TIMEPAC✓

**Towards Innovative Methods
for Energy Performance Assessment and Certification of Buildings**

Deliverable 1.2

Comprehensive analysis of data storage in the participating countries

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Executive Summary

This deliverable summarizes the results obtained in Task 1.2 "EPC data storage" included in Work Package 1 (WP1) of the TIMEPAC project. The objective of WP1 is to carry out a comparative study of the elements involved in the development of future scenarios to work with enhanced Energy Performance Certification, in each of the four identified stages of the EPC data flow: generation, storage, analysis, and exploitation. As a result of this study, possible improvements, vulnerabilities, threats, and risks related to the upgrade of already existing certification schemes are identified.

Within WP1, the purpose of Task 1.2 is to carry out an audit of the current state of data storage systems for each of the partners participating in the project that own EPC data representing six countries and regions of Europe: Austria (Land Salzburg), Croatia, Cyprus, Italy (Piemonte), Slovenia, and Spain (Catalonia). A methodology based on a survey has been developed to collect and compare the current state of the EPC databases facilitated by each partner. The surveys have been carried out with a data collection form structured which enables the comparison between countries.

An audit based on a list of key metrics (which include openness, performance, origin, flexibility to changes, number of users, etc.) and characteristics (technologies, connectivity, etc.) has been completed to identify limitations and deficiencies of current EPC data storage systems. The calculation of the metrics for the six audited EPC databases highlighted important differences between them. The main ones refer to the interlinking of the EPC database with external sources like cadastre, and to the level of access to EPC data granted to citizen and third parties.

From the result of the audit, it can be concluded that there are still some EPC databases that do not provide citizens and third parties with access to their data. One of the main obstacles seems to be the conflicts with the privacy and data protection laws. Also, there are two EPC databases, from Croatia and Cyprus, which could run automated procedures to uploading data to a database management system. Finally, only a few EPC databases include monitoring data on household energy consumption, as well as other data required for the Building Rehabilitation Passport.

The outcomes of the study carried out in this task will contribute to delimiting the work to be carried out in WP2 "Transversal Deployment Scenarios", whose objective is to propose new procedures to work with the improved Energy Performance Certification.

1 Introduction

1.1 Purpose and target group

Despite the introduction of the Energy Performance of Buildings Directive 2010/31/EU; EPBD recast, amended by Directive 2018/844 (European Union, 2018; Recast EPBD, 2010) there is still a diversity in the implementation of EPC schemes in the EU Member States which leads, among other aspects, to a heterogeneity in the way the EPC data are stored and represented in databases. The development of improved EPC schemes, as anticipated in the revision of the EPBD published in December 2021, are part of an overall strategy to improve building renovation across Europe. In accordance with this strategy, one of the objectives of TIMEPAC project is to identify potential barriers that prevent the adoption of new EPC schemes and/or the access to EPC data by citizens, professionals, technicians, and companies.

The purpose of Task 1.2 "EPC data storage" has been to audit the EPC databases facilitated by partner organisations to obtain an overview of their current state regarding their accessibility, usages and users and connectivity with other data sources. The limitations and deficiencies of current EPC databases have been identified based on a set of key metrics (including openness, performance, provenance, flexibility to change, number of users, etc.) and features (technologies, connectivity, etc.). The metrics have been selected after conducting a literature review in different areas, including the assessment of data bases, harmonisation of datasets of EPCs of building, and/or measurement of open data bases for open data.

The target group are mostly the partners who need to know the capacity of existing databases to incorporate future enhanced EPC schemes. Moreover, other organisations outside the consortium can apply the methodology used in the work to analyse the current status of their EPC databases.

1.2 Deliverable structure

After the introduction, the purpose, methods and tools, participants, implementation, and limitations of the research methodology are described. Then the metrics used in the database auditing are introduced. The results obtained in each country using the structured survey are presented in the following sections. The last part of the document is devoted to comparing, analysing, and discussing the results of the surveys.

1.3 Contribution of partners

The EPC database auditing was carried out by FUNITEC with the contribution of the project partners who answered the surveys (ICAEN, MZI, RP, SERA, EIHP) and with the support of JSI and GOLEA.

1.4 Relations to other project activities

The work done in Task 1.2 "EPC data storage" focuses on one of the four stages of the EPC data flow identified in TIMEPAC. It is related to the work carried out in the other tasks of WP1 in the following ways:

- EPC generation (Task 1.1). The upload process of EPCs has been studied as part of the EPC data storage characterization.
- EPC analysis (Task 1.3). The database updating, maintenance and quality control processes have been examined within the EPC database auditing.
- EPC exploitation (Task 1.4). The database uses and EPC data accessibility (open data) has been characterised.

The outcomes of the study carried out in this task will contribute to delimiting the work to be carried out in WP2 "Transversal Deployment Scenarios", whose objective is to propose new procedures to work with the improved Energy Performance Certification.

2 Research methodology

This section introduces the methodology used in the auditing of the EPC databases. It is divided into four subsections: (1) the purpose of the study, (2) the methods and tools used, (3) the profile of the participants, and (4) the limitations of the study.

2.1 Purpose

The objective of the audit of the EPC databases is to identify limitations, deficiencies and obstacles that could hinder the adoption of new EPC schemes.

2.2 Methods and tools

To the date, there are no European regulations that specify the contents of an EPC database and their management. The absence of such regulations has already been observed by authors of several articles and research projects carried out in recent years (e.g., Geissler et al., 2019; Gonzalez-Caceres, Nielsen, 2020), and in some previous research projects Request2Action (Altmann-Mavaddat et al., 2015) and the Concerted Action EPBD (CA EPBD)[1].

This study is based on a list of metrics that characterise the current state of the ECP databases from a technological perspective. The selection and definition of the metrics are based on the analysis of the existing literature on the subject. The explanation of each metric and its references are detailed in section 3 "Metrics for database auditing".

2.3 Participants

The surveys have been completed by partners who are responsible for the EPC database of their country/region. The participants in the study were experts in energy efficiency of buildings and technicians in charge of maintaining the EPC databases. In some cases, these technicians belong to subcontracted companies. In these cases, it has been the contact persons who have asked them for the specific information that was requested in the survey (e.g., number of tables in the data schema).

2.4 Implementation

The surveys have been conducted in the six countries: Austria (Land Salzburg), Croatia, Cyprus, Italy (Piemonte), Slovenia, and Spain (Catalonia).

The application of the methodology entailed the following tasks (Figure 1):

1. To identify the EPC database systems and to analyse data contents (e.g., data schema), sources, access and scope, as well as procedures for updating data, technologies used.
2. To create a list of metrics to enable the evaluation the current state of the EPC databases from considering the future incorporation of Smart Readiness Indicators, Building Renovation Passports, and sustainability indicators.
3. To develop a survey from the list of metrics to be used by each partner country.
4. To introduce partners to the methodology of the study and to support them to fill the survey. This involved to contact staff (e.g., technicians, managers) of the different institutions involved in EPC database management.
5. To refine the survey questions based on the feedback received from partners.

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[1] https://epbd-ca.eu/ca-outcomes/outputs-2018-2022.

6. To collect provisory results of the survey and to share the conclusions with all the partners to ensure the homogeneity of the overall study. This process was carried out in several iterations.
7. Finally, to compare and discuss the results received from all partners and write the conclusions.
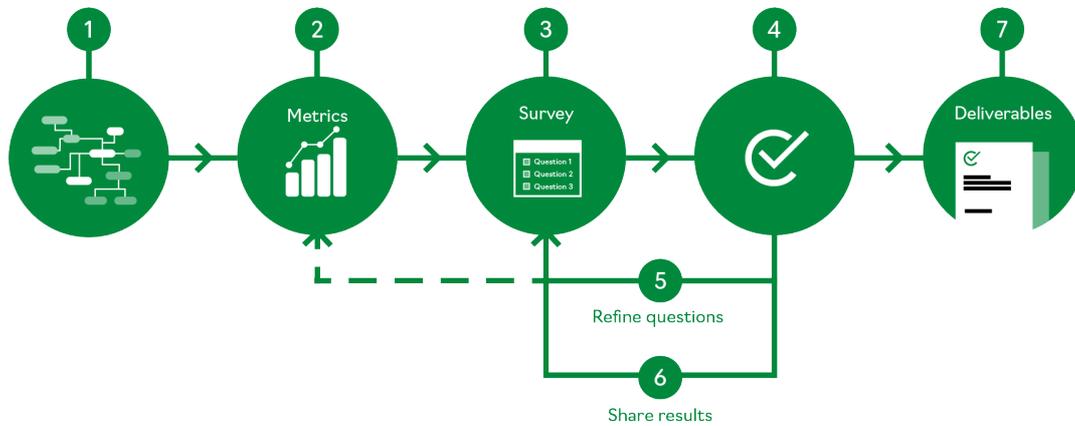
Figure 1. Methodological approach followed to carry out the audits of the EPC database systems

The tasks undertaken as part of the methodology are explained in detail in the following sections.

2.5 Limitations

The main shortcoming of the survey is that has been answered by partners which only represent a few EU member states. In addition, three of the audited EPC databases are from regions (Catalonia, Piemonte, Land Salzburg) rather than countries.

3 Metrics for database auditing

The term 'database auditing' refers to the group of activities involved in analysing and recording the actions that users carry out with the EPC database. But for the results obtained from an audit to be understandable and comparable, it is necessary to use metrics. A metric can be broadly defined as something that can be measured.

To audit EPC databases, a list of metrics has been created representing different aspects such as accessibility of the data, the data sources from which they come, the schema that they follow, etc. After reviewing articles and reports, many of them developed in the context of European research projects in the field of EPC (see the references section), metrics have developed for reach of the following categories:

- Category 1: EPC data uses.
- Category 2: Data sources.
- Category 3: Data access.
- Category 4: Scope.
- Category 5: Procedures for updating data.
- Category 6: Technology and data schema.
- Category 7: Content.

3.1 EPC data uses

This category refers to the identification of the possible uses of the EPC data stored in the databases by the respective national or regional organisations. Knowing about the possible uses can help identify the existing limitations and possible future applications for the energy renovation of buildings, energy planning, investment analysis, quality studies and EPC data validation (Pasichnyi et al., 2019).

The metrics for this category include (Table 1):

- <u>Number of uses</u>: this metric measures the number of uses that national or regional institutions give to EPC data among a range of 8 uses considered the most representative. These have been identified mainly from the literature review, but some of them have also been obtained during the process of surveying the pilot partners. Each of the uses considered is described below:
  1. **Quality control / Quality checking:** different purposes such as detecting missing information, errors made during data entry, duplicated data, data that does not make sense (e.g., data that is out of scale), etc. Specific to the case of EPC data, a quality control should be useful to ensure the confidence of the data and provide an accurate assessment of the dwellings.
  2. **Creation of statistics:** to extract indicators, ratings, etc., for the development of strategic and **planning** documents.
  3. **Policy making:** to develop national renovation and energy efficiency strategies and action plans, or simply as a baseline for policy making decisions.
  4. **Research purposes:** to conduct research on energy efficiency in areas such as energy poverty and climate change.
  5. **Production of results:** to publish reports, identification of buildings most urgently in need of retrofitting, etc.
  6. **To share the contents as open data:** to allow third-party organisations access and reuse them.
  7. **Internal reporting / monitoring current status:** for example, to compare the actual consumption with the calculated demand data of the energy performance certificate, etc.

8. **Issuing of EPC:** administrative process for the issuance of the certificate.
9. **Public information for citizens:** to allow citizens to access the information of the certificates.

Table 1. Metric considered for the EPC data uses category

Ref.	Metric Name	Type of Metric	Value	Description
M1.1	Number of uses	Number	0 - 9	Measures the number of uses that national or regional institutions give to EPC data among a range of 9 uses considered the most representative.

3.2 Data sources

This category deals with the incorporation of data from other sources into the EPC databases. External data can be added to a database directly or after transforming them. Alternatively, a link that points to the original data can be include it (e.g., through a live connection).

The metrics for this category include (Table 2):

- Number of linked data sources: this metric measures the number of connections (of any type) between the database that stores the EPC data and other databases.
- Number of data sources from which some data are obtained: this metric measures the number of data sources from which some data are obtained and stored in the database that stores EPC data.
- Frequency of updating the data: this metric measures how often data from another database is being updated.

Table 2. Metrics considered for the data sources category

Ref.	Metric Name	Type of Metric	Value	Description
M2.1	Number of linked data sources	Number	0 - N	It measures the number of connections (of any type) between the database that stores the EPC data and other databases.
M2.2	Number of data sources from which some data are obtained	Number	0 - N	It measures the number of data sources from which some data are obtained and stored in the database that stores EPC data.
M2.3	Frequency of updating the data	List of items	Instantaneous, Daily, Weekly, Monthly, Yearly.	It measures how often data from another database is being updated.

3.3 Data access

This category is concerned with the accessibility of the EPC data. For the EPC data to be useful for the different actors (citizens, experts, consultants, agencies, etc.), the data must be accessible. There are some methodologies such as the one proposed in the use case "INSPIRE Harmonization of Energy Performance Certificates (EPC) datasets"[2], based on the INSPIRE principles, for the harmonisation of EPC datasets. INSPIRE aims at establishing an accessible and interoperable common knowledge base able to create user friendly web applications to make them accessible and re-usable. National or regional governmental institutions are the owners of the EPC data, but they do not have to be the only users of these data or the only ones that exploit them. It is for this reason that it is important that EPC data are accessible to third parties (Recast EPBD, 2011).

For data to be accessible and reusable, it is important that they are available in the appropriate formats (Table 3). Three cases have been considered: (1) the data are available in proprietary file formats (e.g., MS Excel) or in non-proprietary file formats (e.g., CSV), (2) the data are described according to a data structure (e.g., CSV) or not (e.g., flat text file), and (3) the data are described under a data structure with associated semantics (e.g., RDF) or not (e.g., CSV).

Table 3. Examples of data file formats according to their characteristics

	Non-structured	structured
Non-Proprietary	TXT	XML, CSV, JSON, GeoJSON, RSS, TSV, KMZ, RDF
Proprietary	PDF	MS Excel, Shapefile

Metrics have been provided to measure the number of formats that are used in total and for each of the cases reflected in the previous table for those cells that have a value.

FAIR (Findable, Accessible, Interoperable and Reusable) principles are related to data accessibility. Although FAIR is closer to Open Science than to responding to the issue of sharing the EPC data by administrations, and does not necessarily imply open, the EPC data can be FAIR and shared under restrictions, maintaining the privacy of those data that are confidential and/or internal to a given organisation (Hodson et al., 2018). Data will be more reusable if it follows the FAIR principles. Therefore, it is important to find out to what extent the EPC database administrators are aware of its existence and its value for the European strategy.

Considering the advantages of open access to EPC data, a set of metrics have been considered to analyse the "openness" of their accessibility in databases (Table 4):

- Access level: this metric measures the level of accessibility to EPC data with respect to those that are restricted, according three categories: full, partial, or limited access.
- Level of published data: this metric measures, within five defined ranges, the percentage of data that can be accessed by anyone outside the organisation.
- Number of formats: this metric measures the number of formats used to publish the EPC data.
- Number of formats without data structure: this metric measures the number of formats without data structure used to provide EPC data.
- Number of formats with data structure: this metric measures the number of formats with data structure used to provide EPC data.

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[2]https://inspire.ec.europa.eu/cases-studies/pilot-projects/inspire-energy-pilot/440/bu-data-discoverable-inspire-geoportal/60732.

- Number of non-proprietary formats: this metric measures the number of open formats used to provide EPC data.
- Follow the FAIR principles: this metrics indicates if a database of EPC data follows the FAIR principles or not.

Table 4. Metrics considered for the data access category

Ref.	Metric Name	Type of Metric	Value	Description
M3.1	Access level	List of items	Full open	All the information for everyone.
			Partially open access	Only part of the information is publicly accessible.
			Limited access	Information is only accessible to governments and/or registered experts.
M3.2	Level of published data	List of items	All (100%), Most of them (>75%), Between 75% – 25%, Just a few (<25%), None (0%)	It measures the relation between the EPC data published and the stored in an EPC database.
M3.3	Number of formats	Numeric	0 - N	It measures the number of formats used to publish the EPC data
M3.4	Number of formats without data structure	Numeric	0 - N	It measures the number of formats without data structure used to provide EPC data by administrations.
M3.5	Number of formats with data structure	Numeric	0 - N	It measures the number of formats with data structure used to provide EPC data by administrations.
M3.6	Number of non-proprietary formats	Numeric	0 - N	It measures the number of open formats used to provide EPC data by administrations.
M3.7	Follow the FAIR principles	Y/N	Yes / Not	It indicates if a database of EPC data follows the FAIR principles or not.

3.4 Scope

The metrics related to this category refer to the scope of the EPC database contents: number and type of certificates, and the covered territory. Countries that have federal structures usually have different EPC schemes in each region. This poses a challenge for national policy formulation and for the assessment and comparison of EPCs issued in different parts of the country (Altmann-Mavaddat et al., 2015). The same problem arises at the national-to-European level. In addition, knowing their scope is also necessary in order to compare EPC databases.

The metrics for this category are the following (Table 5):

- Market scope: this metric measures the market scope of the databases according to three options: local, regional, or national.
- Number of certificates: this metric measures the number of certificates stored in the databases based on 5 possible ranges.
- Percentage of houses with certificates: this metric measures the number of certified dwellings with respect to the total number of dwellings.

Table 5. Metrics considered for the scope category

Ref.	Metric Name	Type of Metric	Value	Description
M4.1	Market scope	List of items	Local, Regional, National	It measures the market scope of the databases that stores EPC data.
M4.2	Number of certificates	List of items	0 - 10,000, 10,000 - 100,000, 100,000 – 1,000,000, 1,000,000 - 10,000.000, More than 10,000.000	It measures the number of certificates stored in the databases based on 5 possible ranges.
M4.3	Percentage of houses with certificates	Number	0 - 100%	It measures the number of certified dwellings with respect to the total number

3.5 Procedures for updating data

As suggested by Altmann-Mavaddat et al. (2015), automatically uploading energy performance certificates into a database is a guarantee that certifications are issued accurately and helps to ensure data quality. Automatizing the process for EPC uploading is also important to reduce human error. The metrics selected for the category are concerned with the automation of the EPC generation and storage.

The following metrics have been considered for this category (Table 6):

- Automatically uploaded: this metric indicates if the ECP data are automatically uploaded to the database or not.
- EPCs per month: these metric measures, within four defined ranges, the average number of EPCs that are uploaded to the database each month.

Table 6. Metrics considered for the procedures for updating the EPC data category

Ref.	Metric Name	Type of Metric	Value	Description
M5.1	Is automatically uploaded	Y/N	Yes / Not	It measures the ECP data are automatically uploaded to the database or not.
M5.2	EPCs per month	List of items	1-100, 100-500, 500-1000, >1000	It measures, within four defined ranges, the number of EPC are introduced in the database each

				month.

3.6 Technology and data schema

The technology used in data management systems strongly influences the possibilities of exploiting EPC data. Most institutions across the EU store their EPC data in relational databases, using relational database management systems (RDBMS) to manage them. In these databases, the EPC data are represented with a data structure or schema specific to each institution (different countries, regulations, laws, procedures, etc.). A comparison between the level of complexity of their database schema provides information on the difficulties in adapting them to improved EPCs. For example, institutions that operate with complex data schemas may have to invest more effort when adapting them, while those with a simple schema may find it easier. Several authors have proposed different metrics to measure the complexity of a database schema (Calero et al., 2001; Sinha et al., 2014; Stanger, 2018).

To audit the complexity of the data base schema the following metric is applied (Table 7):

- Simplified database complexity index: this metric measures the complexity of the database schema as the sum of all the attributes, tables, and foreign keys it contains. This is a simplified version of the metric based on the database complexity index (DCI) (Sinha et al., 2014).

Table 7. Metrics considered for the technology and data schema category

Ref.	Metric Name	Type of Metric	Value	Description
M6.1	Simplified database complexity index	Number	0 - N	It measures the complexity of the database schema as the sum of all the attributes, tables, and foreign keys it contains.

3.7 Content

This category concerns the data that are not usually stored in the databases. This is the case of the data provided by the Building Renovation Passports (BRP), a document that includes a long-term step-by-step renovation roadmap for a specific building, resulting from an on-site energy audit and meeting the criteria and specific quality indicators established together with building owners (Fabbri et al., 2017). In this case, monitoring data would include the energy consumption data (electricity, gas, water) of a dwelling every certain period (hour, week, month) over the years.

The following two metrics have been considered to audit whether an EPC database includes monitoring and BRP data (Table 8):

- Store monitoring data: this metric indicates if monitoring data of EPCs are currently being stored in the database.
- Store Building Renovation Passports data: this metric indicates whether an EPC database includes Building Renovation Passport (BRP) data or not.

Table 8. Metrics considered for the content category

Ref.	Metric Name	Type of	Value	Description

		Metric		
M7.1	Store monitoring data	Y / N	Yes / No	It indicates if monitoring data of EPCs is currently being stored in the database.
M7.2	Store Building Renovation Passports data	Y / N	Yes / No	It indicates whether an EPC database includes Building Renovation Passport (BRP) data.

4 EPC Database auditing

The EPC database auditing is based on a survey that has been filled by partners representing six European countries. As described in the methodology section, the process to obtain the answers has involved several iterations. As a result of these iterations, the survey has been updated twice to include new questions based on the feedback received from partners.

The survey has been implemented in an Excel sheet document structured in different parts according to the categories described in section 3:

- Part 1 - EPC data uses.
- Part 2 - Data sources.
- Part 3 - Data access.
- Part 4 – Scope.
- Part 5 - Procedures for updating data.
- Part 6 - Technology and data schema.
- Part 7 – Content.

In most questions, different options are provided in which the partners should tick (mark with an 'x') those which they agree with. Other questions concern figures and numerical data. The Excel sheet also includes cells for partners to enter a description considering a maximum length of words.

While designing the survey, the data necessary to obtain the metrics were considered (see Section 3). In some questions, the incorporation of a text field in which the user is asked to give an additional explanation was considered to be a good idea (e.g., to justify the answer, describe a procedure, add technical details). In some questions, the incorporation of a text field in which the user is asked to give an additional explanation (e.g., to justify the answer, describe a procedure, add technical details) was thought to be appropriate. Although all questions have been formulated so that they can be clearly understood, there are some that cannot be completely satisfied with a simple tick answer, or simply others that require an additional explanation to know if they have been correctly understood.

Annex A includes the results of the surveys completed by the partners involved and a comparison table that summarizes the surveys.

The survey has been carried out on a total of six partners that represent six countries or regions, as indicated in the following Table 9, and whose geographical scope is represented in the map in Figure 2. The interviewees have been the contact persons of each institution and the technicians responsible for maintaining the database.

Table 9. List of partners responsible for each case study

ID	Partner Name	Country	Region
1	SERA	Austria	Land Salzburg
2	EIHP	Croatia	-
3	CEA	Cyprus	-
4	PIEMONTE	Italy	Piemonte
5	MZI	Slovenia	-
6	ICAEN	Spain	Catalonia
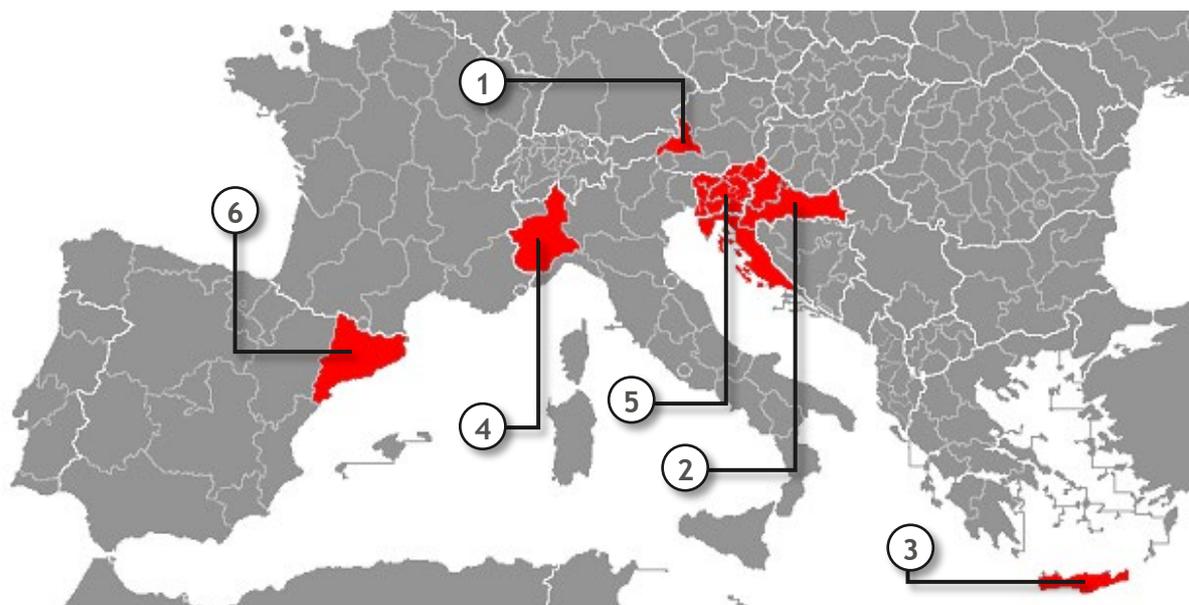
Figure 2. Map showing the countries and regions that have participated in the audit

The following sections describe the partners who participated in the survey and provide a summary of their responses.

4.1 Austria (Land Salzburg)

SERA is an organisation that supports the administration of the Salzburg region in Austria (Figure 3) in managing the Energy Performance Certificates of buildings. The administration owns the ZEUS database that includes the EPC database. Gizmocraft GmbH is a software developer in charge of the implementation of the database and all the necessary steps for its further development.

Country: **Austria (region: Salzburg)**

Number of buildings: **112,649**

Number of EPCs in databases: **35,253**

Percentage of dwellings certified: **31.00%**

EPC Database

- DBMS: **MySQL**
- Tables: **117**
- Attributes: **1,591**
- Foreign keys: **286**

Figure 3. Map showing the region of Salzburg in Austria

4.1.1 Audit results

Based on the survey filled by SERA, the metrics has been calculated and are displayed in Table 10.

EPC data uses. Regarding the possible uses of the EPC data, SERA indicated 6 of the 9 options available in the survey. The EPC data are used to create statistics for quality control and checking. Statistics are also used to determine the decrease in demand for heating energy, share of renewable energy at the level of the Salzburg region, etc. Statistical data are used to policy making. EPC data are also used to produce results (e.g., to generate the necessary documentation according to building code to receive the building permit). Other uses include internal reporting and monitoring the current status of buildings to determine EPC-related grants. Their use for research is regulated by law at regional level.

Data sources. The regional EPC database is not linked to any external database. However, the database includes the data from three other external databases using, for example, a unique EPC identifier to select the corresponding information. Among the databases there is GWR-Zahl[3] (a statistical national database), Basemap[4] (a cadastre database run by Statistics Austria), and SAGIS[5] (a geographical database).

Data access. The EPC data are not available to the public due to conflicts with data privacy issues. Only governmental organisations have full access to the information, as well as experts and building owners to their own data. Also, research organisation can be given access to the data on request. In those cases, the data are provided through different open structured and non-structured data formats (i.e., XML, CSV, XLSX), one of them being a proprietary format.

Scope. The ZEUS EPC database of the region of Salzburg reaches a regional market since it only covers the region. It contains certificates between 100,000 – 1,000,000 with a percentage of 31.00% of dwellings with EPC compared to the total number of dwellings. However, it is worth mentioning that other Austrian provinces also use the ZEUS database system, adapted to the legislative framework of their region.

Data update procedure. Energy performance certificates are automatically uploaded by an expert. This uses an EPC calculation program that generates an XML file that is automatically uploaded to the EPC database. Between 100 and 500 EPC are issued per month.

Technology and data scheme. The ZEUS EPC database has been implemented in a MySQL database management system. The schema of the database has 117 tables, which are interconnected through 286 relations (i.e., foreign key). There is a total of 1,591 attributes to store the EPC data in the database. The simplified database complexity index of the database (1994) indicates a level of complexity that can be considered reasonable for EPC data storage (see M6.1 in Table 10).

Content. The ZEUS EPC database is storing the basic EPC data mandatory by the current legislation, but the ZEUS database system also incorporates data, presently on a voluntary basis or required by a funding scheme, to develop the Building Renovation Passport. They include information from: (1) Legislative or technical standard (Gebäudetechnik-Datenbank: Heating systems database with approved energy efficient products), (2) Monitoring data (production and consumption, open to all building owners and facility managers, and mandatory for those receiving a grant or subsidized loan), (3) Survey on-site (Energieberatung: energy consulting for renovation), and (4) Interviews (Energieberatung: energy consulting for renovation).

Table 10. Auditing result for Austria (Land Salzburg)

Ref.	Metric Name	Value
M1.1	Number of uses	7/9
M2.1	Number of linked data sources	0
M2.2	Number of data sources from which some data are obtained	3
M2.3	Frequency of updating the data	N/A
M3.1	Access level	Limited access
M3.2	Level of published data	None (0%) *
M3.3	Number of formats	3
M3.4	Number of formats without data structure	0
M3.5	Number of formats with data structure	3
M3.6	Number of non-proprietary formats	1

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[3] https://www.statistik.at/web_de/services/adress_gwr_online/energieausweisdatenbank/index.htm
[4] https://basemap.at/
[5] https://www.salzburg.gv.at/sagis

M3.7	Follow the FAIR principles	No
M4.1	Market scope	Regional
M4.2	Number of certificates	100,000 – 1,000,000
M4.3	Percentage of houses with certificates	31.00%
M5.1	Is automatically uploaded	Yes
M5.2	EPCs per month	100 - 500
M6.1	Simplified database complexity index	1994
M7.1	Storing monitoring data	Yes
M7.2	Storing Building Renovation Passports data	Yes

* No data are published to the public although governmental organisation and research organisation can be given access to the data on request

4.2 Croatia

In Croatia (Figure 4), the Energy institute Hrvoje Požar (EIHP) is responsible for managing Energy Performance Certificates. The Department for Renewable Energy Sources and Energy Efficiency is an integral part of the EIHP.

Country: **Croatia (national)**

Number of dwellings: **1,519,038**

Number of EPCs in databases: **300,000**

Percentage of dwellings certified: **19.7%**

EPC Database

- DBMS: **MS SQL Server**
- Tables: **n/a**
- Attributes: **6,428**
- Foreign keys: **954**

Figure 4. Map showing the country of Croatia

4.2.1 Audit results

Based on the survey filled by EIHP, the metrics has been calculated and are displayed in Table 11.

EPC data uses. Regarding the possible uses of the EPC data, EIHP indicated 8 of the 9 options available in the survey. This includes their use for quality control by means of a complete checking of the input data and the results, including recommendations to improve the energy performance of the building. The check is performed for the selected EPCs, either by random selection or through a report. The EPC data are used for EPC issuance, to obtain statistics used in the development of strategic and planning documents, to perform analysis and calculations as a baseline for policy making decisions, and to share key EPC data as open data so that citizens can access them.

Data sources. The national EPC database is not linked to any external database. However, the experts (energy auditors) use the cadastre number and building location extracted from the cadastre database to generate the EPC data. These are used in the same format and structure defined in the cadastre database.

Data access. Most of the EPC data are open to the public, however only data which refers to the owners (owner's name) of the building / building unit are not visible due to the GDPR (General Data Protection Regulation). Furthermore, detailed technical data are not publicly available. The data are accessible through the page of the Ministry of Physical Planning, Construction and State Assets,

as an extract of the base in PDF format, a single non-open (proprietary) and non-structured data format (i.e., PDF).

Scope. The EPC database of Croatia reaches a national market. It contains certificates between 100,000 – 1,000,000 with a percentage of 19.80% of dwellings with EPC compared to the total number of dwellings.

Data update procedure. Energy performance certificates are not automatically uploaded to the database. An authorised person (energy certifier or auditor) enters the information of the EPC to be issued into the database manually. Between 100 and 500 EPC are issued per month.

Technology and data scheme. The EPC database has been implemented using MS SQL Server. The schema of the database contains 954 relations (i.e., foreign key) and 6,428 attributes. The simplified database complexity index of the database (7,382) indicates that the database has a complex data schema with a lot of information for each EPC or data related thereto (M6.1).

Content. The EPC database stores the basic mandatory EPC data under the current legislation. However, it does not store data that are expected to be part of the enhanced EPC schemes (M7.1, M7.2).

Table 11. Auditing result for Croatia

Ref.	Metric Name	Value
M1.1	Number of uses	8/9
M2.1	Number of linked data sources	0
M2.2	Number of data sources from which some data are obtained	1
M2.3	Frequency of updating the data	N/A
M3.1	Access level	Partially open access
M3.2	Level of published data	Just a few (<25%)
M3.3	Number of formats	1
M3.4	Number of formats without data structure	0
M3.5	Number of formats with data structure	0
M3.6	Number of non-proprietary formats	1
M3.7	Follow the FAIR principles	No
M4.1	Market scope	National
M4.2	Number of certificates	100,000 – 1,000,000
M4.3	Percentage of houses with certificates	19.80%
M5.1	Is automatically uploaded	No
M5.2	EPCs per month	100 – 500
M6.1	Simplified database complexity index	7,382
M7.1	Storing monitoring data	No
M7.2	Storing Building Renovation Passports data	No

4.3 Cyprus

In Cyprus (Figure 5), the Cyprus Energy Agency (CEA) is the administration responsible for managing Energy Performance Certificates. CEA is an independent, non-governmental, non-profit organisation, cofounded in 2009 by the European Commission, through the Programme "Intelligent Energy for Europe" and by the Cyprus Union of Communities.
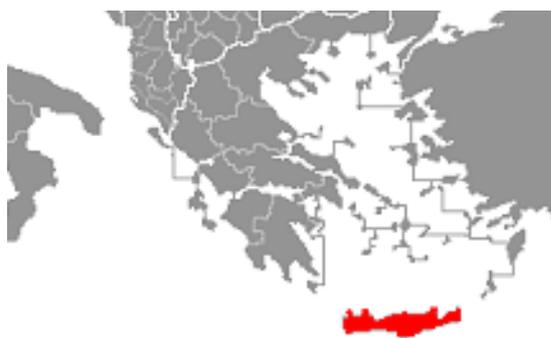
Country: **Cyprus (National)**

Number of dwellings: **448,701**

Number of EPCs in databases: **n/a**

Percentage of dwellings certified: **10.0%**

EPC Database

- DBMS: **n/a**
- Tables: **n/a**
- Attributes: **n/a**
- Foreign keys: **n/a**

Figure 5. Map showing the country of Cyprus

4.3.1 Audit results

Based on the survey filled by CEA, the metrics has been calculated and are displayed in Table 12.

EPC data uses. Regarding the possible uses of the EPC data, CEA indicated 2 of the 9 options available in the survey: (1) Research purposes, where EPC data are used to extract conclusions for the building behaviour and the energy efficiency before and after changes; and (2) Public information for citizens, where the data are used to advise citizens on energy matters, providing them with information and advice on how to carry out a building renovation in terms of energy efficiency.

Data sources. The EPCs are not linked to any external database, and they only import the data from survey on site and energy bills for the creation of EPCs and / or suggestions for energy improvements.

Data access. In general, the data of the certifications are not public. In some European projects in which the agency has been involved, EPCs were created by themselves, or by an independent professional run under their supervision. In this case, the information was published in PDF for research purposes only, a single non-open (proprietary) and non-structured data format.

Scope. The EPC database of Cyprus reaches a national market. It contains a small number of certificates, less than 10,000. The percentage of dwellings with EPC compared to the total number of dwellings is about 10%.

Data update procedure. Energy performance certificates are not automatically uploaded to the database. Every time a new EPC is created, the information is collected and imported into the ISBEMCy software[6]. Procedures for the preparation of the certificate include site visit, drone imagery, gathering information from existing materials through inspection or any available information, and/or owner/architect plans if they are available. Otherwise, a new plan is created in which they investigate through their existing database / knowledge, the properties of materials and techniques. All that information, along with the new EPC, is stored in a folder. Between 1 and 100 EPC are issued per month.

Technology and data scheme. Since the database has been conceived simply in a folder structure, the issues regarding technology and data schema do not apply.

Content. The information of the certifications is organized in a folder structure.

Table 12. Auditing result for Cyprus

Ref.	Metric Name	Value
M1.1	Number of uses	2/9

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[6] http://www.isbem.co.uk/downloads/cyprus/index.php?clave=chipretonidklaldkfjeodkflela11829kmcnsh

M2.1	Number of linked data sources	0
M2.2	Number of data sources from which some data are obtained	3
M2.3	Frequency of updating the data	N/A
M3.1	Access level	Partially open access
M3.2	Level of published data	Just a few (<25%)
M3.3	Number of formats	1
M3.4	Number of formats without data structure	0
M3.5	Number of formats with data structure	0
M3.6	Number of non-proprietary formats	1
M3.7	Follow the FAIR principles	No
M4.1	Market scope	National
M4.2	Number of certificates	0 – 10,000
M4.3	Percentage of houses with certificates	10.0%
M5.1	Is automatically uploaded	No
M5.2	EPCs per month	1 – 100
M6.1	Simplified database complexity index	N/A
M7.1	Storing monitoring data	No
M7.2	Storing Building Renovation Passports data	No

4.4 Italy (Piemonte)

In the region of Piemonte (Figure 6), in Italy, Regione Piemonte (Piemonte) is the public administration responsible for the management of the Energy Performance Certificates of the buildings for the whole region. The EPCs are stored in the IT web platform called SIPEE (Information System for the Building Energy Performance).

Country: **Italy (region: Piemonte)**

Number of dwellings: **1,922,089**

Number of EPCs in databases: **470,600**

Percentage of dwellings certified: **24.50%**

EPC Database

- DBMS: **Oracle**
- Tables: **144**
- Attributes: **1,472**
- Foreign keys: **143**

Figure 6. Map showing the region of Piemonte in Italy

4.4.1 Audit results

Based on the survey filled by PIEMONTE, the metrics has been calculated and are displayed in Table 13.

EPC data uses. Regarding the possible uses of the EPC data, Region Piemonte (Piemonte) indicated 6 of the 9 options available in the survey. All the data stored are aimed at certifying and assessing the performances of the regional building stock. The Regional Agency for Environment (ARPA), which is in charge of the quality check of the EPC, performs the control activity having access to the database. The EPC data are also used for Quality control, creation of statistics, policy making, production of results, and to share the contents as open data.

Data sources. The regional EPC database is linked to the Sistema Informativo sugli Attestati di Prestazione Energetica (SIAPE), the national energy database of Italy, using a web service. Piemonte, just like other Italian regions do, send the data of each EPC to SIAPE system. The upload takes place every 30 minutes using an authentication protocol. The EPC are uploaded to SIAPE with two different purposes: to be added in the national database and to delete the expired or updated certificates. Also, part of the information included in the EPCs is published in the SIAPE portal as open data[7] to ease the processing and statistical treatment of data by research institutes, universities and the general public. The EPC data are also provided to other regional web platforms, such as Felicity[8] and Building Energy Performance (BEP). The former is a simulation tool for the evaluation of the energy saving potentialities. The latter is a tool supporting municipalities in energy management activities.

SIPEE is linked with the Regional Cadastre for heating systems (CIT) via the numerical code of the heating system (boiler, exchange station or heat pump) installed in the building (if there's one). The databases are also connected with geographical information driven by the address of the building (a street repository contain coordinates values in Decimal degrees). The SIPEE is also linked with a protocol routine that verifies the timestamp and integrity of the electronic signature of the certificate. The EPCs are also stored in the official online file storage of the Piemonte Region. The flow of documents is performed by an automatic process.

Data access. Most of the EPC data are open to the public and published in open format, but only governments and control agency have full access to the information. The data published in open data format are the most relevant ones that are shown in the certificates, such as the location of the building, geometric data and information related to energy. Access to open data are done through the portal owned by Regione Piemonte[9]. The services of this portal are managed by CSI (the regional in house IT society) via Yucca Smart Data Platform. Some data cannot be published due to privacy issues. The published data are provided only through an open structured data format (i.e., CSV).

Scope. The database of the region of Piemonte reaches a regional market. It contains certificates between 100,000 – 1,000,000 with a percentage of 24.50% of dwellings with EPC compared to the total number of dwellings.

Data update procedure. Energy performance certificates are automatically uploaded by a professional in charge of issuing them. An energy model of the building is drafted using a commercial software. The output is a XML file issues using the national standard template (XSD V 5.0 extended version). This template contains almost all the geometry and the thermophysical characteristic of the building and the plant installed for each service provided (Heating, cooling, Hot water, etc.). The XSD/XML files are published on a portal[10]. The professional logs onto the SIPEE by using a secure digital credential, then an EPC empty code is bought, and the XML uploaded into the system. The system prints a PDF version of the EPC that must be signed digitally by the professional and uploaded to the system. This is registered and made available for download after few minutes. The download can be performed by the Notary or by the professional. Over 1000 EPC are issued per month.

Technology and data scheme. The EPC database has been implemented in an Oracle database management system. The schema of the database has 144 tables, which are interconnected through 45 relations (i.e., foreign key). There are a total number of 1,472 attributes to store the EPC data in the database. The simplified database complexity index of the database (1759) indicates a level of complexity that can be considered reasonable for EPC data storage (M6.1).

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[7] https://www.dati.piemonte.it/#/home
[8] https://felicity.tools/
[9] https://www.dati.piemonte.it/#/home
[10] https://www.cti2000.it/index.php?controller=news&action=show&newsid=35241

Content. The EPC database stores the basic EPC data mandatory under the current legislation. However, it does not store data that are expected to be part of the enhanced EPC schemes (M7.1, M7.2).

Table 13. Auditing result for Italy (Piemonte)

Ref.	Metric Name	Value
M1.1	Number of uses	6/9
M2.1	Number of linked data sources	1
M2.2	Number of data sources from which some data are obtained	3
M2.3	Frequency of updating the data	Daily
M3.1	Access level	Partially open access
M3.2	Level of published data	Most of them (>75%)
M3.3	Number of formats	1
M3.4	Number of formats without data structure	0
M3.5	Number of formats with data structure	1
M3.6	Number of non-proprietary formats	1
M3.7	Follow the FAIR principles	Yes
M4.1	Market scope	Regional
M4.2	Number of certificates	100,000 – 1,000,000
M4.3	Percentage of houses with certificates	24.50%
M5.1	Is automatically uploaded	Yes
M5.2	EPCs per month	> 1000
M6.1	Simplified database complexity index	1.759
M7.1	Storing monitoring data	No
M7.2	Storing Building Renovation Passports data	No

4.5 Slovenia

In Slovenia (Figure 7), the Ministry of Infrastructure (MZI) is the responsible for developing and carrying out Slovenia's energy policy. EPCs are issued by an authorized organisation and carried out by a licensed expert. The register of authorized organisations is published by Slovenia's Ministry for Infrastructure.

Country: **Slovenia (national)**

Number of dwellings: **318,900**

Number of EPCs in databases: **31,408**

Percentage of dwellings certified: **9.8%**

EPC Database

- DBMS: **Oracle**
- Tables: **110**
- Attributes: **1,710**
- Foreign keys: **45**

Figure 7. Map showing the country of Slovenia

4.5.1 Audit results

Based on the survey filled by MZI, the metrics has been calculated and are displayed in Table 14.

EPC data uses. Regarding the possible uses of the EPC data, MZI indicated 8 of the 9 options available in the survey. They use the data collected from EPCs primarily for statistical purposes. They carry out annual statistical analysis in which they analyse the deviation in the EPC data in a selected number of certificates. When a deviation is detected, all the data required to generate the EPC are examined in more detail to discover what is causing it. They also use the EPC data for quality control, policy making, production of results, research purposes, to share the contents as open data and monitoring.

Data sources. The EPC database is linked to two external databases: (1) Cadastre database, and (2) Geographical database. Special and customized API interfaces are used to provide the communication between the databases. For example, in the process of generating an EPC, an accredited expert enters the official register of energy performance certificates in Slovenia and initially identifies a building, or part of a building, from the Register of Real Estate in Slovenia, and automatically takes all the available data. Every time a new EPC is generated, the process of automatic data transfer is performed via API. This way, at the beginning of the generation process, the registry of issued EPCs automatically connects with the Real Estate Registry database and imports all the necessary data for the generation of the EPC. In cases where a particular building no longer exists or its spatial data has changed in an external database, the data are edited manually.

Data access. Most of the EPC data are open to the public, but some data are only accessible to experts or to the administration itself. There are also data that are not published due to the personal data protection law. The data are provided to the public via the information portal of the National Agency for Cadastre (Surveying and Mapping Authority of the Republic of Slovenia), which already publishes all other data on all buildings in Slovenia. Published data are provided through an open and structured data format (XML) and in PDF.

Scope. Slovenia's EPC database covers the entire national territory, however the number of certificates included in the database (between 10,000 – 100,000) is very low compared to the number of dwellings in Slovenia. Only 9.80% of dwellings have EPC compared to the total number of dwellings.

Data update procedure. Energy performance certificates are automatically uploaded by the independent, trained, and licensed energy certifier during the process of EPC generation. Within the first step, an independent expert searches through the database for the building for which he is preparing the energy performance certificate. In this step, the EPC registry system is connected to the register of all buildings in the Republic of Slovenia. In the next step, the expert creates the EPC and stores it in the database (electronically signed by him). After that, the EPC must be formally issued and electronically signed by an authorized company for the issuance of energy performance certificates. Each EPC is recorded on a daily basis (every night) in the distribution system of the register, which is publicly visible to all citizens. Between 100 and 500 EPC are issued per month.

Technology and data scheme. The EPC database has been implemented in an Oracle database management system. The schema of the database has 110 tables, which are interconnected through 45 relations (i.e., foreign key). There are a total number of 1,710 attributes to store the EPC data in the database. The simplified database complexity index of the database (1,865) indicates a level of complexity that can be considered reasonable for EPC data storage (M6.1).

Content. The EPC database stores the basic EPC data mandatory under the current legislation. However, it does not store data that are expected to be part of the enhanced EPC schemes (M7.1, M7.2).

Table 14. Auditing result for Slovenia

Ref.	Metric Name	Value
M1.1	Number of uses	8/9
M2.1	Number of linked data sources	2
M2.2	Number of data sources from which some data are obtained	2
M2.3	Frequency of updating the data	Instantaneous / Daily
M3.1	Access level	Partially open access
M3.2	Level of published data	Most of them (>75%)
M3.3	Number of formats	2
M3.4	Number of formats without data structure	1
M3.5	Number of formats with data structure	1
M3.6	Number of non-proprietary formats	2
M3.7	Follow the FAIR principles	No
M4.1	Market scope	National
M4.2	Number of certificates	10,000 - 100,000
M4.3	Percentage of houses with certificates	9.80%
M5.1	Is automatically uploaded	Yes
M5.2	EPCs per month	100 - 500
M6.1	Simplified database complexity index	1865
M7.1	Storing monitoring data	No
M7.2	Storing Building Renovation Passports data	No

4.6 Spain (Catalonia)

In the region of Catalonia, in Spain, the Catalan Institute for Energy (ICAEN) is the entity of the Government of Catalonia responsible for developing and carrying out the Catalan energy policy, especially in the field of energy efficiency and renewable energies. To carry out the EPC procedure for the buildings, both existing dwellings and new constructions, citizens must carry out a registration process where ICAEN is responsible for reviewing and preparing the certificate label (Figure 8).

Country: **Spain (region: Catalonia)**

Number of dwellings: **3,863,381**

Number of EPCs in databases: **1,240,000**

Percentage of dwellings certified: **39.89%**

EPC Database

- DBMS: **Oracle**
- Tables: **130**
- Attributes: **764**
- Foreign keys: 81

Figure 8. Map showing the region of Catalonia in Spain

4.6.1 Audit results

Based on the survey filled by ICAEN, the metrics has been calculated and are displayed in Table 15.

EPC data uses. Regarding the possible uses of the EPC data, ICAEN indicated 6 of the 9 options available in the survey (M1.1). ICAEN's EPC database management has a quality control system aimed at detecting possible errors that is applied in the process of entering data from each EPC. The verification is carried out in the data entry form itself. Additionally, a documentary inspection of between 1 and 1,000 EPCs is carried out annually. ICAEN also creates infographics every 6 months with the accumulated results of the EPCs. Likewise, another use of the data comes from City Councils that want to know the level of the certifications of their buildings to detect where to implement rehabilitation policies. The EPC data are also used for research purposes. City councils, universities and real estate agencies are interested in EPC data processed in their local area to evaluate rehabilitation plans, aid, etc. The information on the certificates is published in Open Data with a fortnightly update.

Data sources. Regarding the use of data linked to other data sources, the ICAEN uses a connection with the cadastral database via Web Service in real time (M2.1, M2.2). The identification of the property data in the cadastre database is done from the cadastral reference value or physical address of the property. The retrieved data includes cadastral reference, tax address, use (urban or rustic, residential), surface area and age.

Data access. ICAEN shares most of the data they have in their database as open data through the open data portal of the Catalan government (M3.1, M3.2). In particular, more than 75% of the EPC data are published in multiple structured formats (10 different formats), most of them non-proprietary formats (M3.3-M3.6). Although, they do not follow FAIR principles, they are making accessible their EPC data using a structured format with semantics (i.e., RDF).

Scope. The database of ICAEN reach a regional market since it only covers the Catalonia region (M4.1). However, it contains more than 1,200,000 certificates (M4.2) which is considerable number of certificates. The percentage of certified dwellings is almost 40%, which is a very high figure (M4.3)

Procedures for updating the EPC data. Energy performance certificates are automatically uploaded through the Catalan government platform (M5.1). The person who certifies the building uploads the data into the platform in a PDF format. Besides these data, the XML file with the data used for the EPC generation and their output indicators are also uploaded into the platform. The data are automatically processed and uploaded into the Oracle database. If no warnings are detected during the data processing, the EPC label is issued. In the case a warning is detected, an ICAEN technician will review the data. Over 1000 EPC are issued per month, most of them without the intervention of a technician (M5.2).

Technology and data scheme. The ICAEN database has been implemented in an Oracle database management system. The schema of the database has 130 tables, which are interconnected through 81 relations (i.e., foreign key). There are a total number of 764 attributes to store the EPC data in the database. The simplified database complexity index (975) in the ICAEN database points out that the database is not so complex (M6.1).

Content. The ICAEN database stores the basic EPC data mandatory under the current legislation. However, it does not store data that are expected to be part of the enhanced EPC schemes (M7.1, M7.2).

Table 15. Auditing result for Spain (Catalonia)

Ref.	Metric Name	Value
M1.1	Number of uses	6/9
M2.1	Number of linked data sources	1
M2.2	Number of data sources from which some data are obtained	1

M2.3	Frequency of updating the data	N/A
M3.1	Access level	Partially open access
M3.2	Level of published data	Most of them (>75%)
M3.3	Number of formats	10
M3.4	Number of formats without data structure	0
M3.5	Number of formats with data structure	10
M3.6	Number of formats with data structure and semantics	1
M3.7	Number of non-proprietary formats	8
M3.8	Follow the FAIR principles	No
M4.1	Market scope	Regional
M4.2	Number of certificates	1,000,000 - 10,000.000
M4.3	Percentage of houses with certificates	39.89%
M5.1	Is automatically uploaded	Yes
M5.2	EPCs per month	> 1000
M6.1	Simplified database complexity index	975
M7.1	Storing monitoring data	No
M7.2	Storing Building Renovation Passports data	No

5 Cross-country comparison

This section presents the values of the metrics obtained from the results of the surveys carried out by each partner, presented in the previous sections. As indicated in the methodology for conducting the audit (see Section 3), a comparative table was created and completed with the metric values (Table 16) for each of the partners involved. The colour of the cells is merely indicative and does not represent values of any kind, it only implies that values may be unsatisfactory or that they are not aligned with the current European directive 2018/844 (European Union, 2018) (red cell), compared to those that are (green cell).

Table 16. Comparison table of the metrics for each category

	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Country	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Region	Salzburg	*N.A.*	*N.A.*	Piemonte	*N.A.*	Catalonia
Pilot partner	SERA	EIHP	CEA	RP	MzI	ICAEN
Metrics category 1 – EPC data uses						
M1.1: Number of uses	6	8	2	6	8	6
Metrics category 2 – Data sources						
M2.1: Number of linked data sources	0	0	0	1	2	1
M2.2: Number of data sources from which some data is obtained	3	1	3	3	2	1
M2.3: Frequency of updating the data	*N.A.*	*N.A.*	N.A.	Daily	Instantaneous / Daily	*N.A.*
Metrics category 3 – Data access						
M3.1: Access level	Limited access	Partially open access	Limited access	Partially open access	Partially open access	Partially open access
M3.2: Level of published data	None (0%)	Just a few (<25%)	Just a few (<25%)	Most of them (>75%)	Most of them (>75%)	Most of them (>75%)
M3.3: Number of formats	3	1	1	1	2	10
M3.4: Number of formats without data structure	0	0	0	0	1	0
M3.5: Number of formats with data structure	3	0	0	1	1	11
M3.6: Number of non-proprietary formats	1	0	0	1	2	8
M3.7: Follow the FAIR principles	NO	NO	NO	YES	NO	No
Metrics category 4 – Scope						
M4.1: Market scope	Regional	National	National	Regional	National	Regional
M4.2: Number of certificates	100.000 – 1.000.000	100.000 – 1.000.000	0 - 10.000	100.000 – 1.000.000	10.000 - 100.000	1.000.000 - 10.000.000
M4.3: Percentage of dwellings / buildings with certificates	31,00%	19,80%	< 10%	24,50%	9,80%	39,89%
Metrics category 5 – Data updating procedure						
M5.1: Is automatically uploaded	Yes	No	No	Yes	Yes	Yes
M5.2: EPCs per month	100-500	500-1000	0-100	>1000	100-500	>1000
Metrics category 6 – Technology and data schema						
M6.1: Simplified database complexity index	1994	7382	n/a	1759	1865	975
Metrics category 7 – Content						
M7.1: Store monitoring data	Yes	No	No	No	No	No
M7.2: Store Building Renovation Passport data	Yes	No	No	No	No	No

EPC data uses. All EPC databases is being used for multiple purposes, the cases of Slovenia and Croatia stand out with 8 EPC data uses out of a total of 9 (M1.1). The current version of the EPBD (amended by European Directive (EU) 2018/844, urges EPC database owners to carry out quality control as one of the main uses. Likewise, it is indicated that when the control system for EPCs is complemented with an optional database that goes beyond the requirements of the current directive, the data can be used for compliance checking and generate statistics on the regional and national building stocks. All partners using the data for this purpose.

> The metric of EPC data uses shows that partners are exploiting the EPC databases almost to the fullest.

Data sources. All EPC databases are getting data from at least one external sources (M2.2). In the case of Land Salzburg (Austria) and Piemonte (Italy), their databases are obtaining data from 3 external sources. All the EPC databases are obtaining data from the cadastre and three of them (Catalonia, Slovenia, and Italy) are linked to the cadastre through a Web service or API (M1.1) in real-time.

> Although all EPC databases are linked to or are getting data from the corresponding cadaster databases, there is still missing relations with other databases such as BIM repositories, statistical databases, and building technical inspection databases.

Data access. Most of the EPC databases have partially open access (M3.1). Land Salzburg's case is particularly different and difficult due to many national provisions, as only government agencies and, on request, research organisations have access to the EPC data but not the citizens and third parties because they conflict with possible data privacy issues. Three pilots make more than 75% of the EPC data stored in the database accessible to all public, although the cases of Land Salzburg and Croatia do not share anything or less than 25% (M3.2). With regards to how the data are shared (M3.3-M3.6), the case of Catalonia stands out as the data are shared in 10 different formats, 8 of them using non-proprietary formats. On the other hand, Croatia only shares data in a single proprietary format which hinders the reuse of data by citizens and third parties. The other pilot partners are sharing the EPC data in more than one structured non-proprietary formats. Following FAIR principles is much related to research data however is a good practice to go along with to make better use of EPC data. Only one the Piemonte case is following FAIR principles (M3.7).

> The inadequate sharing of EPC data in terms of quantity and the way it is shared (non-proprietary structured formats and FAIR principles) limits its reuse by the scientific community, the citizenship, and third parties to analyze it and create new services based on EPC data. This is particularly evident in the cases of Land Salzburg and Croatia that are sharing limited or no data with the citizens and third parties.

Scope. There are three pilot partners that collect EPC data from a region and two partners at national level (M4.1). The regional partners have many more certificates stored in their databases (M4.2) and also have a higher percentage of certified houses than the national pilot partners (M4.3). The case of Catalonia stands out as there are more than 1.200.000 certificates almost 40% of the region's dwellings are certified.

> The difference in the number of certificates and the percentage of dwellings certified between regional and national databases would require a detailed study which is out of the scope of this deliverable.

Data updating procedure. Most of the pilot partners upload the EPC data using an automated procedure, however, EPCs in Croatia are not automatically uploaded into the database (M5.1). Automating the EPC uploading process is important to reduce human errors and will become even more important when enhanced EPC schemes are implemented, as they will incorporate more data (e.g., SRI, Building renovation passports, and monitoring data among others).

There are two cases in which the number of EPCs issued per month is 100-500 and the other are over 500. It is particularly striking that in the case of Croatia between 500 and 1,000 certificates are issued per month using non-automated procedures.

Only one of the partners is not carrying out an automated procedure to upload the EPC data to the database.

Technology and data scheme. 5 out of 6 pilots use a relational database management system (RDBMS) to store and handle their EPC data. The simplified database complexity index of most of EPC databases indicates that their level of complexity can be considered reasonable for EPC data storage. At the extremes there is the case of ICAEN with a simple database schema for storing EPC data. And at the other extreme, there is the case of Croatia, whose database schema is the most complex. A special case is Cyprus, which is using a folder structure to store the EPC data. Cyprus has a lot of room for improvement as switching the storage system to a database manager will allow them to generate customised queries and real-time statistics with very little effort.

Only in one case is the EPC data represented in a highly complex schema.

Content. The current version of the EPBD (amended by European Directive (EU) 2018/844), urges EPC database owners to collect data on the measured or calculated energy consumption of covered buildings, including at least public buildings for which an energy performance certificate has been issued. However, most cases have not considered including monitoring data of the consumption of the dwellings, or information for the Building Renovation Passport, in their EPC databases as information to be part of the enhanced EPC schemes.

To date, only one of the partners (region of Salzburg in Austria) has considered storing data in addition to the EPC data, namely monitoring data on the energy consumption of dwellings, as well as some data necessary for the Building Renovation Passport.

6 Relation to other tasks

This section includes the relations (Table 17) between the EPC databases audited in Task 1.2 and the Transversal Deployment Scenarios (TDS) to be carried in WP2.

Regarding BIM data, TDS 1 and TDS 3 will link the data from BIM models and EPCs. For example, for generating EPCs from a BIM model to increase its data quality and for generating building renovation passports from EPCs and BIM models. As the results of the audit of the EPC databases show, none of the partner databases are linked to a BIM database or include BIM data.

TDS 2 will enhance EPC schemes using monitoring data (real energy consumption, energy bills, etc.). At present, there is only one case which offers the option storing monitoring data along with the EPC (Land Salzburg). In the rest of cases, monitoring data will have to be collected from other sources. EPC database managers can learn about how to store and cope with monitoring data from managers of Land Salzburg's EPC database given that the monitoring data will become part of the enhanced EPC schemes.

TDS 3 is aimed at generating BRPs from the available data such as EPC and BIM models. As for TDS2, Land Salzburg is the only case which is already considering BRP data in the extended database system. Again, EPC database managers can learn from managers of Land Salzburg's database system about how to store and cope with BRP data given that the monitoring data may have a string link with the enhanced EPC schemes.

The database complexity index is related to those TDSs which will analyse the database such as TDS 4 and 5. Having a less complex database schema will reduce the efforts to update the schema to include new indicators (SRI, sustainable indicators, etc.) and will ease the statistical analysis of the EPC databases.

With regards to the use of EPC data, all cases use the database to create statistics as can be seen in the survey (Annex A). This is much related to TDS 5 which aims at carrying out large scale statistical analyses of the EPC databases. Here, TDS 5 can carry out the statistical analysed based on the already existing statistics made from the databases.

The number of certificates and the percentage of certified dwellings outlined in the EPC database auditing should be taken into consideration when the statistical analysis is carried out in TDS 5. As stated in the analyses there are three EPC databases that have a significant percentage of certified dwellings, but still do not reach even 50% of total number of dwellings.

Table 17. Relation between TDS and the EPC database auditing

Transversal Deployment Scenarios	EPC database auditing topics
TDS 1 - Generating enhanced EPCs with BIM data	Linked data sources and BIM
TDS 2 - Enhancing EPC schemas through operational data integration	Monitoring data
TDS 3 - Creating Building Renovation Passports from data repositories	Building Renovation Passports and BIM
TDS 4 - Integration of Smart Readiness Indicators and sustainability indicators in EPC	Database complexity
TDS 5 - Large scale statistical analysis of EPC databases	EPC data uses, Data access, Database complexity, Number of certificates, and percentage of certified dwellings

7 Conclusions

The work carried out in Task 1.2 of TIMEPAC project has focused on auditing the EPC databases in six EU countries. To carry out this task, a methodology has been proposed and a survey has been developed to collect data from the different partners involved in the project. The aim of the survey has been to understand the current status of the EPC databases and to identify the common limitations and obstacles that may prevent the adoption of the new EPC schemes.

The six EPC databases audited have scored differently on each of the metrics. On observation of the results, it can be concluded that the databases of Catalonia and Piemonte regions have similar metrics with slight differences, such as the number of formats used to share the data and the use of FAIR principles. Although all audited EPC databases are linked to or obtain data from the corresponding cadastre databases, links with other databases such as BIM repositories, statistical databases, and building technical inspection databases are still missing.

The Open Data Directive (European Parliament and European Council, 2019) and Data Governance Act (European Parliament and European Council, 2020) encourage public administrations to adopt open data policies, allowing broad use and reuse of their data. However not all the EPC databases audited are making their data accessible to citizens and third parties due to conflicts with possible data privacy issues arising from the GDPR (General Data Protection Regulation). It is important to stress that publicly sharing energy performance certificates in a non-proprietary format will enable third parties to develop new energy services and businesses models.

The relations of the outcomes of this task to the upcoming tasks of the project concern understanding the current state of the databases and how the TDSs can benefit from existing data (e.g., monitoring data in the case of Land Salzburg, creation of statistics in all cases).

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Annexes

Annex A – Survey results

This annex includes the comparison tables with the results of the surveys divided by sections, one for each category.

Comparison for the category "EPC data uses":

Part 1 – EPC data uses						
1.1. What is your database intended use for? [Multiple choice]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Quality control / Quality checking	X	X	X	X	X	
Creation of statistics	X	X	X	X	X	
Policy making	X	X	X	X	X	
Research purposes.	X	X		X	X	X
Production of results		X	X	X	X	
To share the contents as open data	X	X	X		X	
Internal reporting / monitoring current status	X	X		X	X	
Issuing of EPC					X	
Public information for citizens		X				X
Other:			Law obligat.			
Describe the reasons for each of the uses you have selected (200-500 word):						
ICAEN	Quality control / Quality checking: Our back office (BO) has defined configurable alarms to detect errors in different fields of the EPC. These alarms are activated in the form itself or in our BO. Depending on the severity, they are divided into ERROR (they do not allow processing) or WARNING (they allow processing but ask the technician to check or justify the data). A documentary on-site inspection of 1/1000 EPCs is carried out annually. Creation of statistics: Every 6 months an infographic is created with the accumulated results of the EPC's. Policy making: some municipalities ask us about the energy certificates of their population to detect where to carry out rehabilitation policies. Research purposes: City councils, universities or real estate agencies request data from the EPC's processed in their local areas to evaluate rehabilitation plans, aid, etc. These queries are made with SQLDeveloper and exported to Excel. To share the contents as open data: The information on the certificates is published in Open Data with a fortnightly update. Internal reporting / monitoring current status: we review daily energy certificates that have not passed the alarms.					
MZI	All collected data that is necessary for the generation of each individual energy performance certificate (visible on the issued energy performance certificate), is stored in the database. Also, database contains all the data needed to calculate the energy performance of buildings in accordance with the national Rules on efficient use of energy in buildings. The accredited experts must import these data into the database via a special "xml" file when creating/generating the energy performance certificate. Data from all generated energy performance certificates for all types of buildings is used for statistical purposes. For those energy performance certificates that are selected to be reviewed in detail, all data that was necessary to calculate the energy performance of building and that was imported by the accredited experts in the database via "xml" file, is now exported from the database. During the regular annual statistical analysis of selected number of issued energy performance certificates deviation in data presented on energy performance certificate is analysed. In the case that statistical analysis reveals deviations in numbers presented on a particular energy performance certificate, all the data necessary for its generation is examined in more details in order to discover the cause of discovered deviations.					

Piemonte	Regione Piemonte is responsible for the EPC cadastre according to the related national and regional laws. The database is online and it is called SIPEE (Sistema Informativo per la Pretazione Energetica degli Edifici). Its role is mainly related to the generation and storage of the EPCs. The regional cadastre is linked with other databases (the cadastre for heating systems) and interconnected with the national EPC database (SIAPE) managed by ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development). All the information stored are aimed at certifying and assessing the performances of the regional building stock. In Italy the generation of an EPC is mandatory for houses/apartment selling and renting, Regione Piemonte is guarantor for the authenticity of the documents and for the responsibility of the emitter. Besides an EPC is required in case of new construction or energy refurbishment of the building/apartment. Under standard conditions the EPC has its validity for 10 years. The Regional Agency for Environment (ARPA), which is in charge of the quality check of the EPC, performs the control activity having access to the database.
SERA	Quality control / Quality checking: (independent control system; sample and recalculation etc.) Creation of statistics: for example on decrease of heating energy demand; share of renewable energy; at the level of Land Salzburg region. Grant award: Housing subsidy is based on EPC; EPC database is connected with subsidy system Policy making: indirectly based on statistics. Research purposes: official application with data request (type of data and format) and purpose of data use is sent to authority; authority approves, makes a query and sends data to applicant. Production of results: database is used to process the EPC as part of the documents needed according to building code to receive the building permit; the responsible department of the municipality that is the building authority approves the EPC in the database. Internal reporting / monitoring current status: for example on EPC-related grants.
EIHP	Quality control – full check of the input data and the results, including the recommendations to improve the energy performance of the building or building unit. Quality control is done for selected EPC's either through random selection or on report. Creation of statistics – data from database is used for development of planning and strategic documents. Policy making – data from database is used for various analysis and calculations that are baseline for policy making decisions. To share the contents as open data – key data from EPC's is available in open format for citizens to access. Issuing of EPC – database is used for EPC generation (calculations are done by experts and the results are uploaded to the database to generate EPC).
CEA	Research purposes: Our organisation is using the existing EPC's to extract conclusions for the building behaviour and the energy efficiency before and after changes. Public information for citizens: Our duties is to consulting citizens in energy matters, providing them information and advices on how to energy upgrade buildings.

Comparison for the category "Data sources"

Part 2 – Data sources						
2.1. What data sources is your EPC database linked to? [Multiple choice]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Cadastre database.	X	X	X			
Geographical database.		X				
Regional or national database.						
Statistical database.						
Survey on-site.						
Legislative or technical standard.						
Based on occupant interview.						
Existing energy report.						
Numerical assessment.						
Energy bills.						
BIM repository.						
Other:					NIAS (e-Citizens)	
If applicable, describe how the link between your database and an external source is made (API, Web services,…) (200-500 word):						
ICAEN	The connection with the cadastre will be made through a Web Service in real time from the cadastral reference or the address of the property. The information obtained will be stored in the Oracle database, and will be displayed both in the BackOffice and in the Certificate Viewer. The information that will be consulted is the following: cadastral reference, tax address, use (urban or rustic, residential), surface area and age.					

MZL	Special and customised interfaces mean dedicated API(s) which serve(s) as an automatic connection(s) between different applications. For example, at the beginning of the EPC generation process, accredited expert enters the official register of energy performance certificates in Slovenia and initially identifies a building or part of a building from the Real Estate Register in Slovenia and automatically takes over all available data. This process (automatic data transfer via special API) is repeated each time when the new EPC is being generated
Piemonte	The regional EPC DB is linked with national DB (SIAPE, operated by ENEA) via web services. Regione Piemonte and other Italian regions send each EPC to SIAPE system. The upload takes place every 30 minutes using an authentication protocol. The EPC are sent towards SIAPE with two different purposes: to "upload" the new EPCs in order to be added in the national database and to "delete" the expired or updated certificates. Besides, part of the information included in the EPC is published as open data in order to ease the processing and statistical treatment of data by research institutes, universities and the general public. The open data access is (https://www.dati.piemonte.it/#/home). A set of information taken from the SIPEE cadastre is also delivered to Municipalities via a cloud portal, named IOCOMUNE, where other energy information is stored in a way to be made available for policy and planning purposes. Besides the EPC data are also provided to other regional web platforms, such as Felicity (https://felicity.tools/) and Building Energy Performance (BEP). The former is a simulation tool for the evaluation of the energy saving potentialities, the latter is a tool supporting municipalities in energy management activities.
SERA	N/A
EIHP	No connection to any other database
CEA	N/A

2.2. In case your EPC database has a connection to one or more external databases, how often is it updated? [Please, choose only one]

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
Instantaneous.		X				
Every day.		X				
Every week.						
Every month.						
With other frequency:			30 mins			

Describe the reason for this frequency (e.g., if this is the desired one, if there are limitations, etc.) (200-500 word):

ICAEN	The connection with the cadastre is not yet implemented.
MZI	All information available to citizens from EPC are updated daily. Also, at the beginning of the generation process the register of issued EPCs in Slovenia automatically connects with other external databases (for example Real Estate Register in Slovenia) and imports all necessary data for the generation of energy performance certificate. In cases when we are informed that a particular building no longer exists or its spatial data has changed, we intervene and manually edit that data
Piemonte	Every 30 minutes (excluding the week-end) due to technological aspects and based on agreements defined at National level. The frequency set is the desired one. A standard flow of information from SIPEE to SIAPE (National DB) is scheduled. The web services upload the new EPCs and delete the updated and expired EPCs. For the other regional platforms the information are updated about every other week. Since 2020, the IOCOMUNE platform is also able to keep track of the evolution of the EPC issue at regional level, in a way that it is possible to know how many EPCs are issued every year and for which energy class or building type.
SERA	NA
EIHP	No connection to any other database
CEA	Our database in not connected to any external database but we are adding manually information from new EPC's with frequency of once every six months.

2.3. What other databases does your EPC database get the data from? [Multiple choice]

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
Cadastre database.	X	X	X	X	X	

Geographical database.		X	X	X		
Regional or national database.			X	X		X
Statistical database.						
Survey on-site.						
Technician defined.						X
Legislative or technical standard.						
Based on occupant interview.						
Existing energy report.						
Numerical assessment.						
Energy bills.						X
BIM repository.						
Other:						

Describe how the data are reused (e.g., maintaining the same structure of original, etc…) (200-500 word):	
ICAEN	In most cases, the cadastral reference is available, and if not, the property address is available. Based on that, the idea for the future is to process the energy certification from the BO connecting it to the Cadastre Database (via API) in real time to make checks and / or add useful information to the certificate search engine. ICAEN needs to know what information can be obtained from the Cadastre Database API in order to select the required data and the checks to be made. Information that can be consulted through free web services: • Cadastral reference • Tax domicile • Use (Urban or rustic, residential) • Surface • Coefficient of participation • Antiquity • List of construction units (with staircase / floor / door and surface) • Surface of the common elements • Free web services of the Cadastre • List of subplots (with subplot code, crop, production intensity and area)
MZI	In order to assure the transparency and traceability of paired data we follow the rule to always maintain the structure of the original.
Piemonte	SIPEE is linked with the Regional Cadastre for heating systems (CIT) via the numeric code of the heating system (boiler, exchange station or heat pump) installed in the building (if there's one). The databases are also connected with geographical information driven by the address of the building (a street repository contain coordinates values in Decimal degrees). The SIPEE is also linked with a protocol routine that verify timestamp and integrity of the electronic signature of the certificate. The EPCs are also stored in the official online file storage of the Piemonte Region. The flow of documents is performed by an automatic process.
SERA	The same structure of the original source is maintained: (*) Statistical database: GWR-Zahl (unique EPC identifier) https://www.statistik.at/web_de/services/adress_gwr_online/energieausweisdatenbank/index.html (*) Cadastre database: Basemap https://basemap.at/ (*) Geographical database: SAGIS https://www.salzburg.gv.at/sagis The following is not part of the ZEUS EPC database as such, but part of the ZEUS database system. Systems listed in the Heating systems database and Monitoring has been mandatory for building owners applying for an energy-related grant or subsidised loan (new construction or renovation). Recently, work started to make use of these elements for creating the Building Renovation Passport: (*) Legislative or technical standard: Gebäudetechnik-Datenbank (Heating systems database with approved energy efficient products) (*) Monitoring data: production and consumption; open to all building owners and facility managers; mandatory for specific systems receiving a grant or subsidised loan (*) Survey on-site: Energieberatung (Energy consulting for renovation) (*) Based on occupant interview: Energieberatung (Energy consulting for renovation)

EIHP	Cadastre database – experts (energy auditors) use cadastre number and location on EPC from Cadastre database. The cadastre number and location is used in the same format and structure as defined in Cadastre database.
CEA	We are importing data from survey on site and energy bills for the creation of an EPC and/or suggestions for energy improvements.

Comparison for the category "Data access"

Part 3 – Data access						
3.1. What is the access level to your EPC database? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Full open access (all the information for everyone).						
Partially open access (only part of the information is publicly accessible).	X	X	X		X	X
Limited access: to experts who have registered.						X
Limited access: to governments.				X		
Limited access: to experts who have registered and governments.						
Other (explain):			X	X		
Other:						
ICAEN	NA					
MZI	Each stakeholder, for example an independent expert, has access to the register (database) so that it can produce records (EPCs) and review its own records (EPCs). Certain amount of data are completely open to the public. Ministry of Infrastructure has a special administrative access to all data stored in the database.					
Piemonte	Governments and control agency have full access to the information, data in open format are published for everyone					
SERA	For research and scientific work, based on official application which must be approved by the authority; purpose of data use is regulated by law at regional level (and differs between the Austrian provinces)					
EIHP	NA					
CEA	NA					
3.2. How much data are publicly available (to anyone outside the organisation) compared to those stored in the EPC database? [Please, choose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
All (100%).						
Most of them (>75%).	X	X	X			
Between 75% and 25%						
Just a few (<25%).					X	X
None (0%).				X		
If you do not publish all the data, would you be able to tell why? (political or technical reasons…) (200-500 word):						
ICAEN	NA					
MZI	Some part of the data are not published due to personal data protection requirements.					
Piemonte	Data that are not published are conflicting with potential privacy issues. The data published as open data format are the most relevant ones shown in the certificates, such as location of the building, geometrical data and energy related information.					

SERA	Political reasons; GDPR concerns; regarding GDPR concerns a detailed study was done in the context of the ENERFUND project; the situation is still the same; a solution can come from the EC, by defining the building address as non-personal data
EIHP	All issued certificates are publicly available, only data which refers to owner (owner's name) of the building/building unit are not visible due to the GDPR (General Data Protection Regulation). Also, detailed technical data are not publicly available (mostly
CEA	Generally In Cyprus the EPC's are not published. In some European projects were we was participated the EPC's was created by us or by freelancer directed from us and were published for researched reasons.

3.3. If you have published data (publicly available) in which of the following formats is it available? [Multiple choice]

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
XML	X	X		X		
RDF	X					
TXT						
CSV	X		X	X		
Excel	X			X		
JSON	X					
RSS	X					
TSV for Excel	X					
KMZ	X					
Shapefile	X					
GeoJSON	X					
PDF		X			X	X
Other formats:						

3.4. Does your EPC database follow FAIR principles [Please, choose only one]

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
Yes			X			
No	X	X		X	X	X

3.5. How data are made publicly accessible? [Please, choose only one]

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
Directly through your company						
Through a third party	X	X	X	X	X	
Other:		X			X	X

* Geodetic Administration of the Republic of Slovenia

Provide details about your answer (200-500 word):

ICAEN	From the Oracle database, CSV files are generated with the EPC's information and sent via FTP to Socrata for publication on the Open Data platform. There are 3 datasets: 1. Identifying information, epnr, emissions, demands, existence of renewables, georeferencing, average transmittances. 2. Information about thermal installations. 3. Information about enclosures.
MZI	The data are provided to the public via the information portal of the National Agency for Cadastre (Surveying and Mapping Authority of the Republic of Slovenia), which already publishes all other data on all buildings in Slovenia.
Piemonte	The website (https://www.dati.piemonte.it/#/home) is owned by Regione Piemonte, the services are managed by CSI (the regional in house IT society) via Yucca Smart Data Platform.

SERA	The Province of Salzburg owns the ZEUS database. There is a legal mandate for the establishment and all changes. gizmocraft GmbH is a software developer entrusted with the implementation of the database and all necessary steps for further development. If there is the need for data for a research project, an official application must be sent to the authority, and after approval the request is processed by gizmocraft on behalf of the authority.
EIHP	The data are accessed via a web address available on the Ministry of Physical Planning, Construction and State Assets page, as an extract from the base in PDF format.
CEA	The data are published through results of a project that we were participated.

Comparison for the category "Scope"

Part 4 – Scope						
4.1. What is the market scope of your database? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Local.						
Regional.	X		X	X		
National.		X			X	X
4.2. What is the number of certificates currently stored in your database? [Please, choose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
0 - 10,000.						X
10,000 - 100,000.		X				
100,000 – 1,000,000.			X	X	X	
1,000,000 - 10,000.000.	X					
More than 10,000.000						
4.3. What is the percentage of total dwellings vs dwellings with EPC in the databases? [Please, enter a percentage]						
%	**32.09%**	**9.80%**	**24.50%**	**31.00%**	**19.80%**	**<10%**

Comparison for the category "Data updating procedure"

Part 5 – Data updating procedure						
5.1. How is your database updated? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Manual		X				X
Automatically	X	X	X	X		
Other (explain the process):					X	
What procedures are followed to introduce data in the EPC database? (200-500 word):						
ICAEN	From the processing platform of the Generalitat de Catalunya (Tràmits Gencat), the technician sends to the ICAEN all the documentation related to the certificate through a PDF form. From this documentation, the data are loaded into the different oracle tables. If the EPC get over all the alarms that we have configured, the corresponding label is sent automatically and is published both on our website and in the corresponding section of Tràmits Gencat. In the event that the EPC does not exceed any of the alarms, an ICAEN technician will review the certificate and will require the technician to modify or justify it.					
MZI	Insertion of new record in the database is initiated by the independent, trained and licensed energy certifier during the process of EPC generation. Within the first step, independent expert searches through the database for the building for which he is preparing the energy performance certificate. In this step the EPC registry system is connected to the register of all buildings in the Republic of Slovenia. In the next step independent expert creates new energy performance certificate, stores it in the database and signs it electronically. After the generation of the energy performance certificate which is done by the independent, trained and licensed expert, it has to be formally issued and electronically signed by an authorized company for the issuance of energy performance certificates. Each energy performance certificate is on a daily basis (every night) also recorded in the distribution system of the register, which is publicly visible to all citizens.					

Piemonte	The professional in charge of issuing the EPC drafts an energy model of the building using a commercial software. The output is a XML file issues on the national standard template (XSD V 5.0 extended version). This template contains almost the entire geometry and the thermophysical characteristic of the building and the plant installed for each service provided (Heating, cooling, Hot water...). The XSD/XML is published on https://www.cti2000.it/index.php?controller=news&action=show&newsid=35241). The professional logs in the SIPEE by using a secure digital credential, then an EPC empty code is bought and the XML uploaded into the system. The system print a PDF version of the EPC that has to be signed digitally by the professional and uploaded in the system. The signed EPC in PDF format is registered and made available for download after few minutes. The download can be performed by the Notary or by the professional.
SERA	The approved EPC calculation programmes have an automatic XML upload interface to the EPC database.
EIHP	Authorised persons - energy certifiers and auditors enter data on issued energy certificates
CEA	Every time we need to create a new EPC we collecting many information. After the collection of the necessary information is done we have to import the information in the ISBEMCy software for the EPC creation. The procedures we are following are: site visit, pictures from drone, collect information for existing materials through inspection or any available information, plans from the owner/architect if any available otherwise we create one new plan, research through our existing database/knowledge for the properties of materials and technics. All those information together with the new EPC are stored in a folder in our database.

5.2. How many EPC are introduced in the database each month (in average)? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
1-100						X
100-500		X		X		
500-1000					X	
>1000	X		X			
Other (explain the process):						

Comparison for the category "Technology and data schema"

Part 6 – Technology and data schema						
6.1. What is the format of the database? [Please, choose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Folder structure						X
Excel spreadsheet						
Specific format						
Database management system (DBMS)	X	X	X	X	X	
Other (explain):						
6.2. In case your EPC data are stored in a DBMS, what is it? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Oracle database.	X	X	X			
Microsoft SQL Server.					X	
MySQL.				X		
Other:						
6.3. What is the level of detail of your EPC database schema?						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Number of attributes it has in all the tables:	764	1710	1472	1591	6428	n/a
Number of foreign keys it has:	81	45	143	286	954	n/a
Number of tables it has:	130	110	144	117		n/a

Comparison for the category "Content"

Part 7 – Content						
7.1. How is your database managed (maintenance, updating…)? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Directly through your company.		X				X
Through a third party?	X		X	X	X	
Other:						

Provide details about your answer. Explain how do you maintain the database. (200-500 word):	
ICAEN	The server that contains the registry database is external and makes the corresponding backup copies, as well as reindexing of tables, and scripts to control data quality.
MZI	Ministry of Infrastructure has a special contract with the external company that is responsible for the database development, management and updates. However, in terms of content the register is managed by employees of the Ministry of Infrastructure.
Piemonte	Consorzio per il Sistema Informativo (CSI, the In House IT Company of Regione) is committed to build, operate and maintain the SIPEE. The system was created in 2009 and a full refurbishment of the system has been performed in 2015. The maintenance service is based on the following services: help desk, ordinary maintenance, backup and communication via a periodic newsletter. On a yearly basis potential improvements are agreed between Regione Piemonte and CSI. The maintenance costs are covered by the fee for the release of the EPC, which is paid by the professional in charge of drafting the certificate. The fee cost is 15 euro for each EPC whatever the building is.
SERA	The owner of the database is the Province of Salzburg and the responsible department/authority has a legal mandate for maintaining and further developing the database. Each request by users, for example if there is a failure, is sent to the responsible administrative unit within the Province of Salzburg. gizmocraft GmbH provides second level support.
EIHP	The base is owned by the Ministry of Physical Planning, Construction and State Assets and maintenance and updates are entrusted to a third party through service contracts.
CEA	

7.2. Are you storing monitoring data (consumptions, temperature…) in your database? [Please, chose only one]						
	Spain	**Slovenia**	**Italy**	**Austria**	**Croatia**	**Cyprus**
Yes				X		
No	X	X	X		X	X

In affirmative case: explain how the monitored data are stored (200-500 word):	
ICAEN	NA
MZI	NA
Piemonte	NA
SERA	Online energy accounting has been available for municipalities, property developers, property management companies and private individuals since April 2013. Via the ZEUS database, in which energy performance certificates have already been managed since 2007, meter data can now also be collected to record energy consumption and renewable energy production. This makes it possible to compare the actual consumption data (ACTUAL data) with the calculated demand data of the energy performance certificate (TARGET data). Energy accounting offers the following functions: (*) Building management, (*) Meter management per building, (*) Recording of meter readings per meter, (*) Data export and energy reports. This is not yet part of the EPC and largely voluntary or required for certain types of grants/subsidized loans. However, this will be considered for developing the Building Renovation Passport.
EIHP	NA
CEA	NA
7.3. Are you storing data about Building Renovation Passports in your database? [Please, chose only one]	

	Spain	Slovenia	Italy	Austria	Croatia	Cyprus
Yes				X		
No	X	X	X		X	X

In affirmative case: explain how the data about Building Renovation Passports are stored (200-500 word):	
ICAEN	NA
MZI	NA
Piemonte	NA
SERA	The following is not part of the ZEUS EPC database as such, but part of the ZEUS database system. Systems listed in the Heating systems database and Monitoring has been mandatory for building owners applying for an energy-related grant or subsidised loan (new construction or renovation). Recently, work started to make use of these elements for creating the Building Renovation Passport: (*) Legislative or technical standard: Gebäudetechnik-Datenbank (Heating systems database with approved energy efficient products) (*) Monitoring data: production and consumption; open to all building owners and facility managers; mandatory for specific systems receiving a grant or subsidised loan (*) Survey on-site: Energieberatung (Energy consulting for renovation) (*) Based on occupant interview: Energieberatung (Energy consulting for renovation)
EIHP	NA
CEA	NA