Urban Building Energy Modelling

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Introduction

For the European Commission, the **Urban Digital Twin** is crucial to address challenges such as decarbonization and achieving the **Green Deal** goals and to develop Smart Cities. **Infrastructures energy management** makes it possible to reduce consumption, integrate renewable energy and plan sustainable cities. This technology is a strategic lever for creating greener, more resilient cities aligned with European sustainability goals.

Data

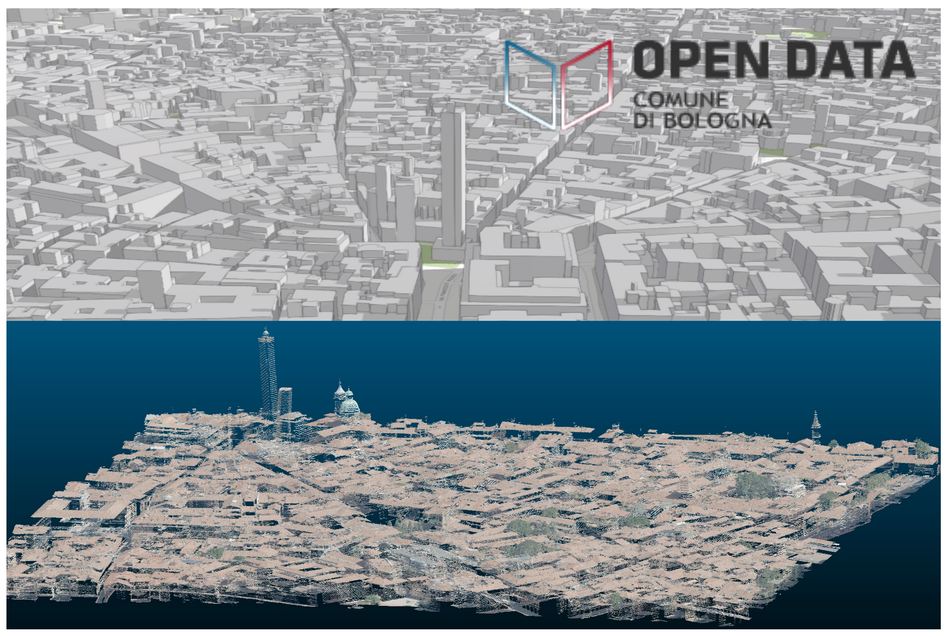

Fig 1. Above: 3D representation of Bologna, from Comune di Bologna. Open Data Bologna has a dataset with a series of information about buildings such as height, volumes, plan area, geo-shape. Below: A tile of the Bologna 2023 LiDAR campaign. In addition to Open Data, there are LiDAR data from which it is possible to extract information, using QGIS software, to make comparisons and supplement missing Open Data Bologna.

Methods

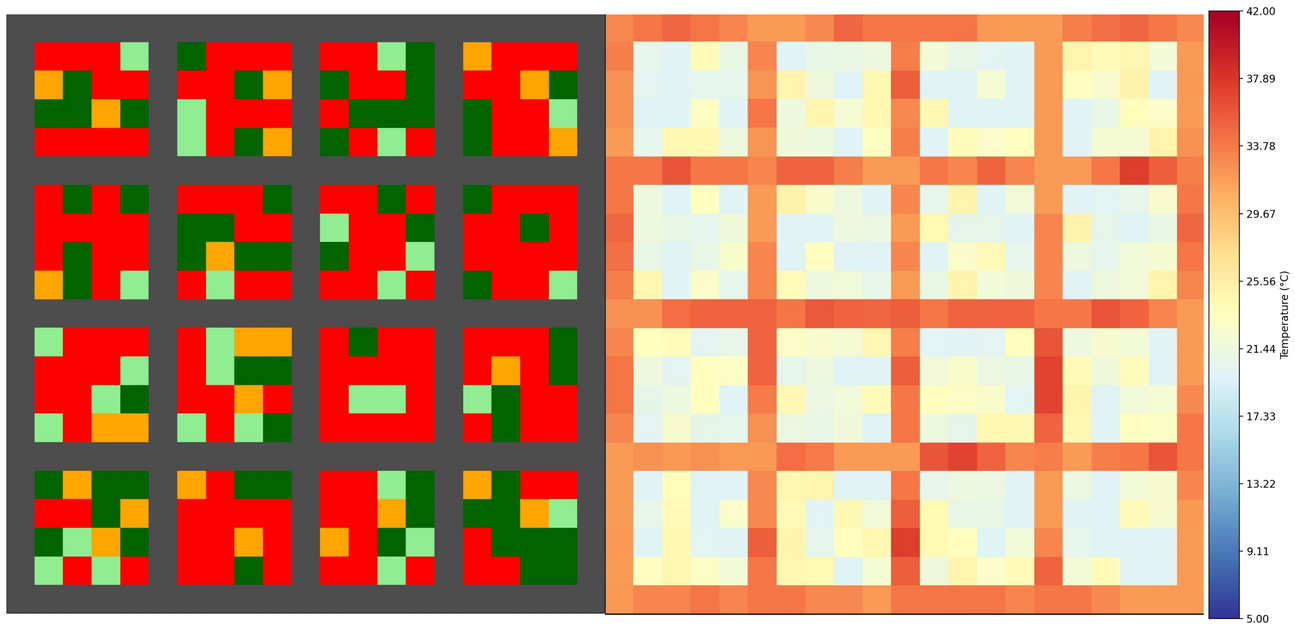

Fig 2. Empirical simulation of a fictitious urban heat island (UHI). Left: Each cell can affect its 8 neighbors; the light green cells are energy class A-B buildings, the orange cells for class C-D-E, the red class for class G-F, the green cells for vegetation, the dark grey cells for street. Right: Heat map generated by the simulation when the outside temperature is 32° C.

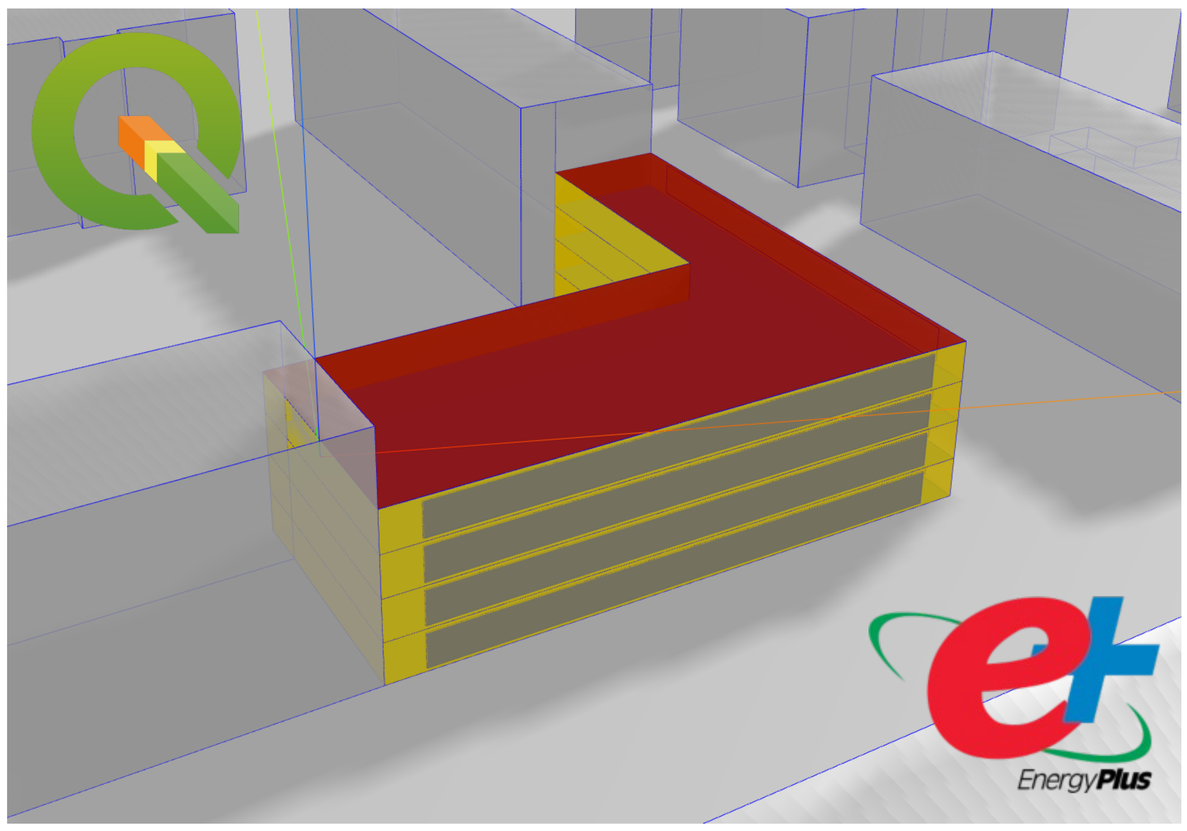

Fig 3. Tridimensional representation of a building in Bologna, from Energy Plus (EP). This kind of representation is made with the creations of idf file (the input file for EP), a file with all information about the building such as height, volumes, plan area, materials.

Fig 4. Buildings shapefile, each color represents a different period when the last infrastructure change occurred. The idea is to clusterize, using DBSCAN, these buildings to have clusters with similar features such as materials, wall thickness.

Conclusion

The workflow starts from collecting all geometrical parameters (such as plan area, volume, height) that EP needs for the energy consumption simulation. In order for the simulation to be plausible, it is important to have some non-geometrical data on the building (e.g. materials and wall thickness). Due to privacy issues, such data sets are not available, but it is possible to cluster (using DBSCAN) buildings into various types of archetypes (such as year of construction) and use normative or TABULA-related data to fill in the gaps: some data obtained from legal regulations are windows-to-surface ratio and energy efficiencies. Each cluster can have one building, representative for the entire cluster, of which some data are already known and use these for the other buildings in the cluster. A further step could be an analysis of UHI with satellite thermal data to assess the impact of buildings in urban settings. The finale objective is to have, for each building, the energy estimation in KWh/m^2.