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Annex 51: Case studies and guidelines for energy efficient communities

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ABSTRACT

While IEA EBC Annexes usually are focused on R&D about single energy technologies, their broad scale use in practice is of even higher importance to contribute to global energy goals. This practical application of low-carbon technologies on community scale has been the subject of Annex 51, carried out from 2010 to 2013. In this Annex, evaluating 25 community energy case studies of the 10 participating countries, a 'Guidebook on Successful Urban Energy Planning' has been extracted from these evaluations to directly address practical urban/energy planners and municipal decision makers. The main content of the Guidebook with respect to planning approaches is summarized in this paper, distinguishing between the different planning fields of 'urban energy planning', which is addressing whole cities and communities, and 'local energy planning', oriented to neighbourhoods or building clusters. The necessary link between both is emphasized, considering a city as an interconnected energy system requiring a holistic approach rather than a compartmented consideration. As a side effect, a general method to calculate the primary energy performance of buildings and neighbourhoods employing different energy systems, including energy efficiency or energy conservation technologies, was derived. Using appropriate system characteristics, such as seasonal performances, this approach can be applied for every energy system, and for every building or neighbourhood. It is presented in this paper supplying an example from one of the case studies.

1. Background and problem definition

1.1. Energy and the building stock

Most of the IEA EBC[1] Annexes address a single technology category. This has contributed in the past to the development and commercialization of new technologies in the building sector. Today we have achieved standards of (new) individual buildings, such as "green" buildings, zero-energy buildings, CO_2-neutral buildings and the like, that allow very large reductions in fossil energy consumption and greenhouse gas (GHG) emissions, from 'factor 4' to 'factor 10'. Due to economies of scale, a number of technologies, like cogeneration or combined heat and power, waste heat utilization, biomass, geothermal energy, solar heating (and cooling), and others, are more efficient – in technical and economic terms – when used in large installations instead of small ones. Taking advantage of these technologies (if locally available), the effective fossil energy consumption achieved by an integrated system may fall even below best available standards for new detached buildings, but with lower cost and with the advantage of feasibility in large scales. While for detached buildings, new or existing, improving technical components and reducing their costs will be decisive to achieve the long-term energy goals, in *compact built areas* a centralized approach will generally offer better economic options.

Considering existing energy and GHG goals – such as reduction of fossil energy use and GHG emissions by 50–70% – communities and cities must undergo an energy transition practically for the whole built environment, not just for new buildings, since most of the buildings that will exist in 2050 are already in existence today. Thus the focus must be to find economically feasible solutions – conventional or innovative – for the *existing building stock*.

The achievement of ambitious energy targets at this scale is both easier and more difficult than it is for individual demonstration buildings: While on neighborhood scale there may be more technical and economic possibilities, it is much more challenging to find an agreement with the involved stakeholders about the best local

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[1] IEA EBC – International Energy Agency's Implementing Agreement (a co-operation agreement of IEA member states) on 'Energy in Buildings and Communities', one of several IEA agreements on cooperative energy R&D projects (www.iea.org). Individual EBC projects are labeled 'Annexes'.

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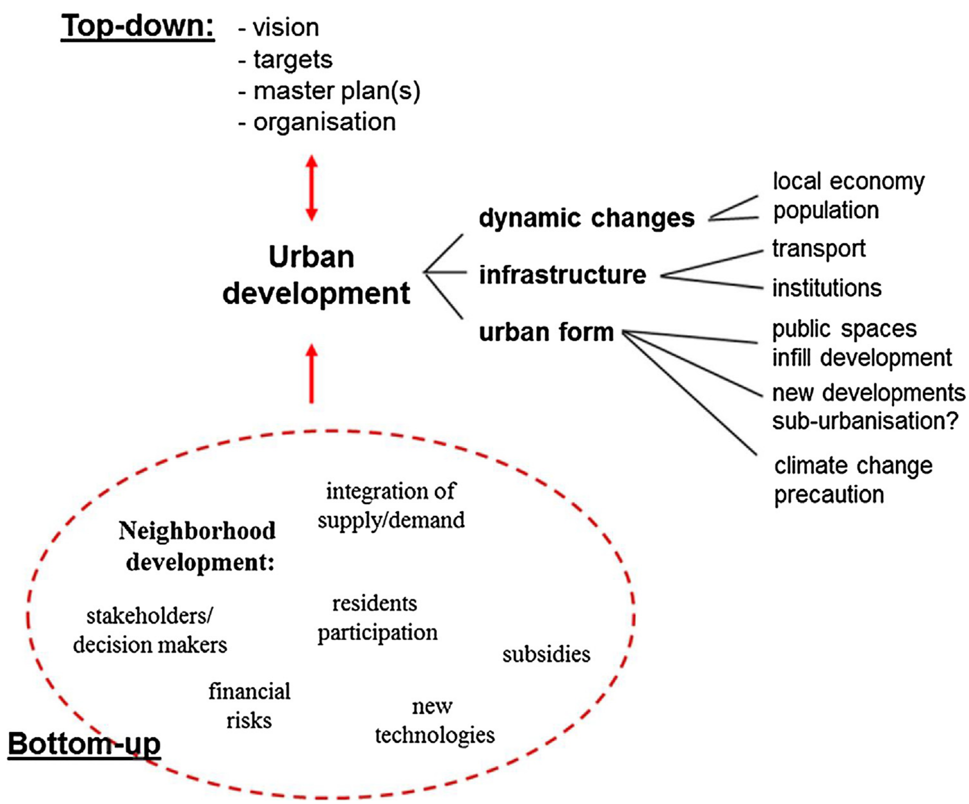

Fig. 1. Urban energy planning requires both bottom-up and top-down approaches to be successful [1].

energy plan and its implementation. Therefore, decision-making processes, organization and implementation strategies have much more weight compared to more technical or planning issues to be addressed in the case of individual building projects. Another important difference lies in the fact that, contrary to single demonstration buildings, the aim of neighborhood scale energy plans must be to find an economically optimized solution *for the whole neighborhood* rather than the latest technical solution for few show-case buildings, otherwise comprehensive implementation would not be affordable.

1.2. Cities: complex systems

Rather than being just a collection of independent constituents like buildings, roads, supply infrastructures etc., cities must be considered as a complex system with interacting components that contribute to the functioning of the whole. Thus, while individual decisions/investments in energy conservation or energy supply measures must be taken on the scale of buildings or local neighborhoods by different individuals with divergent interests, a holistic perspective of the city as a whole must be maintained. As a result, a combined top-down and bottom-up municipal energy strategy is required, where

- a general long-term low-carbon plan is defined by the municipality in consultation with experts and stakeholders and
- implementation decisions are prepared on the level of neighbourhoods or urban districts to develop individual energy and infrastructure projects.

This is illustrated in Fig. 1, extracted from the Annex 51 Guidebook [1].

As a consequence, to plan a 'future-proof' municipal energy system, to a larger extent than in the past, a *systems approach* is necessary, by which interactions of, and feed-back processes between different parts of the urban system must be considered adequately.

It was the aim of Annex 51, carried out from 2010 to 2013, to analyze practical experiences made within the ten countries (several European countries, Canada, Japan and the USA) participating in this Annex. Case studies employing such integrated approaches on the scales of neighbourhoods and cities have been carried out there in the years since 2000. Conclusions should be drawn from these experiences that can directly be applied by the urban planning community and local decision makers as well.

2. Annex 51 work plan approach

Annex 51 is focused on strategies, decision processes, planning tools and implementation instruments rather than doing R&D for technological innovations. Proven methods and instruments must be made available for urban planners, decision makers and stakeholders to enable them to design building clusters, neighborhoods, and urban agglomerations to achieve the goal of an energy-efficient low-carbon community. It was the objective of Annex 51 to derive such principles of a holistic approach and consequent methods and tools that can directly be used for community energy planning. With this general goal, the following tasks were pursued:

2.1. Case study evaluation

Practical experiences gained in 25 case studies made in the participating countries should be evaluated with respect to their practical approaches, methods used and results achieved, detecting success factors as well as barriers or reasons for failures.