



A methodology for sustainable and inclusive local energy planning



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ABSTRACT

First initiatives of energy and climate action at the local level can be tracked back into the 1990s. Nevertheless, only in the last decade integrated local energy planning initiatives have gained greater expression. The new energy paradigm calls for a need to focus on the energy services for which energy is actually demanded and to critically assess the levels of demand and identify the appropriate energy carriers and technologies to satisfy those services. Thus, a holistic perspective to local energy systems is deemed necessary. This paper proposes a decision support methodology for assisting local sustainable energy planning processes, covering the whole energy planning process – from structuring to the choice of the action plan. From the energy model point of view, the focus is on providing an energy services-oriented modelling approach and a technically solid and comprehensive basis for evaluating alternative energy action plans. From the process point of view, since energy planning involves choices regarding the future of the community, the values and preferences of the local actors are included through a multi-criteria evaluation process. The methodology was applied to a practical case in Portugal, demonstrating how it can be made operational.

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1. Introduction

1.1. The transition to a new energy paradigm and the role of local authorities

Energy contributes to the satisfaction of human needs and aspirations, the major objective of development. It provides a variety of energy services to which access is fundamental to ensure human welfare. Sustainable development has become a goal of our society and it must be the driver of energy planning processes as energy systems of today are still markedly unsustainable.

The need to shift to a new energy paradigm first emerged after the oil crisis of the 1970s (Goldemberg, Johansson, Reddy, & Williams, 1987). The deep concern with the implications of the conventional fossil fuel supply-side paradigm has led several authors to work out a new approach to energy planning. They suggested that the emphasis on energy planning needed to shift from expanding energy supply to improving energy use. Energy is useful as 'it provides such services as cooking, lighting, heating, refrigeration, mechanical work, and personal and freight transport in ways that improve the quality of life' (Goldemberg et al., 1987). The important

thing is to understand how and by whom different forms of energy are used today and how the energy end-use system might evolve in the future. The use of an end-use approach allows at identifying better ways of meeting future energy demand, by focusing on the level of energy services instead of the magnitude of energy consumption. Energy services can be increased not only by increasing the supply, but also by using energy more efficiently (Reddy, 2002).

The 'global' problem of climate change has its roots in the intensive use of energy, which is in turn used 'locally' to sustain local activities. Therefore, cities or municipalities (herein referred as local authorities) have a significant role to play in the new energy paradigm. A decentralised design of policies allows for better fit local circumstances and citizens' needs. 'Citizens are also more likely to interact directly with their local government, providing greater opportunities for addressing local social acceptance issues by gaining support for local clean energy programs' (Bushe, 2010, p. 4).

First initiatives of energy and climate action at the local level can be tracked back into the 1990s. Nevertheless, it has only been during the last decade that pioneer cities started to prepare their local energy and climate action plans in response to acting on climate change and other local motivations in an integrated manner. Particularly at the European Union (EU) level, the Covenant of Mayors initiative (Ballesteros Torres & Doubava, 2010) was a tipping point in the development of those integrated action plans. Although

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a number of local energy and climate action plans can be identified, the topic is still seldom documented in the scientific literature, making it necessary to delve into local energy planning practices taking place on the ground as carried out by (Neves, 2012).

1.2. The concept of local sustainable energy planning

The concept of local sustainable energy planning adopted in this work is rooted on the new energy paradigm in which the focus of energy systems planning is on the level of services that energy provides to human beings. Sustainable development is the ultimate goal of the energy planning process. Thus, it becomes necessary to integrate economic, environmental and social dimensions in the process. The main goal of local sustainable energy planning is to plan how future energy services needs could be satisfied regarding multiple sustainability objectives. A future energy system which reduces the side effects on the environment to a level within its assimilative capacity, and which raises opportunities for economic and social development, taking a longer-term perspective, is the basis to achieve greater sustainability. The concept is applied to cities or municipalities, a low level administrative division of a country.

A so-called reference (or business-as-usual) scenario gives the expected evolution of the energy demand for a certain time horizon, based on current trends and compliance with legal requirements and policies foreseen today. The reference scenario is thus the basis to build and compare possible alternative strategies. The alternatives of action at the local level refer to what energy demand side actions can be implemented and/or small-scale energy supply infrastructure (based on endogenous energy resources) can be deployed during the implementation period of the plan.

Since the planning is community-wide, the actions undertaken will have implications at several levels in the community: economic development, environmental protection and social welfare. The effectiveness of the implementation of actions depends on the receptivity by citizens and business, namely in changing their behaviours. Therefore, it is necessary to involve the local actors and consider their points of view in the energy planning, to ensure transparency and legitimacy of the process and better chances of actual implementation. The process shall result in the choice of an option based on the local actors' values and preferences. Local sustainable energy planning thus endeavours to assess and weight the impact of alternatives under well-defined and agreed environmental, economic and social objectives.

1.3. Research scope

This paper aims at proposing a methodology for energy planning in order to support local authorities addressing energy and climate challenges in the frame of the new energy paradigm. It focuses on end-use energy modelling and on the generation and evaluation of alternative scenarios (or strategies) based on multiple sustainability objectives. Energy planning is a decision process and thus involves choices regarding the future of the community. In order to ensure transparency and make well-weighted choices, it is important to include the values and preferences of the local actors into the energy planning process.

In this context, the key research question underlying this work is: how to develop a methodology for decision support on local energy planning, which allows selecting a mid-term energy action plan based on local actors' sustainability objectives and preferences? In order to address this question, it becomes necessary to explore methods from different disciplines to support the design of the methodology, namely energy modelling techniques to aid in modelling the local energy system at the end-use level; problem structuring methods to help in defining the objectives of the local

sustainable energy planning problem; and multi-criteria evaluation methods to support on the incorporation of multiple objectives and preferences from the local actors into the energy planning process.

Therefore, a technically sound and scientifically based decision support methodology for local sustainable energy planning is provided, which accommodates the multiplicity of objectives and preferences of local actors. It combines technical modelling with involvement of local actors, leading to the creation of a socio-technical approach to local energy planning. By adopting a comprehensive approach, the methodology proposed seeks to pave the way towards sustainable and inclusive local energy planning.

The remainder of this paper is organised as follows: Section 2 describes the decision support methodology for local sustainable energy planning; Section 3 provides results from the application of the methodology to a practical case and the discussion of those results; and Section 4 presents the conclusions.

2. Theory/calculation

2.1. Outline of the new decision support methodology for local sustainable energy planning

The proposed methodology consists of nine methodological steps, in which different methods and/or tools are applied (Fig. 1). The methodology results in a patchwork of an array of methods offering support to the different stages of an energy planning process. In order to design a methodology supporting the whole energy planning process, an eclectic approach was deemed necessary.

The first step (modelling the local energy system) consists in making a diagnosis of the current situation and estimating future energy demand. For this, it was necessary to design an end-use energy model (Section 2.2), which includes the disaggregation of energy demand into end-use categories and allows the projection (estimate of future trends) of energy demand under a reference scenario. The model was implemented in a Microsoft Excel spreadsheet and was named as Local Energy Planning Assistant (LEPA) tool (Neves, 2012). To be noted that the design of the model employed in this step relates to the attributes chosen in step IV (Section 2.5) and to the actions identified in step V (Section 2.6). The model is further used in step VI (Section 2.7) for assessing the impact of alternatives in each objective. In case additional actions and different objectives would be identified at some point in the future, it would be necessary to incorporate them in the model.

The second step consists in identifying the relevant local actors (Section 2.3) who will further be involved in other methodological steps (as represented in Fig. 1). Next (step III), objectives of local sustainable energy planning are identified and structured (Section 2.4). This step makes use of cognitive and causal mapping techniques (Bryson, Ackermann, Eden, & Finn, 2004; Eden, 2004) to involve the local actors in the identification and structuring of the objectives following a value-focused thinking approach (Keeney, 1992). Afterwards (step IV), appropriate attributes (Section 2.5) for the objectives are proposed, which after being validated by the local actors will be used to measure the extent to which alternatives satisfy the objectives.

Thereafter, alternatives need to be generated. This is what step V (Section 2.6) focuses: first on identifying a catalogue of actions and after on generating alternatives by adopting a 'strategy generation table' procedure (Howard, 1988; Kirkwood, 1997; Matheson & Matheson, 1998). An alternative is herein considered as a combination of individual actions that achieve a pre-specified GHG emissions reduction target. For the evaluation process to take place, it becomes necessary to assess the impacts of the alternatives in step VI (Section 2.7). The assessment of the impact of each

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