IEA DHC|CHP

iea Energy Technology Network

International Energy Agency Technology Collaboration Programme on
District Heating and Cooling including Combined Heat and Power

Annex XII final report summary for a non-technical audience

MEMPHIS

Methodology to Evaluate and Map the Potential of Waste Heat from Industry, Service Sector and Sewage Water by Using Internationally Available Open Data

May 31, 2019

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Annex XII final report
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This project has been independently funded by
the International Energy Agency Technology Collaboration Program on
District Heating and Cooling including Combined Heat and Power
(IEA DHC).

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MEMPHIS

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Citation

Johannes Pelda, Roman Geyer, Colin Sinclair, Romana Stollnberger, Ernst Gebetsroither-Geringer, Stefan Holler (2019): MEMPHIS - Methodology to Evaluate and Map the Potential of Waste Heat from Industry, Service Sector and Sewage Water by Using Internationally Available Open Data, Published on IEA-DHC.org.

Executive Summary

The mitigation of Global Warming triggered by accelerated greenhouse gas (GHG) emissions requires changes in the energy supply such as towards the increased use of renewable energies and improved energy efficiency. The potential of district heating systems (DHSs) to reduce GHG emissions is considerable through more efficient use of primary energy and the utilization of synergies. To make this happen, the heat generation of existing DHSs has to react to increasing fossil fuel prices, the need to reduce greenhouse gas emissions and the partly decreasing heat demand of buildings due to improved building insulation envelopes. These challenges present growing opportunities for research in to ways of supplying DHSs with alternative and renewable energy.

Taking advantage of renewable energy sources requires a DHS on a low-temperature level to meet technical requirements set up by renewables.[1] Currently, extended research is being carried out to transform existing high temperature DHSs of the 2nd to 3rd generation into low-temperature DHSs of the 4th generation.[2] The research results prove that renewable energy systems such as solar thermal systems, geothermal systems and power to heat (PtH) can provide a stable heat supply throughout the year. Particularly, heat pumps (HPs) promise a wide range of use and economical feasibility by exploiting waste heat sources.

Besides the ecological aspects, DHSs offer also a great potential to give flexibility to power systems that are marked by increasing fluctuations of renewable energy sources.[3] Decentralized, flexible, combined heat and power (CHP) stations, as well as PtH technologies, support the interaction between DHS and the electricity market. Characterized by their highly flexible operating mode they increase their dispatchability to the electricity grids. In particular, HPs combined with environmental or waste heat sources have been discovered to be most efficient in economic and ecological perspective.[4]

Many thermal and mechanical processes generate waste heat. Waste heat sources can be production machines or plants, hot air appliances and furnaces for drying, waste water from cleaning, washing, dyeing or cooling processes, but also cooling systems, motors or the heated exhaust air arising in production halls and office areas.[5] Due to various barriers, these potentials are typically only used to a small extent. Reasons for this include structural, financial, information-related and operational obstacles, for example the spatial and temporal correspondence of heat supply and demand, or insufficient profitability. Concerns about production reliability and amortization expectations also emerge as special barriers. On the other hand, rising energy prices as well as image enhancement and personal commitment of management and energy commissioners have a positive effect.[6]

Utilization of waste heat or surplus heat is a basic principle of DHSs and it makes sense to also utilize waste heat from industrial processes or sewage channels. If companies use or even sell their waste heat, they can often reduce their own energy consumption, save energy costs and increase their own competitiveness.

[1] See Rämä et al., 2018.
[2] See Averfalk et al., 2016; Connolly et al., 2014; H. Lund, Duic, et al., 2016; H. Lund, Werner, et al., 2014; Schmidt et al., 2017; Ziemele et al., 2018.
[3] See Clastres, 2011; Hast et al., 2018; Lake et al., 2017.
[4] See Bloess et al., 2018; R. Lund et al., 2016; Yilmaz et al., 2018.
[5] See Pehnt et al., 2010.
[6] See ibid.

The research project MEMPHIS, funded within the IEA DHC Annex XII, aims to develop an international applicable and freely distributed methodology to assess waste heat potential from the industry and business sector and sewer networks. The results promote the identification of spatially distributed waste heat sources which are currently otherwise wasted (see **Fig. E-1** to **E-2** which shows the online tool of the Waste Heat Explorer (WHE) available at ***http://cities.ait.ac.at/uilab/udb/home/memphis/***).

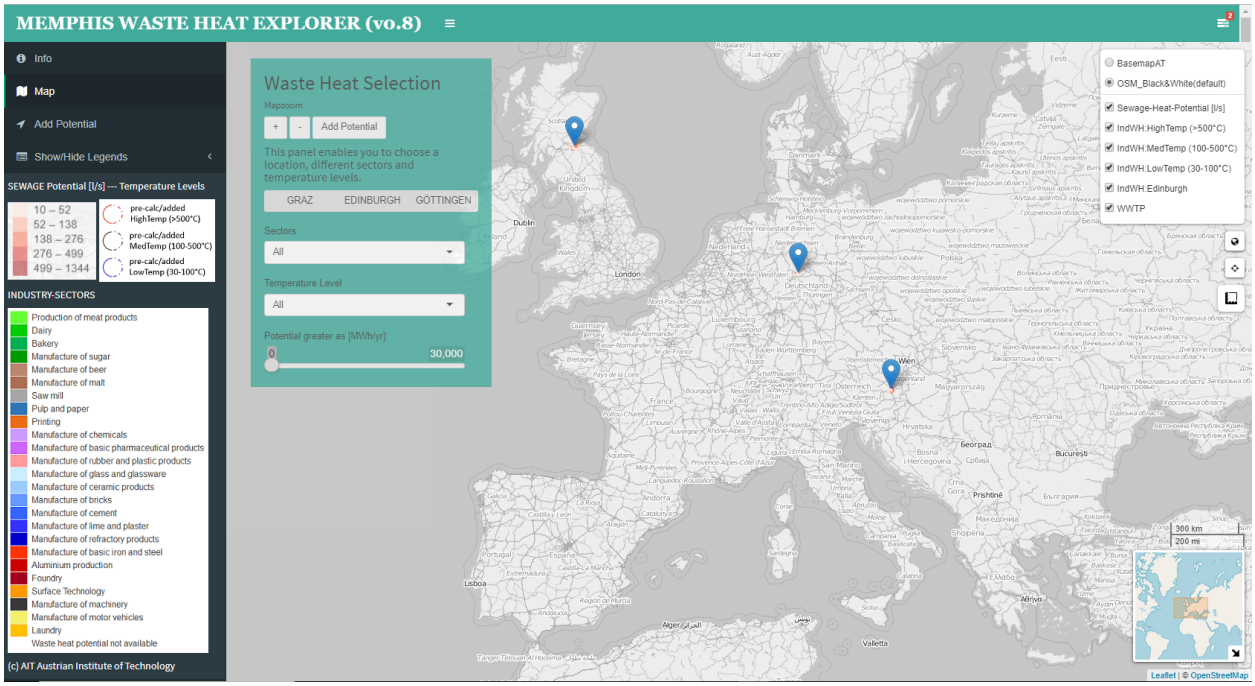

Fig. E-1 Waste heat explorer screenshot of home screen

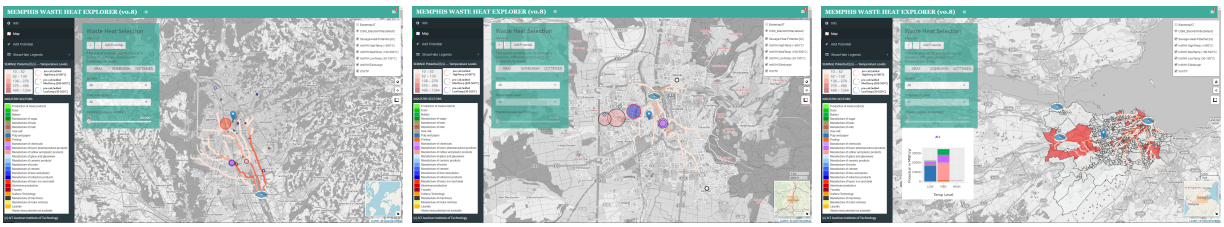

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Fig. E-2 Waste heat explorer with three case study locations

The WHE is also a platform that enables the cooperation of potential producers and consumers of waste heat. For example, an industrial company can enter its waste heat potential and an energy supplier can find it and contact the company. In this way, the share of alternative energies in heat networks can be increased without installing additional generation capacities. For stakeholders (utilities, energy consultants etc.) this means support in the development of future strategies and improved energy spatial planning for either new and existing or expanding networks.

Furthermore, the results give an estimation of the economical and ecological potential of waste heat sources when integrated into DHSs via HPs. Conclusively, the three project partners AIT Austrian Institute of Technology GmbH (AIT), Building Research Establishment Limited (BRE) and HAWK University of Applied Sciences and Arts Hildesheim / Holzminden / Göttingen (HAWK) give an evaluation of the current market maturity and present business models considerations for the utilization of waste

heat sources.

To obtain an internationally applicable methodology the use of open source and open data technology is required. This challenge was well met regarding open source technology like programming languages and visualisation tools. Regarding the open data, the challenge could not be fully met but was overcome using a combined bottom-up and top-down approach. Statistical data was also used to help overcome missing local information about waste water disposal in the research areas. These combinations led to new, innovative approaches and granted an open source and open data based methodology that is transferable to other cities, regions and countries.

The results of the MEMPHIS project show that there is potential for utilizing waste heat from industry and service sectors as well as sewer networks. It is however recognized that the waste heat sources are spatially distributed and vary in temperature level and temporal availability. Although little information about the DHSs in the example cities was available, it can be concluded that either at least one heat sink like a building is nearby a waste heat source or a linkage to an existing district heating network (DHN) can be easily and cost-effectively established. Overall, it is most likely that the waste heat can be utilized within economical scope. Unfortunately, it is not possible to give a general statement about the amount of the heat that can be gained utilizing waste heat sources from the industry sector as this source contains various media. However, for the heat extraction from water a more general statement is presented.

The results of this project are diverse. On the one hand there is rare information about waste heat sources and the big challenges in communicating and establishing connections between waste heat disposers and heat seekers. On the other hand, the methodology offers a unique opportunity to collect useful information at national level and provides a suitable web-based tool for that. Waste heat disposers, heat seekers, local authorities, city planners and developers will be able to use the tool to identify maximum size and diversity of waste heat potential at a local level. This can improve decentralized energy planning and provide an informed basis for well-founded strategies for developing new, or expanding existing networks.

List of Abbreviations

CHP	Combined Heat and Power
DHN	District Heating Network
DHS	District Heating System
GHG	Greenhouse Gas
HP	Heat Pump
PtH	Power to Heat
WHE	Waste Heat Explorer

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