Energy & Buildings 226 (2020) 110347

Contents lists available at ScienceDirect

Energy & Buildings

journal homepage: www.elsevier.com/locate/enb

Operational optimization of district heating systems with temperature limited sources

Sam van der Zwan [a], Ivo Pothof [a,b,*]

[a] Department Hydraulics for Infrastructure and Industry, Deltares, Delft, Netherlands
[b] Department Process & Energy, 3mE, TUDelft, Leeghwaterstraat 39, 2628 CB Delft, Netherlands

ARTICLE INFO

Article history:
Received 15 March 2020
Revised 23 June 2020
Accepted 24 July 2020
Available online 2 August 20

Keywords:
District heating
Operational optimization
Model predictive control
Geothermal energy

ABSTRACT

Future district heating systems (DHS) will be supplied by renewable sources, most of which are limited in temperature and flow rate. Therefore, operational optimization of DHS is required to maximize the use of renewable sources and minimize (fossil) peak loads. In this paper, we present a robust and fast model-
e without violating tem-
focus on an operational
urces, like a geothermal
x optimization problem,
nples show that the peak
is used and the heating
er balance between ben-
dditional heat losses due

ublished by Elsevier B.V.

1. Introduction

Scarcity of resource
of CO_2, has led to in
energy. While wind tu
limelight, relatively lit
used for heating and cooling. Heating and cooling account for 38% of the primary energy use in the Netherlands and around 50% in the European Union.

Using renewable energy sources for heating or cooling is subject to a spatial, temporal and temperature mismatch between production and demand. The spatial mismatch can be overcome by using a district heating/cooling network. A temporal mismatch can be overcome by making use of heat storage. This can be for example a seasonal storage like an aquifer thermal energy storage. Another option for short-term storage is preheating of buildings (load-shifting), or the installation of a heat buffer. It is a challenge to make optimal use of the different heat sources and storage possibilities. The temperature mismatch can be solved by (fossil) peak supply, heat pumps and by using short-term storage to limit the

s are limited in peak
ization techniques are
sources and minimize

imization techniques
on achieving a minimum acceptable supply temperature using the heat demand as a boundary condition to the optimization. Benonysson [1] has addressed many of the challenges associated with operational optimization of a district heating network, including time delays due to supply temperature variations, variable revenues from CHP production units and cost functions. Madsen et al [2] investigated stochastic prediction and control methods to minimize heat losses and CHP heat production costs, subject to constraints on the minimum required supply temperature for each consumer and a constraint on temporal temperature gradient. Dahl et al. [3] have investigated the impact of weather-forecast uncertainty and heat demand uncertainty on the operational supply temperature and associated savings. They conclude that the potential benefit of using dynamic uncertainties is larger for district heating systems with smaller pumping capacities.

More recently, model-predictive control (MPC) solutions were developed for a wide range of control problems in district heating systems. Faharani et al. [4] developed a MPC-based day-ahead pro-

* Corresponding author at: Department Process & Energy, 3mE, TUDelft, Leeghwaterstraat 39, 2628 CB Delft, Netherlands.
E-mail address: i.w.m.pothof@tudelft.nl (I. Pothof).

https://doi.org/10.1016/j.enbuild.2020.110347