TIMEPAC

Towards Innovative Methods
for Energy Performance Assessment
and Certification of Buildings

TIMEPAC FACTSHEET

Exploring future scenarios for EPC enhancement:

Procedures and services to undertake large-scale statistical analysis of EPCs databases

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TIMEPAC aims to modernize building certification practices according to the latest Energy Performance of Buildings Directive (EPBD) review. Through five future "Transversal Deployment Scenarios," we enhance certification by integrating diverse data sources like operational data and renewable energy production. We also merge energy performance certificates with other assessment instruments like the Smart Readiness Indicator (SRI) and sustainability metrics. Our focus includes improving EPC reliability using BIM technologies during renovations and utilizing EPC databases for decision-making in large-scale renovation programmes.

This scenario prioritizes enhancing data quality to enable energy balance assessments and informed decision-making for building refurbishment.

Leveraging building archetypes and EPC databases for interoperability and accuracy

The upcoming Energy Performance of Buildings Directive (EPBD) introduces the obligation for each Member State to establish *"a national building renovation plan to ensure the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, with the objective to transform existing buildings into zero-emission buildings"*. Such renovation plans will rely on national databases of the building stock which may consist of interconnected ones, including land register and Energy Performance Certificate (EPC) databases. In this context, it becomes essential to assure the interoperability of EPC databases with other information systems. In addition, the upcoming EPBD refers to the gathering of building typologies and their use in national building renovation plans.

Building archetypes, which are representative of clusters within the building stock, can significantly contribute to the formulation of a national building renovation plan. These archetypes encapsulate the diverse characteristics of the building stock, thereby improving the accuracy of urban energy models while simultaneously reducing their complexity. Utilizing long-term renovation strategies based on archetype-based building stock energy models can engage multiple stakeholders, including public administrations, urban planners, and local and national energy authorities.

An EPC database represents a core source of information to create the archetypes and analyse the energy performance status of the building stock. Therefore, the quality of the data provided by the certificates is crucial to assure the validity of the archetypes.

Enhancing EPC data quality and utilization: Building archetypes and urban building energy models

In the envisioned enhanced EPC, the increase of data quality is addressed by implementing a set of control rules used both to remove inconsistencies in the EPC databases and to detect inaccuracies in the EPC generation phase. As a result, reliable EPCs could be used to create building archetypes to be used in conjunction with Urban Building Energy Models (UBEMs). This EPC enhancement process implies:

- **Defining standardised rules to verify the EPC quality and creating archetypes**
  Defining data quality-checking procedures based on customized rules and scoring systems to assess the reliability of EPC data. These objectives are interconnected: the quality of the EPC data is a prerequisite for creating reliable building archetypes, which are valuable for developing building stock energy models and conducting accurate refurbishment scenario analyses.
- **Using EPCs for benchmarking, planning, and assessing the improvement of the building stock energy performance**
  To forecast the energy performance of buildings in urban areas by association them with a building archetype that captures their attributes (climatic zone, building use, construction period, building size, for example).
- **Setting up controls on EPC input data to increase reliability in the future**
  This is accomplished through the use of confidence intervals, which can identify the true value of a parameter based on a sample, thus quantifying the uncertainty associated with the estimation.

Figure 1 shows the components of the data quality process considered in TIMEPAC and the envisioned improvements. The enhanced EPC database, in turn, would help to improve the building stock model in subsequent scenario analyses. Overall, this iterative process is characterized by a continuous cycle of improvement, feedback incorporation, adaptation, and refinement, all aimed at enhancing the quality of the EPC data and the resulting analyses.

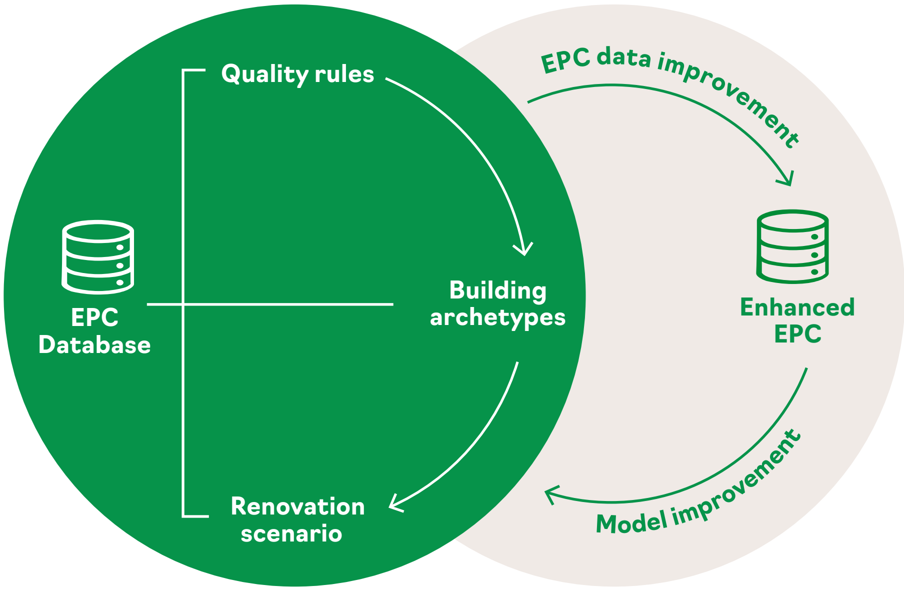

Figure 1: Quality process components and envisioned improvements

The utilization of EPC databases, facilitated by the procedures and services developed in TIMEPAC, enables target groups to execute energy refurbishment scenarios on regional and/or national scales across various time frames. This capability facilitates the implementation of policies aimed at promoting effective energy efficiency measures for renovating the existing building stock.

Advancing EPC enhancement: Methodologies and applications in TIMEPAC

To accomplish the aforementioned objectives within the context of a holistic EPC enhancement, the work developed in TIMEPAC has encompassed three main tasks:

1. **Verification and improvement of the quality of EPC data to create building archetypes**
2. **Use of EPCs to conduct energy balances of the building stock**
3. **Generation of confidence intervals for crucial EPC data**

Performing these steps has been crucial for ensuring the reliability and effectiveness of the overall enhancement process.

1. Data quality checking and building archetypes

The “Guidelines to Create Archetypes of the Building Stock from EPC Data” provide a shared, harmonized, and flexible methodology for archetype creation. The established procedures have been successfully implemented and validated across TIMEPAC partner countries, resulting in the generation of over 150 building archetypes.

The guidelines start with an introduction to a tailored-rule score procedure aimed at ranking EPC reliability. The objective is to select reliable EPCs to generate building archetypes encompassing both geometric and non-geometric data. Subsequently, the document offers a comprehensive overview of the building archetype schema, highlighting key performance indicators (KPIs) representative of the energy performance of the building stock categorized by building use, climatic zone and construction period.

These indicators encompass geometric data, thermal properties of the building envelope, technical characteristics of building systems, and energy indicators derived from statistical analysis of the EPC database. The archetype dataset consists of median values and interquartile ranges for each KPI. An illustrative example of a KPI result, specifically concerning the thermal transmittance of opaque envelope components, is presented in Figure 2 for single-family houses in the Piedmont Region, Italy, grouped by construction period.

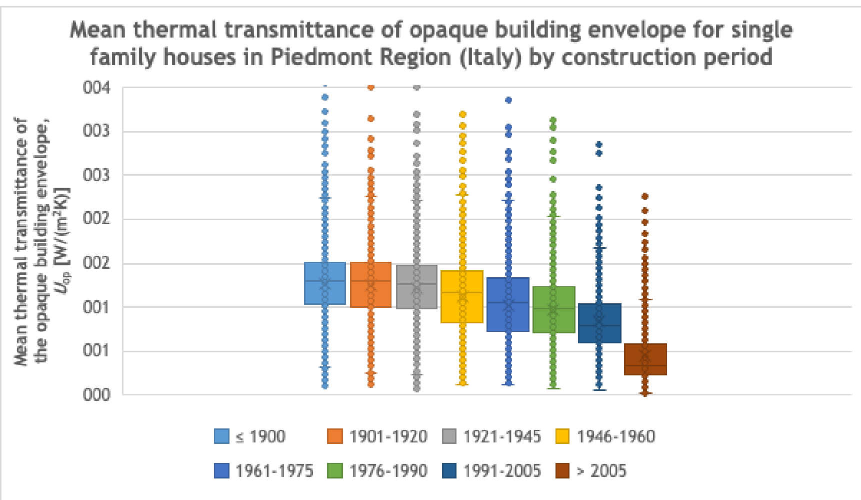

Figure 2: Example of statistical analysis outcome. Boxplot of the thermal transmittance of the opaque building envelope for single family houses in Piedmont Region (Italy) by construction period

2. Energy balances of the building stock

The energy balances of the building stock are performed by means of a large-scale energy model that relies on the energy performance indicators derived from the EPCs. Utilizing the information available in a library of building archetypes, this model enables the assessment of large-scale energy balances through a bottom-up approach. Furthermore, the modelling tool can assess the effectiveness and efficiency of various energy refurbishment scenarios applied to the building stock to ensure compliance with long-term targets. An example outcome is shown in Figure 3, illustrating a decrease in the overall non-renewable energy performance indicator for the most prevalent combination of energy efficiency measures for single-family houses in Piedmont, categorized by construction period.

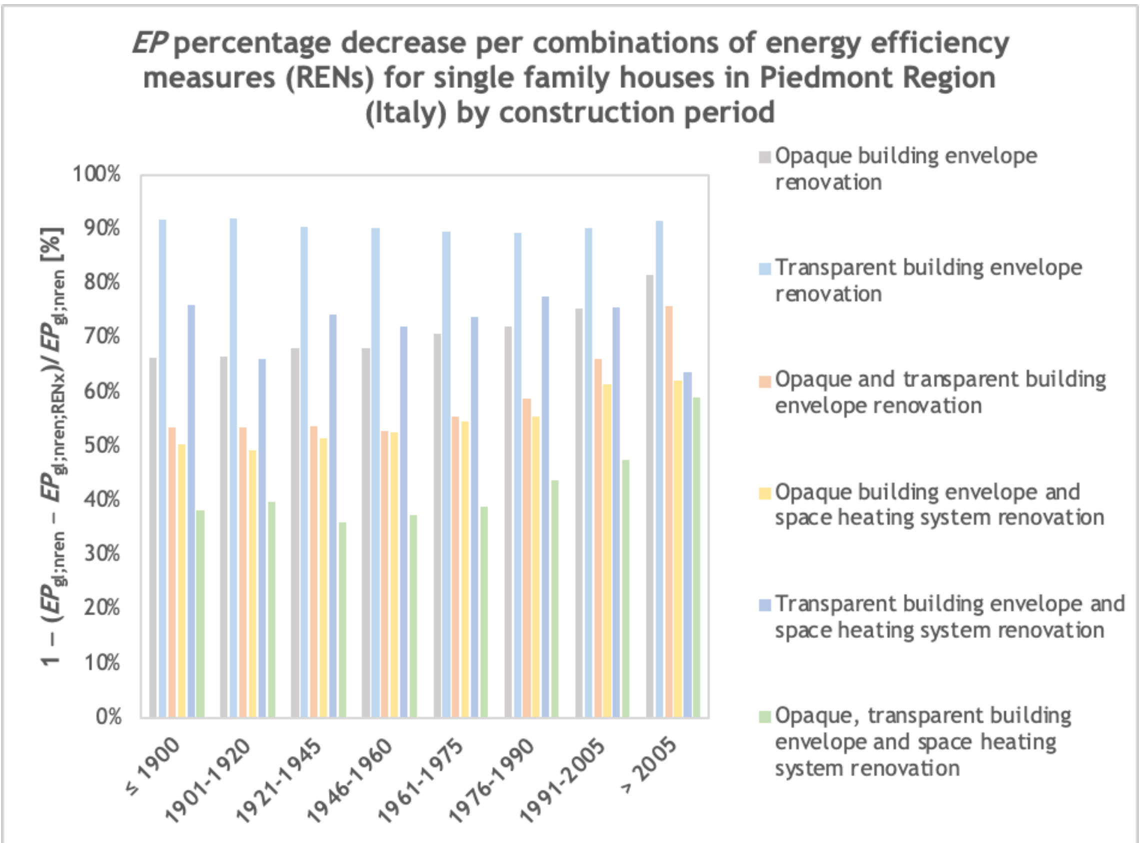

Figure 3: Example of results of the energy model tool. EP percentage decrease per combinations of energy efficiency measures (RENs) for single family houses in Piedmont Region (Italy) by construction period

3. Confidence intervals

Confidence intervals provide a range of plausible values for the input data derived from EPC databases which significantly influence the energy performance of buildings. These inferential values can be seamlessly integrated into the building EPC generation process through predefined rules. By employing confidence intervals, it is possible to estimate the actual value of a parameter based on a sample and precisely quantify the associated uncertainty. Figure 4 provides examples of a kernel density function developed from the analysis of the EPC database in Piedmont Region. Such analysis serves as a means to ensure control over input data during certificate generation, enhancing its reliability for future applications.

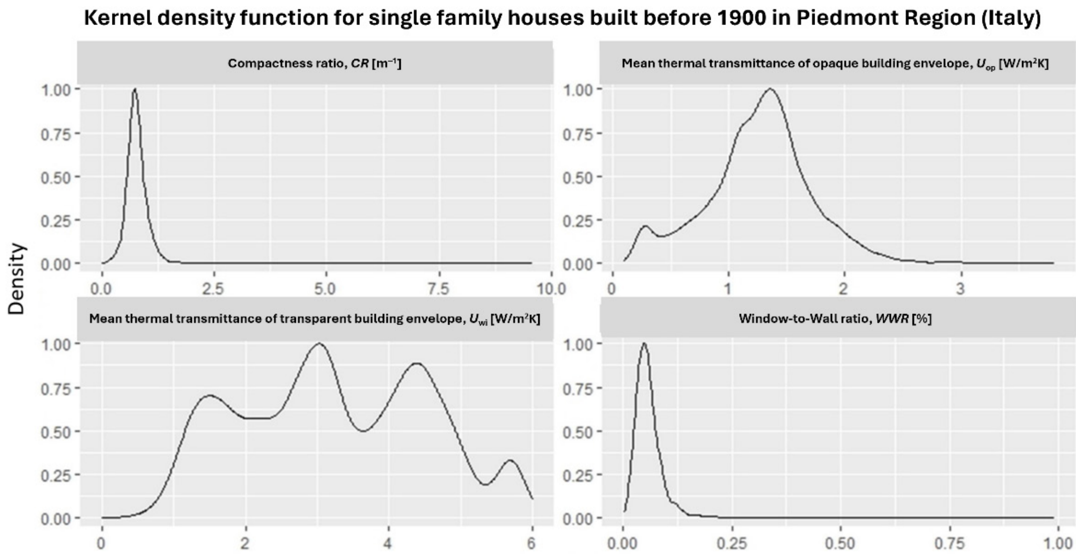

Figure 4: Examples of confidence intervals creation from EPC data processing. Kernel density functions for single family houses built before 1900 in Piedmont Region (Italy)

Outcomes

The procedures developed to enhance the quality of existing EPC data lays the foundations for improving the utilization of the next generation EPC.

The EPC databases across various countries have proven to be valuable sources of data, albeit with certain limitations inherent within the current EPC schema. These include constraints such as limited data availability, static assessment of building energy performance, incomplete energy-related information, and the presence of low-quality data. However, despite these shortcomings, the findings derived from this work offer valuable insights into establishing standardized procedures for verifying EPC quality, benchmarking energy performance across typical building uses, and implementing controls on EPC input data to enhance reliability.

In this context, a common methodology for leveraging EPC databases has been developed. The approach has demonstrated ease of application and upgradability, along with its adaptability to country-specific requirements and tasks to be performed.

In TIMEPAC's vision for the future, the enhanced EPC will undoubtedly lead to higher effectiveness and reliability of results. It will become the cornerstone of future EPC databases within the EU, ensuring that both the archetypes and energy models of the building stock receive continuous updates to align with the variability of the EPC database content.

For more detailed information, please see the report "Procedures and services to undertake large-scale statistical analysis of EPCs databases – Transversal Deployment Scenario 5"

timepac.eu/reports/procedures-and-services-to-undertake-large-scale-statistical-analysis-of-epcs-databases

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