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A planning process map for solar buildings in urban environments

Jouri Kanters*, Maria Wall

Energy and Building Design, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden

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ABSTRACT

Our future built environment will not only consume energy, it will also produce (partly) its own energy need. Solar energy has been proven to be a valid strategy for producing on-site renewable energy. Planning for integrating solar energy in buildings involves many players and decision-making. In this article, a process map defining which decisions regarding solar energy needs to be discussed in which design stage, is presented. With the help of this process map, more informed decisions should facilitate the implementation of solar energy in buildings.

Contents

1. Introduction

Our way of thinking about energy and buildings is changing; was the building solely considered to be energy-consuming, future buildings will be need to consume less energy while producing (part of) their own energy [1]. One way to produce renewable energy on-site is by means of active solar energy. By doing so, buildings will reduce the impact on the environment and reduce the dependence on imported energy. Current legislation is already directing towards such energy efficient and energy producing buildings, with the European directive for the energy performance of buildings [2] as the clearest example.

* Corresponding author. Tel.: +46 46 222 7236.
E-mail addresses: Jouri.Kanters@ebd.lth.se (J. Kanters), maria.wall@ebd.lth.se (M. Wall).

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The installed capacity of solar energy is growing rapidly (average annual growth rate of 40% for photovoltaics (PV) [3], 12% for solar thermal (ST) (from 2000 to 2010 in Europe) [4]), mainly due to dropping solar energy system prices and favourable political conditions. Solar energy has become more and more accessible for a larger group of people. Technically, solar energy, especially PV, has developed a lot since its invention; starting with a PV efficiency of 15% in the 1950s, to 17% in the 1970s, towards 28% nowadays [5]. However, most common PV systems commercially available still have an efficiency between 12–15% [5]. Even though more efficient solar cells and panels will become available on the market in the future, other factors are slowing down a wide implementation of solar energy. A lack of knowledge amongst decision-makers in the urban planning and building design process is one of these factors. Urban planners and architects are important decision-makers as regards to the planning, design and eventually construction of buildings with embedded solar energy; a key driver to achieve an energy-efficient built environment. Without adequate knowledge amongst decision-makers, sub-optimal decisions might be taken. The final decision regarding solar energy is in many cases taken by real estate developers, whose decisions are often based on a financial basis. Therefore, economic feasibility studies and financial information are a key issue during the whole design process. However, this does currently not have a high priority in the planning process, partly because it is unclear whose task it is to provide such information. Until now, it has mainly been the sole domain of the real estate developer. Preferably, information should come from different players, supported data obtained from relevant tools.

The main aspects of integrating solar energy (technical, economic, political, and social), have been subject to many studies. However, a comprehensive compilation and overview of relevant decisions and actions, used tools, and involved players in chronological order of the planning and design process is absent. The objective of this work is to bridge this gap; providing an overview of relevant decisions and actions, used tools and involved players supported by relevant literature. The outcome of this study is a process map per design and planning phase.

This study is limited to buildings making use of solar energy in the urban context. Also, most focus is on the active utilisation of solar energy.

2. Method

The objective of this study was to develop a process map for the planning for solar energy for buildings in the urban environment. This process map is based on previous research conducted by the authors as well as by an additional literature review.

2.1. Research by authors

The authors were involved in Task 41: an IEA Solar Heating and Cooling Programme research project which focused on the integration of solar energy in architecture (started 2009, ended in 2012). The goals of the task were to “help achieving high quality architecture for buildings integrating solar energy systems, as well as improving the qualifications of the architects, their communications and interactions with engineers, manufacturers and clients” [6]. An international team from academics and the industry from 14 countries participated. Research was done on three main topics: (a) architectural quality criteria for solar energy systems, (b) tool development for early design stage consideration and (c) integration examples by means of surveys, development of guidelines, collecting case studies and by publishing reports. In the light of this research project, the authors conducted qualitative interviews with Scandinavian architects [7], investigated the role of tools used by architects for solar design [8], the solar potential of building blocks [9], and developed a Facade Assessment and Design Tool for Solar Energy [10]. All common publications of Task 41 can be found on task41.iea-shc.org.

Results of research performed in IEA SHC Task 41 made clear that, in the case of buildings in urban environments, much of the conditions for solar energy are already determined by zoning plans, although urban planners might not be fully aware of their role of creating conditions for solar energy in buildings. The IEA SHC Task 51: solar energy in urban planning was started to “provide support to urban planners, authorities and architects to achieve urban areas and eventually whole cities with architecturally integrated solar energy solutions” [11] (started 2013, planned to 2017). Here, an international team from academics and the industry from 12 countries participates. Work will be done in four main topics: (a) legal framework, barriers and opportunities for solar energy implementation, b) development of processes, methods and tools, c) case studies and action research, and (d) education and dissemination. All participants within Task 51 engage in action research, where they set up a collaboration with their local urban planning department to learn about the process of urban planning and how solar energy can be better implemented. The authors set up a collaboration with the local urban planning department of the Swedish cities Malmö and Lund, focusing on two new urban districts Hyllie and Brunnshög. Until now, the authors investigated the role of design decisions on net zero energy solar buildings in Sweden [12] and analysed solar maps as a knowledge base for solar energy use [13].

2.2. Literature review

The material of the literature review comprises peer-reviewed research articles published in international journals. Earlier research by the authors [6,7] as well as other IEA Task 51 members has pointed towards critical issues regarding solar energy in the building design and planning process. In the literature review, articles were selected from 1990s onwards. A search was done in the electronic databases of ScienceDirect and LUBSearch (an EBSCO search engine), with a focus on the terms *solar energy*, *urban planning* or *architecture* in the keywords, titles and abstracts. The articles from the search ‘solar energy and architecture’ and ‘solar energy and urban planning’ were then filtered and divided from type of aspect (economical, technical, social, political) to chronological aspect (which design stage).

3. Literature review and process map

In this section, first the process map is presented (3.1), followed by a detailed description per phase.

3.1. Process map

The planning process map for solar buildings in urban environments is shown in Fig. 1 [14].

The planning and design process is divided into the following phases:

a) Political decisions phase: this is the phase where decisions are made regarding the political context of solar energy on a large scale (administrations on European Union, national and local level). This also implies the indirect consequences of political decisions, e.g. the lack of political decisions.