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# The energy efficiency management at urban scale by means of integrated modelling.

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**Abstract**

Innovative technologies such as ICTs (Information and Communications Technologies) are recognized as being a key player against climate change and the use of sensors and actuators can efficiently control the whole energy chain in the Smart Thermal Grids at district level. On the other side, advances on 3D modelling, visualization and interaction technologies enable user profiling and represent part of the holistic approach which aims at integrating renewable energy solutions in the existing building stock. To unlock the potentiality of these technologies, the case study selected for this research focuses on interoperability between Building Information Models (BIM), GIS (Geographic Information System) models and Energy Analysis Models (EAM) for designing Renewable Energy Strategies (RES) among the demonstrator. The objectives aim at making a whole series of data concerning the energy efficiency and reduction at district level usable for various stakeholders, by creating a District Information Model (DIM). The described system also integrates BIM and district level 3D models with real-time data from sensors to analyse and correlate buildings utilization and provide real-time energy-related behaviours. An important role is played by the energy simulation through the EAM for matching measured and simulated data and to assess the energy performance of buildings starting from a BIM model or shared data. With this purpose interoperability tests are carried out between the BIM models and quasi-steady energy analysis tools in order to optimize the calculation of the energy demand according to the Italian technical specification UNI TS 11300. Information about the roofs slope and their orientation from the GIS model are used to predict the use of renewable energy – solar thermal and PV – within the selected buildings (both public and private) of the demonstrator in Turin, Italy.

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The expected results are a consistent reduction in both energy consumption and $CO_2$ emissions by enabling a more efficient energy distribution policies, according to the real characteristics of district buildings as well as a more efficient utilization and maintenance of the energy distribution network, based on social behaviour and users attitudes and demand. In the future the project will allow open access with personal devices and A/R visualization of energy-related information to client applications for energy and cost-analysis, tariff planning and evaluation, failure identification and maintenance, energy information sharing in order to increase the user's awareness in the field of energy consumption.


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*Keywords:* BIM; District Information Model; interoperability; urban energy management; RES

## 1. Introduction

In the last years the European Commission has enhanced policies for developing strategies to promote ICTs (Information and Communications Technologies) for energy efficiency in buildings at urban level, asking the Member States to ensure minimum energy performance requirements of buildings in order to achieve cost optimal levels. Within the smart cities context, real-time data concerning energy consumption are needed at district level, considering both the building and people sub-levels. In this regard pervasive sensors and actuators can efficiently control the whole energy chain while advances on 3D modeling, visualization and interaction technologies enable user profiling and real-time feedback to promote energy efficient behaviours. Therefore data coming from such different sources and devices need to be merged into a common database for the energy management of the district. By using middleware technologies the different data can be processed and made accessible to different users.

In order to move forward the Smart City vision, ICT is recognized as a key player [1] to enhance energy optimization in cities [2]. At building level, monitoring and control solutions have been developed as well as user awareness policies to promote green behaviours [3]. Real-time information about environmental characteristics and energy consumption can be accessed from pervasive devices deployed in the building. At district level, information about district heating/cooling and power grid can be accessed as well by sensor networks. In this context, heterogeneous devices are involved for the monitoring and the management process of buildings and grids. Hence allowing the exchange of information between such different devices is an issue that can be overcome thanks to middleware technologies. Indeed, middleware technologies can help in enabling the interoperability across heterogeneous data-sources, either hardware or software, and in providing an abstract view of their functionalities. Once the interoperability is enabled, the information from the miscellaneous data-sources can be linked and merged into a common "smart digital archive" for the energy management of the district. In this scenario, different actors playing in the Smart City context can access this information or push new data. On top of that, ICT revolution in Building Information Modelling (BIM) [4] enables digital organization of building characteristics and parameters. Hence, making district energy production and consumption data available jointly with BIM information to client application and control policies would increase the energy efficiency at urban level. For instance, more performing policies can be developed taking advantages from building performance and characteristics. The adopted software infrastructure fosters to extend *Near zero energy buildings* strategies at district level, considering that *Near zero energy districts* are the next frontier in energy efficiency and sustainability.

The proposed methodology mainly aims at making the energy demand of buildings rational, which involves the optimization of load profiles and set-points. This is expected to determine a reduction in energy request of buildings and load shift. The positive impacts for producers are represented by the reduction of peak request (peak shaving) and, consequently, the possibility to connect new users to the energy distribution network even in saturated areas. The positive impacts for users are a reduction of the total energy demand and the possibility to shift part of the load in hours characterized by lower energy costs.

In the presented paper the DIMMER (District Information Modelling and Management for Energy Reduction) project's architecture is shown, describing how the core – represented by the middleware infrastructure – is able to manage both real data from sensors and simulated data from numerical models. In particular, two energy models