Energy from Sewers

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Background

A significant portion of heat in homes is lost through sewers. In a typical house, about 20% of the heat loss is from hot water discharge to the drainage system. In a modern, well insulated house, where other losses have been reduced, this heat loss represents a higher proportion of the heat loss which can be up to 50% of the total heat lost from the house. Once in the sewer, most of this heat is lost to the surrounding soil. Recovering more energy from wastewater transfer and treatment is a key element of Ofwat's strategy for delivering benefits to customers through operational efficiency and out performance by the increased use of innovation. Coupled with continued government support for decarbonised renewable heat through the Renewable Heat Incentive Scheme, the demand for recovering heat from sewers will continue to grow as the potential for energy recovery from sewers is currently a largely untapped resource.

There are also potential opportunities for recovery of hydraulic energy from sewers in the form of electricity.

Despite the opportunities this technology has yet to be adopted more widely largely due to concerns about the risks of installing these recovery systems that may have a detrimental impact on the operation of the sewer network and wastewater treatment works.

In UKWIR commissioned WRc in association with CSTB in France and the University of Bath to look at the risks and opportunities for recovery of energy from sewer systems, to look at the legal implications and to identify the scale of opportunity.

Drivers

The Renewable Energy Directive (2009/28/EC) sets mandatory targets for member states on the share of energy from renewable resources and requires them to have plans to achieve those targets in the areas of transport, electricity and heating and cooling.

The UK and Irish Governments have set targets for the reduction of Carbon Emissions in line with the Kyoto Protocol. To achieve these they have, together with the devolved administrations in Scotland, Wales and Northern Ireland given objectives to various organisations, including local authorities and the water and energy industry regulators to reduce their carbon emissions in various sectors.

Ofwat requires water companies to include the shadow price of carbon in their CBA methodology as part of the price review process and expects them to consider low-carbon investment options [Ofwat, 2008].

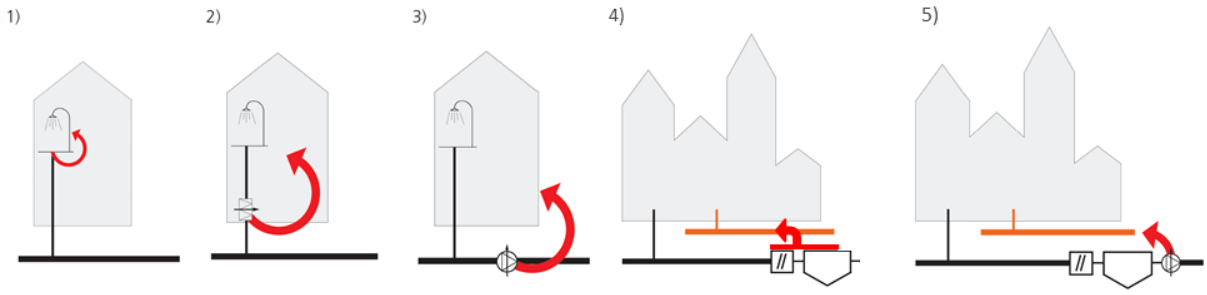
The National Planning Policy Framework for England [MHCLG, 2018] requires Local Planning Authorities to have plans that provide a strategy for increased use of energy from renewable or low carbon sources and encourages developments to draw their energy from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers. Scottish Planning Policy [Scottish Government, 2014] and Planning Policy Wales [Welsh Government, 2018] includes similar requirements.

In addition some organisations have non-financial drivers to reduce carbon which may influence decisions on heat recovery schemes.

Technologies

The technology for heat recovery comprises a heat exchanger, installed either on-line or off-line in one of five different locations within the wastewater system. These are shown in Figure 1.

Figure 1 The five stages from which heat can be recovered



Heat exchangers can be standard units used in other applications or they can be specialised units including some that are integral parts of tanks or pipes.

In almost all cases the heat is required at a higher temperature than the wastewater and this is achieved by using heat pumps to produce water at a higher temperature. This involved input of energy in the form of electricity, but also produced cooling as a by-product. In addition to demand for low-carbon heat, there is also an increasing demand for cooling.

Examples

There have been examples where heat recovery from sewers has been undertaken with a number of systems being installed in Europe and North America. In the UK the most notable example is a heat recovery scheme operated by Scottish Water in Galashiels.

There are much few hydro-electric energy recovery systems in use.

Internationally, the largest heat recovery systems produce over 100 MW of heat from treated wastewater. Systems for recovery of heat within the sewer system are typically much smaller and most systems produce less than 1 MW of heat. The largest wastewater heat recovery system in the UK is 1 MW. The largest hydro-power systems produce in excess of 100 kW of power.

Risks

The installation of heat recovery or hydraulic energy capture technologies in existing sewer systems has the potential to introduce a variety of risks. Such risks could include reduced capacity of sewers, reduced sewage flow velocities, increased potential for sedimentation, blockages, odours and flooding. Risks for the receiving wastewater treatment works through reduced sewage temperatures, changes to influent flow profiles etc. also need to be identified and assessed.

The risks can be broadly classified as risks to:

a) the operation of the sewer system;
b) the operation of the wastewater treatment plant;
c) the operation of the energy recovery system;
d) legal risks.

The principal risk to performance of the sewer system comes from blockage of the wastewater flow through the heat exchangers or turbines. The use of integrated heat exchangers in the pipe wall can control this risk by have a large opening. Blockage is likely to be a particular problem where there are existing problems with accumulation of fats oils and grease in the sewer.

Where the opening through a heat exchanger is small, or where a turbine is used to recover energy, the wastewater should be screened and or macerated to minimise the risk of blockage. Off-line systems should be preferred in this instance to ensure reliability of the sewer system. This risk is minimised if the heat is recovered from treated effluent downstream of the wastewater treatment plant.

The principal risk to the wastewater treatment plant from heat recovery systems is that the reduced temperature will impact on the performance of nitrification. The temperature at which this will take place depends on the design of the plant. There is no risk to the performance of the wastewater treatment plant if heat is taken from the treated effluent and this is where the largest European plants recover their energy.

The temperature of the minimum wastewater reaching the wastewater treatment plant should be a key design parameter of any project to recover heat from sewers.

The risks to the operation of the energy recovery system come from fouling or blockage of the heat exchangers or turbines or from insufficient heat in the wastewater. If a significant proportion of the heat comes from a single user, then there is a risk that the user will close or take the opportunity to recover that heat themselves.

Legal considerations

The key legal consideration is the status of any wastewater if it is removed from the sewer system. In this instance the wastewater may be re-classified as a waste and separate environmental permits may be required. The design of energy recovery systems should ensure that wastewater is always retained within the sewer system or wastewater treatment plant.

Other legal considerations for heat recovery systems concern it eligibility for the Government's Renewable Heat Incentive scheme, which will depend both on the recovery system and the use of the recovered heat.

Technology appraisal

A selection tool has been provided for the high level appraisal of potential wastewater energy recovery opportunities. This allows water companies to make informed decisions on the initial business case for a particular installation.

Opportunities

The scale of opportunity for recovery of energy from sewers is highly dependent on local conditions. In the case of heat recovery it depends on the availability of a user near to a point where there is a suitable heat source. In the case of hydro-power systems it is the availability of a suitable site.

Suitable heat users are large institutional buildings, industrial process heat users and district heating schemes. Cooling is a by-product of heat recovery systems which can also be used.

Systems for the recovery of heat from sewers have been shown to be eligible for payments under the renewable heat incentive scheme in England, Scotland and Wales.

Heat recovery from wastewater can make a significant contribution to the reduction of carbon in the generation of heat.

In seeking opportunities for heat recovery systems, priority should be given to identifying potential users of the heat in proximity to the sewer system or wastewater treatment plant.

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