International Journal of
Sustainable Energy Planning and Management

Smart District Heating and Electrification

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ABSTRACT

District heating systems are prevailing in parts of Northern Europe and this editorial introduces work on the optimisation of such systems in Denmark, Britain and Norway. Focus of two of the articles are on low-temperature systems. This is either directly through lowering the forward temperature and analysing system consequences and optimal forward temperatures as in the work of Lund et al. – or it is by the use of the return pipe water for heating in district heating systems functioning at relatively high temperature levels, as in the work by Ianakiev et al. on Nottingham. Analyses by Trømborg et al. probe into future Norwegian electricity market prices and their effects on the operation of district heating storage and electric boilers. Finally, Ogundari et al. compare photo voltaic systems to diesel systems in stand-alone systems for Abuja, Nigeria.

Keywords:

Low temperature district heating;
Electricity for district heating;
Stand-alone electricity systems;

URL:
dx.doi.org/10.5278/ijsepm.2017.12.1

1. Introduction

This editorial introduces the 12th volume of the International Journal of Sustainable Energy Planning and Management. This volume contains articles presented at the *2nd International Conference on Smart Energy Systems and 4th Generation District Heating*, held in Aalborg, Denmark in September 2016 [1,2] as well as two ordinary submissions [3,4]. The first three articles focus on district heating systems while the last focus on stand-alone electricity systems for domestic consumption.

The issue follows up on the 2016 special issue on the *1st International Conference on Smart Energy Systems and 4th Generation District Heating*, held in Copenhagen, Denmark in August 2015 [5], that introduced work on district heating and cooling in Austria [6], smart energy systems in Italy [7] and optimisation of district heating networks [8].

2. Low-temperature district heating

Lund et al. [1] compare different temperature levels in district heating systems with forward temperatures ranging from 55°C via 45°C to 35°C. Such temperature levels call for appropriate household installations – not least in order to provide domestic hot water at appropriate temperature levels without the risk of legionella formation[9,10]. Low temperature levels also enable higher efficiencies in production units – e.g. heat pumps and cogeneration of heat and power (CHP) units – while providing for lower grid losses as a consequence of the lower temperature difference to the surrounding soil. Using EnergyPLAN [11,12], the authors find that the 55°C option forms the optimal case based on an economic assessment. Basically, the temperature should only be reduced to the point where additional equipment in the form of e.g. booster heat pumps or electric (resistance) heating

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is required to reach appropriate domestic hot water temperatures.

Ianakiev et al. [2] investigate the district heating system in Nottingham, United Kingdom, with a view to analysing whether return water (i.e. district heating water that has served its primary purpose and dissipated heat in radiators or heat exchangers in buildings) can be used for heating additional houses with systems designed for the lower temperature of the return pipe. The system in Nottingham operates at high temperatures – 85°C to 120°C depending on season – and return temperatures are thus also high. At around 70°C these are comparable to forward temperatures in some district heating systems. The return water is used in heat exchangers to source 60°C systems. As the authors point out, a system like the proposed would *"extract unused heat from existing systems and to make it more efficient and profitable. The Nottingham district heating system has extra thermal capacity that can be extracted without affecting the hydraulic capacity by using the return pipe option."*

3. Electricity for district heating

Trømborg et al. [3] investigate future electricity market prices on the Nordic spot market and the impacts on the choice of heating technology. They apply the regional energy system model Balmorel (see e.g. [13–15]) for establishing future energy scenarios for the Nordic region and derive electricity prices for this. Subsequently, they use the plant investment analysis model energyPRO (see e.g. [16–18]) to assess the impact of the time-varying prices on the operation of heat-only district heating systems in Norway. The authors find that daily price variations will increase in the future, and that both thermal storage and electric boilers will become more interesting. The stronger role of thermal storage supports previous findings from this journal on the role of thermal storage in smart energy systems[19] stressing that heat storage should be applied to establish flexibility before resorting to the more expensive and inefficient electrical storage systems.

4. Electricity supply in Nigeria

Nigeria is on the one hand facing an increasing electricity demand and on the other hand an electricity supply infrastructure that is not following the pace of the demand development. In [4], Ogundari et al. therefore investigate various means of providing off-grid electricity to residences. In one alternative, they assess the potential for photo voltaic collectors for housing complexes combined with batteries and all required converters to form a stand-alone electricity supply system. For comparison, they establish a diesel generator scenario. All scenarios are based on an assessment of the electricity demand for the housing complexes as a reference as well as with an efficient lighting system as alternative. Notable is that electricity demands are substantial due to low costs of grid electricity – which in turn aggravates black outs. In their findings, the authors conclude that the photo voltaic system is preferable to the diesel generator system. This is also supported by previous work published in this journal, that showed good promise for solar energy for Kenya, at a comparable latitude as Nigeria [20].

References

[1] 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 Manage 2017;12:5–18. http://dx.doi.org/10.5278/ijsepm.2017.12.2.

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

[3] Trømborg E, Havskjold M, Bolkesjø TF, Kirkerud JG, Tveten ÅG. Flexible use of electricity in heat-only district heating plants. Int J Sustain Energy Plan Manage 2017;12:29–46. http://dx.doi.org/10.5278/ijsepm.2017.12.4.

[4] Ogundari IO, Akinwale YO, Adepoju AO, Atoyebi MK, Akarakiri JB. Suburban Housing Development and Off-Grid Electric Power Supply Assessment for North-Central Nigeria. Int J Sustain Energy Plan Manage 2017;17:47–63. http://dx.doi.org/10.5278/ijsepm.2017.12.5.

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

[6] 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 Manage 2016;10:3–19. http://dx.doi.org/10.5278/ijsepm.2016.10.2.

[7] 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 Manage 2016;10:33–52. http://dx.doi.org/10.5278/ijsepm.2016.10.4.

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

[9] Yang X, Li H, Svendsen S. Decentralized substations for low-temperature district heating with no Legionella risk, and low return temperatures. Energy 2016. http://dx.doi.org/10.1016/j.energy.2015.12.073.

[10] Yang X, Li H, Svendsen S. Evaluations of different domestic hot water preparing methods with ultra-low-temperature district heating. Energy 2016;109:248–59. http://dx.doi.org/10.1016/j.energy.2016.04.109.

[11] Østergaard PA. Reviewing EnergyPLAN simulations and performance indicator applications in EnergyPLAN simulations. Appl Energy 2015;154:921–33. http://dx.doi.org/10.1016/j.apenergy.2015.05.086.

[12] EnergyPLAN website n.d. www.EnergyPLAN.eu.

[13] Münster M, Morthorst PE, Larsen H V., Bregnbæk L, Werling J, Lindboe HH, et al. The role of district heating in the future Danish energy system. Energy 2012;48:47–55. http://dx.doi.org/10.1016/j.energy.2012.06.011.

[14] Tveten ÅG, Bolkesjø TF, Ilieva I. Increased demand-side flexibility: market effects and impacts on variable renewable energy integration. Int J Sustain Energy Plan Manage 2016;11. http://dx.doi.org/10.5278/ijsepm.2016.11.4.

[15] Kirkerud JG, Trømborg E, Bolkesjø TF, Tveten ÅG. Modeling the Power Market Impacts of Different Scenarios for the Long Term Development of the Heat Sector. Energy Procedia 2014;58:145–51. http://dx.doi.org/10.1016/j.egypro.2014.10.421.

[16] Østergaard PA, Andersen AN. Booster heat pumps and central heat pumps in district heating. Appl Energy 2016;184:1374–1388. http://dx.doi.org/10.1016/j.apenergy.2016.02.144.

[17] Streckien? G, Martinaitis V, Andersen AN, Katz J. Feasibility of CHP-plants with thermal stores in the German spot market. Appl Energy 2009;86:2308–16. http://dx.doi.org/10.1016/j.apenergy.2009.03.023.

[18] Fragaki A, Andersen AN. Conditions for aggregation of CHP plants in the UK electricity market and exploration of plant size. Appl Energy 2011;88:3930–40. http://dx.doi.org/10.1016/j.apenergy.2011.04.004.

[19] Lund H, Østergaard PA, Connolly D, Ridjan I, Mathiesen BV, Hvelplund F, et al. Energy Storage and Smart Energy Systems. Int J Sustain Energy Plan Manage 2016;11:3–. http://dx.doi.org/10.5278/ijsepm.2016.11.2.

[20] Oloo F, Olang L, Strobl J. Spatial Modelling of Solar energy Potential in Kenya. Int J Sustain Energy Plan Manage 2015;6:17-30. http://dx.doi.org/10.5278/ijsepm.2015.6.3.