Smart strategies for the transition in coal intensive regions

Project No: 836819

Fact Sheet:
Usage of Surplus Heat

September 2019

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Description

Surplus heat is e.g. heat from machines, or processes that could be used for heating applications. There is quite a high potential all over Europe, but it's also an issue of economic feasibility to implement a heat recovery system. Some of the heat recovery processes need electricity to run heat pumps to higher the temperature level. In best cases this electricity should come from renewable energy.

There is a big energy savings potential in industrial surplus heat. It has been estimated, that in Finland the technical potential to use surplus heat is about 19 TWh/a and the economically feasible amount about 4–5 TWh/a. (Lauri Suomalainen, 2019)

Industrial surplus heat is energy recovered from a production process. There are different temperature levels at the heat source, e.g. cooling of product (40 to 60 °C), melting (>100 °C), cooling (30 to 40 °C), compressed air (60 to 70 °C), server (25 to 40 °C) and waste water (7 to 30 °C). (Diget, 2019)

Achievements

Usage of surplus heat could give some great opportunities for the producer and consumer. Nowadays there is still a lot of surplus heat wasted, that could be used e.g. for heating industrial processes or space heating. The usage of surplus heat does not only belong to former coal intensive regions, it's more a national wide issue to consider to achieve the energy transition.

> *"Public opinion is mostly in favour of boosting the use of surplus heat inside the plant or selling it to the community. They see it to be good for the environment because less primary energy is used and this type of utilization can in some way be compared to renewables."* (Lauri Suomalainen, 2019)

Best practice example – heat from coffee roaster in Viborg (Denmark): In the process of Peter Larsen Coffee the coffee beans are roasted to get the right flavour. The natural gas oven is used 8 hours per day, 5 days a week. The temperature level after the roasting is very high, between 90 and 500 °C. A flue heat exchanger uses the surplus heat to generate about 500 MWh per year heat for the Viborg district heating system. (Diget, 2019)

Best practice example – heat recovery from a brewing process in Graz (Austria): The "Brauquartier Puntigam" consists of about 800 apartments, needs 3.8 GWh/a heat and is located close to the Brewery Puntigam. Within the brewing process there is surplus heat available between 14 and 25°C (heat from NH_3 condensation). Two heat pumps provide usable heat at 75 °C and 46 °C to supply the apartments of "Brauquartier Puntigam" for heating. The total heat output of the heat pumps is about 4.3 GWh/a, so the total heat demand of the apartments could be covered with the surplus heat. (Koglbauer, 2018) Further information: https://translate.google.at/translate?hl=de&tab=wT&sl=de&tl=en&u=https%3A%2F%2Fwww.puntigamer.at%2Fbrauquartier-waerme-aus-bier%2F

Best practice example – Cloud&Heat Technologies (Germany): The German company Cloud&Heat Technologies provide sustainable solutions for energy efficient servers by using water cooling technologies. The surplus heat from servers (water cooled, Figure 1) is used to for industrial or household heating. If there is less demand, there are still dry coolers available. The heat output temperature is about 60 °C. A data centre in Frankfurt (Germany) saved with this technology cooling costs of about 95,000 EUR/a and 65,000 EUR/a heating costs. The CO_2 emissions were lowered by about 557,000 kg/a, that equals about 80 football fields of forrest. (Cloud&Heat, 2019) Further information: https://www.cloudandheat.com/

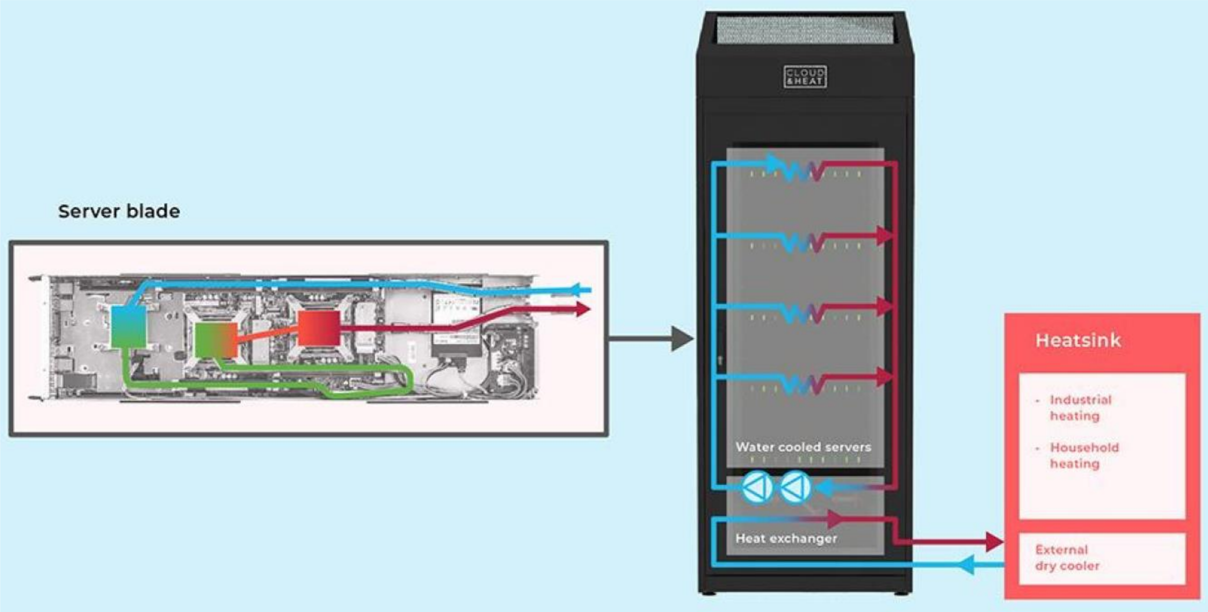

Figure 1: Water cooled servers generates surplus heat for industrial or household heating (source: Cloud&Heat Technologies)

Best practice example - Bjerringbro District Heating (Denmark): A partnership between the pump factory Grundfos and Bjerringbro Heating plant shows how usage of surplus heat for cooling and district heating can go hand in hand. A jointly owned energy centre (Figure 2) supplies 100% cooling to Grundfos and 15% of the heat to Bjerringbro district heating plant. During the winter period, Bjerringbro Varmeværk produces cooling for Grundfos and at the same time utilizes the heat from the cooling machines for district heating. In summer, Grundfos collects cooling from a groundwater reservoir. (Worm, 2019) Further information: https://heatpumpingtechnologies.org/annex47/wp-content/uploads/sites/54/2018/12/annex-47sub-projetcsbjerringbroexcess-heat-and-cooling.pdf

Figure 2: Heat pumps at Grundfos for usage of surplus heat (source: C. Doczekal)

Best practice example – Hospital in Viborg (Denmark): The hospital needs cooling all year, e.g. for server and air conditioning. They install a large heat pump, instead of many small chillers. This air-water heat pump is planned to be used for heating the hospital in winter and using the surplus heat the rest of the year to supply the Viborg district heating grid. 4,000 MWh per year are expected to achieve. (Diget, 2019)

Challenges

The economic feasibility is the most important factor from the company view. Companies will carry out investments that are not economically sound only if they are force to do so from e.g. environmental reasons. Very tight payback times, quarterly reports and lean organizations are seen as big obstacles in economical use of surplus heat. Energy saving projects are on the same line as production investment projects when money is concerned and due to limitation of the budget there is not always money to energy savings. (Lauri Suomalainen, 2019)

There are several challenges to handle with, e.g.

- The surplus heat is not always available continuously
- The temperature level is fluctuating
- The temperature level is lower than the needed level (boost with heat pump?)
- What are the back-up systems?
- How to set the price? (Diget, 2019)

There is vast amount of surplus heat that can be used economically. The obstacles in surplus heat utilization can be divided in to four categories:

- economic feasibility
- lack or unreliability of proper technology
- lack of proper heat sinks
- obstacles in legislature or in politics or public opinion. (Lauri Suomalainen, 2019)

Enabling conditions

When planning how to make most of surplus heat it is important to look at the big picture and not to grasp the first and easiest solution. Heat from processes etc. can be used as secondary energy in the same or some other processes. This can simply be done for example by changing the pipe connections of the process flows or by updating the process automation. It is useful and necessary to approach the finding and use of surplus heat in a systematic way. Pinch analysis is one way to approach this problem. Pinch analysis is a systematic method to analyse cooling and heating needs of a plant.

All surplus heat sources must also have proper sinks, preferably nearby. The source and the sink must match in many ways (thermal power, simultaneousness, duration etc.). If these demands are not met in sufficient amount the heat recovery installation will not be feasible. (Lauri Suomalainen, 2019)

All industrial cases are different from one another, that's why different enabling conditions are shown here.

Heat sinks outside plant limits:

When a plant has plenty of surplus heat that it cannot use inside the plant limits it is usually possible to consider selling the surplus heat to neighbouring company or community. There are basically three ways how to deal with this possibility, by selling the surplus heat

- as district heat to a local district heat company
- to enterprises near by
- to new business company for e.g. biofuel drying. (Lauri Suomalainen, 2019)

Selling surplus heat to other party:

It is very important that when surplus heat is sold to other party the terms and agreements are up-to-date and thoroughly checked. There are lots of technical and economical things and contractual relations that have to be considered and verified before the agreements are signed.

The most important things that have to be agreed technically are:

- Seller: Heat source, temperature levels, peak output, quantity of energy, duration, reliability of delivery and limitations.
- Byer: Heat sink, peak input, temperature levels, quantity of energy, duration and limitations.
- Distribution to customers: Temperature and pressure levels, flows.

From the economic and legal point of view there are also several things that parties have to agree on, e.g.:

- Investment cost per party (joint acquisition).
- Tariffs.
- How to change the tariffs, terms etc.?
- Length of the term and dismissal.
- Maintenance etc.

All of those terms and conditions have to be thoroughly viewed and agreed which takes time, resources and money. The better this work is done fewer difficulties will arise. (Lauri Suomalainen, 2019)

Cooling as a Service (CaaS) with heat recovery:

For **example**, in Stockholm heat recovery can be conducted in two ways. Either data centres produce their own cooling with heat pumps, and reject excess heat into the district heating network at an appropriate temperature. Alternatively, Fortum Värme provides Cooling as a Service, (CaaS), where a data centre’s excess heat is carried to a production plant in a return pipe. At the production plant, excess heat enters on the evaporator side of large centralized heat pumps that generate heat for the district heating network. (Värme, 2019)

References and further links

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 836819. The sole responsibility for the content of this report lies with the authors.