Chapter 25
ICT-Based Solutions Supporting Energy Systems for Smart Cities

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ABSTRACT

This chapter describes ICT solutions for planning, maintaining and assessing urban energy systems. There is no single urban energy system, but – like the city itself – a system of sub-systems with different scales, spatially ranging from buildings to blocks, districts and to the city, temporally ranging from real time data to hourly, daily, monthly and finally annual totals. ICT support must consider these different sub-systems which makes necessary dividing the chapter into different sections. The chapter starts with framework conditions and general requirements for ICT solutions, and continues discussing urban development simulating models. Then decision support tools are described for energy supply and demand as well as for energy efficiency improvement assessment. Later further instruments for Smart Grid-, district heating- and cooling-planning, as well as demand side management are addressed. In the final section tools are discussed for building automation systems as smallest physical entity within the urban energy system.

INTRODUCTION

With respect to urban energy planning, ICT systems and solutions address all Information- and Communication Technology-based instruments and features which (i) simulate the urban system as a spatial framework and the (urban) energy system behaviour for *ex ante* assessment of applying energy strategies and measures, (ii) monitor energy supply and consumption as well as the state of the energy generation

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and transmission system, and (iii) manage – which is control and adaption of the energy supply and – if committed – also the demand side, to improve the future energy system performance: to enhance energy efficiency, mitigate environmental impacts, reduce supply and transmission costs and finally strengthen energy supply security.

Integrated city planning and management are crucial to initiate transformations of urban development, urban governance and infrastructure required to become a Smart City. There exists a wide range of ICT solutions for different purposes, audience and scales – spatial as well as temporal – to support these urban transformation processes. One urban planning approach involves supporting a holistic view by integrated modelling – i.e. modelling the city as a system of systems considering all important interdependencies. A different approach involves supporting sectorial planning, applying solutions which are tailored for experts in the sector to provide answers to technical questions, as well as assessing the related impact. Both approaches support decision makers in evaluating different options and effects of energy supply technologies and changes in demand. Thus decision support tools play a crucial role for performance assessment, benchmarking and easy-to-understand visualisation of different transformation scenarios and their economic, environmental and social impacts (Tommis & Decorme, 2013).

Going into detail would require a complete book instead of a single chapter. Taking into account the wide range of available and suggested ICT solutions and the space available in this chapter to debate the most relevant topics, we have divided the chapter into several sections to give an overview. Keirstaed (2011) has carried out a classification of models related to urban systems and energy systems, which gives some orientation for structuring the chapter:

- *Urban development models* – including urban growth, land use change and transportation models. These models are the key to understanding urban energy topics as they typically model structure and activities in a city, finally used to estimate the energy demand for these activities.
- *Policy assessment models* examine the city and try to assess long-range policy goals, e.g. to identify which measures and technologies might meet a given carbon target most cost-effectively.
- *Technology design models* target the energy supply and demand side, dealing with optimisation of energy supply technology, supply mix and costs and finally improvements to consumption shapes to better balance supply and demand.
- *Building design (and automation) models* look at the performance of buildings.

Following Keirstaed's classification, this chapter is divided into the following sections:

- Background and requirements for ICT solutions related to energy and Smart Cities
- General ICT solutions for urban development, as a framework for energy planning
- ICT solutions for energy system planning enabling smart urban development
- ICT for energy supply solutions: Smart Grids, district heating
- ICT for demand-side energy management
- ICT for building automation
- Future research directions
- Conclusions and outlook.

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