Assessment of Use Cases Involving Data from the Energy Performance Certification Process for Buildings - From Individual Buildings to Regional Scale

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Abstract. The main objective of this paper is to analyse use-cases which are based on data from the Energy Performance Certification (EPC) process. This data, which is often collected for compliance checks by authorities, can be used exploited for multiple purposes. The most basic service is energy consulting by engineers, based on a living document from the EPC process, depicting the buildings thermal characteristics and specification of the HVAC system. But also, the design of regional decarbonization can be data driven, and the drafting of energy policies supported, investigating effect of renovation and decarbonization incentives. When using data from EPC software export files to set up thermal building models for digital twins, peak load shifting at the individual building and district level can be initiated. A high coverage with EPC as source for digital twins can be achieved by marketing for pre-planning decarbonisation of quarters. This paper is originating from the work in the research project EPC4SES which is funded in the ERANet RegSys program and by HORIZON, and develops six use-cases and analyses strengths, weaknesses, opportunities, and threads of services making use of data from the EPC process.

Keywords. Open data, EPBD, Digitalisation, Digital Twin, Decarbonisation, EPC, Regional Energy Planning.
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1 Objective for the research

The hypothesis of this research in the project EPC4SES is that valuable information from the energy performance certification EPC does exists which might be exploited to the good of reducing energy demand and CO2 intensity for heating/colling of buildings. This assumption is also backed by literature that "EPC data to add value for policy making, monitoring and research analysis" (Pasichnyi, Wallin, Levihn, Shahrokni, & Kordas, 2018). Such information from EPC was available publicly in an open data registry for England and Wales until Sept. 2021 (Department for Levelling Up, Housing & Communities, 2022). Depending on the regional schemes in the EU member states extended information – to be uploaded to EPC registries – may also be available to the building owners. Such data is embedded in transfer formats (usually XML) and can contain all information to model the thermal behaviour of buildings. In the Austrian Province of Vorarlberg, we find a many fold more detailed data model (Energieausweis-Zentrale, 2017) compared to the Viennese WUKESA system. The ZEUS system in Austria which was adopted by four regions (Archiphysik, 2020) has a similar data model than Germany, and presents a registry functionality for the erectors, EPC issuers and authorities. Since the data model of the transfer files varies across one country and the EU the project shall make a statement with regards to the EPC data usage scenarios. The project EPC4SES shall investigate exploitation of such data to build digital twins for buildings, allowing microscopic simulation of buildings and Model Predictive Control to data owners being building owners or entities which have been allowed to use that data, like operators of district heating networks or Distribution System Operators, DSO. EPC4SES shall validate whether significant savings of energy and CO_2 might be achieved in this way. With correct data from the EPC-process, thermal modelling of buildings is possible and state of the art (Richter, 2009). It shall be possible to divide buildings into zones when modelling and take into consideration energy conversion and heat loss of piping and ducts in the simulation since respective parameters are entered into the EPC-software and are exported via XML. In nine EU member states building characteristics are stored in EPC register databases (Arcipowska, Anagnostopoulos, Mariottini, & Kunkel, 2014). Authorities demand XML uploads for quality checks of the EPC and for controlling compliance to building codes. Thus, we shall investigate the usage of building and HVAC characteristics from the exported XML and not primarily the result of the EPC assessment which is also stored in the XML. Unfortunately, in case of consumption based operational EPC, which is allowed in some member states, such direct exploitation of EPC data is very limited. But the application of the so called ''invoice/bill based" operational EPC type was cancelled in France in 2021, thus giving access to the building characteristics from asset-based EPC in future (ISOVER, 2022).

2 Project description EPC4SES

The project EPC4SES is exploiting input data that are collected for the issuing of Energy Performance Certificates (EPCs). This data, respectively building models based on it, may be used for optimal planning and operational control of smart energy systems and for defining innovative applications. The best evaluated model-based prediction applications are implemented in the project as research prototypes with real data from the pilots in four pilot regions, Andalusia, Berlin, Salzburg, and Vienna, to determine impact and evaluate effort when establishing virtual (digital) twins of buildings.

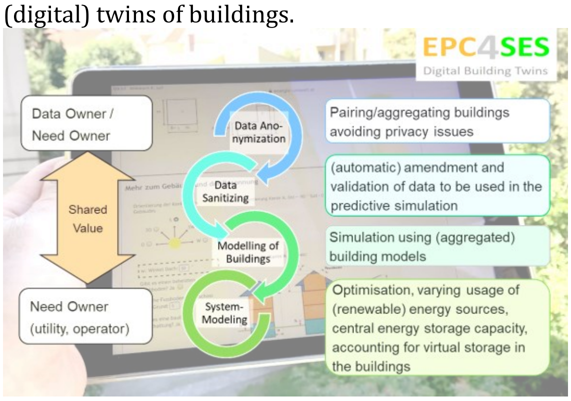

Figure 1 Working hypothesis EPC4SES

All results of the ongoing project including approaches to support decarbonization through virtual storage and interoperable smart energy systems will be fed back to the scientific community of ERANet. The final aim of the project is to exchange information between energy supplier and/or DSO and energy users over standard interfaces like shown in Fig. 2, to allow increase of renewable energy utilization. Using physical and/or virtual storage will allow to increase utilization of feed-ins from heat waste (or anergy) and solar in thermal networks and increase utilization of PV and wind energy in the power grid.

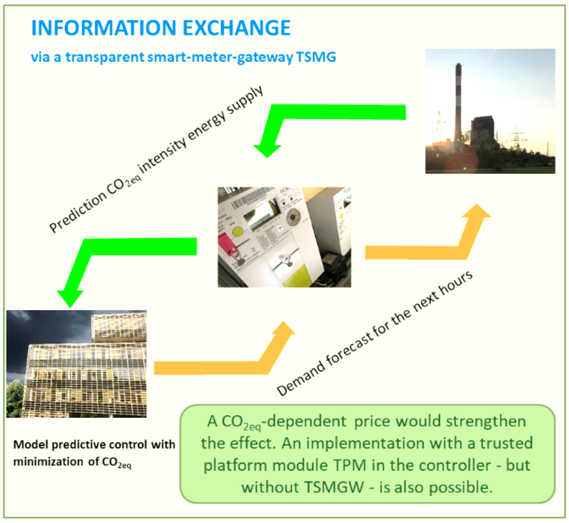

Figure 2 Bidirectional information flow between Smart Energy Systems via Transparent smart meter

The project EPC4SES – EPC based Digital Building Twins for Smart Energy Systems – aims also at decarbonizing heating & cooling energy demand through load shifting by adding model predictive control (MPC) functionality utilising CO_2 prognosis data from networks/grids. Model-based simulation of demand is considering the thermal capacity of buildings and behavioural models for consumer attitudes based on preferences. MPC allows single building owners, energy communities and facility managers to compile a demand forecast which is based on the optimisation and to transmit the prognosis to local DSO and/or energy suppliers. In the case of Energy communities, the load forecasting would consist of a whole community prognosis, taking into consideration optimized internal energy exchange.

3 Policy Context

3.1 Regulatory Background

The Energy Performance Certificates (EPCs) were introduced in 2002 by the Energy Performance of Buildings Directive (EPBD, Directive 2001/91/EC) [1] as a mandatory requirement for the EU Member States. The current certification scheme, regulated by the EPBD directive 2018/844 [5], which amended the Directive 2010/31/EU, had not modified the articles related to issuing and displaying of the energy performance certificate (Articles 11, 12 and 13). Basically, the directive requires the Member States to lay down the necessary measures to establish a system of certification of the energy performance of buildings, including a methodology for the calculation of the energy performance of buildings which shall be transparent and open to innovation.

The recasts of the Energy Performance of Buildings Directive in 2010 (2010/31/EC) [2] and in 2018 (2018/844/EC) [3] reinforced the EPCs obligation for the Member States and delivered detailed provisions for the energy performance certificates (EPCs). Particularly, according to the article 9 of the

2010 directive (2010/31/EC2), Member States should develop a joint methodology of calculating the energy performance of buildings. The member states are eligible to amend their methodology to include not only thermal characteristics but also other significant parameters which may affect the energy consumption such as HVAC equipment, renewable energy applications, passive heating and cooling, shading, indoor air-quality, as well as other elements. Moreover, according to article 10, Member States are required to set national minimum requirements for the energy performance of buildings and building elements as well as to review them on a regular basis, in accordance with the status of the technological progress. These requirements should be set, based on the target of achieving cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building. The lack of sufficient quality assurance requirements from the initial directive of 2002, was addressed in the succeeding recasts of the directive, establishing the required framework to improve EPCs 'quality. An independent control system was introduced in the 2010 recast, specifying the verification of EPC schemes such as the validation of the input data, the verification of results and recommendations, the on-site visit of the building as well as other equivalent measures. However, the current regulations have led to the status that the energy performance certificates do not generate any further benefit beyond the presentation of energy performance certificates when building, renting, selling and renovating properties. In some countries operational EPC are called display EPC and are applied for larger public buildings. Allowing a low-cost, low-quality approach for EPC deprives authorities of investigating the thermal renovation potential.

3.2 Standardisation process

The issuance of EPCs is framed by the EU regulations, which allow the adoption of national regulatory provisions. The EU member states are also responsible to establish rules to comply to the GDPR while implementing EPC register schemes. An alternative in the project context would be to exchange forecasts instead of disclosing building data, so only interfaces shall be standardised. However, this is not applicable for pre-planning cases lacking the output of a model predictive Building Energy Management System. An IEC 62559 based standardisation of the digital twin and data model would start with the requirements for those applications which are utilising data from the EPC process.

The project includes work on XML schemas or Document Type Descriptions DTD for defining the XML files, harmonising the approaches in the regions and member states. EPC4SES found small deficits in the XML schemas like lacking thermal capacity figures and orientation or inclination of transparent elements in some cases but also ways adding adiabatic energy storing internal elements. EPC4SES proposes to develop a European open-source XML format for storing energy related building data as a specification to facilitate the development of applications in transnational approaches on the standardisation level and for software industry and ESCOs. Modelling building energy performance in MPC is dynamic by nature and thus could be nearer to 13786:2017 than to ISO 52000-1.

3.3 Barriers to implementation

To make data derived from the EPC process useful for citizens, academia, and business, accessibility has to be improved, since it varies among the member states and among their provinces if federated systems are enacted. Inaccessibility to aggregated EPC data causes challenges for national policy makers, and for anyone wanting to access and compare information about EPCs issued in different parts of the country (Altmann-Mavaddat, Tinkhof, Simader, Arcipowska, & Weatherall, 2015). Also the variance interpreting EU regulations is an actual barrier. Making EPC mandatory for all buildings will benefit regional energy planning because of the higher coverage of the building stock. Data privacy is highly relevant for European citizens, but aggregation makes possible even to exploit data from single family homes if it is shown as one pixel on a 1 km x 1 km grid, whereas in city centres 100 m x 100 m are possible without a GDPR problem. Considering the priorities to be tackled within the climate emergency, apart from policy makers all actors in the energy market and researchers should be able accessing that data. Apart from the indirect use of EPC data without house owner involvement it is possible to set up contracts between district heating supplier and building owners to make available detailed data or the results from prognosis of the building energy management system. Application could be the model predictive control of the connected energy system featuring Renewable Energy RE storage.

The accuracy of data collected in the EPC process is vital for modelling. So, quality of EPC input data shall be improved. Most trivially the surfaces of building elements and its characteristics are erroneous. While the first could be overcome by comparing to or using GIS/LIDAR, validity checks using data from similar buildings can improve quality of building element data, namely u-values windows to wall ratio etc.. Data fusion when compiling EPC - taking data from 3D models - can help to minimize errors. Introducing concrete rewards like better EPC rating or funding in the smart readiness initiative will help to introduce building energy management systems having model predictive control in need of EPC derived data.

3.4 Preconditions

EPCs are reflecting the current thermal standard of the respective building at the time they were issued, and in some countries also reflect the optimal renovated status as benchmark. Operational EPCs based on energy consumption data are biased by the behavioural influences of the building occupants, which should be levelled out by the rule that only buildings with more than four flats might have operational EPC. Those operational EPC are lacking detailed information for the building envelope which would be provided by asset based EPCs. For the planning of a large-scale building renovation, including their future energy supply, preferably based on renewables, data from both types of EPC are required. On the building level, for the evaluation of a modernization plan it is essential to prioritize the recommendations given in the EPC and implement them step by step. The success of each step should be evaluated via frequently recurring operational EPC to adjust for possible mistakes in the implementation. Here the boundaries to energy monitoring are fluent, but it important to ensure that with operational EPC original consumption data is stored additionally to the normalized data.

Smart meters are beginning to diffuse based on EU regulations which targets distribution system operators DSO, (electric meters are leading, gas meters following). They are allowing monitoring the energy used for space heating/cooling/ventilation and lighting (heating for gas and district heating smart meters). Those meters will provide real-time energy consumption of buildings as base value for load prognosis. But smart meters can also act as gateway to establish communication between market participants and customers, which is assumed in the project to transmit prognosis of CO_2 intensity and load forecast to DSO and energy suppliers (Fig. 2).

At EU level, the aim is to constantly improve the quality of energy certificates and their usefulness. Decarbonisation is high on the agenda, but it also needs data to plan it. Designing new carbon free settlements and energy networks is often difficult because the necessary data is not always available. The same applies to existing buildings and energy networks, where the lack of data for a digital twin makes prognosis and model-based control in operation difficult.

The quality assurance activities for EPC are supporting the use cases. Correct and accessible building element and HVAC equipment data is the key to many applications orchestrating the decarbonisation and efficiency improvement process, either for property owners, (public) network operators, public authorities, but also for the renovation industry. Energy consulting for individual buildings, based on data from the energy performance certification (EPC) can extend the XML data model and produce a living document. Persistence and accessibility of that information - also via QR - code is a precondition for some use cases.

Finally, model predictive control and decentral load prognosis needs accurate and affordable weather predictions, also including solar irradiation.

4 Use Cases

In this chapter we describe six use cases for data collected in the EPC process and stored in a standardised format. The use case scenarios imply a multilevel perspective of implementation ranging from individual to regional scale.

4.1 UC1 Energy consulting for individual buildings, based on energy performance certificate (EPC) data (extended XML), XML as living document, also accessible via QR code.

The quality of the individual consulting for property owners shall be made more efficient and be based on quality assessed building data used in EPC. Energy performance certificate (EPC) data contained in extended XML could be provided by commercial or public entities as living document being updated each time an EPC is due and made accessible via QR code for building owners and contracted entities like energy consulters. This would help energy consultants not to start from scratch but from input data to EPC. Enriching with actual data for energy price and renovation cost it is used to define reduction measures for the energy related cost and CO_2 footprint of a building. As the extended EPCs provide a continuous picture of the building, energy consultants issuing EPCs can build up a steady relationship with customers to accompany them on the modernization path of their buildings. The application of digital twins could help to forecast energy savings and CO_2 reductions for each modernization step and at the same time keep EPCs up to date. Thus, by controlling energy efficiency improvement via the extended EPCs, the quality of the individual consulting for property owners is made more efficient and based on quality assessed building data used in EPC. This is an outstanding service, not yet available on the market. Moreover, EPC software providers can innovate their solutions and provide a new service module including new business networks with ESCOs that can connect their services to EPCs to forecast and evaluate the success of their services.

4.2 UC2 Support of market development for thermal refurbishment through Big Data approach using anonymous EPC data

In a big data approach, commercial entities of the energy efficiency market may either address trusted aggregators to retrieve predefined detailed statistics stemming from the EPC process or postulate SQL queries with a minimum geolocation area not to create privacy problems. This can have a positive effect on the energy efficiency market as it helps the refurbishing industry to better estimate the demand of cost-efficient products. Anonymous aggregated EPC XML data from enhanced EPC registers allow the refurbishing industry to adapt their portfolios according to the most demanded refurbishing measures and materials of the respective building stock market. One example might be analysis of data uploaded into the Salzburg province EPC registry

ZEUS, where tendency to switch heat converter type with building reconstruction might be quantified (Prieler, Leeb, & Reiter, 2017).

4.3 UC3 Support of energy policy by using EPC data (forecasts, scenarios, revealing deficits...)

Energy policies shall be based on empirical data, employing data science on enhanced EPC register data. An open harmonised information basis is vital for a good energy oriented urban planning, especially if geolocation is available (Schardinger, et al., 2021). Implementing Directive 2003/4/EC on public access to environmental information the bodies or authorities in charge shall allow researchers access to anonymized EPC XML based data (stored in database fields). In UC3 also statistics are exploited but different to UC2 the focus is on efficiency of policy measures. So, the renovation rate may be correlated with the existence of monetary and non-monetary incentives. Funding is correlated with changes in energy demand and public funding of renovation also triggers issuing of new EPC if they are mandatory for obtaining funding. Researchers, energy agencies or officers from responsible public entities may correlate renovation measures with funding schemes.

Using EPC register data and applying data fusion, the design of funding schemes can be optimized and tailored to the actual situation of the building stock. Also, using data from EPC registries the effect of funding different renovation measures on the total energy demand and funding exchange of oil and gas furnaces CO2 footprint can be evaluated.

Such models to calculate energy demand and CO_2-footfrint shall be calibrated with the help of manual input (Pfeifer, 2017), also coping with the fact that for private buildings not rented out no EPC is mandatory.

4.4 UC4 Pre-planning of energy systems (e.g., rural district heating networks or energy communities) with the help of EPC data acquired from potential customers.

This use case involves different actors. An example of implementation could imply a contract among the energy system designers and building owners of a settlement to get accurate data for planning smart energy systems starting from the conduction of an asset-based EPC. Energy system designer use the geo located digital twins to simulate extension of networks or planned networks. Building owners commit to deliver the data in return to a free EPC. The digital twin might also be offered by third parties processing EPC data to be used in a simulation tool for the energetic performance of the building in the network context.

Another example is the application within an energy community. Pre-planning for a community with different degrees of urbanization is one of the fields of application. The energy community could be seen as a guarantor of the policy implementation. If the energy community has enough power or weight or organization, it could modulate the behaviour of the DSO. To achieve this the energy community can plan a demand responsive system managing a multitude of peak prognosis related to different single units rather than managing just the one of a whole energy community. The market power of an energy community or a federation of them could be important introducing local renewable energy production and model predictive control of storage facilities maximising solar yield or yield from heat pumps.

4.5 UC5 Building energy management with model predictive control (MPC) based on own EPC data (accessed via link or QR-code)

This use case foresees a commitment of energy suppliers or grid/network managing entities to provide prognosis of CO_2 intensity digitally via API like we see with (Prognosis, 2022). While conducting asset-based EPC, the building data is collected and used for a digital twin which is then used for model predictive control minimizing energy demand/CO_2 intensity based on the CO_2 prognosis for the energy supply. In one example the building owner procures an EPC with the possibility to export an enhanced XML, this could be then used in a digital twin in the building energy management system (BEM). The EPC issuer uploads the data to the BEMS. The BEMS producer foresees interfaces to import that building data and read weather forecasts. The BEMS features a simulation model for the building. Literature in this case is very optimistic estimating a 35% cut in energy consumption and 50 to 100 % cut in carbon emissions (Lukesh, 2021). Especially for larger buildings the cost for a Building Energy Management System can be paid back rapidly.

4.6 UC6 MPC for local energy systems (with fluctuating RE feed-in) using forecasts from the customer's building MPC.

This use case is a further development of the above-described UC 5, extending the application by renewable energy utilised on the network level. While active elements for UC5 are the building thermal mass, and if available buffer and DHW tanks, UC5 focuses on DH-network/grid . Modulating energy conversion and storage using model predictive control with load prognosis data from clients and weather forecast data, efficiency, renewable energy yield resp. utilisation rate can be increased. Without forecast provision from single buildings this use can also be linked to UC4 since the digital twins from planning may also be used for MPC at the network level.

4.7 Use Case Application in different markets

To structure the use cases they were arranged in a triangle according to their purpose (*Figure 2*).

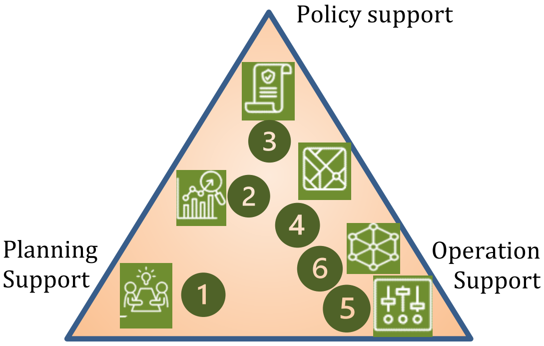

Figure 3 Strategic purpose of the use cases

In the following we undertake a qualitative assessment of the use cases. In Germany, **Use Case 1** is the most promising use case with business potential. The other use cases based on EPC registers don't have many chances now in Germany, as up to date no accessible national, regional, or local EPC registers exist which are featuring the data collected for quality control of EPC by the DIBt (Deutsches Institut für Bautechnik). Thus, as a pre-condition for the other use cases, data already collected via XML should be stored in national or regional accessible building registers.

In Austria, **Use Case 1, 2** and **4** have the most business potential as EPC data registers exist in four of the federal regions (Salzburg, Styria, Vorarlberg, and Burgenland). They have a different pace in terms of adopting new rules and data access to the public but the situation is converging. The roll-out of Use Case 4 depends on the acceptance of future clients to provide enhanced EPC data, which is required for the higher accuracy of the model.

In Norway, **Use Case 3 and 4** are most promising. In Spain theoretically **Use Case 6** should be very attractive, given the high potential of renewable energy. On the other hand, constant weather conditions would require long term forecast and long-term storage.

4.8 Use Case Evaluation

The use cases were analysed in terms of data availability (feasibility), the theoretical CO_2 saving potential, the potential overall market size, the acceptance amongst stakeholders, and the existence of usable technological solutions, in
Table *1*:

Table 1 Evaluation of use cases

UC	EPC based data availability	CO_2 saving	Applicable building stock	Accep-tance	Techno-logical maturity	Total
UC1 Energy consulting	+++	+	+++	+++	++	++++++++++++
UC2 Market support	+	+	+++	++	+++	++++++++++
UC3 Policy support	+	+++	+++	++	+	++++++++++
UC4 Pre-planning of energy systems	+	+++	++	++	++	++++++++++
UC5 Building energy Management	+++	++	++	++	++	+++++++++++
UC6 Energy system management	++	++	++	+++	+++	++++++++++++

Some rating of use cases depends on the actual quality of the legislation, so acceptance of use cases may be replaced by compliance to regulations. The most promising start seems to be **UC6 model predictive control of smart energy systems using heating demand prognosis from connected buildings**. This is an upgrade from statistical approaches employing multivariate regression with parameters like outside temperature and sunshine hours. The more demanding the use of fluctuating renewable energy is, the better prognoses should be, being based on user preferences and real status and characteristics of the building. UC5 Building energy management using MPC will then become part of UC6. UC1 to UC4 have quite high marks, so they should be implemented in parallel. UC1, UC2 and UC3 not only depend on the data model for the EPC registry, but also on the coverage. So, in a less perfect world, UC1 is to be preferred, because lacking data might be acquired during energy consulting and stored in the living EPC document, representing the building. This not only would enable simulating savings with renovation by energy consultersbut allow to connect a notification service if the prices change, or new funding is introduced.

5 Validation of the approach

5.1 Aim

For the projects pilots the main focus was on use case 5 and partly 6, which have very severe requirements for the building data. To validate the hypotheses, we need to evaluate the results applying MPC and to test the automated production of RC thermal building models.
The results of the retrieval of the XML files should be identical whatever software is used for producing the exported XML transfer file to be uploaded in the EPC control scheme.

5.2 Methodology

The savings in energy and CO_2 were calculated on the basis of an experimental approach as described in (Cebrat, Chan, Kofler, Manzini, & Brunauer, 2021) .The preliminary findings show that taking more active elements into the MPC, like Domestic Hot Water DHW tanks or central district heating storage benefits the CO_2 savings significantly.
In the validation report of the interoperability of the project the following methodology was applied. XML exports from two different EPC software products were used, from one XML files for different Austrian ZEUS based XML collection regimes were exported. The PHP scripts then analysed the results of the production of R and C but also checked parallel data exchange via SOAP and HTTP request.

5.3 Results

From building electrical analogue RC models, which are depicting the thermal behaviour and testing extraction of such models from exported XML to different regional requirements in the Austrian EPC registry scheme ZEUS, we can deduct the following:

- In some XML schemes some characteristics of the hull elements is lacking, like orientation of windows, which is necessary to calculate solar gains and specific heat of building elements, which is necessary to calculate the C (heat capacity);
- EPC software allows to enter adiabatic interior elements like floors/ceilings, but data entry staff (which often is not identical to the authorized issuer of the certificates) must be urged to do so to be able to calculate correct thermal capacity of the building;
- Correctness of those XML exports should be validated before upload so it can be utilised in digital twins.

6 Policy recommendations to enable the market uptake

6.1 General Comments

With the introduction of EPC, the EU hoped that a renovation and behavioural change with buyers or renters of apartments and buildings would have been induced. Since the years until 2021, the energy price was low and apartments scarce , this strategy did not work out. Quality of EPC deteriorated with the absence of quality control, correlating with lowered prices for EPC. Also, public authorities did not make sufficient use of the big EPC data, so data quality was not an issue. However, the situation has improved much for all those points. The EU has updated the EBPD directive, introducing mandatory quality measures and energy prices increased. Public authorities begin to provide EPC data after issuing them in an electronic form.
Currently, funding schemes are triggering new EPCs, if EPCs are mandatory when applying for fundings. However, the big enabler would be to legislate a minimum standard of insulation for all buildings, to be documented in a living document, where data for compiling EPC resides. The more future buildings will be available for planning Smart Energy Systems, the better the accuracy of regional energy plans based on EPC derived data will be. EPC drafts should therefore be available from the first phase of the building development, which is implemented in schemes where building codes are checked from that data by authorities.
Smart readiness characteristics of course may improve actual performance, so indicators should be included in the XML. Science might contribute with an assessment of the impact including prebound and rebound effects.

6.2 SWOT

The paper elaborates the best strategy for usage of EPC data, based on enhanced SWOT. The following SWOT analysis in Table 2 reflects the evaluation of strengths, weaknesses, opportunities, and threads for all use cases.

Strengths	**Opportunities**
Usage of data generated during the EPC process is an enabler of planning and operational efficiency.	Usage of data from the EPC process depends on correctness of this data and frequent data usage will put more emphasis on EPC quality.
Weaknesses	**Threats**
Quality of data, and its availability are key points for success.	Member states do not support usage of data from the EPC process in legislation and do not define a minimum data model for EPC register data. Privacy concerns and lack of resources with public authorities may prevent exploitation

Figure 2 SWOT analysis of the use cases

Combining strengths and threats, member states shall create ecotopes for using EPC related data in regional contexts. A minimum specification for required data for EPC register data allows to test applications in other markets. Combining weaknesses and opportunities, the usage of EPC related data will automatically require higher EPC quality. There is also the possibility to combine asset-based and operational EPC to calibrate EPC, if Smart Metering develops.
We propose the following list of points necessary to bring forward digitalisation of energy systems in the building sector:

- A mandatory description of EPC schemes in English for all EU regions allowing in depth review and harmonisation attempts.
- An EPC register database with minimum data set and both individual owner access and public access to aggregated data.
- Mandatory publication of CO_2 prognosis' in networks/grids
- Provision of regional weather prognosis (including irradiation) by energy agencies for free for private persons.
- Standard for communicating load prognosis for buildings stemming from the digital building twins.
- DIN SPEC on negotiating demand control using digital twins.
- Public GIS support for horizons, supporting shading calculation.
- Special funding on connected big thermal and power storage making use of the digital twins.

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