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GIS APPLICATIONS FOR A RENOVATION OF LEGACY RADIOLOGICAL FACILITIES

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ABSTRACT

Determination of future fate for nuclear and radiological legacy facilities is becoming an extremely important near term issue.Our proposal is to enhance information on the actual, legacy radiological facilities, for decision to treatment or replace radiological facilities and exceptional buildings.With GIS applications and analytical database, the inherited facilities can be classified according to the seriousness and importance of modernization or treatment, so that the competent authorities can decide to carry out the renovation, replacement or decontamination of the radiation buildings. We used in the study develop a database analysis methodology that allows GIS tools to quickly and accurately test some facilities. Through these tools, buildings that need to be replaced and buildings that can be renovated more easily can be identified, taking into account the criteria for the design and construction.The use of GIS model for each building represents a fundamental added value of the method since it supports the identification of particular buildings or clusters of buildings, their quantification and their distribution. The GIS tool developed (Energy Scout)* can help in a clear knowledge of customized scenarios and statistical analysis that can be analyses in order to evaluate energy, economic and social impacts of selected technical measures.

*Energy Scout is a tool for estimating the energy impacts of various energy conservation measures (ECMs). residential and commercial building. Scout characterizes ECMs using their relative or absolute performance, installed cost, service lifetime, and year of introduction into the market. Probability distributions can be placed on ECM performance, cost, and lifetime inputs, which then propagate through to final energy impacts. Furthermore, ECM energy performance can be calculated using whole-building energy simulation with Energy Plus on prototype building models.

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INTRODUCTION

Nuclear facilities and radiologicalrequire analysis of nuclear, radiation and environmental safety throughout their lifecycles, and the safety analysis results form the basis for the development of documentation required to have any particular activities licensed. Such analysis is normally based on design data, engineering and radiological survey (ERS) findings for respective facilities and predictive modeling of important processes involved in their evolution. This includes decommissioning steps to this end in the international federal target program "Ensuring Nuclear and Radiation Safety for 2008 and Up to the Year 2015". Problems arising in justification of decommissioning options for such facilities, in terms of radiation protection and safety assessments both for the public and personnel, differ greatly from tasks involved in design of new nuclear installations. The explanation is a critical shortage of information on both nuclear legacy facilities they contain. Extra complexities stem from regulatory requirements to facilities of this type having changed greatly since the time these facilities were built, for safety for nuclear legacy facilities the results of which have confirmed the efficiency of the solutions used in its design. Special difficulties arise in a safety analysis for nuclearandradiation-hazardous facilities (NRHF) classified as nuclearlegacy facilities (NLF) [1–3] , There is a whole range of factors to explain this. One of these factors is a critical difference in approaches to justification of safety as compared to facilities under design or construction. It is possible to select the suitable site, materials, etc. for new projects, while the situation is quite different for nuclear legacy facilities due to a great number of uncertainties and their locations which, as a rule, fail to meet modern requirements. Another factor is that most of these facilities were built in the early years of nuclear power with less stringent (as compared to the present time) regulatory requirements to ensuring safety. Most of them were shut down back in the previous century and the systems of safety barriers for protection against the spreading of radioactive materials into the environment are nearing the end of their service life.In fact, the method and tools described in our study are aimed at stimulating all the stakeholders involved in radiological buildings management, detecting the possible drivers towards a progressive improvement of the built environment.

METHOD AND TOOLS

One important innovation of our study is the collection, the harmonization and the connection of all the useful available information at building level in a GIS. we used developed a set of innovative GIS-based tools able to support the proposed policies and services. Further, we tested our method and tools in order to verify the overall feasibility and reliability. Due to the importance of the radiological building legacy and considering the difficulties related to its management, we focus our research in used developing a GIS tool specifically devoted to this issue. In practice, we include the radiological building legacy in the set of tools that help to boost the renovation in the whole buildings. The main purpose of the Energy Scout could help in give a territorial representation of areas suitable for developing micro grids or district, using knowledge about the barriers A feature added thanks to the MHM is to prioritize heritage buildings, signaling those under strict preservation order versus the ones that could undergone renovation, with the possibility to detail it (full or partial renovation, rehabilitation, restoration, etc.) and what are the most compatible available technologies. Moreover, the local administration may promote measures and projects involving a particular group or cluster of buildings (joint projects), i.e. those belonging to a historical center This lets also to directly taking into account the architecture typologies of those buildings, i.e. in the case of courtyard or adjoining buildings that are very popular in the historical center.

The architecture of the tools developed in our proposal is reported in Figure1 and therefore includes: Municipal Model (MEM) and Municipal Heritage Map (MHM) as foundation maps; Planning, Energy Scout as supporting tools.The information block consists of a facility information's. The former contains reference data required for safety justification: generalized information on the facility, and international regulations [6–12]*(2), data on radionuclide characterization (from assessed nuclear data libraries [13,14] * (3), the host environment properties, etc. The GIS facility database stores the following data for each facility: general information, facility location and state, design data, radiation characteristics, parameters of the host environment and processed data. Generation of respective initial data file sections in the conversion of a dedicated template CAD model of the facility. Besides geometrical parameters, such model uses references to data on materials and sources from the information system. The ultimate purpose of the calculation is to estimate the expected dose for a person involved in activities in the radiological conditions being modeled. The service system enables display of the CAD model and the calculation results for the spatial dose rate distribution. The use of GIS model for each building represents a fundamental added value of the method since it supports the identification of particular buildings or clusters of buildings, their quantification and their distribution. The GIS tool developed can help in immediately identifying the most promising areas to be involved in the process of renovation and in simulating possible scenarios. A clear knowledge of the regulation framework and the method permits also the definition of customized scenarios and statistical analysis that can be analyses in order to evaluate energy, economic and social impacts of selected technical measures.

Foundation maps

According to the considerations reported, the MEM can be defined as a bottom-up hybrid model, because it uses both collected data of the specific building and archetypal approach to fill the lack of data. The focus is on a model that could be quickly implemented for each municipality. The MEM is able to give a geo-referenced representation of the state of the entire building stock of the municipality, with information about energy consumption, production, and features with a level of detail of the single building. With the proposed national data collection framework, it will be possible to develop MEM for every municipality, since the methodology uses data publicly available, or will be available, for each municipality. Therefore, the MEM is effectively a GIS based tool able to support a massive energy retrofit.In order to investigate and support the sensitive challenge of improvement of the building heritage, we propose to connect the model with a new Municipal Heritage Map (MHM in the following). This map permits the collection at the local level of all the information about architectural heritage in a GIS map, as reported in Figure 1, resumed in Figure 2, the first part of our research shows.

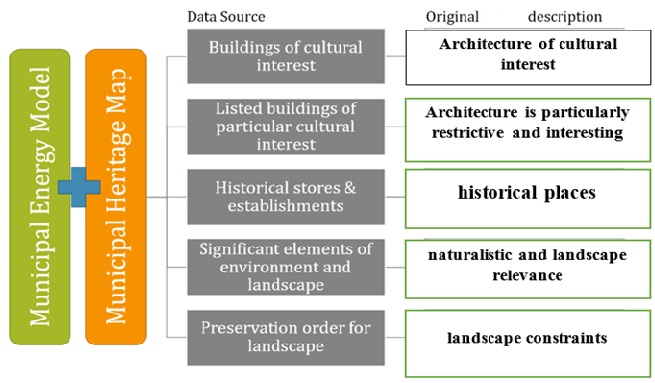

Fig. 1 Elaboration of the map of the building heritage in the framework of the local energy plan and in connection to the municipal energy mode

That municipalities have huge problems with dispersion of data among several municipal offices and other administrative entities; lack of coordination among the different offices; and different archives systems for data and/or lack of digital archives. As a result, in general, public entities are not aware of data available or collected and they do not organized systematic data set in a coherent framework. For example, usually municipality have historical maps (i.e. the maps related to old and historic cadaster, maps that report the state of the built environment at different stages and ages) and a register of the building permits. Nevertheless, they do not have a map of the age of construction for all the building stock, also because often maps and registers are not available in digital format and are not connected together. The age of construction is a pivotal parameter not only in the MEM, but also for heritage conservation. The MHM could work as a stand-alone map to be used mainly for heritage preservation planning and source for information. However, the true potential is to use it in the broader planning, such as the LEP. Since it is possible to assign the same identification code to each building in MEM and MHM, it is also possible to link the data collected and therefore to share and overlap information about energy or heritage features for each building.

as described in this framework, the building heritage will be thus part of the process and specifically addressed. One of the features is to benchmark the city and set feasible goals targeted on the municipality the peculiarity of the local heritage should be considered when comparing municipalities and when setting realistic goals.

Test Results of the Method and Tools: In order to test the feasibility, reliability and applicability of the method after the insights about the radiological buildings heritage, we follow

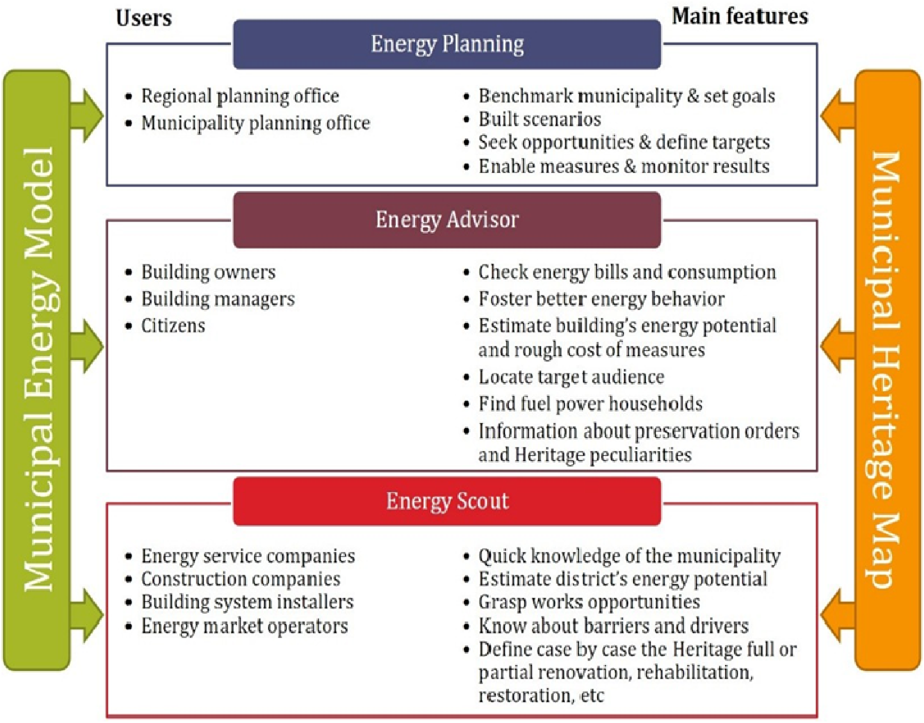

Fig. 2. Overall architecture of the GIS based tools based on MEM and MHM

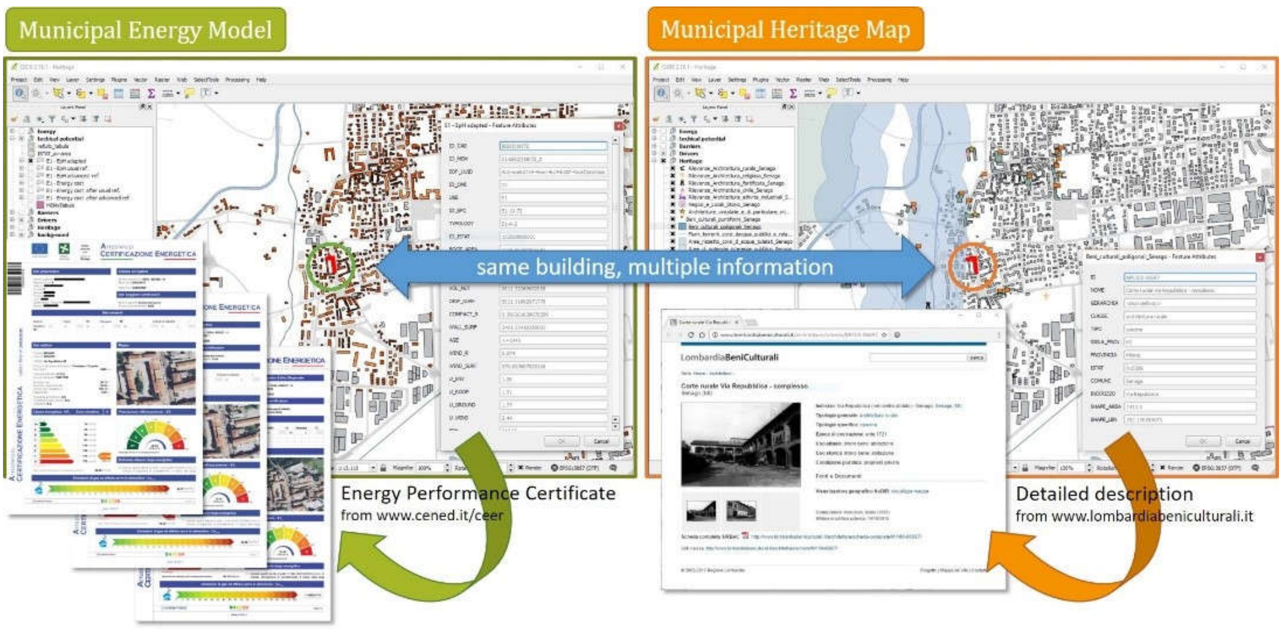

Fig. 3. Example of application of MEM and MHM; representation of the available information and use

Framework of the supporting tools: The supporting tools already developed in the previous works could thus be enriched by data about the building heritage. The intended users and the main features of the tools that arise from the MEM and linked MHM are listed in Figure 2. The Planning tool they represent the support for LEP provided by the MEM,

the same method reported. Therefore, we develop the MHM for the same municipality already used. we selected the following GIS database in the test geoportal Region:

- Buildings of radiological interest, archive managed by the regional informative system.

- Listed buildings of particular nuclear and radiological impact interest buildings
- Significant elements of environment and landscape, database managed by the Cartography Department.
- Preservation order for landscape database and emergency of hazard managements.

By the integration of the available information in the GIS, it was possible to create quite rapidly the MHM and integrating it with the already existing MEM and derived tools. The result of the integration is shown in Figure 3. The possibility to collect and interrogate information about the same building with different oriented database should not be underestimated. Thanks to Energy Scout, it would be easier to involve the private owners into a joint project to improve the overall energy performance and at the same time to preserve the value of the build. Certainly this type of application is only one example of the multiple interesting application of the GIS tools developed in the framework of the research. The features of the method developed could support many interesting insights also towards a harmonious, but diffuse and effective retrofit of the building heritage. The results of information prediction for the state of nuclear legacy facilities based on a system analysis of the entire set of experimental data obtained have made it possible to optimize the content and sequence of activities for establishment of additional safety. After the problem is defined and the available information on the facility of interest is collected and assessed for being sufficient and accurate, the purpose of which is to acquire the radiation source, the current state of engineered safety barriers and the properties of the host environment. Personnel and/or public doses and their respective radiological risks are estimated for the facility evolution options under consideration.

Conclusions

The method and tools developed in the framework of the research constitute a robust support to effective plans. To the Model (MEM) and derivate GIS tools permit, to activate towards the involvement of different stakeholders of the legacy nuclear and radiological buildings sector interested in providing the same method and tools can contribute to overcome barriers that obstacle the actual improvement of the existing public and private legacy buildings, to bringing results from the economic, energy, and environmental point of view.
General description of the study involving a nuclear, radiation legacy facilities and environmental safety analysis suggests the use of GIS tools for the computational modeling of information processes in the most evolution scenarios with objective and sufficient information being available on the facilities in question. This requires an integrated approach to assess the radiological risks to humans based on the complete set of influencing factors evaluated with regard for the results of Virtual studies.All these features can evidently contribute to boost the building renovation following a more massive but harmonious, rational, and cost effective approach, and will contribute to sound strategic decision-making on the future fate of such facilities.

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