



CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale, CISBAT 2017 6-8 September 2017, Lausanne, Switzerland

Energy monitoring of a low temperature heating and cooling district network

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Abstract

The district “Suurstoffi” in Central Switzerland is a progressive and innovative project in the field of low-temperature heating and cooling networks for which the main goal is to ensure a fully renewable energy supply and CO₂-neutral operation. In order to verify the project goals, the Lucerne University for Applied Sciences has been monitoring and optimizing the district over the last five years. The monthly analysis of more than 300 measuring points and complementary user surveys resulted in numerous findings, the most relevant observation being the performance gap identified for the heat demand and electricity consumption of the heat pumps and auxiliary equipment. The survey of the network heat balance proved to be a relevant indicator to ensure the functioning of the project in the long-term.

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Peer-review under responsibility of the scientific committee of the CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale

Keywords: monitoring; low-temperature; district thermal network; renewable energies; performance gap; Suurstoffi; decentralised energy system.

1. Introduction to low-temperature heating and cooling networks (LTN)

LTN are new solutions to increase the use of renewable energy at district level. In such systems, buildings are so-called “prosumers” that can supply and consume heat simultaneously, resulting in a bidirectional thermal network, a

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core element in a decentralized energy system (DES). For instance, waste heat from cooling can either be used directly to supply the next consumer or injected into a seasonal storage for its regeneration. LTNs along with long term thermal storage (e.g. borehole fields) play an important role in balancing seasonal variation in heat demand and supply.

Nomenclature

BF	Building field (in german “Baufeld”)
DES	Decentralised energy systems
DHW	Domestic hot water
E	Electricity
ERA	Energy reference area
SH	Space heating
HP	Heat pumps
HSLU	Lucerne University for Applied Sciences
LTN	Low temperature network
PV	Photovoltaic panels
PVT	Hybrid solar panels (photovoltaic and thermal)
Q	Heat
SPF	Seasonal performance factor

1.1. Description of the district “Suurstoffi”

In 2012, one of the first LTN in Switzerland was taken into operation in the district „ Suurstoffi“ in Rotkreuz. Formerly used as an industrial area, the real estate agency and owner “Zug Estates AG” transformed the Suurstoffi complex into a district with residential, commercial and industrial buildings, starting from 2010. The realization of conceptual designs and plans was divided into several stages of construction. A salient characteristic of the complex is its solution for the heating and cooling supply as it is provided by a LTN. A large geothermal borehole field functions as seasonal storage. Instead of supply and return ducts with a predefined mass flow direction, the LTN uses a main warm and a main cold duct and allows for bidirectional mass flow (Fig. 1). These ducts function as thermal reservoirs from which a building can serve itself. If in need of cooling it will supply itself from the cold duct (so-called free-cooling, via decentralized heat exchangers at building level) and if in need of heating the warm duct will represent the heat reservoir for its decentralized heat-pump. In addition, the area produces electricity by the mean of PV and PVT systems to operate the heat pumps and other building technologies such as circulating pumps, heating bands, ventilation, etc. The heat produced from PVT as well as waste heat from free-cooling is used to regenerate the seasonal storage. The energy reference area (ERA) of the first buildings that were taken in operation in 2012 (BF2) and 2013 (BF5) is approximately 47'000 m². The existing seasonal storage of the LTN consists of a field comprising 215 geothermal boreholes, each with a length of 150 m. During the upcoming construction stages another 118'000 m² of ERA will be added to the complex and the LTN will be expanded including a second field with additional 180 boreholes of 300 m length. The completion of the whole complex is estimated for 2020.

1.2. Objectives of the energy monitoring

The district “Suurstoffi” is planned to be fully operated with renewable energy and without CO₂ emissions. In the context of the Swiss energy strategy 2050, a collaboration project between industry and research partners has been supported by the Swiss Federal Office of Energy to gain knowledge on and experience in the field of LTN. From the early planning stages until the operation phase, a close collaboration between Zug Estates AG and the Lucerne University for Applied Sciences (HSLU) took place. Among others, the HSLU has been commissioned by Zug Estates to analyse the energy monitoring of the district “Suurstoffi” over the last five years in order to verify the project objectives and to carry out optimization measures.

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