D^2EPC POLICY BRIEF v2

Next-generation Dynamic Digital EPCs for Enhanced Quality and User Awareness

August 2023

The D^2EPC project has received funding from the EU's Horizon 2020 research and innovation programme under grant agreement No 892984

Summary

The present report is an updated and final policy brief, prepared at the end of the D^2EPC project, focusing on the identified challenges of the existing Energy Performance Certificates, as the current scheme needs holistic strengthening and improved quality. The proposed solutions, presented as Policy recommendations are the outcomes of the project's research and progress, aiming at addressing the mentioned challenges. The advancements of the EPC-related policies and standards along with guidance for their implementation could pave the way toward the Next Generation of Energy Performance Certificates, which will increase user awareness and engagement on buildings' energy efficiency, facilitate planning and decision-making on local and regional policy levels.

The present policy brief points out the nine challenges that were identified within the D^2EPC project and the related policies that currently apply. Based on that, policy recommendations were formed on how to overcome the challenges or further improve the solutions that are now in place.

The previous version of the policy brief document was prepared at the mark of two years of the project and can be accessed through this link:

https://www.d2epc.eu/en/Project%20Results%20%20Documents/D%5E2EPC_Policy%20brief_v1.pdf

Description of the problem and current policies

Notwithstanding the positive contribution that current Energy Performance Certificates (EPCs) have had on improving the energy performance of buildings, experience has unveiled a number of constraints and limitations.

Current EPCs are based on a set of European standards (based on the European Commission's Mandate M/480[1] to the European Standards Organization for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance buildings (2010/31/EU)) and national parameters or criteria.

These standards provide a common approach but, due to the differences at the national level, the implementation has certain diversity among the Member States (MS). Some of the simplification rules for the calculation process, intended to reach a "low-cost approach", such as simplifications for buildings with varying window qualities and wall thicknesses, wrong building construction year, and inaccurate occupancy have led to the opposite effect and resulted in inaccurate outcomes[2].

When planning thermal renovations, the building owners and authorities responsible for local energy plans are usually not making their decisions based on the EPCs.

There are no CEN or ISO standards for operational energy efficiency and those MS with a methodology for operational EPCs have quite divergent approaches.

EPCs were thought to be a game changer putting pressure on landlords and the housing industry to offer energy-efficient spaces. However, in many countries, the renovation potential was not quantified, and the quality of EPC was poor. Therefore, even if the quality assessment was introduced in total there was a trend to opt more for regulations, than for mandatory information via EPC.

Within the D^2EPC project, several challenges (CH) have been identified. Below they are described, together with the current policies that apply to the mentioned constraints.

[1] https://energy.ec.europa.eu/publications/2010-european-commission-mandate-cen-m480_en

[2] https://www.sciencedirect.com/science/article/abs/pii/S0301421519301867

Challenge 1: Limited information on the actual energy performance of buildings

According to existing practices, energy performance certificates are issued at the early stages of the building construction, thus they fail to present the actual energy performance of the building over time. The availability of building energy-related data and recordings from the actual energy consumption of buildings through smart meters and sensors introduces several possibilities for integrating building management systems and digital twins into the certification process.

CURRENT POLICIES ON CH1

The collective analysis of data for the specific features of EPCs revealed that among the twenty-seven (27) EU Member States, eleven (11) have adopted the methodology exclusively based on calculated energy consumption. In some Member States, both the actual and calculated energy consumptions are foreseen. In addition, for new and existing buildings, the period of validity of an EPC currently issued to receive a building permit is up to ten (10) years in most EU countries. It is recommended, and in some countries required, to update the EPC following a major renovation of the building, especially for receiving a grant. Furthermore, none of the EU Member States applies incentives or penalties concerning the owners' compliance or non-compliance with the certificated assessment, in case of re-assessment of an EPC, based on operational data. Penalties are rare and are mainly addressed to energy assessors in case of incorrect EPC.

Challenge 2: Insufficient information to building users and limited user-friendliness

Although the EPC calculation process is based on a comprehensive set of standards, it still overlooks some important determinant attributes such as indoor air quality and penetration of daylight, which can negatively impact occupants' experience in buildings. Also, there is space for the enhancement of the information provided by the EPC to the building user, in terms of simply interpreted indicators. Even though thermal and acoustic comfort, indoor air quality, and provision of daylight are among the primary drivers for buildings renovation, they are not considered in current EPCs. At the same time, the recommendations for energy upgrades are automatically generated by a standard list (e.g., increasing insulation, replacing windows, etc.) and do not offer a user-friendly document that would motivate renovation.

CURRENT POLICIES ON CH2

Analysis across the EU Member States, energy-related financial indicators are not found to be included in current EPCs schemes and procedures in any EU Member State. It appeared that, in several countries, the energy cost and the carbon dioxide emissions per m^2 are included in the EPC procedures. Apart from that, financial indicators for the proposed investments in the building retrofit and for the payback time of proposed measures, economic values of energy improvements, as well as evaluation recommendations for cost-effective measures are reported, but not directly issued in the EPC procedure. It was recognized that environmental/LCA-related or financial indicators are usually not taken into consideration for the EPC issuance. Environmental indicators, which are present in energy certificates today, are usually linked to carbon dioxide emissions, which consequently vary from country to country depending on the energy system of each country, and in particular by the factor of the primary to final energy conversion. The conversion of final energy consumption to primary energy

consumption for the production of an electric unit or thermal energy is the rationale behind the Primary Energy Conversion Factor. Although provisions for indoor environmental quality (including air quality, thermal comfort – the risk of overheating and ventilation, lighting, and acoustics) are not covered in current EPC regimes and are not included in the calculation procedure for certification of EU countries.

Challenge 3: Need for harmonization of EPCs with the smart city concept

Smart buildings in connection to smart cities constitute a major challenge for the construction industry in the decades to come. Energy efficiency certificates should incorporate and disclose to the users, information related to the building's intelligence. The requirement to integrate Smart Readiness Indicators (SRI) into the energy calculation procedure is also marked by the latest EPBD recast for non-residential buildings.

CURRENT POLICIES ON CH3

As the energy transition of the EU building stock aims to ensure all EU citizens have access to energy services regardless of their income, the smart readiness indicator (SRI) is expected to become an inexpensive measure promoting healthier, more comfortable, low carbon impact and low energy use buildings capable of integrating Renewable Energy Sources (RES). Digital smart home systems optimize the use of RES installations, battery storage, heating systems and Electric Vehicle (EV) charging and thereby help to integrate renewables into the power grid through data-driven energy services. It is envisioned that real-time consumer data (if in line with GDPR) will reveal consumer patterns and improve energy management at the building level and that users will become empowered by easy-to-use and informative tools to better monitor and control their energy use and benefit from energy cost savings. Around 30% savings of energy can be obtained when implementing a package of smart technologies. The processing of consumers' personal data requires privacy protection mechanisms and a power system enhanced by digital technology must be resilient to cyber-attacks.

The SRI is complementary to the EPC as both schemes are applied towards improving the energy efficiency of the EU building stock and thus share a goal of promoting decentralized, renewable-based, consumer-focused, and interconnected, essentially, smarter buildings. The SRI could be a good monitor for understanding the potentialities of a building as it is, linked to the current EPC. Therefore, to lever the smart readiness capabilities and the overall energy performance a logical and integrated procedure at the single building scale would have to formulate scenarios of renewal that include improvements of SRI potentiality. On the contrary, relay on the SRI without EPC could be misleading. This is demonstrated by the fact that the SRI is not an assessment tool for a building's overall energy performance as a building can achieve a high SRI score whilst simultaneously having a poor energy performance and therefore a low EPC score. The potentialities of a holistic approach including SRI indicators in the EPC demonstrate their value even more at an aggregated upper scale (district, city, and regional level). These scales of analysis could pave the way toward future scenarios of smart energy systems able to integrate tools and methods for system planning, considering the new types of flexibility services, as in the case of a low inertia network. Novel monitoring and control tools and advanced modelling tools for better operation management and decisional support are linked to the scenario of improving the SRI possibilities of aggregated single buildings. The scenario of SRI maximised at the single building should be envisaged in renewal planning standards at the district and city levels.

Implementation strategies, data protection, and quality control schemes can therefore be shared between them where applicable, however, no provisions for SRI and EPC integration have been formally introduced.

Challenge 4: A human-centric certificate

The revised EPBD (2018/844/EU) requires the integration of human-centric elements into the energy performance calculations, which will provide the building with the ability to adapt its operational mode in response to the needs of the occupant by maintaining healthy and convenient indoor climate conditions. It is considered that human comfort aspects related to occupant well-being in inhabited spaces are currently not considered by the existing EPC schemes.

CURRENT POLICIES ON CH4

Although human-centric aspects are not integrated -for the time being- in current EPC schemes, there is a multitude of well-established building assessments, at the European and national levels, certifying a building's sustainability in terms of several indoor environmental categories. Such certifications (e.g., BREEAM, LEED, WELL, and others) contain tailored methodologies with the view to evaluate the indoor ambient conditions that affect the inhabitants' comfort and well-being. The thermal, visual, and acoustic comfort, as well as the breathable air act as the centrepiece for these human-centric assessments. In this way, the quality and the occupant's perception of the indoor conditions are associated with the overall operation of the building. At the European level, the concept of indoor environmental quality has already been incorporated into different green building frameworks. More specifically, the gradually adopted LEVEL(s) framework for sustainable buildings, integrates specific indicators for the assessment of the comfort and wellbeing of the occupants. Meanwhile, within the SRI framework, comfort and well-being constitute two of the main impact criteria that the smartness of a building to be evaluated. As envisioned within the EU, these human-centric aspects will become an integral part of future energy performance certifications. The next generation EPCs will pave the way for the upgrade of the overall building stock towards delivering more comfortable and healthier indoor conditions to EU citizens.

Challenge 5: Limited data quality

The accuracy of the EPC results is determined by the national EPC calculation methodology's level of detail and its input data quality. Current EPB standards are not based on real-time data, as are estimated mainly with project information. The link with IoT or other relevant information is not covered yet, thus limiting the potential of assessment of constructed assets and the comparison between the designed building and the real *as-built* building. The performance gap, i.e., the difference between estimated and actual energy performance may be hindering EPCs' reliability; 15% of EPCs lodged are incorrectly rated[3] (due to user behaviour or lack of proper documentation in a logbook after some changes have been performed), having a score within 2 points of an upgrade or downgrade if measured accurately. EPC ratings only assess theoretical performance or design intent and do not measure actual energy consumption, while for a large number of properties, there is little or no correlation between EPC ratings and actual energy performance. For example, systematic small errors

[3] https://uploads-ssl.webflow.com/6095a610a4763f422bdafe21/60f946d24b08cd0545e06743_White-Paper_Impacts-of-Inaccurate-Area-Measurement-on-EPC-Grades-min.pdf

and using 'average sizes' of walls and rooms measured simply, quickly adds up over a whole property to potentially significant overall variations from reality. The substantial gap between the EPC and the actual energy demand makes it difficult for policymakers to successfully make plans for future strategies.

CURRENT POLICIES ON CH5

The majority of EU countries do not employ by any means BIM (Building Information Modelling) documentation and literacy or digital logbooks for the issuance of EPCs. Even though in some countries there is the provision of BIM documentation and digital logbooks, these are rarely used as a source of information for the EPC assessment procedure or energy simulations for building permits. There is no provision, national requirement, or legal obligation of a Building Management System (BMS) existence in connection with the operational EPCs. BMS data documentation is not employed as a source of relevant data or there are no provisions or legal obligations to be used in the issuance or re-issuance of operational EPCs. Additionally, in most of the EU Member States information related to the Geographic Information System is not included in the EPCs, and consequently, it is not exploited for issuing, validating, monitoring, and verification processes of the EPC calculation. The use of GIS (Geographic Information System) could support providing accurate data for the EPCs.

Regarding data quality, the future standard under development in CEN/TC 371/WG 5 should provide guidance or requirements to ensure the quality of real-time data.

Challenge 6: Software credibility and quality

Although significant progress has been achieved in the past decade in the field of buildings digital design with the use of advanced tools, most of the software used in EU MSs is based on simplified architecture. The calculation methods on which EPC's software relies, follow the monthly model of ISO 52000 standard, where the description of the building is simplified and based on aggregated values (in terms of building elements' areas, thermal zones, etc.) and look-up tables (in terms of material thermal properties, infiltration rates, etc.), while correlation factors or predefined schedules are also used for the dynamic effects modelling. Also, in most cases, EPCs calculation is not combined with the building energy performance simulation for the design of the HVAC equipment and buildings thermal comfort, but it is performed individually, using different calculation paths. These practices make it more difficult to ensure the quality of the EPC calculation procedure and introduce additional design steps, of questionable quality. In addition, BIM models do not generally cover energy-related information, and, to have a model of the asset *as-built*, a digital twin should be used. There are several standards defining format and procedures for BIM data, but not for a digital twin.

CURRENT POLICIES ON CH6

D^2EPC proposes the development of advanced tools for the definition of EPCs across the EU MS. The role of standardisation in this field is significant, for the development of a more detailed framework, that will secure the quality of the tools used for EPC calculation. This requires the development of further joint repositories with information and specifications for building systems and building materials. The structure provided in EN ISO 10456:2007 was considered as a baseline to create joint repositories with information and specifications for building systems and building materials. The repositories could also be initially delivered on a national basis, based on good practices and standards of the MS. In order to further enhance the credibility and quality of the tools used for the calculation of the EPCs, it is also imperative to exploit the numerous abilities provided by BIM tools and documents, where building-related information is collected and managed in a consistent manner.

Challenge 7: Data discrepancies due to the subjectivity of energy auditors

Moreover, the competency of the assessors is an important reason for these gaps, as currently, most EPC calculations rely on a range of standard inputs or default inputs; The EPC delivery process can be subjective, and, as a result, data quality can be easily influenced by the energy assessors because of the standard assumptions made in the process of producing the certificate.

CURRENT POLICIES ON CH7

Collected EPCs constitute a significant database, where big data concerning the actual energy performance of the European building stock are gathered. Most EU Member States have developed central databases for the collection, registration, and inspection of EPCs and technical building systems of existing and new buildings. By no doubt, there is no existence of a database describing the energy efficiency potentials of the building stock as a whole. Nevertheless, in some cases, there is available comprehensive information regarding the physical stage of the existing building stock gathered during the EPC issuance procedure. The employment of inventories, in relation to properties of building materials and building systems, is not a practice that is usually followed, but as time goes by, this kind of information and databases could be enhanced and included in the next-generation EPCs. One-third of EU countries do not have provisions for systematic and regular evaluation/assessment of energy assessors' competence and skills. Intending to further improve the quality of the EPCs, experts have to update their skills and knowledge continuously through regular training. More specifically, there is a qualification system, according to which assessors need to renew their occupational qualification certificates in a period of time, depending on their country.

Challenge 8: Lack of connection between sustainability assessment and energy performance

Even though the whole building sustainability assessment of buildings with the use of Life Cycle Assessment (LCA) has reached maturity levels that allow their analysis for existing and new buildings, information concerning building embodied environmental resources is not available to building users and owners. Moving to an era where resource efficiency is getting bigger attention and is integrated into all major aspects of the energy sector, further advancements in the field of EPCs with the integration of LCA-related indicators are of vital importance. In this direction, the European Commission has recently launched LEVEL(s), an assessment and reporting framework that provides a common language for the sustainability performance of buildings.

CURRENT POLICIES ON CH8

D^2EPC identifies the necessity to move to a holistic assessment of the building's environmental performance, in order to expand the understanding of the actual impact of the building on the environment as a whole. To this end, the introduction of a set of LCA-based indicators for the energy assessment of buildings is proposed. These indicators shall be based on well-established databases across Europe concerning the environmental impact of building materials, with emphasis on the Level(s) scheme, and they will result in a life cycle assessment of the buildings, as well as of individual components of the building (building envelope, building systems, building materials, etc.). This assessment will also provide the option to the building design engineers to improve and optimize the

environmental performance of the building, based on changes to be integrated at the initial design stages of the building. To address the requirement of building shell and building system-oriented approach, novel indicators could be classified into building shell and building system-oriented indicators. This will also allow the extraction of additional indicators such as the share of renewable energy used.

prEN 15978-1 (which will supersede EN 15978:2012) deals with the environmental assessment of buildings, including a module B6 for operational energy use. Like other CEN/TC 350 standards, this document is based on an LCA using common modules for product, buildings and civil engineering works sustainability assessment. D^2EPC has been following the development of the standard, as it can help bridge the gap between LCA and energy performance calculations.

Challenge 9: Need to establish and harmonise the operational rating within MS

D^2EPC revealed the fact that numerous EU MS exploit as well the operational rating schemes for the extraction of EPCs. Despite the fact that the employment of operational practices for the classification of buildings requires fewer calculation procedures, compared to the asset rating, digital EPC requires access to the intelligent metering device data stored at the DSO, or the installation of specific equipment, mainly smart meters/sensors, as well as the development of advanced practices concerning data transmission and management. The advantages of operational rating are well understood, as the classification provided is based on real values and not on as-designed calculation values. Although the introduction of practices and requirements that oblige MS to employ operational classification schemes would support a more comprehensive understanding of the performance of buildings and would allow for more effective energy policies, the gap in the existence of common standards and regulations on the operational rating seems to be a deterrent parameter.

CURRENT POLICIES ON CH9

D^2EPC envisions and proposes the development of all required structures that will allow for the development of standardized procedures, employable by all MS, or the development and adoption of operational rating schemes for the energy assessment of buildings among all MS. The proposed framework should provide specific answers concerning the applicability, common ways of calculating the operational rating of buildings, minimum requirements and indicators that should be delivered, the time step of the assessment, weather, and occupancy normalization practices as well as guidelines for reference values, based on which the classification will result. The development of this information requires the establishment of standardization working groups in the field of operational rating.

To achieve this goal, D^2EPC proposed a new European standardization working group, CEN/TC 371/WG 5, dealing with operational energy performance ratings for buildings. The Convenor and the Secretariat of this WG are members of D^2EPC. This group started the drafting of a new European standard on operational energy performance assessment. See D7.12 for more information.

Policy recommendations

The identified challenges are within the D^2EPC project being addressed by the following objectives and policy recommendations.

Objective 1

The introduction and establishment of the concept of the dynamic EPC (dEPC), an operational certificate to be calculated and issued on a regular basis

Although cutting-edge monitoring technologies allow the real-time integration of measured data into the calculation process of EPCs, this has still not been regulated either by existing EPC tools or methodologies. D^2EPC project aspires to define the required framework to empower the regular energy classification of buildings, based on their operational performance. Building users will also be informed about the actual energy performance of their buildings through a dedicated platform and will be able to regulate their energy habits. The dynamic character of the calculation procedure will also impose in the future the regular update of the reference values of the building stock, and thus the continuous update of the minimum energy performance requirements of buildings on a national level. Based on the continuous improvement of the minimum energy requirements of EU MSs for new buildings, and in view of the nearly Zero Energy Buildings era, this development will lead to the enhancement of the actual energy performance of EU MSs building stocks.

In this manner, a more active role of next-generation EPCs in policymaking will be enabled. Finally, the visualization of EPCs in a GIS environment will present a comprehensive overview of the actual performance of buildings that can facilitate efficient energy planning.

The future standard on operational energy performance assessment, under development in CEN/TC 371/WG 5, will provide the technical support for the establishment of dEPCs in Europe.

This objective addresses CH1, CH2, CH5

Objective 2

The definition of the drawbacks and discrepancies of the current EPC scheme, as well as the update of EU standards on the classification requirements of buildings

Current practices and tools of energy performance assessment and certification applied across Europe face several drawbacks and discrepancies. D^2EPC aims to analyse the quality and the drawbacks of the current EPC schemes, identify technical challenges that currently exist in order to overcome them (e.g., performance gap, etc.), and set the grounds for the next generation of dynamic EPCs. D^2EPC scheme will be based on the relevant EU standards and the Energy Performance of Buildings Directive, in order to allow for an EU-wide deployment. One of the main objectives of the project is to conclude a specific series of proposals and measures to be used for the update of the ISO/CEN standards developed under Commission Mandate M/480.

D^2EPC has participated in CEN/TC 371 “Energy performance of buildings” and other related committees to promote improvements in current EPB standards and propose new developments.

This objective addresses ALL challenges

Objective 3

The enhancement of EPCs through a novel set of indicators that cover environmental, financial, human comfort, and technical aspects of new and existing buildings, aims to simplify the understanding of buildings' energy performance and to present a more comprehensive overview of the actual energy performance of buildings.

Although remarkable progress has been achieved in the past few years concerning energy efficiency indicators for buildings, these have still not been integrated into the EPC on a European level. D^2EPC project aims to establish a set of indicators that will foster the reliability, user-friendliness, and cost-effectiveness of energy certificates across Europe.

These indicators, which will be human-centric and oriented towards the whole life cycle of the building, will enable the evaluation of buildings holistically and cost-effectively across several complementary dimensions which will consider both the envelope and the system performances of buildings. New elements including climate correction final energy consumption and energy expenditure, and comfort levels, expressed also in monetary terms are envisioned in the new scheme.

This objective addresses CH2, CH4, CH5

Objective 4

The integration of actual operational data from buildings into the EPCs using advanced data collection infrastructure and BEPS tools integrated into BIM

EPCs are currently issued with the use of verified software which is either open to the public or proprietary, depending on the legislation and requirements of the EU MSs. Although the quality and effectiveness of the available software cannot be questioned, there is still a significant gap between the state-of-the-art practices of Industry 4.0, digital construction tools and the existing Building Energy Performance Simulation (BEPS) tools. The D^2EPC project aims to bridge the gap with the introduction of the digital twin concept, which will enrich BIMs with operational data taken from BEPS and/or an IoT-based data collection infrastructure. This way, the proposed project will inject an inverse modelling dimension into the BIM tools that will allow building models (i.e., digital twins) to be evolved in line with the actual building performance. To this end, the project will make use of an available and increasing number of building energy-related data from sensors, smart meters, connected devices, and building systems. D^2EPC aspires to employ 6D Level 3 BIM, the main point of which is the attainment of full integration (BIM) of the information in a cloud-based environment. The use of advanced digital construction design tools will contribute to the improvement of the effectiveness of certificates, by demonstrating how these could be strengthened, modernised, and best linked to the user needs and requirements.

D^2EPC sent two pilots as examples for the Technical Report, under development in CEN/TC 442/WG 9, gathering use cases of digital twins in Europe. The publication of this CEN/TR will help disseminate the use of digital models for energy performance assessment.

This objective addresses CH5, CH6, CH7

Objective 5

The integration of smart readiness rationale into the building's energy performance assessment and certification

The ability of buildings to be smartly monitored and controlled and, to get involved in demand-side management strategies is one of the new requirements envisioned in Directive 2018/844 on the energy performance of buildings. Smart readiness indicator should be used to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and the grid and to improve the energy efficiency and overall performance of buildings. D^2EPC scheme envisions introducing an agreed list of parameters concerning the level of smartness of buildings which will allow comparable good quality, in order to instil trust in the market and incite investments in energy-efficient buildings. The assessment criteria of SRI will be summarized on a set of criteria, including the heating, cooling, ventilation, lighting, and electric vehicles as well as the smart grid integration potentials of buildings, as well considering the share of renewable energy used in the buildings.

This objective addresses CH1, CH3

Objective 6

Intelligent operational digital platform for dynamic EPCs issuance and actual building performance monitoring and improvement, validated and demonstrated under realistic conditions

Current EPC schemes are based on a cradle-to-site rationale, completing their mission after the delivery of the certificate to the building user, overlooking the user's behaviour and the actual energy performance of the building that might change dynamically within time. D^2EPC will utilize a multi-sensorial framework to collect multi-modal data from the buildings as related to energy consumption profiling and occupancy information, indoor environmental conditions, and air quality. The input data streams will be aggregated and processed extracting meaningful intra-building information to be utilized for calculating the necessary human-centric indicators in the dynamic EPC which is useful for the assessment of the building's actual energy performance. On top of that, the project will deliver a holistic digital solution that not only will issue the next-generation EPCs but will also extend EPCs applications and usability. Added value services include the provision of customised recommendations for energy performance upgrades (roadmapping tool), the provision of performance forecasting (AI-driven forecasting tool) in order to coordinate the operation of the building's assets in the optimal comfort and efficient way as well as the provision of notifications and alerts (notifications and alerts tool) to avoid the risk of performance downgrade. Further to that, the project envisions the provision of extended applications that include comparing buildings with the performance of other buildings in more than one normalised metric as per the SRI framework (building energy performance benchmarking) as well as verifying the credibility of the data collection and processing (performance verification and credibility tool). A D^2EPC GIS Tool will visualise generated EPCs in a GIS environment, empowering users to perform various types of spatial and attribute queries. D^2EPC scheme will be validated and demonstrated under real-life conditions through piloting activities driven by CERTH, CLEO, FRC, and SEC; six buildings including domestic, multifamily houses, and tertiary buildings have been identified in Greece, Germany, and Cyprus for this purpose.

This objective addresses ALL challenges

Objective 7

Promotion of European standards to include the link between digital data and operational energy assessment

Some Member states started using operational assessment based on real-time data, but this process does not have harmonisation at the EU level yet.

D^2EPC is actively promoting the development of European standards which should include the link between digital data and energy assessment, with a new working group (WG) for an operational energy assessment of buildings: CEN/TC 371/WG 5 "Operational rating of the energy performance of buildings"., This European standardisation working group was approved in August 2022 and the Convenor (Paris A. Fokaides, FRC) and the Secretariat (Aitor Aragón, UNE) are both partners of D^2EPC.

The first meeting took place on October 2022 and the last one in July 2023. The next meeting will take place on the 4th of September.

Experts from industry, research bodies, academia, and other stakeholders are participating in the development of a future **European standard on operational energy performance rating**, currently under development. A first draft, including D^2EPC results, was presented in April and the next version should be available for the meeting in September.

More information is available in D7.12 – Final version of standardization activities performed in the project. Which is available on the project's website.

This objective addresses CH5, CH6

Conclusions

The D^2EPC project aims to improve the existing EPC scheme as currently many drawbacks were identified as challenges at the proposal stage and were updated in year two of the project. The goal of the project is to address questions such as:

- how to improve the limited information on the actual energy performance of buildings,
- how to make EPCs more user-friendly and human-centric and provide sufficient information to building users,
- how the EPCs can be harmonised with the smart city concept,
- how to improve the data quality in general and how software can support this step,
- how to avoid the auditor's subjectivity which can lead to data discrepancies,
- how to achieve a better connection between sustainability assessment and energy performance and
- how to establish and harmonize the operational rating among all member states.

Throughout the project, these questions are being investigated and research is being done on what solutions could be provided to improve the existing schemes and make EPCs a better tool for everyone. At this point of the project, some challenges are already being addressed by the policy recommendations, which are listed as the project's objectives. Firstly, it is crucial to understand the current EPC scheme, its drawbacks, and discrepancies, in order to introduce and establish the concept of the dynamic EPC which also includes the operational information. Further on, to bring EPCs closer to people, simplify the understanding and offer a more comprehensive overview, additional information should be presented, such as a novel set of indicators, which covers environmental, financial, smart readiness, human comfort, and technical aspects of a building. To achieve all that, the advantages of using advanced data collection infrastructure (Building Information Models) should be utilized, together with the development of a digital platform for dynamic EPCs issuance and actual building performance monitoring and improvement. Finally, all the solutions should be promoted to improve the European standards and create, if needed, new standards, linking digital information (digital models and real-time data) and operational energy assessment.

Current solutions are the reflection of a two-year work on the project and will be updated after the third and final year, providing all the outcomes and ways how EPCs can become a digital, dynamic, and user-friendly tool, supported by European standards.