

# INPUT 2016

9th International Conference  
on Innovation in Urban  
and Regional Planning



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edited by G. Colombo | P. Lombardi | G. Mondini



9th International Conference on Innovation in Urban and Regional Planning

**e-agerà/e-ἀγορά for the transition toward resilient communities**

Conference Proceedings Book

ISBN 978-88-9052-964-1



POLITECNICO  
DI TORINO



UNIVERSITÀ  
DEGLI STUDI  
DI TORINO



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## DIPENDE – a tool for energy planning of building districts based on energy performance certification data

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Key-words: Building, Energy planning, data visualization, monitoring and assessment.

### Introduction

Low-carbon and energy efficiency targets in the building sector still require relevant information and training efforts for decision makers to establish long term strategies. Big-data creation taking advantage of the contribution of the stakeholders, who are both final users and main policy implementers, is worldwide assumed as a priority.

In Italy databases are already being used for the registration and quality control of energy performance certification (EPC) and inspections of heating/air-conditioning (HAC) systems, but have an untapped potential for wider use.

Within an European project, ENEA has recently developed a system architecture model, based on an integrated dataset combining estimated building performance data with bottom-up information on recent energy services and products installations and housing status, which can be used as a tool to support decision making at regional and municipal level. To date, such model, named DIPENDE- *Database integrato per la Pianificazione ENergetica dei Distretti Edilizi*, has been delivered and implemented for Lombardy region only, but the prospective for wider applications is enabled by the present legislative context. The aim is to facilitate analysis and visualization of the energy performance of the building stock: for public authorities, to enhance control, monitoring, planning and, for private actors, to establish marketing and business strategies.

The paper shows the methodology, outputs and possible applications of DIPENDE.

## Methodology

Databases of Energy Performance Certificates (EPC) have the potential for much wider usage, and some examples already exist in Europe: Ireland, United Kingdom, Lithuania, France, and Hungary. In some cases calculated data are combined to real measured ones (Sweden, Netherlands), in others the EPC database is used to establish renovation strategies (i.e. Austria). In Portugal the analysis of EPC data was used to establish new minimum standards for buildings (whole building, lighting, and building envelop systems and technical elements) and voluntary labels (i.e. for windows). (1)

The Italian Lombardy region has the only totally public EPC open database (2) in Europe. Moreover these data are combined with the regional cadastre of building technical heating systems (3) and the ground source heat pumps cadastre into a wider information system for energy and environment (4). This system feeds and updates the regional energy balance and the regional emission monitoring system and was used to draft the Regional Energy and Environmental Plan. Nevertheless consistency of the certified building sample, combination with socio-economic territorial data and information of actual progress due to retrofit interventions are missing in the system.

Within the REQUEST2ACTION project, *Removing barriers to low carbon retrofit by improving access to data and insight of the benefits to key market actors*, starting from this leading experience, ENEA elaborated and integrated data from the EPC pen database. Cross referencing with other datasets was developed so allowing further analyses: for example, , establishing consistency and relationship between performance/EPC issued and ownership and occupation, building stock age and typology, population/household density, geographic/climatic issues, technical building plants and elements replacement/retrofit, identifying erroneous records.

Notably, bringing EPC information up-to date with unregistered performance levels variations can be inferred by overlaying bottom-up installation data coming from 65% tax deduction scheme inventory managed by ENEA. (5)

The integrated database is made of social, territorial, building and building components data, energy and energy service data, as set in the figure below:

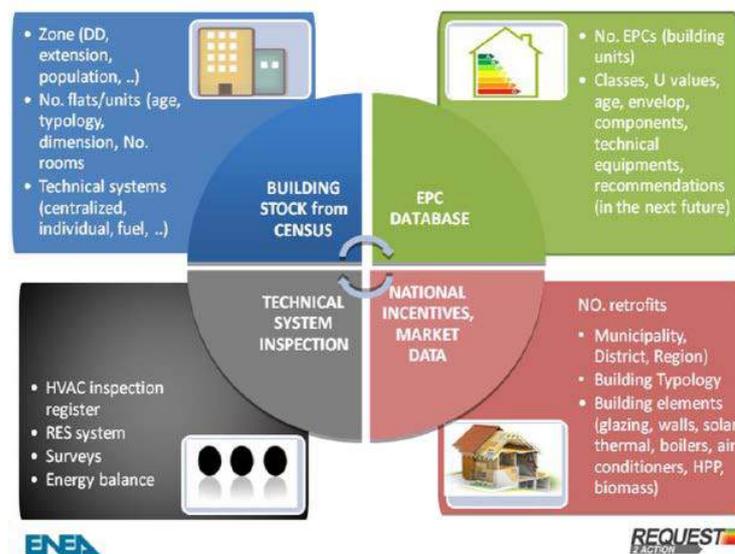


Fig. 1. DIPENDE – the integrated database model architecture.

Records are aggregated at urban level. The database covers more than 1500 municipalities in Lombardy region, includes more than 60 fields for each record and amounts to nearly 100.000 data.

The fundamental assumptions at the basis of the DIPENDE model were:

- to allow *analysis* at municipal, district, regional level
- to provide *targeted support* to both public and private decision makers by easy-to interpret analysis outputs (tables, graphs, GIS)
- to enable *replication* and wider use on the national territory

Analysis:

The following requirements have been taken into account in the DIPENDE design:

- The harmonisation of regional cadastres to the new national EPC
- Interoperability of different datasets and the possibility to stock, monitor and analyze data from all of them
- Analysis standardization and setting up relevant queries for stakeholders group
- Selection of a list of common indicators that can be relevant for comparison of different territorial contexts
- Definition of easy-to-understand output formats.

The analysis process is shown in figure 2 below:

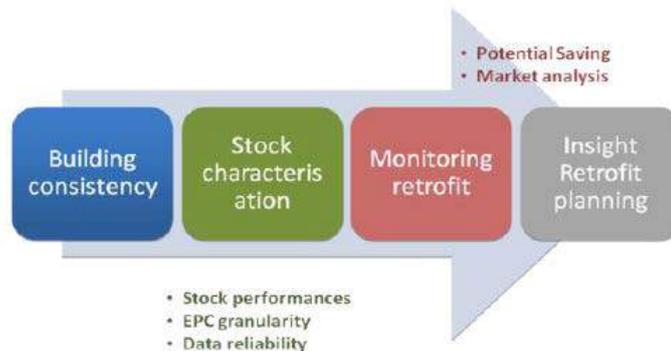


Fig. 2. DIPENDE – analysis process.

Future users’ feedback was supplied from the pilot region authority through several contacts and meetings. IlSpa, Lombardy in-house company, acting as local energy agency and manager of the regional energy datasets, provided support to the analysis of their EPC open-data and helped in customizing the tool. IRE Liguria energy agency was also consulted and reaction from a wider stakeholders’ audience was sought<sup>8</sup>.

Targeted support and visualisation:

The DIPENDE tool will be soon available on an ENEA Hub for Energy efficiency of Existing Buildings (7). The outputs will be visualised as tables, graphs and geo-referenced maps illustrating standardized or free queries, depending on user’s rights.

<sup>8</sup> Presentation of DIPENDE at the Workshop *Metodologie e strumenti a supporto della pianificazione energetica locale* (“Support to local energy planning”), Turin 19th April 2016 organised by LAME, [http://www.politocomunica.polito.it/events/appuntamenti/\(idnews\)/7595](http://www.politocomunica.polito.it/events/appuntamenti/(idnews)/7595)

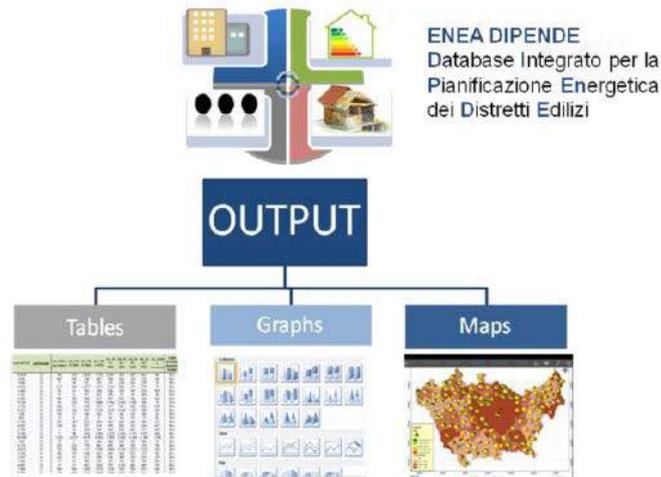


Fig. 3. DIPENDE – Possible analysis output formats.

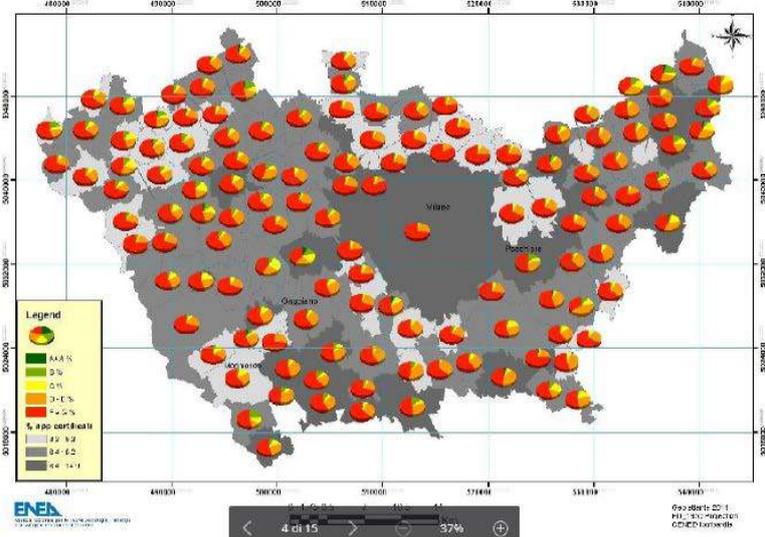


Fig. 4. Example of the analysis output (phase 2\_ stock characterization) - Energy classes. Percentage of building residential units with an EPC out of the total stock and distribution of energy classes in the municipalities of Milan province.

**Replication:**

Further repeatability of the model is guaranteed by the reference to the new harmonized EPC scheme, by selecting indicators available in all the regions and by the use of available resources (65% tax deduction scheme data managed by ENEA, national Census and open data). It is also facilitated by the current legislation<sup>9</sup>.

<sup>9</sup> DM 26.06.2015, Adaptation *National guidelines for Energy Performance Certification* in the framework of EPBD implementation. Beyond EPC harmonisation, this decree assigned ENEA the role of developing a national information system (SIAPE) and to assist regions to analyse/manage their main energy building related registers. The upcoming SIAPE (collecting EPC data from all the Italian regions), guarantees the interoperability of existing regional systems and links between other databases (TBS, cadastre) to create a Business Intelligence in the near future. It will allow statistical analysis in an Open Data format (according to law 134/2012).

## Results and discussion

The major content of the paper in this section will deal with:

### Benefits and barriers:

- The benefits of, and barriers to, combining various building-related databases (value / cost-justification / privacy) with reference to the delivered DIPENDE tool and to other experiences from Request2Action partner countries.
- Data quality / validity / consistency / primacy

### Application:

- From Public Authorities: identification and localisation of intervention priorities and saving potential (i.e. visualisation of areas where certification/retrofit promotion campaigns are needed), building stock characterisation and energy performance benchmarking for the development/monitoring of policies (within Municipal Sustainable Energy and Environment Plans within the Covenant of Mayors initiative, Regional Energy and Environment Plans)
- From private actors (service providers, investors, associations of trades): identification of business opportunities, investment programmes and market strategies (i.e. visualisation of the relationship between temporary houses and penetration of individual cooling/heating equipment)

### Predicted impact:

- Actions/policies defined by using the database (i.e. to support implementing regional/national decrees transposing EU legislation such as EPBD, EED, Ecodesign and Ecolabelling)
- Improvement of governance and coordinated actions by linking the local, regional and national levels
- Recommendations and advances on how to deal with incomplete or unreliable energy and building information and solutions for filling the gaps
- Stakeholder involvement: the model could be enriched by further feedback and data from the private sector (trades company, ESCOs, cooperatives, banks, DSO, property associations, consumers).

## Conclusions

EPC data have a high usability potential in aggregated forms rather than in raw format. Meaningful analyses are feasible if EPC data are combined with other datasets and if subsequent modelling is undertaken.

Barriers to wider application are:

- consistency and quality of data
- system interoperability
- accessibility and easy-to-interpret data
- financial and human resources and skills.

The DIPENDE tool provides:

- Cleaning and processing services and creation of easier-to-interpret categories
- Elimination of systematic errors
- Key indicators and user-friendly standard output formats
- Integration with other datasets for added-value analyses

- On-purpose customised paying services to relevant key private actors after consent of the regional authorities providing data. (8)

Moreover the new regulatory framework in the energy and building sector can endorse the replication of this prototype and extension to the national level, to help achieve policy targets and implement EPBD (Energy Performance of Building Directive art.10 “definition of support measures”) and EED (Energy Efficiency Directive art.4 “building renovation strategy”).

Integration with other database (product databases, materials databases, renewable energy/district heating databases, other financial schemes) would be possible in collaboration with local authorities and other stakeholders. Further opportunities could arise from possible development of like real-time prospects (i.e. intelligent monitoring and metering).

## Acknowledgments

We would like to thank Mauro Brolis and Dino De Simone from Infrastrutture Lombarde, for their precious support and feedback during the development of the project.

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