure pipes of this type, but generally the heat exchanger must be tightened around the pressure pipe, or the pressure pipe must be replaced by a pipe section in which a heat exchanger is integrated. Pressure pipes are generally used for energy generation if the heat exchangers are installed at the same time as a pressure pipe is restored or installed for the first time. Ultimately, an individual inspection is necessary and advisable for every project.

1.9 What is the overall potential of energy from wastewater?

Up to 14 % of the requirement for heat in buildings in Germany can be met with energy from wastewater. Wastewater is an energy source that has major potential in urban areas in particular. Because wherever there are lots of people, there is also a great deal of wastewater and a high demand for energy. So, supply and demand fit perfectly. If one bears in mind that the heating market accounts for well over 50 % of the ultimate consumption of energy in Germany, it becomes clear how massive the energy potential of wastewater is. The heating market is a crucial playing field for the success of energy transition.

In Europe, there are already more than 100 Therm-Liner systems in use to extract wastewater energy decentrally out of the sewer system, most of them are in Germany, in France, the Netherlands and Scandinavia. The plant sizes vary between an output range of 50 kW and 2 MW. It is forecast that even higher heat extraction rates will be achieved in the area of district development. In the last ten years, the technology has become commercially viable and is now ready to be used as part of the heating transition. Demand has already risen dramatically in the last two years. Before this, demand in the heating market had been low because of minimal efforts to protect the environment and the clear dominance of gas and oil. This is now changing rapidly, especially as heat pumps are thought to play a major role in the decarbonisation of the

heating market. The sewer network operators are also showing increasing interest in wastewater energy. Some of them have already demonstrated the energy potential online in the form of energy maps. This means that anyone can check whether there is potential in the sewer at a particular location. It would be a good idea if all sewer network operators could provide energy maps of this type.

2. Energy legislation

2.1 Where is the use of energy from wastewater legally regulated?

In Germany energy from wastewater is legally classified as Renewable Energy. It is defined and regulated in the Building Energy Act (GEG). The use of wastewater heat is listed as an option here. It can be used to meet the energy requirements of GEG just as well as any other renewable supply options. At EU level, wastewater heat is also recognised and listed as renewable energy. This provides easy access to funding in this area.

2.2 What is the primary energy factor of energy from wastewater?

Wastewater has a primary energy factor of 0. In addition, there is the primary energy factor of the auxiliary energy for the heat pump. After the heat pump, the primary energy factor of the wastewater heat is 0.4 to 0.45. All German energy efficiency standards can thus also be met for buildings with energy from wastewater. Energy from wastewater is even equal to or superior to the district heating option, which is often attractive in terms of primary energy.

2.3 How much CO_2 will I save with energy from wastewater?

Energy from wastewater is CO_2-free. Only the essential power for the heating pump must be considered when it comes to CO_2. In districts, this electricity is often produced renewably locally, which means that no CO_2 is emitted anyway. If we remember that the general electricity mix is getting greener every day, then energy from wastewater will be completely CO_2-free in the medium term, even with the conventional electricity mix. At the moment, using energy from wastewater reduces CO_2 emissions by 50 to 70 % compared with gas and oil.

2.4 What permits do I need for extracting energy from wastewater?

Basically, the operator of a wastewater heat extraction plant only needs the permission of the sewer network operator. The sewer network operator decides whether a system for extracting energy from wastewater can be installed in a particular sewer or not. The deciding factor for the sewer network operator, as the party with a sovereign responsibility, is that the sewer operation is not restricted in any way by the use of the wastewater for energy. This is precisely what we can ensure with our system, the Therm-Liner. As a company that has been working in sewer construction for five decades, we are well acquainted with the requirements inside the sewer. Before a plant is commissioned, all the parameters, such as the length of use, the basic technical conditions and the usage fee to be paid, are defined in a usage agreement. We are happy to provide templates for usage agreements of this type.

There is no increased cleaning, maintenance or monitoring work for the sewer network operator in the sewer section used. In addition: The modules and connecting pipes are operated with pure tap water, and only run with a water-glycol mix in a few exceptional cases. This also simplifies the approval phase.

3. Therm-Liner: The heat exchanger modules from UHRIG

3.1 What do the heat exchangers modules consist of and how do they work?

The Therm-Liner heat exchangers are made from 1.4404 stainless steel. The surface is designed in such a way that the maximum possible energy extraction rate per m² of surface is achieved and dirt deposits are kept to a minimum. We always take the formation of a biofilm, which is inevitable to a certain extent, into account when designing the systems. In addition, the systems are designed for the minimal dry weather flow on a very conservative basis, so that the required output is available at any time.

The heart of the heat exchangers is an integrated water cycle. The water in the module is colder than the wastewater in the sewer, so that the water in the module is warmed by the wastewater flowing over the module. This means that a heat transfer take place, although the wastewater and the water in the module are not in contact. The heat is transmitted via the stainless steel. The water, which is now heated, flows from the module through a pipe to the heating plant and forms the forward and return flow to the heat pump. Using a small amount of power, the heat pump makes the energy extracted from the sewer usable. A kWh of heat generated in this way consists of 75 % energy from wastewater, with only 25 % from electricity – this is energy efficiency and climate protection in action.

3.2 Where are the heat exchanger modules made?

The Therm-Liner modules are produced by us at our headquarters in Geisingen on the Danube. They are made in Germany and patented and certified. Every Them-Liner system is made to measure for the project in question, since the framework conditions vary in every sewer. These framework conditions are considered in every plant layout and clarified in an inspection of the sewer network during the planning phase. In addition, for the sake of safety, both the volume and temperature of the wastewater in the sewer in question are measured again beforehand over a long period of time. This ensures that the plant performs efficiently. The data from the sewer network operators, which are always accurate, are thus verified.

3.3 What makes UHRIG's Therm-Liner so special?

UHRIG's Therm-Liner can be fitted precisely into any sewer without causing any restrictions on operation. This is also the basic precondition for using the sewer system. After all, wastewater management must not be disrupted in any way. As a civil engineering company that has been working in sewer construction for five decades, we are well acquainted with the requirements and conditions inside the sewer. Accordingly, the installation of the systems is one of our company's particular skills and is also a major factor in the success and efficiency of the systems. The Therm-Liner system is patented and certified. We are the world market leader in the field of sewer heat exchangers and are currently expanding our production and installation capacity as fast as we can.

4. Installation and operation

4.1 How are the heat exchangers or systems built into the wastewater sewer?

The heat exchangers are installed in accordance with the relevant requirements of the regulator, DWA (German Association for Water Management, Wastewater and Waste). The requirements are defined in DWA

leaflet 114. The heat exchanger modules are not concreted in, for example; they are fixed with “hold-down devices”. Hold-down devices are brackets which are fixed in the sewer wall with an HKD expansion anchor. The maximum bore depth is 40 mm, bore diameter 12 mm. The anchor is screwed in flush, using countersunk screws (DIN 7991 M10x25). All fixing elements are made in 1.4404 quality to avoid interactions. The elements and connecting parts are protected from dirt and damage by deflector plates. These deflector plates and the cladding of the forward and return flow pipes are also made from 1.4404 steel. The transition areas from the sewer bottom to the first element and from the last element are each protected by run-up and discharge ramps so that no coarse matter can get stuck. The ramps are also made from 1.4404 steel.

4.2 Can heat exchangers also be installed in wastewater pressure pipes?

Heat exchangers can also be installed in wastewater pressure pipes. The energy yield is always very high in these pipes. The only disadvantage compared with normal sewers, known as gravity sewers, is that the installation of the heat exchangers requires some excavation work. Wastewater pressure pipes must be uncovered, and usually a whole section of a pressure pipe is replaced by a new pipe section with an integrated heat exchanger system. If a pressure pipe is installed for the first time or rehabilitated, this approach is still very attractive economically. But if no new building or rehabilitation is required, the extent of the excavation work is decisive for an evaluation of the economic viability. The extent of this work is different for every project. Because gravity sewers can be walked through, from a particular dimension, the installation of the heat exchangers does not require any excavation work. This makes the system essentially very attractive, especially in urban areas where, because of the lack of open space, many renewable energies cannot really be considered as supply options.

4.3 How do sewer operators feel about the technology and its installation?

Sewer network operators have a higher responsibility, which is wastewater management. Undisrupted operation is a top priority, and heat exchangers in the sewer are therefore only approved if they do not cause any restriction in the management of the sewer network. We meet this requirement with the Therm-Liner system. Our heat exchangers can be installed during ongoing sewer operation and actually benefit from regular sewer cleaning, which a heat exchanger system must not restrict or impede in any way.

In 19 of the 25 largest cities in Germany, the sewer network operators now approve the installation of sewer heat exchanges, led by Berlin. The sewer operators often receive a usage fee, which covers the small amount of administrative work that they have to do. This fee has also increased the willingness of the sewer network operators to look at wastewater heat, or the energy potential in their own networks. Some sewer network operators have already illustrated their potential in energy maps, which are now available online. It is thus now possible to check a particular location in seconds to see if energy from wastewater is an option.

One of the network operators’ frequent reservations earlier was the cooling of the wastewater by the removal of energy. It is correct that thermal energy is removed from the wastewater when wastewater energy is recycled. The wastewater is cooled. But it recovers very quickly too, through the inflow of new wastewater and because it absorbs ambient heat through the sewer. The rule of thumb is: A system for recovering energy from wastewater needs a recovery line afterwards around two to three times the length of the plant itself, and then the temperature of the wastewater has recovered again. If a system is 100 m long, the wastewater has

regenerated itself in terms of energy after 200 to 300 m at the most. Consequently, for the sewage treatment systems, which generally assume a minimum temperature of the wastewater, the only deciding factor is how much heat the last system withdraws from the wastewater before the sewage treatment plant and how far this is from the sewage treatment plant. The removal of energy in the network beforehand is irrelevant for the sewage treatment plants. The wastewater cooling is thus not a restriction on the extraction of energy from wastewater.

4.4 How long does it take to install a system?

We estimate that the installation of a heat exchanger system will take around one to four weeks, depending on its size. If necessary, one or two weeks may need to be added for construction of the infrastructure, i.e. the pipe from the sewer to the boiler room. The time required varies for every project and is defined precisely beforehand. Only heavy rains which fill the sewer with unusually large volumes of water can cause delays in the installation of the heat exchanger modules. At the moment, the lead times for the building and installation of a plant are 2 to 3 months, depending on workload. Installations within the EU do not require any additional time.

4.5 Does regular sewer operation have to be interrupted during installation?

No. The heat exchangers are installed during ongoing operation. If necessary, the dry weather flow is guaranteed by means of water retention, i.e. a bypass is laid during the installation period allowing work to continue without disruption. The need for and extent of water retention measures are determined as part of the obligatory sewer inspection during the project planning phase. Guaranteeing uninterrupted operation of the sewer during installation is a major factor in the success of the technology. Otherwise, it would not be approved.

4.6 Do Therm-Liner systems need to be maintained or cleaned?

The heat exchangers are usually cleaned when the regular sewer cleaning is carried out, which is normally everyone to two years. Like the sewer, the heat exchanger system can be cleaned with a conventional rinsing vehicle. Ideally, streamlined rinsing nozzles should be used, and the maximum rinsing pressure on the vehicle should be 160 bar. It is also possible to clean the system by hand, e.g. with a pressure hose or high-pressure cleaning equipment, during an inspection. The need for cleaning is very low. We also offer our customers monitoring services so that the systems can be evaluated.

4.7 How do you ensure that the specified performance is always achieved?

The required extraction rate must be guaranteed even in the worst conditions, i.e. lowest possible temperature and lowest dry weather value. The same also applies if, in extended periods of dry weather, the extraction rate is reduced due to deposits and adhesions (biofilm) on the surface of the heat exchangers. In the latter case, the reduction is estimated, using complicated calculations that take various factors into account, to be around 40 % normally. This reduction in performance is made up for by having a larger transfer surface.

4.8 How much is the wastewater cooled down by the removal of energy?

Heat is extracted from the wastewater for wastewater heat recycling, and depending on the size of the plant, cooling is around 0.5 to 1 k. In exceptional cases, it can also be higher. However, this is ultimately negligible. The wastewater is cooled down, but it recovers very quickly too, through the inflow of new wastewater and because it absorbs ambient heat through the sewer. The rule of thumb is: A system for recovering energy from wastewater needs a recovery line afterwards around two to three times the length of the plant itself, and then the temperature of the wastewater has recovered again. If a system is 100 m long, the wastewater has regenerated itself in terms of energy after 200 to 300 m at the most. Consequently, for the sewage treatment systems, which generally assume a minimum temperature of the wastewater, the only deciding factor is how much heat the last system withdraws from the wastewater before the sewage treatment plant and how far this is from the sewage treatment plant. The removal of energy in the network beforehand is irrelevant for the sewage treatment plants. The wastewater cooling is thus not a restriction on the extraction of energy from wastewater.

5. Project development and business model

5.1 What should be considered during planning phase? What do I need for my project?

When considering the availability of energy from wastewater for a property project, there are three essential questions that always need to be asked: Firstly: Where is the nearest public sewer network? Secondly: How much wastewater does it carry? Thirdly: What is the temperature of the wastewater? With these three pieces of information, it is possible to calculate immediately how much energy can be made available and at what price. Some sewer network operators now provide energy maps online that you can use to check any particular location in seconds yourself. Other sewer network operators will provide this information on request. You can talk to us at any time if you want to check a location.

5.2 What is the target group for energy from wastewater?

Heating and cooling with energy from wastewater are possible in any building with a power requirement of around 50 kW or more. That is around 15 accommodation units. The largest system constructed to date has a heat extraction rate of 2.1 MW and supplies a district with over 450 accommodation units plus commercial users. Commercial buildings are also easily heated and cooled using wastewater energy. The aim is that energy from wastewater will reach a temperature of 35 to 55 °C using heat pump technology. However, there are now also many projects when energy is stored at a higher temperature. It is always a question of competition and the next best option. Wastewater heat is also particularly suitable for storage in local authority or municipal heat networks.

5.3 When should I get in touch with UHRIG?

If you want to check a location to see whether it is suitable for extracting energy from wastewater, get in touch with us. Your street, house number and postcode are enough initially. If you already have the sewer data for a selected location, all the better. We will then check for you how much energy you can extract at the location in question and give you an initial guideline price. If you do not have any data, talk to us anyway.

5.4 Are the systems designed and operated on a monovalent or a bi-/multi-valent basis?

Most of the systems realised at the moment are bi- or multi-valent. For example, the basic load can be covered with wastewater heat, and district heating, gas or/and CHP plants can be used to cover peak loads. Our heat exchanger plants are always aligned to what is called the minimum dry weather flow, i.e. the moment when the least wastewater is flowing through the sewer. This means that the reliable performance of the systems is guaranteed on a highly conservative basis.

Another option is the use of heating networks. Energy from wastewater is a highly attractive green energy source for district or local heating, whether this is a cold or warm network.

5.5 How do you ensure that the system always achieves the specified performance?

Our heat exchanger plants are always aligned to what is called the minimum dry weather flow, i.e. the moment when the least wastewater is flowing through the sewer. This means that the reliable performance of the systems is guaranteed on a highly conservative basis. In addition, for the sake of safety, both the volume and temperature of the wastewater in the sewer in question is measured again beforehand over a long period of time. This ensures that the plant performs efficiently. The data from the sewer network operators, which are always accurate, are thus verified. Essentially: The level of wastewater can be calculated and forecast precisely over decades, which means that the use of wastewater for energy offers a high degree of reliability. What is particularly attractive is the fact that the temperature of wastewater recovers again very quickly even after large quantities of energy have been extracted. This is due firstly to the inflow of new wastewater into the sewers and secondly to the constant uptake of ambient warmth from the ground. It is therefore possible to install a large number of plants to extract energy from wastewater in a sewer network. The only thing that is important is that the plants must be a certain distance apart. The rule of thumb is: After a wastewater heat recovery plant, a “recovery line” around two to three times the length of the plant itself should be incorporated. If a wastewater energy recovery plant is 100 m long, then another plant can be installed around 200 to 300 m afterwards.

5.6 What approvals are required for a project?

Basically, the operator of a wastewater heat extraction plant only needs the permission of the sewer network operator. The sewer network operator decides whether a system for extracting energy from wastewater can be installed in a particular sewer or not. The deciding factor for the sewer network operator, as the party with a sovereign responsibility, is that the sewer operation is not restricted in any way by the use of the wastewater for energy. This is precisely what we can ensure with our system, the Therm-Liner. As a company that has been working in sewer construction for five decades, we are well acquainted with the requirements inside the sewer. Before a plant is commissioned, all the parameters, such as the length of use, the basic technical conditions and the usage fee to be paid, are defined in a usage agreement. We are happy to provide templates for usage agreements of this type.

5.7 What business models are used to implement energy-from-wastewater projects?

Most projects are now realised on a contracting basis, with the end customer being offered a fixed price in cents/kWh for heat or cold. This ensures transparency and good price stability. Customers, therefore, if they

wish, have nothing to do with the operation or purchase of the plant; instead, they are provided with heat and/or cold in a “worry-free” package at a fixed price.

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