D^2EPC Requirements' Survey

Current status findings, limitations, and information on the gaps in the existing EPC schemes, calculation procedure, and standards

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Summary

This document aims:

- to explore the technological and market conditions under which D^2EPC will be realized, as well as to investigate the challenges of current EPC schemes.
- to set out the conceptual and contextual ground for the next generation EPCs envisioned in D^2EPC project

Energy Performance Certificates (EPCs) are a mandatory requirement for the EU Member States (MS) when constructing, selling, or renting a building. EPCs play an important role in this process as they serve as a transparent information instrument for building owners and real estate stakeholders and they are among the most important information sources regarding energy performance in the EU's building stock. EPCs could act as a criterion for decision-making on energy efficiency property improvements by providing recommendations for cost-effective or cost-optimal upgrading of buildings.

Existing procedures and tools used in assessing buildings' energy performance across Europe present several drawbacks and discrepancies. D^2EPC aims to analyse the quality and weaknesses of the current EPC schemes and identify technical challenges that currently exist to overcome them, setting the grounds for the next generation dynamic EPCs.

This document presents the main findings on the current status of EPCs in EU MS, as well as limitations and gaps in the existing EPC schemes, calculation procedures, and standards (Figure 1).

On the basis of those findings, D^2EPC aims to set the grounds for the next-generation of dynamic EPCs and lead the transition to a systemic instrument that recognizes the whole life cycle of a building as a structure and encourages best practices in the field of energy efficiency. One of the main objectives of the project is to conclude to a specific series of proposals and measures to be used for the update of the ISO/CEN standards developed under Commission mandate M/480[1]. In this sense, it is expected that the next generation EPC envisaged by the D^2EPC project will provide guidance and turn EPCs registries into policy feeding mechanisms, facilitating urban planning and decision making.

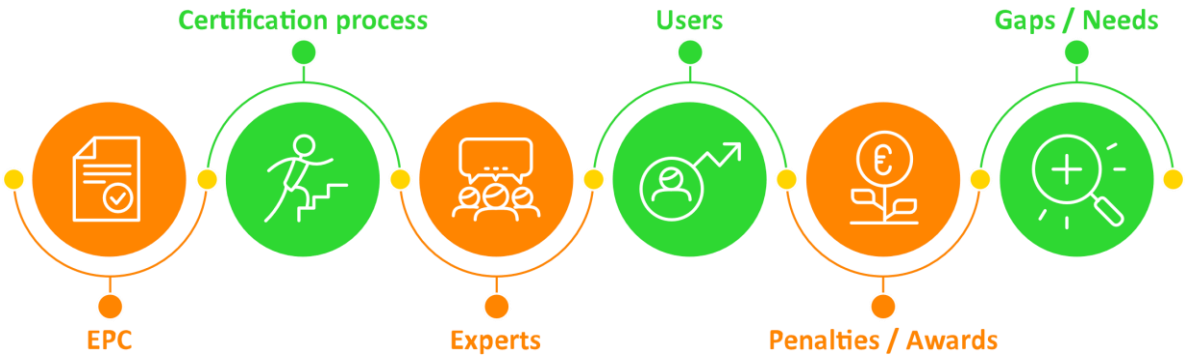


Figure 1. Stakeholders and processes related to EPC

[1] M/480 Mandate of the European Commission to CEN, CENELEC and ETSI 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 of buildings (2010/31/EU)

Terms List

Term	Description
BIM	Building Information Model
CEN	European Committee for Standardization
DT	Digital Twin
dEPC	dynamic Energy Performance Certificate
EPB	Energy Performance of Buildings
EPC	Energy Performance Certificate
EU	European Union
GIS	Geographic Information System
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
MS	Member State

Authors List

Leading Author			
First Name	**Last Name**	**Beneficiary**	**Contact e-mail**
Lina	Šeduikytė	KTU	Lina.seduikyte@ktu.lt

Co-Author(s)				
#	**First Name**	**Last Name**	**Beneficiary**	**Contact e-mail**
1	Paris	Fokaides	FRC	eng.fp@frederick.ac.cy
2	Christiana	Panteli	CLEO	cpanteli@cleopa.de
3	Panagiota	Chatzipanagiotidou	CERTH	phatzip@iti.gr
4	Phoebe-Zoe	Morsink-Georgali	FRC	res.gp@frederick.ac.cy

1 Introduction

This document provides a summary of the technological and market conditions where D^2EPC will be realized and stakeholder requirements, as well as investigates the challenges of current EPC schemes and limiting factors.
For the delivery of a state-of-the-art tool for Dynamic EPCs issuance, it is critical to identify the methodologies currently used for the issuance of EPCs at a European level. The project involves the collection of the key elements and the comparative assessment of the currently used EPC schemes, as well as of other methodologies employed in EU MS for the calculation of the energy performance of buildings. The mapping of the national approaches for the issuance of EPCs, will enable the assembling and reviewing of all the available methodologies, distinguishing between the methodologies that are exclusively based on calculated energy consumption (asset rating) and the methodologies that use actual energy consumption data (operational rating). It is evident that the current status of EPCs lacks alignment with Industry 4.0 digital tools, as well as other important features such as information impact, user-friendliness, and user awareness.

2 Methodology

For the identification of the current status of EPC, limitations, and information for the gaps in the existing EPC schemes, the calculation procedures, and standards, the following methods were used:

Desk research:

- Overview of fifty-two reports to identify the challenges, needs, and opportunities of current EPC schemes, as well as emerging future requirements of the market.
- Documentation of statements within the collected reports, which provide evidence on current practices in the EU Member States. A total of twenty-five statements were collected concerning the methodology, input data, registry, and quality control of EPCs and energy experts in the EU MSs.
- Analysis of the collected statements and the extraction of conclusions concerning good practices and performance paradigms.

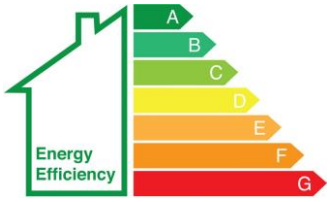
Field research:

- The field research committed as a set of statements with 10 questions relevant to challenging matters of:
    - EPCs issuing, quality, and control,
    - EPCs calculation software and tools,
    - EPCs indicators,
    - Qualified experts' competence and skills.
- Surveys/interviews were addressing the project's stakeholders in order to collect missing data concerning future trends and needs as well as to validate the ones identified in the desk research. Two sets of questionnaires were circulated to the end-users (owners, users, and real estate agents who can use EPCs for rental, sale, or normal use) and technical stakeholders responsible for deploying the EPC service (Tool developers, EPC registries, etc.) as well as service providers (ESCOs, Engineers, Building designers, etc.).

Stakeholders were identified with the use of the Stakeholder Circle® as those who affect the EPC assessment (who are involved in the delivery of EPCs and/or determine the context of the EPCs), those who are directly or indirectly affected by the EPC assessment (e.g., users, community groups and associations, and the general public) or those who may be interested in practices and policies related to EPCs (e.g., for research purposes, media, and campaigns or future projects within this frame of reference).

3 Main findings

EPC



EU member states

- Countries in the EU are able to select EPC calculation methodologies that best suit their needs whilst adhering to current CEN and EPB standards. This gives rise to a variety of methodologies across MSs.
- 16 MSs use asset rating as the energy performance methodology, 2 make use of operational rating, and 11 MSs, including the UK, use a combination of calculated and measured rating.
- Among the 27 EU MSs, 16 have adopted the methodology exclusively based on calculated energy consumption.
- Calculation procedures in most MSs, account for technologies that are typically used locally, where the EPB has not provided any standards.
- In quite many countries, EPC databases are connected to either construction and housing register, to official cadastral register (EPC database), or the joint municipal property register.
- In several countries, the energy cost and the carbon dioxide emissions per m^2 are included in the EPC procedures.
- Most EU MSs have developed central databases for collection, registration, and inspection of EPCs and technical building systems of existing and new buildings, which are used as well for exporting statistics.
- The calculation models followed by various MSs, often do not factor in the quality of work of assessors or operational flaws.
- Most MSs have a national EPC database. Those MSs with regional databases are making efforts to combine them into a central database.
- Regional databases may be bound by different regulations related to data access according to state laws and thus give rise to a variance in the information available on the databases.
- The use of an EPC database, lacking standard template results in energy experts uploading EPCs in various formats, is the case in Romania's central EPC register.
- EPCs issued after renovations are not distinguished in most databases, such as in Belgium, Walloon. Therefore, it cannot be ascertained how many EPCs are issued for renovated buildings. The inclusion of an input parameter in the database

describing renovation works may be advantageous for monitoring the building stock.

Certification process

- The validity of an EPC is up to 10 years in most countries. After this period, a re-issuance of the certificate is mandatory.
- After a major reconstruction-renovation of the building envelope or the technical systems, an update of the certificate is mandatory.
- In some countries, the EPC of new buildings is valid for up to 6 years from the date of commissioning of the building, and the EPC of existing buildings has to be renewed within 3 years.

Experts

- A continuous update of skills and knowledge was documented.
- Periodic training and verification are not required in the majority of the EU MSs.
- In some countries, EPC assessors are certified once and their license is valid for the rest of their lives.
- The inspectors' and EPC audits' infringements are punished with suspension or removal from assessors' registries.

Users

- There is a basic understanding of EPC throughout the EU and among educational levels and age groups.
- There is an overall good understanding of smart building technologies among different countries and age groups.
- The majority of the respondents would wish to receive real-time information of their building's energy efficiency through an energy platform.
- The majority of the respondents are positive for the integration of a new set of indicators (thermal comfort, smartness of building systems, and environmental-related indicators).
- The majority of respondents identified limitations in EPC methodology and calculation tools.

Penalties / Awards

- Penalties are rare and are mainly addressed to energy auditors.
- In several countries, incentives are provided only in terms of tax deductions, either as reduction of construction tax burdens for new private buildings, renovations, or as taxation of real estate.
- Energy-related financial indicators are not found to be included in current EPCs schemes and procedures in any EU MS.

Gaps / Needs

- The majority of EU countries do not employ by any means BIM documentation and literacy or digital logbooks for the issuance of EPCs.
- BIM documentation and digital logbooks are used as a source of information for the EPC assessment procedure or energy simulations for building permits.
- There is no obligation for MSs to use BIM software.
- Within the next year, Belgium will establish BIM source documentation for the declaration of the energy performance of newly built buildings.
- The Netherlands will provide the option to the three suppliers of the validated calculation tool of using BIM for the EPC calculation.
- There is no provision, national requirement, or legal obligation of a 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.
- In most of the EU MSs, GIS information is not included in the EPCs; not exploited for issuing, validating, monitoring, and verification processes of the EPC calculation.
- Environmental/LCA related financial indicators are not considered for the EPC issuance.
- The comfort factor is combined in assessment systems, but it is not calculated in the analysis.
- Comfort assessment or the employment of sustainable materials with low environmental impact from a life-cycle perspective is still not included as a part of a country's EPC calculation method.
- Indoor environmental quality indicators are not covered in current EPC regimes and are not included in the calculation procedure
- In some countries, only parts of the building stock are examined visually or estimated in relevance to the calculations.
- 1/3 of the EU countries do not have provision for systematic and regular evaluation/assessment of energy assessor's competence and skills.
- Smart metering and real-time data are not utilized in the calculation procedures of the EPC in many MSs.
- There is a growing need for calculation tools that cover more complex combinations of RES, the use of innovative technologies, and EPCs issued earlier stages of construction.
- There is a need for an openly accessible EPC registry of all EPCs in Europe MS, addressed by the European Energy Performance of Properties Analysis.

The analysis of the current state of the art in the EU MS, resulted in the steps presented in Fig. 2 for the successful implementation of a new EPC scheme in the EU.

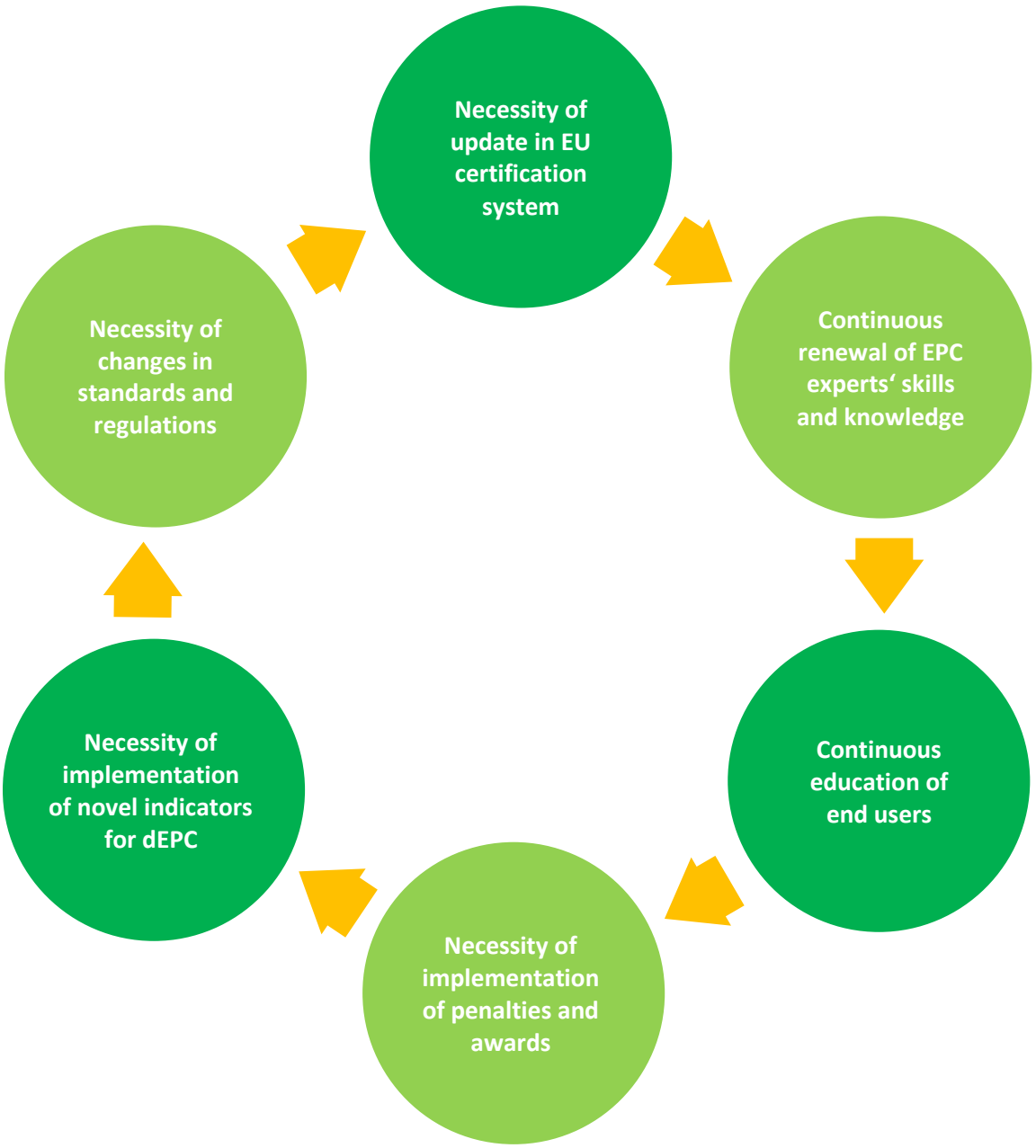


Figure 2. Novel aspects for dEPC

4 D^2EPC vision – novel aspects for dynamic EPC

Notwithstanding the positive contribution that current EPCs have had on improving the energy performance of buildings, experience has unveiled a number of constraints and limitations. There is a need for a holistic framework for strengthening and improving the quality and application of EPCs, by introducing novel and cost-effective approaches of assessing the energy performance of building envelopes and systems.

According to the data collected, the introduction of novel aspects of the certification process and the simplification thereof, the strengthening of its user-friendliness, and conformity with national and European legislation can be accomplished using a standard collection of indicators based on a specific methodology. All upgrade needs of EPCs can be met by choosing acceptable output indicators and their automated estimation.

Based on the research, it was revealed that the majority of EU countries do not employ by any means BIM documentation and literacy or digital logbooks for the issuance of EPCs. The issuance of EPCs based on real-time data and advanced BEPS tools integrated into BIM will be useful.

It was shown that in most of the EU Member States, information related to 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.

From the gathered data, the novel aspects that are suggested to be included in the dEPC are presented in Figure 3.

Figure 3. Novel aspects for dEPC

Novel aspects include new indicators to be used in dEPC:

Smart readiness indicators

The exploitation of the overall amount and granularity of energy consumption data available from smart meters and other connected home devices could enhance EPCs for existing buildings. Real-time energy-related data from smart devices and sensors, addressing issues resulting from incorrect data due to improvements made during the design process, could be considered. The SRI should be viewed as an extension of the generally agreed EPC system, either optional or obligatory, in such a manner as to ensure the multiplication of the SRI's behaviour. SRIs could be used, in compliance with Directive (EU) 2018/844, to (i) assess the ability of buildings to employ information and communication technology and electronic networks, (ii) adjust the

functioning of buildings to the demands of inhabitants and the system, (iii) enhance energy performance and the total operation of the system. The scope of EPCs is mainly applicable to the SRI, but it may also provide further information on building automation and control systems (BACS). A building's environmental efficiency should be viewed in line with its potential to lower its environmental footprint dynamically. SRIs could promote awareness of intelligent buildings' advantages and design, especially from an energy aspect, and make their upgrades more accessible to building occupants, owners, residents, and distributors of innovative technologies. Moreover, they could encourage consumers to increase developments in smart construction innovations and promote the implementation of technological advancement in the construction industry. Furthermore, it would be possible to classify a set of SRIs, that could be derived from the input information of the EPC and establish the methods for their estimation.

Human comfort indicators

Although thermal and acoustic comfort, indoor air quality, and daylight are among the critical factors for rehabilitating buildings, current EPCs do not consider them. Simultaneously, the recommendations for energy upgrade are automatically generated by a standard list, such as increased insulation, replacing windows, and do not offer a user-friendly document that could motivate renovation. By definition, EPCs are indicator-oriented documents that inform building users about their space's energy class. By adding supplemental novel indicators, it appears that this justification will be expanded, turning the energy certificate into a more user-friendly and detailed document, covering various aspects of buildings' energy and comfort efficiency.
Human-centric indicators will allow the holistic and cost-effective appraisal of buildings based on complementary parameters that will consider the efficiency of both the envelope and buildings' framework.

LCA indicators

The need to shift to a comprehensive evaluation of buildings' environmental efficiency and to extend the awareness of the building's real environmental effect as a whole comes into view. Implementing of LCA-based indicators for the energy evaluation of buildings is envisaged for this purpose. These indicators should be based on well-established databases across Europe concerning the environmental impact of building materials (EcoInvent, BRE Greenguide), resulting in an LCA of the building's buildings and individual components (building envelope, building systems, building materials). Through this assessment, the option for building construction engineers to enhance and maximize the building's environmental efficiency, based on improvements to be implemented at the building's initial design stages, could be provided. LCA allows the estimation of any system's environmental effects over its life cycle by taking into account the necessary input and related production resources of that system.

In addition, the suggested strategies optimize their effect by taking the embodied energy and environmental footprint into account by integrating LCA indicators into the efficiency upgrade road-mapping method.

Financial indicators

A set of financial indicators could be developed, based on the well-established principle of life-cycle costing, to allow the individual elements of buildings' energy efficiency to be interpreted into standardized numerical values. The delivery of such indicators could allow the use of EPCs for the financial evaluation of energy upgrading measures for buildings. Additionally, it could allow the exploitation of the information produced by EPCs by energy audit processes, bridging the gap between the energy-related directives of EPBD and the energy efficiency. These should provide the ability to produce several strategic scenarios and encourage substantiated decision-making based on several indicators, as described above, such as financial indicators, energy indicators, condition of building elements, renovation time, and level of comfort.

BIM & DT

Geolocation

Notwithstanding the positive contribution that current EPCs have had on improving the energy performance of buildings, experience has unveiled a number of constraints and limitations. There is a need for a holistic framework for strengthening and improving the quality and application of EPCs, by introducing novel and cost-effective approaches of assessing the energy performance of building envelopes and systems.

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As a novelty, it is suggested to include ***BIM, DT*** and ***GIS*** into the new dynamic energy certification system.

Since the onset of the EPBD in 2002, numerous standards have been published and amended, aiming to simulate and predict the energy performance of the EU MSs building stock on the design stage. According to the research findings, countries in the EU are able to select EPC calculation methodologies that best suit their needs whilst adhering to current CEN and EPB standards. The resultant EPCs produced by each member state may not be comparable in order to provide valuable information about the overall state of EU building stock, monitor progress towards energy performance goals set in the EPBD or develop energy efficiency policy. The next-generation EPC scheme should be based on the relevant EU standards and the Energy Performance of Buildings Directive in order to allow for an EU-wide deployment. There is a need for the ***development of a new set of standards*** that will enable the concept of the dynamic EPC through the integration of real-time monitoring data into buildings' energy performance simulation paths. One of the main objectives of D^2EPC is to conclude to a specific series of proposals and measures to be used for the update of the ISO/CEN standards developed under Commission mandate M/480.

5 Conclusions

- 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. The dynamic EPCs will allow for the monitoring of the actual performance of building users on a regular basis and the introduction of intelligent financial schemes associated with output-based assessment. These schemes will either be based on financial awards (e.g., tax reliefs) for those building owners who exceed EPC expectations or on penalties for the "unconscious" users, not meeting the EPC expected class, based on the "polluter pays" principle.
- D^2EPC is in line with the belief that "next generation EPCs should introduce an agreed list of parameters concerning the level of smartness of buildings". The vision of this project is to achieve a solid link between the SRI and the dynamic EPC in a uniform way so as each time an EPC is conducted, an SRI assessment to be offered.
- D^2EPC project also aims to propose additional indicators, which demonstrate the environmental performance of buildings, for their introduction in the next-generation EPCs. For the development of the environmental indicators, LCA methodologies and tools can be introduced to the dynamic EPC scheme for the efficient energy design of buildings and for enabling the parameterization of its embodied energy and primary energy demand, to be included in the dynamic EPCs.
- The research showed that since an intimate connection between BIM and DT is observed, it is crucial to implement best practices on BIM legislations and standards to define the use of DT. In the context of EPC, BIM is a promising technology that has the potential to simplify procedures, particularly when it comes to data collection.

On the basis of those findings, D^2EPC will lead to the transition from the EPC to a systemic instrument that recognizes the whole life cycle of a building as a structure and will encourage best practices in the field of energy efficiency. The project aspires to deliver the next generation of dynamic EPCs for the operational and regular assessment of buildings energy performance, and it subsequently builds upon actual data and the "digital twin" concept to calculate energy, environmental, financial, and human comfort indicators and through them the EPC classification of the building. The proposed scheme will provide sufficient background for the redefinition of EPC related policies through regular benchmarking and upgrade of the reference buildings, as well as with the integration of geolocation and "polluter pay" practices into the EPC rationale. The implementation of the proposed project is also anticipated to foster the energy-saving consciousness of buildings' users through their regular information on the actual energy performance of their buildings and suitable incentivisation. The proposed D^2EPC scheme is expected to transform EPCs into a user-friendly, reliable, and cost-effective, informative tool for both the wide public (building users, occupants, owners, etc.) and professionals (building managers, engineers, designers, etc.), as well as to establish the grounds for turning EPCs registries into consistent policy feeding mechanisms.

Partners

- Centre for Research and Technology Hellas, Information Technologies Institute, Greece
- Kaunas University of Technology, Lithuania
- Geosystems Hellas A.E., Greece
- Cleopa Gmbh, Germany
- SEnerConGmbh, Germany
- AsociacionEspanola de Normalizacion, Spain
- DEMO Consultants BV, Netherlands
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- Frederick Research Center, Cyprus
- Austrian Energy Agency, Austria

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