Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 83 (2015) 310 – 319

Energy Procedia

§7th International Conference on Sustainability in Energy and Buildings

Geographical Information System as support tool for Sustainable Energy Action Plan

Antonio Gagliano[a]*Francesco Nocera[a], Antonio D'Amico, Catalina Spataru[b]

[a]*Department of Industrial Engineering, University of Catania,Viale A. Doria 6, 95125 Catania, Italy*
[b]*UCL Energy Institute, University College of London, Central House, 14 Upper Woburn Place, London WC1H 0NN, United Kingdom*

Abstract

The Sustainable Energy Action Plan (SEAP) shows that in 2008, the European Commission approved a package of measures entitled "Energy for a Changing World" which is also known as "20–20–20" targets. Therefore, for quality control management and efficiency in the SEAP, it is essential obtaining suitable information on the building's energy performance and consumptions. This paper illustrates a methodology to support energy policies at the urban level using Geographical Information Systems (GIS) in order to characterize and monitoring the energy performance of a region. In this way, the GIS platform provide a mapping representation of the actual state of energy resources in order to develop sustainable energy policies. It was concluded that the GIS can be a useful support during the phases of organization of a SEAP and, for monitoring the actuation of the actions which were foreseen. As a case study, a small town in the Sicily region (Italy) was considered. The proposed methodology aims to help local communities to make decisions for estimating and monitoring the energy consumption in buildings (residential, commercial, industrial), and to simulate effects of energy policies.

Peer-review under responsibility of KES International

Keywords: energy policy, GIS, urban planning, SEAP .

1. Introduction

EU leaders have committed to transforming Europe into a highly energy-efficient, low carbon economy. After the adoption, in 2008, of the EU Climate and Energy Package, the European Commission launched the Covenant of Mayors to endorse and support the efforts deployed by local authorities in the implementation of sustainable energy policies [1,2]. Indeed, local governments play a critical role in mitigating the effects of climate change, especially that 80% of energy consumption and CO_2 emissions are associated with urban activity [3,4]. The recent Covenant of Mayors Agreement demonstrated strong local support for active involvement in sustainable energy planning. The

* Corresponding author. Tel.:+39-095-7382451; fax:+39-095-738-2496.
E-mail address: agagliano@dii.unict.it

Peer-review under responsibility of KES International
doi:10.1016/j.egypro.2015.12.185

agreement focuses on communities reducing CO_2 emissions and waste, as well as foreign energy dependence reduction and increase of energy efficiency and sustainable urban mobility. In order to achieve the European target every city must develop its own SEAP [5]. After that, the plan will be monitored and evaluated by an outside organization to determine its compliance.

The actions of the SEAP affect the following sectors: built environment; municipal infrastructure (heating, cooling, public lighting,); land use and urban planning; distributed renewable energy sources; public and private transport policies and urban mobility. Consequently, the local communities have the opportunity to have an impact on the climate change initiative by starting a new energy policy based on energy efficiency and renewable energy sources in order to diminish emissions of CO_2.

Undoubtedly, cities have a high level of complexity, especially considering problems related to obtaining suitable information on building's energy performance and consumption. So, obtaining suitable information about the building's energy performance and consumption became essential for quality control management and efficiency in the SEAP. A useful tool that can help the development and the monitoring of the SEAP is the geographic information system platform (GIS), which makes possible the management of all available information. GIS method has been valued for improving communication and collaboration in decision making, for effectively managing resources and assets, enhancing the efficiency of workflows, improving the accessibility of information, and generally offering tangible cost savings to small and large organizations. The energy class of buildings and their energy consumption can be stored in the GIS platform and periodically updated for estimating, monitoring and verification of any reductions in energy consumption. In addition, the forecast of the CO_2 emissions due to improving energy efficiency and/or use of renewable energy sources (solar thermal, solar PV, wind, etc.) can be verified.

Furthermore, a web interface or interactive informative totem can be created, which inform citizen on the energetic consumptions of their communities and encourage them to perform sustainable actions in their own houses or work activities. In the last ten years, many studies have used GIS platforms for energy and environmental prediction models [6, 7, 8]. Many researchers investigated energy consumption in the buildings sector, such as the work done by Tommerup et al [9], Dascaloaki et al. [10], Theodoridou et al.[11]. In addition to these, there are studies for energy performance classification of residential building stocks at the urban scale such as Dall O' et al. [12], studies on energy strategies in the building sector at urban scale such as Caputo et al [13] which support energy policies.

2. Methodology

The proposed methodology in this study aims to help local communities to make decisions for estimating and monitoring the energy consumption in buildings (residential, commercial, industrial), and to simulate effects of energy policies. In this way, the implementation of GIS platform became essential to give a mapping representation of the actual state of energy resources in order to develop sustainable energy policies.

In Italy, information on the building stock can be obtained from the National Census database, (ISTAT population census year 2001, 2006, 2012) [14], and from the buildings' map that are available at the Technical Departments of the Municipalities (TDM).

The National Census database provides information about the population and buildings for a geographic area. While the buildings' map provides information about the layout, dimensions (area, perimeter and height of buildings) and destination of use of the buildings. In some cases the energy building consumption are also available.

After data collection, the first step was dedicated to link the ISTAT National Census information with the buildings 'geometric data in order to characterize the building stocks considering construction period classification as reported in the National Census.

Whereas energy-building behavior is not only related to the construction period but also to the architectural, morphological and technological solutions that characterize each building [15]. Consequently the authors used the ''ANNEX B'' reported in the standard UNI TS 11300-1 (2008) [16] in order to define the thermo-physical and construction characteristics of buildings such as: size, number of floors and the form factor (S/V), that is the ratio between external surface of the building envelope and heated volume. The relative energy consumptions for space heating and Domestic Hot Water production (DHW) were evaluated by taking into account typical system and