INTEGRATIVE SMART CITY PLANNING - Buildings and Mobility in Évora

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Overview

European policy has acknowledged the significance of local and regional communities for the deployment of innovative low carbon technologies and their potential for sustainable energy production and use. A number of initiatives and programmes (e.g. Covenant of Mayors) have been set up in order to engage European cities in efforts towards a low carbon future and an improved quality of life through sustainable economic development. It has been recognized, that there is a critical need for improved comprehensive city planning driven by an integrated and strategic approach, focused on ex-ante cost-benefit assessment towards a sustainable energy use. Hence, innovative tools and models to assess and perform in-depth analysis of alternative measures will help to pave the way towards more efficient energy use, to fully capture the potential of each city in the most efficient (economically, socially and technically) way.

The ongoing European project InSMART brings together four EU cities: Évora (Portugal), Cesena (Italy), Nottingham (UK) and Trikala (Greece), and scientific organizations of the same countries aiming to establish a methodology for enhancing sustainable energy planning for future city needs through an integrative and multidisciplinary planning approach.

The focus of this paper is on the Évora case regarding transport and mobility and building stock assessment and analysis. Évora is located in the Alentejo region and had in 2011 a population of 56 596 (INE, 2011), with a per capita annual energy consumption of 4 874kWh (PORDATA, 2014). Évora is awarded a UN patrimonial and cultural world heritage, is a major international tourist attraction town, and is the first town in Portugal holding a massive smart metering system, under the INOVCity flagship project (EDP, 2010). The demographic and economic potential, the importance of research and training supply and concentration of industrial and logistics make this city a strong and dynamic regional hub.

Methods

The project has the overall objective of identifying the optimum mix of short, medium and long term measures for a sustainable energy future, addressing the efficiency of energy flows across various city sectors with regards to economic, environmental and social criteria intended to pave the way towards actual implementation of priority actions, through multi-criteria methods involving different stakeholders from city planning bodies to private services.

Extensive technical expertise and specialized tools and models are used to create a platform for implementation of the project idea. Each city's energy system is analysed, covering all relevant sectors (buildings, industries, transports, waste and water management) and a comprehensive GIS energy database and mapping is being developed. In order to address the research goal, the cities buildings stocks have already been characterized, located and will be modelled through a typology approach (in CitySim and Energy Plus modeling tools). In the same way, a mobility analysis will be done through a transport-based energy and carbon model. The data needed as input to these two models are being collected through surveys within each municipality.

In Évora, we are carrying out around 400 surveys for the transport and mobility patterns through travel diaries and fulfilling different quotas for several variables (geographic location, days of the week, age and working status) in order to assure representativeness of the data collected.

For the buildings stock assessment, near 500 surveys are being carried out mainly in the residential sector, to obtain data on construction characteristics (e.g. materials, insulation), energy consuming equipment characteristics and energy consumption profiles combined with socio economic data. The information resulting from the buildings stock survey will be combined with data from a smart grid project - InovGrid which presents detailed information for the households on: daily electricity consumption profiles, load diagrams, identification of peak hours.

The next steps of the project include linking the GIS database to the technological optimization model TIMES (Loulou et al., 2005) that will be advanced in order to incorporate the spatial dimension to become a city planning model. This model will be used to analyse the cost-optimal mix of measures required to meet sustainable energy targets taking into account exogenous parameters (e.g. environmental targets, city expansion). The general methodology framework is presented in Fig. 1.

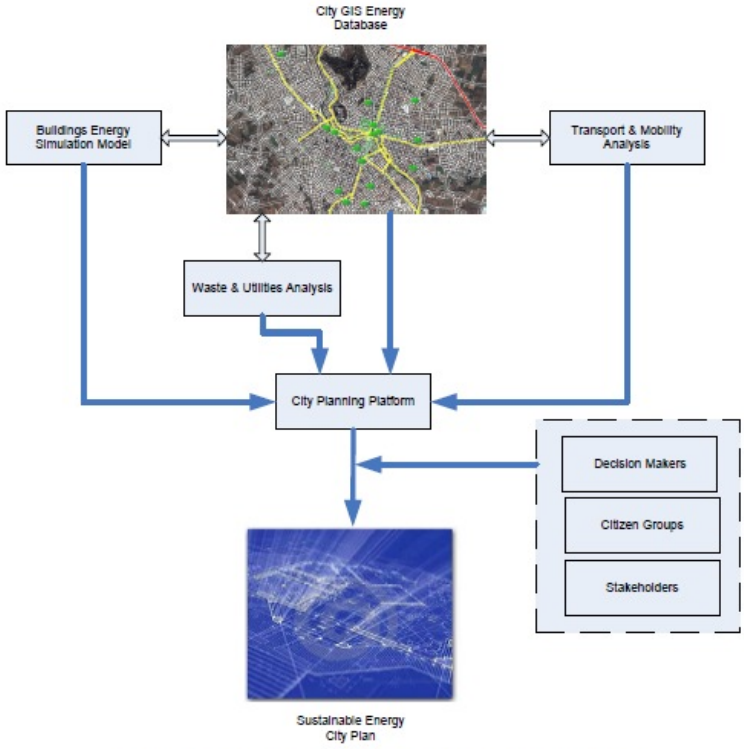

Figure 1. The InSMART concept for an Integrated Sustainable City Plan

Results

The first results allow us to set the scene through the identification of current sustainability plans in place and a general city characterization providing a comprehensive understanding of its energy system. The city spatial building stock characterization with a selection of relevant building typologies based on household type, period of construction, building heights and roof types was already conducted and supported by the Portuguese Census data (INE, 2011). From this assessment we concluded for 10 relevant typologies to be modelled (e.g. Detached House from 1946-1990, two floors, sloped roof) and where the surveys will be addressed.

It is also expected that the following work will enable the production of informative maps such as building stock distribution; energy flows; mobility maps, among other outputs, and will be the basic platform for the graphical representation of the outcomes of the forthcoming technical analysis. Through the GIS platform used as a development simulation tool, we will also achieve a spatial-temporal analysis of the residential sector energy demand, by simulating the city structure in the past, present and future, supporting the design of appropriate energy policies and measures.

Conclusions

Integrative city planning driven by cost-benefit assessment towards sustainable energy use will allow to deliver alternative policies and measures to pave the way towards more efficient energy use to fully capture the potential of each city in the most efficient (economically, socially and technically) way.

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