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Latest Developments in 4th Generation District Heating and Smart Energy Systems

Poul Alberg Østergaard*[a], Rasmus Magni Johannsen[a], Henrik Lund [a], 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 31st volume of the International Journal of Sustainable Energy Planning and Management. This volume reports some of the latest developments in energy systems analyses of smart energy systems and of district heating as well as in methods and analyses using multi-objective optimisation. In one of the analyses, the authors investigate the effects of decentralised storage in district heating systems, finding positive effects on grid design as the impact of peaks can be reduced. Three contributions address the more sociological factors influencing acceptance and energy system development such as ownership, awareness, and moral.

Keywords

District heating grids
Storage and systems
Optimisation
Acceptance and ownership

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1 Introduction

This editorial introduces the 31st volume of the International Journal of Sustainable Energy Planning and Management which partly reports work from the 6*th International Conference on Smart Energy Systems 4th Generation District Heating, Electrification, Electrofuels and Energy Efficiency*. This conference organised by Aalborg University with Energy Cluster Denmark, was initially planned to be held in Aalborg, Denmark, October 2020 but was eventually moved online to accommodate for COVID 19 restrictions. This has proven to be a successful conference series attracting a large international gathering each year, and it has resulted in a series of previous special issues in *Energy* [1–4] as well as in this journal [5–10]

In addition to reporting the latest research from the mentioned conference, this volume also reports other new findings from within the general smart energy systems and energy planning sphere.

2 Special issue - District heating grids and systems

Based on a case study of Heide in Germany, Röder et al. [11] investigate the possibilities of including distributed storage in district heating systems with a view to reducing grid sizing and losses in e.g. systems with low heat densities. Both losses and costs can be reduced by some 10-13% if e.g. a 1000 l heat storage is included in the houses of the case study.

Minimum Spanning Tree is a methodology that may be applied to investigate optimal district heating layouts for new district heating systems [12]. Dénariá et al. apply the methodology to analyse grid layouts taking Milano, Italy as a case.

Lund [13] also investigates heat storage in energy systems with a focus on *compressed heat energy storage*, which functions both as a heat and an electricity storage. The energy system impacts and thus relevance of the storage depends on the system in question, but in

*Corresponding author - e-mail: poul@plan.aau.dk

places with district heating and electrified heat production, the system shows promise. These results are found analysing Germany as a case.

Kersten et al. [14] also investigate district heating in Germany. They investigate the composition of the energy system using the Open Energy Modelling Framework (oemof), finding that district heating systems based on a combination of cogeneration of heat and power, photovoltaics, heat pumps and storage show promise. Such systems can reduce CO_2 considerably compared to current systems.

Trabert et al. [15] investigate the use of river water-based heat pumps for district heating provision using energyPRO finding seasonal coefficient of performance values between 3.4 and 3.7. The system, however, is not cost efficient against currently applied solutions – though flexibility of the system can improve the economic performance.

Vilén et al. [16] investigate two different policy means of decarbonising the district heating system of Gothenburg, Sweden: A direct ban on fossil fuels vs a more gradual phasing out through gradually increasing carbon taxes. The analyses conducted in TIMES do not reveal a difference in the district heating use – however the fuel consumption clearly depends on whether there is a direct ban from a given data – or a gradual phasing out caused by the phasing in of a carbon tax.

3 Special issue - Smart energy systems

Mezzera et al. [17] investigate different overall compositions of the Italian energy system with a focus on the role of power-to-x in the energy system and the exploitation of waste heat streams for district heating systems.

Groissböck [18] also investigate integrated smart energy systems, but with a focus on open source tools to analyse these. Based on a review of existing frameworks, Groissböck synthesises a new modelling framework for the analyses of smart energy systems.

4 General energy planning analyses

D'Alessandro et al. [19] investigate the effects of the 2008/2009 financial crisis and the 2011 earthquake, tsunami and ensuing meltdown of the Fukushima nuclear power station on electricity demand. Their analyses indicate that a *"combination of both economic incentivization and philanthropical messaging may be positively leveraged in sustaining and enhancing the response of all users to the need for energy use reduction in times of disaster, and for engendering low-carbon energy transitions"*.

Rygg et al. [20] investigate small hydro plants in Norway with a view to ownership and acceptance in line with previous work by e.g. Hvelplund [21–24]. Rygg and co-authors identify a necessity to keep ownership in mind and conclude "that local ownership of small hydropower projects is valued highly among the municipality actors".

Bishoge et al. [25] investigate the energy consumption from a more sociological perspective, focusing on *"awareness, motivation factors, moral and normative concerns, environmental norms, knowledge concerns, technology adoption concerns, and contextual factors and habits"*, stressing the importance of acknowledging these issues and implementing further studies for their analysis. The same authors have previously reported their work on Community participation in the renewable energy sector in Tanzania [26].

Hasibi [27] investigate optimal renewable energy expansion based on multiple objective optimisations with costs and emissions as objective functions. Applying the methodology to Bali, Indonesia, results indicate that there is an unresolved policy issue in Indonesia as there is a mismatch between what is optimal in terms of costs and what is optimal in terms of emissions.

Finally, Bowley and Evins [28] develop transition scenarios for an urban area using multi objective optimisation, investigating different supply options and also carbon-negative measures under different frameworks.

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