URBAN ENERGY WEB. A TRANSNATIONAL AND COMMON ENERGY CITY PLATFORM FOR SUSTAINABILITY IN THE BUILT ENVIRONMENT

Massimiliano Condotta[1]; Markus Biberacher[2]; Sabine Gadocha[2]; Andrea Mancuso[1]; Stefano Picchio[1]; Giovanni Borga[1].

1: University Iuav of Venice, Department of Design and Planning in Complex Environment. Santa Croce 191, Tolentini, 30135 Venezia, Italia.

2: Research Studios Austria Forschungsgesellschaft mbH – Studio iSPACE, Schillerstraße 25, 5020 Salzburg.

ABSTRACT

Knowledge on the energy related status of urban areas is an important basis for measures to improve sustainability and energy efficiency of the built environment. The "Urban Energy Web" project (UEb) developed an IT solution to share knowledge about energy consumption/energy behaviours of buildings and/or cities. The main output is the "UEb City Platform", a transnational web based platform to be used both as "Information Portal" and "Decision Support System". The platform was implemented and tested in two pilot areas: the city of Feltre, in the Veneto Region (Italy) and the region of Pinzgau Pongau, with a focus on the city of Zell Am See (Austria). The transnational level of the project and cooperation helped to compare policy disparities/differences. The application of the UEb methodology with different premises to the pilots triggered different results. In Feltre the UEb City Platform has been used for developing and integrating the Sustainable Energy Action Plan and to select some critic buildings to be included in a list of retrofitting intervention. In addition, the system triggered a network between experts, public administration and citizens. In Austria is used as an information portal for citizens, politicians and energy consultants. The platform includes indicators on refurbishment rates, average energy savings due to refurbishment, solar insolation on roofs, distances to district heating or gas infrastructure.

Keywords: Energy Saving, City Sensing, City Model, Decision Support System

INTRODUCTION

"Information transfer" and "improved competences" of urban actors are important factors to improve sustainability and energy efficiency of built environment. A wide and detailed "knowledge" of the places and their behaviour is a mandatory – but not sufficient - condition to start policies and initiatives aiming at the protection of the environment. Know-how and awareness of public administrators, building managers and citizens, is the complementary condition to create an enabling environment to make the "knowledge" effective. Moreover, if this information is shared on a common knowledge base it acquires more relevance and transnational cooperation helps to compare policy disparities/differences. This creates a transnational enabling and learning environment for improving the energy efficiency of cities. Against this background the "Urban Energy Web" (UEb) project, co-financed by the Interreg IV cooperation program was set up. The main goal of the UEb project was to create the "UEb City Platform", a transnational web based platform that serves simultaneously as information portal, decision support system and networking platform [1]. The focus is on a shared knowledge of the energetic performance, consumption and behaviour of buildings and cities integrated with information about physical aspects of the built environment.

IMPLEMENTATION METHOD OF THE UEB CITY PLATFORM

Technical implementation

The development of the platform was divided into two tasks. One was dedicated to the creation of the "knowledge", the other one to the implementation of the IT infrastructure to make the "knowledge sharing" possible. Information administrated and provided by the platform is in fact geo-referenced at regional level or at urban level. To support this feature, the platform is map-based: this means that all the information can be visualized and accessed browsing an online map that displays the different kind of data in any possible geographic location.

In Italy the platform has been implemented and tested (at urban level) for the city of Feltre, in Austria for the region of Pinzgau Pongau (at regional level), with a focus on the city of Zell Am See (at urban level). To adapt to the different needs, rules, cultural approaches and available data of the two countries, different information had to be visualized in the platform. For this reason, and also to create an "interoperable" platform, a design approach has been chosen that assures flexibility in the kind of data that need to be managed and displayed. The result is a system that can be adapted to the specific demands of territories/cities.

The platform therefore uses a schema of data implementation that relies on a common map server able to collect and harmonize different kinds of data coming from different sources. The development of the platform is based on *Geonode*, a geospatial CMS for the management and publication of geospatial data. The peculiarity of Geonode is to allow non-specialized users to share data and create interactive maps through a web interface. Geonode uses a Postgres/Postgis database as geospatial data store and *Geoserver* for retrieve and cache spatial information and provide "Open Geospatial Consortium" services.

Special attention was dedicated to the creation of specific styles of data visualization in order to make better interpretable numeric data. Each type of data uses a different visualization style to communicate the appropriate information. This is possible because Geoserver also provides specific functions that allow converting, recoding and interpolating attribute values directly into styling parameters such as color, width and opacity.

To visualize the data an interface that integrates interactive maps inside the CMS *Drupal* was developed. It is the interface that end users interact with and that visualizes the information. The interface uses different layers that can be selected by users via a widget that groups different data sets in three mains categories that can be customized for each specific city. The result is a friendly user interface oriented also to non-technical users.

Data and information structure inside the UEb City Platform

Regarding the "knowledge" organization, in the development of the web platform a general structure of three categories was chosen, whereby each category is customised to the requirements of the specific pilot region.

For the **pilot region of Feltre** (Italy) the three categories were chosen as *City Model*, *City Sensing* [1] and *Energy Model*.

For the category *City Model* two models were developed, based on the fusion of high-resolution aerial images, LIDAR images and terrestrial point clouds laser scanning. One model includes streets, trees and building facades, while the other shows the roofs of the buildings. By the integration of these two models the *City Model* is developed, which is the digital multilevel-knowledge model for the city of Feltre.

In the category *City Sensing* an analysis of existing datasets was carried out to derive information on the real energy consumption and energy losses of buildings, as well as the behaviour of residents and households. The data analysed include gas consumption, heating systems, energy certificates and inhabitants. Furthermore thermographic pictures of buildings were analysed to generate information on the heat losses of building envelopes.

For the category *Energy Model*, information based on the interconnection of the *City Sensing* and the *City Model* was elaborated. This information includes CO_2 emissions of buildings, PV-potential of roofs and the *FEU Index*. It is an index appositively developed to analyse the energy efficiency of a building in relation to the urban surroundings. It is an indicator called "*Firma Energetica Urbana Index*" (Urban Energy Signature Index). It calculates and represents the performance of each building considered as part of the city system. FEU is based on *n* correlated "*performance indicators*" that are related both at energetic characteristics of the building and users behaviours. The parameters that have been considered in this application are:

- **E**nergy consumption (gas, oil, wood, consumption for heating, hot water etc.);
- Energy **D**ispersion of facades (analysed by infrared survey at urban level);
- Users/**P**eoples behaviours (considering moreover energy consumption per person);
- **C**O_2 emissions (calculated on the basis of heating system used).

To each performance indicator a score is assigned that ranges from 1 (good energetic performance, good building) to 5 (bad building). The scale is configured on the basis of the average of all buildings of the city. Considering that these *performance indicators* are reciprocally correlated, the FEU has been conceived as a configurable index where each parameter weight can be increased or decreased to adapt to users needs and demands. The parameters can be adapted by assigning to each parameter variable (αe, αd, αc, αp) a value that range from 1 (to assign low weight to the specific parameter), 4, 6 (medium), 8, to 16 (to assign the maximum relevance to the parameter). The *FEU* formula is:
FEU Index = $(E \bullet \alpha e + D \bullet \alpha d + P \bullet \alpha p + C \bullet \alpha c) / (\alpha e + \alpha d + \alpha p + \alpha c)$.

The platform gives the possibility to the users to customize in real time the Index by giving different weights to each indicator and getting immediate results from the platform (in Fig. 1 a customized configuration of the Index by moving the slider of each specific indicator). This functionality has been realized using a particular characteristic of Geoserver which allows displaying data through the definition of dynamic styles that use formulas processed through WMS requests containing the parameters entered by the user according to the *FEU* index.

For the **pilot region Pinzgau/Pongau** (Austria) the categories were defined as *Energy Coefficients*, *Energy Indicators* and *3D-City Model*.

For the category *Energy Coefficients* available energy certificates of the pilot region were analysed and coefficients on community level on energy sources for building heating, average heating demand, CO_2 emissions and average savings due to refurbishment were derived.

For the category *Energy Indicators,* indicators maps on building and raster cell level were developed for solar potentials, infrastructure and buildings. Infrastructure distances of buildings to available gas or district heating networks have been computed on a 50m raster cell basis. Regarding the solar potential, indicators on insolation on roofs as well as on whole parcels were elaborated. Roofs are classified in areas of "very good", "good" and "less good" solar insolation and the indicators give the available area of each class for every roof. Furthermore an indicator showing the average solar insolation in kWh/m^2 for different classes was developed. For parcels, the average solar insolation per m^2 was computed. For buildings indicators on the roof pitch and roof orientation have been developed and integrated in online maps. As input for the category *3D-City Model,* a model of selected parts of the pilot region such as the city centre of Zell am See based on airborne laser scanning data on a 1m raster resolution and cadastre data on buildings was developed.

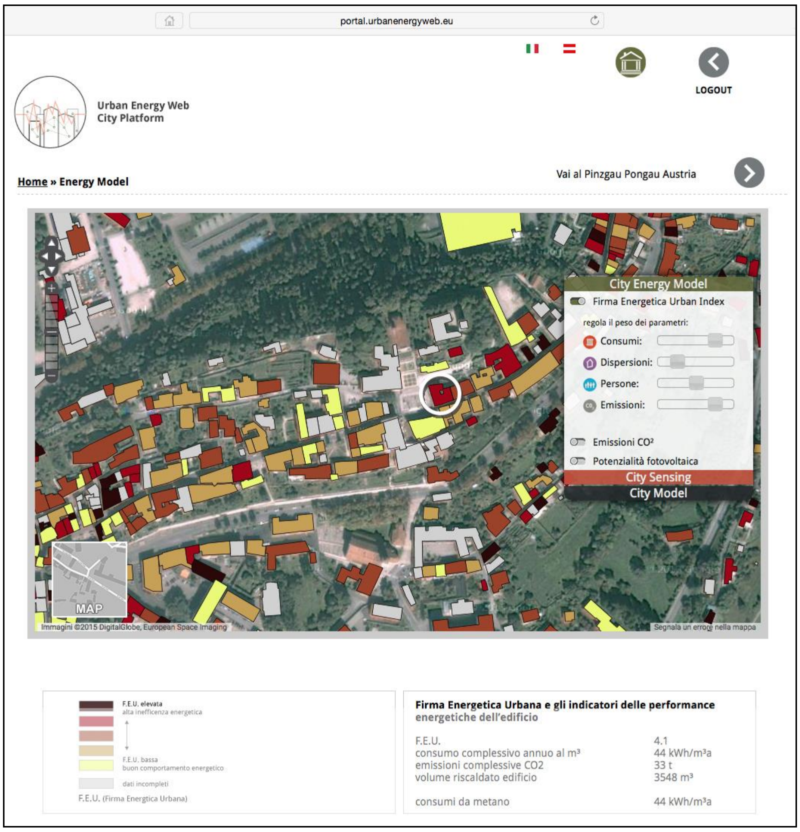

Figure 1: Screenshot of the UEb City Platform about the F.E.U. Index in Feltre.

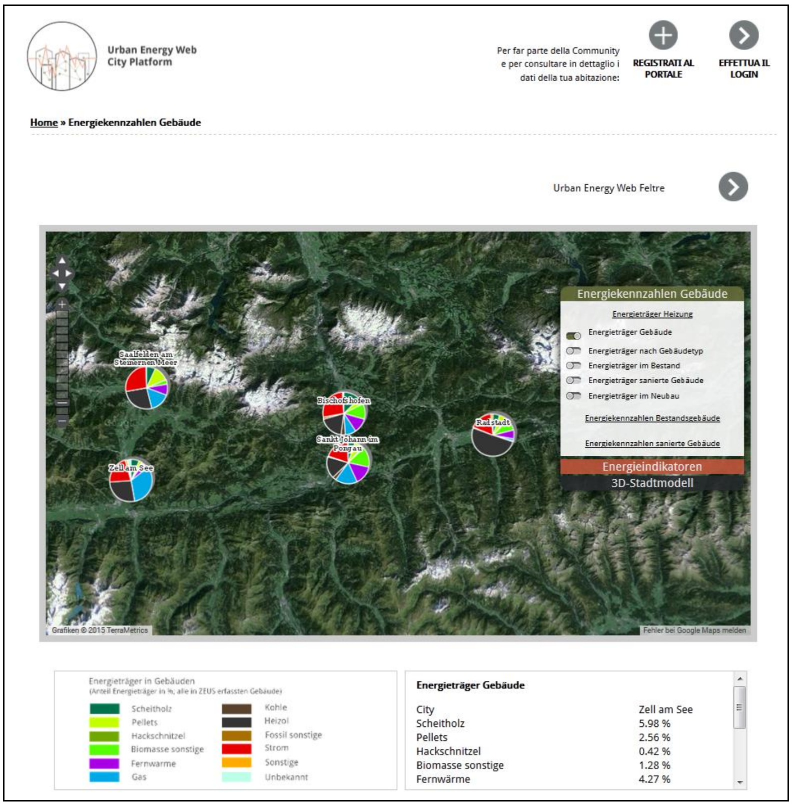

Figure 2: Indicators of share of energy sources for heating purposes in Pinzgau/Pongau.

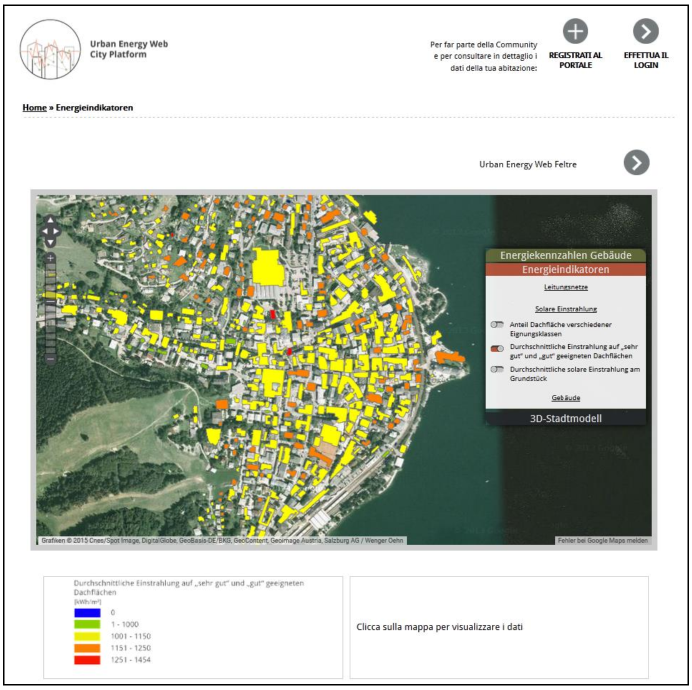

Figure 3: Indicators of solar insolation on roofs in Pinzgau/Pongau.

RESULTS AND OUTCOMES

The Urban Energy Web project reached two main results. The first one is the realization of the transnational UEb City Platform, the second one is the production of a relevant amount of information regarding energy behaviour of the cities and related buildings of the pilot areas. The project platform can be accessed via the project website (www.urbanenergyweb.eu) where the information on the two pilot areas can be obtained. This is the main output of the project that enables the exploitation of all the analysed data and produced information. The platform for Austria includes indicators on energy sources for heating purposes of buildings (Figure 2), refurbishment rates, average energy savings due to refurbishment, solar insolation on roofs (Figure 3), distances to district heating or gas infrastructure and roof pitch. For Feltre, information is given on real consumption of gas, oil or wooden, on CO_2 emissions, on population data, on photovoltaic potential of roofs and the FEU Index (Figure 1). In addition, for both pilot areas, the platform gives access to the 3D City models produced during project lifetime.

The application of the UEb methodology to the pilots, which means the possibility for end users to have access to the shared knowledge of the energetic performance, consumption and behaviour of buildings and cities integrated with information about physical aspects of the built environment, already generated some outcomes. In Feltre the City Platform has been used for developing and integrating the Sustainable Energy Action Plan and to select some critical buildings to be included in a list for retrofitting intervention. In addition, the system triggered a network between experts, public administration and citizens. In Austria the UEb City Platform is used to provide information for citizens, politicians and energy consultants.

DISCUSSION

The experience of the application of the UEb platform to a different context (from a political, geographical and social point view) made evident that is not possible to use exactly the same schema in each occasion. In fact available data and regulations are different and also specific objectives. A simple replication of any IT solution to support energy saving process is therefore not possible. Nevertheless, the overall goal to improve sustainability of the built environment is largely shared. For this reason the approach used in UEb to have a flexible IT structure that can be adapted at specific needs can have more success. The two pilots done in the UEb project demonstrated that it is possible. Moreover the common platform can work as a bridge reducing differences towards a more EU shared approach.

CONCLUSION

The Urban Energy Web City Platform was designed as a transnational web platform for information provision, decision support and networking activities between different actors in the field of energy and energy efficiency. The platform administrates and disseminates information on energy and energy efficiency elaborated during the project and provides it to the different user groups. As the available data, derived indicators and legal regulations are different in the pilot areas, the platform architecture is set up in a flexible way so it can be adapted to the specific needs of the pilot areas. The Urban Energy Web City Platform offers therefore the possibility to share knowledge and experiences on transnational level. Thereby it serves as a basis for the future enhanced use of renewable energy and the increase of energy efficiency in cities and can be considered as a potential tool to tackling non-technological obstacles existing inside EU (such as legislation barriers and know how disparities) towards a more concrete application of already existing energy saving technologies to renovate built environment.

REFERENCES

1. Condotta, M., Onorato, R., Gruber, P., Gadocha, S., Zatta, E., Borga, G., Mancuso, A., Biberacher, M., Picchio, S., Bonan, V. *Urban Energy Web. Conoscenza condivisa per il contenimento dei consumi energetici e sviluppo di energie rinnovabili a scala urbana*. Eds. Condotta, M. Belluno, 2015, Tipografia Tiziano Publisher. ISBN 978-88-900188-8-6
2. Condotta, M., Borga, G. "'Sensing' the city model to improve effectiveness of digital resources." *Territorio Italia. Governo del Territorio, Catasto, Mercato immobiliare. Periodico d'Informazione tecnico-scientifica.* Anno XII no. 2 (2012): 85-93. Published by: Agenzia delle Entrate, Roma, 2013. ISSN 2240-7707