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Design and development of a Web based GIS platform for zero energy settlements monitoring

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Abstract

To support the next generation of multi-process big data and service-oriented computing, a Web-GIS platform is considered a viable solution for gathering and sharing of collected data from various case studies NZE settlements, so that the information flows are easily managed and interpreted, by means of spatial thematic maps related to specific levels of information, within the various case studies. Smart interoperable sensor networks installed in the various case studies' buildings, districts, and energy subsystems are prerequisites for the formulation of the physical layer of the monitoring platform. The aim of the present paper is to analyze the characteristics and architecture of a Web GIS Platform for Zero energy settlements monitoring.
The platform development is based on open software tools, targeting to be a flexible and interoperable tool for zero energy buildings and communities.

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1. Introduction

Improving the energy performance of the building stock is crucial in order to meet the long-term objectives of the climate strategy, as laid down in the European low carbon economy roadmap 2050 [1].
The requirements for moving from Net Zero buildings to a district level are even more demanding. Net Zero Energy

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(NZE) settlements should be places of advanced social progress and environmental regeneration, as well as places of attraction and engines of economic growth based on a holistic integrated approach, in which all aspects of sustainability are taken into account [2]. They will also support the efficient use of natural resources, economic efficiency and the energy efficiency in new and existing buildings.
The monitoring and evaluation of the zero energy settlements is an essential part of their success. To this end, the development of a monitoring platform for zero energy settlements monitoring and performance analysis platform is considered necessary.
In order to support the next generation of multi-process big data and service-oriented computing, a Web-GIS platform [3] is considered a viable solution for gathering and sharing of collected data from various case studies NZE settlements, so that the information flows are easily managed and interpreted, by means of spatial thematic maps related to specific levels of information, within the various case studies. Smart interoperable sensor networks installed in the various case studies' buildings, districts, and energy subsystems are prerequisites for the formulation of the physical layer of the monitoring platform. The Web-GIS platform is designed to the following levels for each case study:

- Level 1: Indoor Environmental Quality of Buildings' Users. This includes thermal comfort [assessed by Predicted Mean Vote (PMV) and Percentage of People Dissatisfied (PDD) indices], visual comfort and indoor air quality [4].
- Level 2: Energy demand profiles for buildings and district (public lighting). The measured energy demand and consumption profiles are collected at this level[5].
- Level 3: Energy production technologies monitoring level. At this level, the energy flows within the energy production subsystems for each case study is monitored. The electrical and thermal parameters of each technology are gathered and analyzed.
- Level 4: The Integrated Resources Management Level and Dashboard. The design of this level allows the monitoring of the overall district/case study following smart grid's configurations. This specific level allows the effective management of energy demand and production profiles in order to achieve the various zero energy objectives.

The aim of the present paper is to analyze the characteristics and architecture of a Web GIS Platform that supports the following activities:

- Assessment of the performance of the involved systems and technologies and also the global energy and environmental performance of NZE settlements.
- In-depth analysis of the results of the monitoring and generation of proper technical information for future feasibility analyses and design.
- Development of the NZE monitoring platform based upon the monitoring protocols for the energy production technologies and subsystems, developed for both, building and settlement level.

The WEB GIS platform is developed in the framework of Horizon ZERO PLUS project (http://www.zeroplus.org/) in order to support the monitoring and data acquisition of four zero energy settlements: in Cyprus, France, Italy, and UK.

2. The layout of the Web GIS monitoring platform

The overall layout of the monitoring platform is depicted in Figure 1 and is comprised of:

- The monitoring devices and data acquisition units at building and at settlement level. In Figure 1, they are represented with each case study flag.
- The Cloud Server which incorporates:
    - The database for storing the monitoring data of each settlement.
    - The spatial database for the geographical data of each settlement.
    - The GeoServer for displaying the geographical data.