Market uptake of small modular renewable district heating and cooling grids for communities

Project No: 691679

CoolHeating Study Tour on small renewable district heating and cooling grids in Germany

WP 2 – Task 2.3 / D 2.3

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Authors: Dominik Rutz, WIP Renewable Energies, Germany

Contact: WIP Renewable Energies
Dominik Rutz
Email: Dominik.rutz@wip-munich.de, Tel: +49 89 720 12 739
Sylvensteinstr. 2
81369 Munich, Germany
www.wip-munich.de

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CoolHeating website: www.coolheating.eu

Contents

1 Introduction

This report on “CoolHeating Study Tour on small renewable district heating and cooling grids in Germany” was elaborated in the framework of the CoolHeating project.

The objective of the CoolHeating project, funded by the EU’s Horizon2020 programme, is to support the implementation of "small modular renewable heating and cooling grids" for communities in South-Eastern Europe. This is achieved through knowledge transfer and mutual activities of partners in countries where renewable district heating and cooling examples exist (Austria, Denmark, Germany) and in countries which have less development (Croatia, Slovenia, Macedonia, Serbia, Bosnia-Herzegovina). Core activities, besides techno-economical assessments, include measures to stimulate the interest of communities and citizens to set-up renewable district heating systems as well as the capacity building about financing and business models. The outcome is the initiation of new small renewable district heating and cooling grids in 5 target communities up to the investment stage. These lighthouse projects will have a long-term impact on the development of "small modular renewable heating and cooling grids" at the national levels in the target countries. A key objective of the project is to exchange information on best practices for small modular district heating and cooling systems.

CoolHeating organises three study tours for target country stakeholders and project partners to best practice examples in Germany, Denmark and Austria. The objective is to show stakeholders examples of small renewable district heating and cooling grids and to facilitate networking among the relevant partners.

A first study tour was organised only for the project participants on the occasion of the Kick-off-Meeting in Germany on 26/27 January 2016. The present report summarizes this study tour. The second and third study tour will be organised on the occasion of the project meetings in Denmark and Austria and will include both project partners and external key stakeholders.

2 Acknowledgements

The consortium would like to thank the responsible persons of the site visits for their time and efforts to guide the Consortium through their facilities: **Martin Welter** (City of Munich); **Thomas Kerner** (Kommunalunternehmen Energie Dollnstein AdÖR), and **Ulrich Bader** (Biogas plant operator in Vatersdorf).

3 Site visit 1: Solar District Heating "Am Ackermannbogen" in Munich

Location: Munich, Germany
Google maps
http://www.ackermannbogen-ev.de/quartier/solare-nahwaerme.html

Technical data	
Heat production technology // Fuel // heat capacity // year of installation	- 2,761 m² flat plate solar collectors on the roof of multi-apartment houses - Capacity: 2,300 kWh_{th} - Connected to the district heating network of Munich in order to cover peak loads - Thermally operated absorption heat pump (560 kW) - Installation year: 2007
Cooling	No cooling devices included
Efficiency	- Solar fraction of about 45-50 % - 180 t/a reduction of GHG - 1,033 MWh/a energy savings
DH network	A mixture of water and glycol transports the energy through the solar network to the heating plant.
Storage	- Water thermal energy seasonal storage (concrete-steel; covered with soil) of 5,700 m³ (load size: 2.3 GWh / year)
Consumers // total annual heat sales	- Capacity: 30,400 m² space heating (320 apartments) - About 1,800 MWh/a heat supply About 200 MWh/a heat losses in the storage tank
Investment cost	5.1 million EURO
Heat price, fixed, variable, total (standard house)	No data
Involved partners	- Research: Bavarian Centre for Applied Energy Research (ZAE Bayern), www.zae-bayern.de - Technical Support: Solites, www.solites.de - System operator: energy utility of Munich (SWM Services GmbH), www.swm.de - Political support: City of Munich: Department for Health and the Environment, www.muenchen.de/rgu

The city of Munich[1] implements various policies to increase energy efficiency and to mitigate climate change. In 2007, the city of Munich realized the solar thermal heating project Am Ackermannbogen which includes a seasonal storage tank.

[1] The description is based on several sources of information, including:

The system supplies about 320 apartments with hot water and heat for space heating in winter. Heat is collected through solar collectors on the rooftop of the apartments. This heat is transported by a water/glycol mixture through pipelines to the seasonal underground hot water storage tank which heats up until autumn to about 90°C. The storage tank is well insulated. During winter, this heat is transported to the apartments (good thermal insulation standard buildings) for space heating and hot water supply.

Figure 1: Solar collectors on the rooftop of the apartment houses at "Am Ackermannbogen" (Source: D. Rutz, WIP)

Depending on the weather conditions of the winter, the stored heat is usually sufficient until January. After this period, a thermally operated lithium-bromide absorption heat pump (560 kW) uses the heat of the district heating network of Munich (80-120 °C) as well as the remaining heat of the storage tank (down to 10 °C) in order to supply the households with heat for the rest of the winter. The supply temperature to the households is about 60 °C. About 45-50 % of the overall energy demand is provided through solar thermal energy.

Figure 2: Seasonal storage tank covered with soil and well-integrated in the urban planning at "Am Ackermannbogen" (Source: D. Rutz, WIP)

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http://www.bine.info/fileadmin/content/Publikationen/Englische_Infos/projekt_0211_engl_internetx.pdf
http://www.itw.uni-stuttgart.de/dokumente/Publikationen/publikationen_05-08.pdf
https://www.energieatlas.bayern.de/energieatlas/praxisbeispiele/details,197.html

4 Site visit 2: Low temperature district heating "Dollnstein"

Location: Southern Germany; Central Bavaria
Google maps
www.dollnstein.de

Technical data

Heat production technology // Fuel // heat capacity // year of installation	- Ground water heat pump (440 KW_{th}) - 100 m² solar collectors - Photovoltaics (191 kW_p) - Combined heat and power unit (gas/LPG) (250 kW_{th} / 150 kW_{el}) - Peak load gas boiler (300 kW_{th}) - Installation year: 2014
Cooling	No cooling devices included
Efficiency	- 70 % reduction of heat demand - 70 % reduction of GHG - 40 % reduction of primary energy
DH network	1,800 m heat pipes and communication wires
Storage	- 27 m^3 stratified heat storage tank - 15 m^3 low temperature storage tank - In each connected household: heat exchanger, at least 0.3 m^3 buffer tank and heat pump
Consumers // total annual heat sales	- 47 connected households, at the moment 23 in use - Communal buildings (school, church, etc.)
Investment cost	1.6 million EURO
Heat price, fixed, variable, total (standard house)	0.11 EUR/kWh for heat consumption 0.10 EUR/kWh of injected heat from private solar collectors
Involved partners	- Operator: Municipal energy utility of Dollnstein (Kommunalunternehmen Energie Dollnstein AdÖR) - Planning: Ratiotherm GmbH & Co. KG - Heat pump supplier: Dürr thermea GmbH (Thermeco2)

Dollnstein[2] is a small community with about 2,700 inhabitants in the heart of Bavaria, Germany. Dollnstein is located in the Altmühltal Nature Park, one of the most popular

[2] The description and the graphs are based on several sources of information, including:
Personal communication

touristic destinations in Bavaria. In 2011, the municipality has initiated and in 2013/14 installed an intelligent heating network for about 40 households and several communal buildings

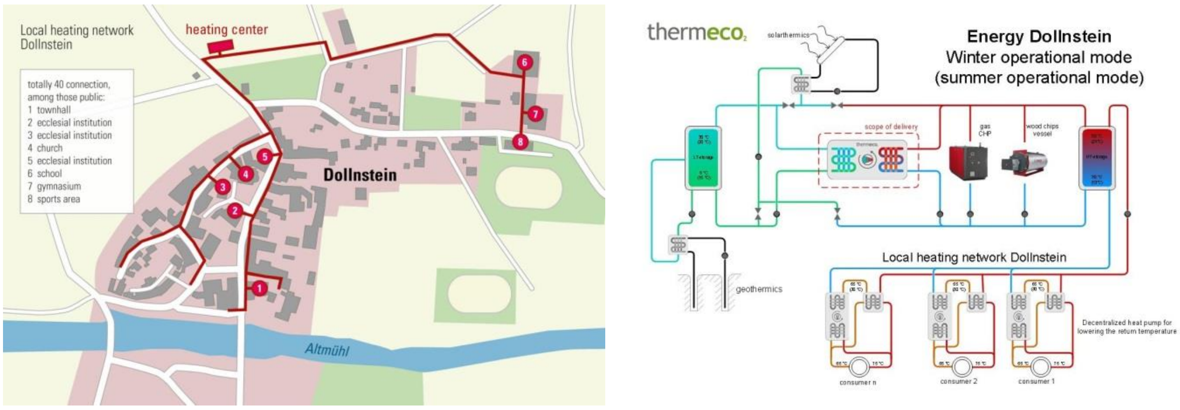


Figure 3: Overview map of the local heating network Dollnstein (Source: MinneMedia); Operating scheme local heating network Dollnstein (Source: Dürr thermea)

The concept of the Dollnstein local heating network is primarily based on two parts: utilisation of renewable energies and flexible temperatures adjusted to the consumption. In a typical network the heating utility permanently provides hot water of 80 °C. In summer, there is no appropriate demand for such a temperature in a small town like Dollnstein, which causes high heat losses. For reducing these losses, the network temperature from May till end of September is lowered in Dollnstein to 20-30 °C. This allows covering the heat demand in summer operation completely by renewable energy, as described below.

In winter, after all, half of the energy comes from renewable sources. One of that is groundwater, which is available at shallow depths. In the heating centre the thermeco2 high-temperature heat pump with a capacity of 440 kW is located. It extracts thermal energy from the low temperature storage tank (which uses the groundwater and the solar panels as energy source) and, thus, provides flow temperatures up to 80°C in the winter heating period. The feature of this technology: The system works with the environmentally friendly refrigerant CO_2.

In the summer months, there is enough solar energy to keep the network temperature at 20 °C to 25 °C. For the hot water demand of private households, for example for showering, this is, however, not sufficient. That is why the transfer stations in the houses are equipped with a small heat pump and buffer storage each. A combined heat and power plant (CHP) and photovoltaic power plants supply the electricity for the thermeco2 machine and the pumps in the households.

In an intelligent system, the heating centre, heating network and consumer are connected to each other – including power supply of the consumer stations. A control cable forwards information about temperature of buffer storages, consumption and other data to the heating center. By doing so, the buffer storages in the houses can be charged in line with the demand. Thus, the small heat pumps only run, if hot water is demanded. To take full advantage of the waste heat from the CHP and of the existing solar plants there is high-temperature buffer storage of 27 m^3 and a slightly smaller low-temperature storage.

http://www.durr-thermeco2.com/en/projects/item/836-district-heating-network-marktgemeinde-dollnstein
https://www.energieatlas.bayern.de/kommunen/praxisbeispiele/details,583.html
http://www.ratiotherm.de/fileadmin/daten/bilder/ratiotherm/Presse-Veroeffentlichungen/PM%20Er%F6ffnung%20Nahw%E4rme-Netz%20Dollnstein_ratiotherm.pdf

5 Site visit 3: District heating with biomass in Vatersdorf

Location:
Vatersdorf, southern Germany
Google maps

Technical data

Heat production technology // Fuel // heat capacity // year of installation	- Biogas plant with 549 kW_{el} and 600 kW_{th} installed capacity - Input material for the biogas plant: manure (35%), corn silage, grass silage - One woodchip boiler of 220 kW_{th} - Peak load boiler (heating oil/biogas) (900 kW) - Total peak load: about 900 kW_{th} - Drying facility for woodchips and cereals - Installation year: 2006 (biogas plant), 2012 (heating grid)
Cooling	No cooling devices included
Efficiency of plants	- 100% utilized heat of the biogas plant - About 180,000 l/a heating oil saved
DH network	4,700 m heat pipes
Storage	- 20 m³ buffer tank hot water, - biogas storage of 1,900 m³ - Drying of wood chips
Consumers // total annual heat sales	- about 85 households connected - guaranteed heat supply (24h/365days)
Investment cost	- 1.45 million EUR (heating grid only)
Heat price, fixed, variable, total (standard house)	- about 0.078 EUR/kWh heat - basic fee: 15 EUR/kW/a - connection fee: 250-300 EUR/kW (during the first project phase); for new connections: 9,500 EUR/connection
Involved partners	Operator and owner: Ulrich Bader, engineer and farmer

The farmer and agricultural engineer Ulrich Bader installed in 2006 a biogas plant in Vatersdorf[3], a small village in southern Germany. In its initial phase, the main objective of the

[3] Some details are obtained from:
Personal communication
http://www.biogas-in-bayern.de/links/Infokampagne-Bayern/BGA-Buch-am-Erlbach/4113/

biogas plant was to only maximize power production due to the favourable conditions in Germany for renewable electricity generation (feed-in tariffs). Besides the heat supply for heating the digesters, for his farmer's house and for drying woodchips, the heat was released without use. This was typical for most biogas plants in Germany. Due to this inefficient overall energy use, Ulrich Bader decided to install a small district heating network in order to supply the households of Vatersdorf. In 2012, the heating grid was realized by Ulrich Bader, who did most of the planning and construction himself. He was supported by the heat pipe manufacturer Rehau.

Some biogas plant operators who have also a heat grid only sell as much heat as they have available. This means that the heat supply is not guaranteed, so that the consumers still have to maintain their own heating system in the house as back-up. Ulrich Bader, however, decided to be fully responsible for the heat supply and to guarantee it throughout the year and at any low ambient temperatures. Thus, the households practically do not need any other heating device in their household, except the connection point to the heating grid. In such a system, he needs further heat sources to complement the heat supply of the biogas plant. This is done by two woodchip boilers which are in use in the cold season. For peak load demand he furthermore has a fossil oil boiler, since other solutions would not have been economically feasible. Nevertheless, the operation of this peak load boiler is very limited.

The available heat from the biogas plant in summer is still too much for the hot water demand of the households. In order not to waste this heat, Ulrich Bader has invested in a feed-and-turn dryer, which can dry woodchips (for the small heating grid of Ulrich Bader as well as for external woodchip traders) and cereals. The woodchip drying can be considered as energy storage, since it increases the energy value of the wood chips. In doing so, all the heat of the biogas plant is used and the additional demand is covered by the woodchip and peak load boilers.

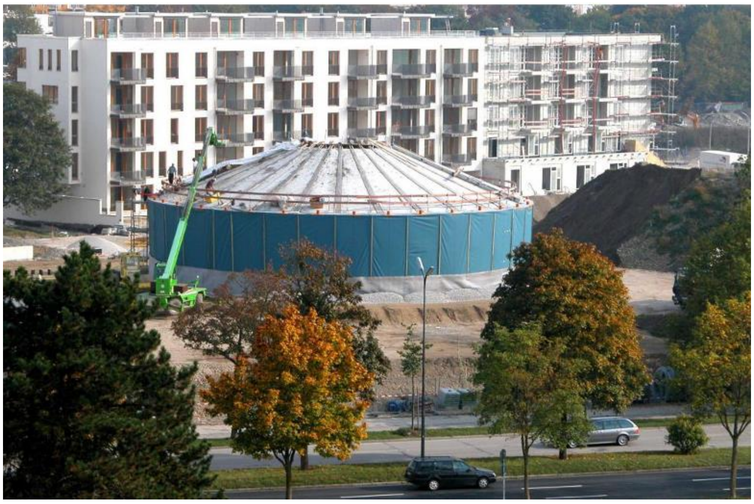
Figure 4: Digesters of the biogas plant and woodchip storage in Vatersdorf (Source: D. Rutz, WIP)

6 Agenda

Site Visits

26-27 January 2016, Munich, Germany

- Agenda -



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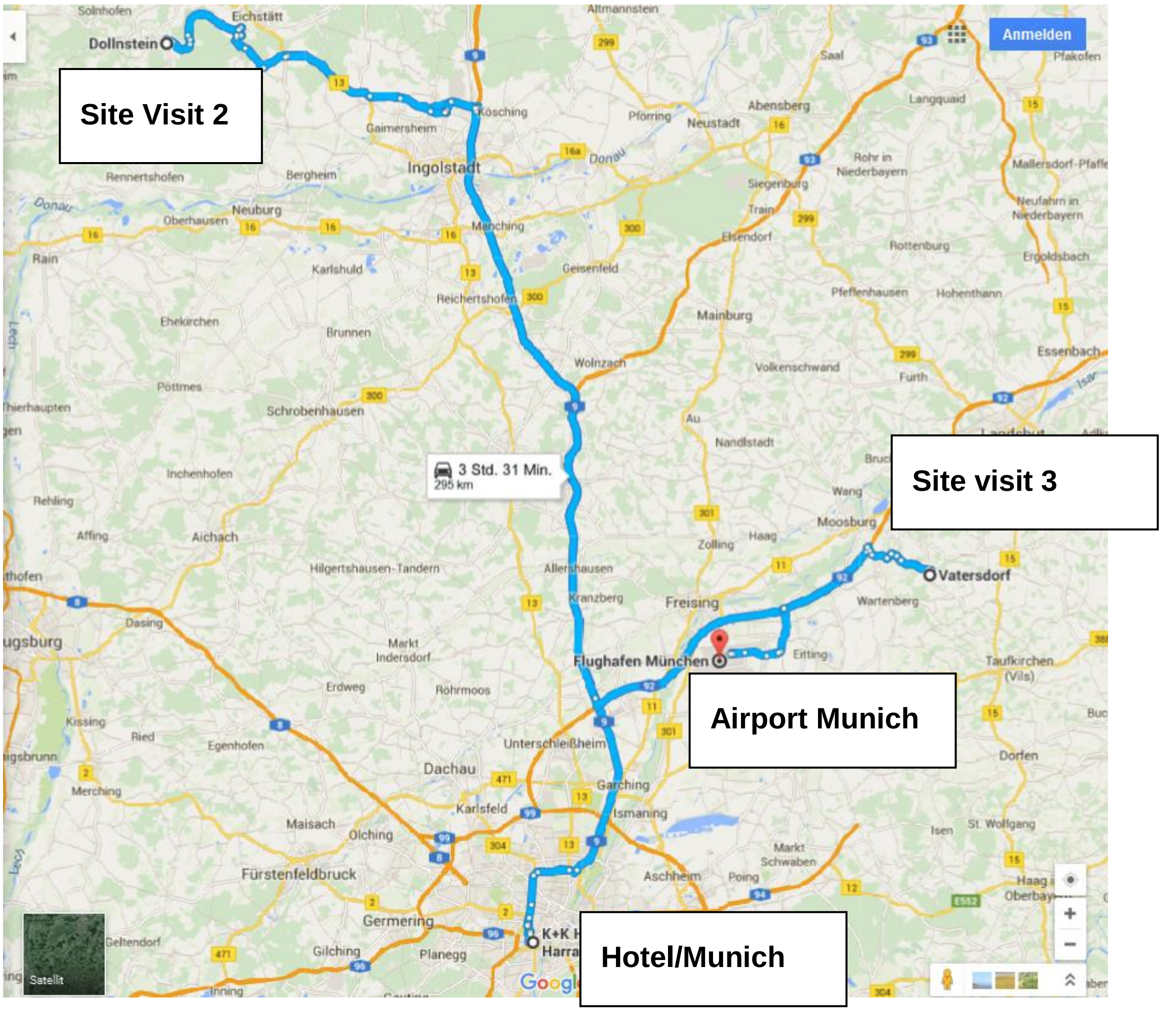
Tuesday 26 January 2016

13.30	14.30	Travel by public transport to “Hohenzollernplatz” (U2)	
14:30	16.00	**Site visit 1: Solar District Heating “Am Ackermannbogen” in Munich** District heating of 320 households with 45% solar thermal energy and a seasonal storage   More information (in German): https://www.energieatlas.bayern.de/thema_sonne/solarthermie/praxisbeispiele/details,197.html	City of Munich Martin Welter Bayerstr. 28A 80335 München Tel: (089) 233-47714 martin.welter@muenchen.de
16.00	17.00	**Return to hotel or visit of Munich**	
19:00		*Optional dinner (optional) on own expenses at “Der Pschorr” (http://der-pschorr.de)*	

Wednesday 27 January 2016

7.30	09.30	Travel by bus	
09.30	11.30	**Site visit 2: Low temperature district heating “Dollnstein”** Innovative low-temperature (20-25°C) district heating grid supplying 40 households and public buildings with solar thermal energy, heat pumps and storage systems.   More information (in German): https://www.energieatlas.bayern.de/kommunen/praxis	Kommunalunternehmen Energie Dollnstein AdÖR Thomas Kerner Papst-Viktor-Straße 35 Eberswanger Straße 1 (Wärmezentrale) 91795 Dollnstein kerner@energie-dollnstein.de

		beispiele/details,583.html	
11.30	14.00	Travel by bus	
14.00	15.00	**Site visit 3: District heating with biomass** Agricultural biogas plant using surplus heat in a small district heating system to supply about 80 households. For peak load, a woodchip and oil boiler is available. Surplus heat in summer is used to dry woodchips.   	Bader Ulrich Sochenberg 1 84172 Buch, Sochenberg 08762/1335 Ulrich.bader@gmx.de
15.00	16.00	Travel by bus to Airport Munich and/or to Munich city	


Site Visit 2
Site visit 3
Airport Munich
Hotel/Munich
Dollnstein
Eichstätt
Ingolstadt
Kösching
Gaimersheim
Manching
Reichertshofen
Wolnzach
3 Std. 31 Min.
295 km
Allershausen
Freising
Moosburg
Vatersdorf
Flughafen München
Unterschleißheim
Dachau
Garching
Ismaning
Fürstenfeldbruck
Germering
Augsburg
Neuburg
Landshut
Anmelden
Satellit

7 Participant list

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