International Journal of
Sustainable Energy Planning and Management

Developments in 4th generation district heating

Poul Alberg Østergaard[a,*], Henrik Lund[a] and Brian Vad Mathiesen[b]

[a] *Department of Planning, Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark*
[b] *Department of Planning, Aalborg University, A.C. Meyers Vænge 15, 2450 Copenhagen SV, Denmark*

ABSTRACT

This editorial introduces the 20th volume of the International Journal of Sustainable Energy Planning and Management. Papers included are all from the conference on 4th generation District Heating and Smart Energy Systems, Aalborg, 2017, treating the control of heat systems, technical and non-technical barriers to low-temperature district heating. Temperature levels are also key-parameters in an investigation of heat pumps and heat sources for heat pumps in Tallinn. In parallel to apps focusing on electricity systems, an app focusing on heat systems is presented.

Keywords:

District heating;
Control systems;
Heat pumps;

URL
http://dx.doi.org/10.5278/ijsepm.2019.20.1

1. Introduction

The 4th generation district heating [1,2] and smart energy system [3–5] approaches are becoming well-established terms within the energy research community and is also the cornerstone of the annual conference on 4th generation District heating and Smart Energy Systems that is alternating between Aalborg and Copenhagen, Denmark.

The 2018 conference in Aalborg follows successful events from previous years documented in this journal with special issues from 2015 ([6–9]), 2016 ([10–18]) and 2017 ([19–23]) – as well as special issues in Energy [24–26].

2. Contents

In this Special Issue, Roberto et al. [27] take a starting point in how district heating systems are developing in the same direction as electricity systems with more generators in the grid and how this leads to on the one hand better energy efficiency but also in a more complex energy system to control. The authors model the district heating system of Turin finding that a system with distributed heat generation also benefits from a system of distributed heat storage.

Volkova et al. [28] develop a mobile app to increase district heating users' awareness of the technology's benefits compared to other heating solutions with the aim of strengthening district heating's position. The app is intended to enable users to see the benefits of district heating, see how 4th generation district heating can impact fuel consumption, emissions and more as well as showing the operation of district heating systems.

Brange et al.[29] treat how lower temperatures while positive for losses and efficiencies in the district heating systems also may decrease transmission capacity of the same with bottlenecks as a result. In bottleneck situations, a variety of solutions exist including increased supply temperature, larger pipes, increased pumping power and/or new pumps, better cooling, local heat supply and demand side management. These are explored and a method for choosing among them is elaborated. This is a continuation of work by the same authors presented in [30].

Pellegrini [31] stress the importance of heading for lower district heating temperatures, but also point to some issues encountered when performing the transition.

[1]Corresponding author - e-mail: poul@plan.aau.dk

The transition is meet by barriers of both a technical and non-technical nature to which the authors present advice for decision makers.

Pieper et al.[32] investigate heat pumps in district heating systems and the use of optimal low-temperature sources. Analyses performed over the year probe into optimal heat sources over the year and optimal heat pump investment strategies with a view to minimising consumer costs. Based on a case study of Tallinn, they show how large-scale heat pumps based on sewage water, river water, ambient air, sea- and ground water can play an important role in the local district heating system.

References

[1] Lund H, Werner S, Wiltshire R, Svendsen S, Thorsen JE, Hvelplund F, et al. 4th Generation District Heating (4GDH). Integrating smart thermal grids into future sustainable energy systems. Energy 2014;68:1–11. http://doi.org/10.1016/j.energy.2014.02.089

[2] Lund H, Østergaard PA, Chang M, Werner S, Svendsen S, Sorknæs P, et al. The status of 4th generation district heating: Research and results. Energy 2018. http://doi.org/10.1016/j.energy.2018.08.206

[3] Lund H, Andersen AN, Østergaard PA, Mathiesen BV, Connolly D. From electricity smart grids to smart energy systems - A market operation based approach and understanding. Energy 2012;42:96–102. http://doi.org/10.1016/j.energy.2012.04.003

[4] Lund H, Østergaard PA, Connolly D, Mathiesen BV. Smart energy and smart energy systems. Energy 2017. http://doi.org/10.1016/j.energy.2017.05.123

[5] Lund H, Vad Mathiesen B, Connolly D, Østergaarda PA. Renewable energy systems - A smart energy systems approach to the choice and modelling of 100 % renewable solutions. vol. 39. 2014. http://doi.org/10.3303/CET1439001

[6] Østergaard PA, Lund H, Mathiesen BV. Smart energy systems and 4th generation district heating. Int J Sustain Energy Plan Manag 2016;10:1–2. http://doi.org/10.5278/ijsepm.2016.10.1

[7] Büchele R, Kranzl L, Müller A, Hummel M, Hartner M, Deng Y, et al. Comprehensive Assessment of the Potential for Efficient District Heating and Cooling and for High-Efficient Cogeneration in Austria. Int J Sustain Energy Plan Manag 2016. http://doi.org/10.5278/ijsepm.2016.10.2

[8] Razani AR, Weidlich I. A genetic algorithm technique to optimize the configuration of heat storage in DH networks. Int J Sustain Energy Plan Manag 2016;10:21–32. http://doi.org/10.5278/ijsepm.2016.10.3

[9] Prina MG, Cozzini M, Garegnani G, Moser D, Oberegger UF, Vaccaro R, et al. Smart energy systems applied at urban level: the case of the municipality of Bressanone-Brixen. Int J Sustain Energy Plan Manag 2016;10:33–52. http://doi.org/10.5278/ijsepm.2016.10.4

[10] Østergaard PA, Lund H. Smart district heating and electrification. Int J Sustain Energy Plan Manag 2017;12. http://doi.org/10.5278/ijsepm.2017.12.1

[11] Lund R, Østergaard DS, Yang X, Mathiesen BV. Comparison of Low-temperature District Heating Concepts in a Long-Term Energy System Perspective. Int J Sustain Energy Plan Manag 2017;12:5–18. http://doi.org/10.5278/ijsepm.2017.12.2

[12] Ianakiev AI, Cui JM, Garbett S, Filer A. Innovative system for delivery of low temperature district heating. Int J Sustain Energy Plan Manag 2017;12:19–28. http://doi.org/10.5278/ijsepm.2017.12.3

[13] Østergaard PA, Lund H. Editorial - Smart district heating and energy system analyses. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.1

[14] Flores JFC, Espagnet AR, Chiu JN, Martin V, Lacarrière B. Techno-Economic Assessment of Active Latent Heat Thermal Energy Storage Systems with Low-Temperature District Heating. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.2

[15] Leeuwen RP van, Wit JB de, Smit GJM. Energy scheduling model to optimize transition routes towards 100% renewable urban districts. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.3

[16] Sernhed K, Gåverud H, Sandgren A. Costumer perspectives on district heating price models. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.4

[17] Szép TS. The effects of utility cost reduction on residential energy consumption in Hungary – a decomposition analysis. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.5

[18] Hülk L, Wienholt L, Cußmann I, Müller UP, Matke C, Kötter E. Allocation of annual electricity consumption and power generation capacities across multiple voltage levels in a high spatial resolution. Int J Sustain Energy Plan Manag 2017;13. http://doi.org/10.5278/ijsepm.2017.13.6

[19] Østergaard PA, Lund H, Mathiesen BV. Editorial - Smart energy systems and 4th generation district heating systems. Int J Sustain Energy Plan Manag 2018;16:1–2. http://doi.org/10.5278/ijsepm.2018.16.1

[20] Knies J. A spatial approach for future-oriented heat planning in urban areas. Int J Sustain Energy Plan Manag 2018. http://doi.org/10.5278/ijsepm.2018.16.2

[21] Sneum DM, Sandberg E. Economic incentives for flexible district heating in the Nordic countries. Int J Sustain Energy Plan Manag 2018;16. http://doi.org/10.5278/ijsepm.2018.16.3

[22] Best I, Orozaliev J, Vajen K. Economic comparison of low-temperature and ultra-low-temperature district heating for new

building developments with low heat demand densities in Germany. Int J Sustain Energy Plan Manag 2018;16. http://doi.org/10.5278/ijsepm.2018.16.4

[23] Schuchardt GK, Kraft S, Narften M, Bagusche O. Development of an empirical method for determination of thermal conductivity and heat loss for pre-insulated plastic bonded twin pipe systems. Int J Sustain Energy Plan Manag 2018;16. http://doi.org/10.5278/ijsepm.2018.16.5

[24] Lund H, Duic N, Østergaard PA, Mathiesen BV. Smart Energy and District Heating: Special Issue dedicated to the 2016 Conference on Smart Energy Systems and 4th Generation District heating. Energy 2018;160:1220–3. http://doi.org/10.1016/J.ENERGY.2018.07.012

[25] Lund H, Duic N, Østergaard PA, Mathiesen BV. Smart energy systems and 4th generation district heating. Energy 2016;110. http://doi.org/10.1016/j.energy.2016.07.105

[26] Lund H, Duic N, Østergaard PA, Mathiesen BV. Future district heating systems and technologies: On the role of smart energy systems and 4th generation district heating. Energy 2018;165:614–9. http://doi.org/10.1016/J.ENERGY.2018.09.115

[27] Roberto R, Iulio R De, Somma M Di, Graditi G, Guidi G, Noussan M. A multi-objective optimization analysis to assess the potential economic and environmental benefits of distributed storage in district heating networks: a case study. Int J Sustain Energy Plan Manag 2019;20. http://doi.org/10.5278/ijsepm.2019.20.2

[28] Volkova A, Latõšov E, Mašatin V, Siirde A. Development of a user-friendly mobile app for the national level promotion of the 4th generation district heating. Int J Sustain Energy Plan Manag 2019;20. http://doi.org/10.5278/ijsepm.2019.20.3

[29] Brange L, Sernhed K, Thern M. Decision-making process for addressing bottleneck problems in district heating networks. Int J Sustain Energy Plan Manag 2019;20. http://doi.org/10.5278/ijsepm.2019.20.4

[30] Brange L, Lauenburg P, Sernhed K, Thern M. Bottlenecks in district heating networks and how to eliminate them – A simulation and cost study. Energy 2017. http://doi.org/10.1016/j.energy.2017.04.097

[31] Pellegrini M. Classification through analytic hierarchy process of the barriers in the revamping of traditional district heating networks into low temperature district heating: an Italian case study. Int J Sustain Energy Plan Manag 2019;20. http://doi.org/10.5278/ijsepm.2019.20.5

[32] Pieper H, Mašatin V, Volkova A, Ommen TS, Elmegaard B, Markussen WB. Modelling framework for integration of large-scale heat pumps in district heating using low-temperature heat sources: A case study of Tallinn, Estonia. Int J Sustain Energy Plan Manag 2019;20. http://doi.org/10.5278/ijsepm.2019.20.6