



Towards Innovative Methods
for Energy Performance Assessment and Certification of Buildings

Deliverable 5.7

Proceedings of the TIMEPAC-22 International Workshop

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www.timepac.eu



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Executive Summary

This is a report of TIMEPAC-22 International Workshop “Enhancing energy performance certification to drive the deep renovation of Europe’s building stock”, organized by the Politecnico di Torino (POLITO) that took place on November 30th 2022 in Torino, Italy.

The workshop was divided into three sessions:

- **Session 1 - Enhanced EPC in the framework of legislative evolution.** This session explored new EPBD regulations and strategies for the EPC enhancement through a dynamic, flexible, and holistic energy certification process to boost the deep renovation of EU building stock.
- **Session 2 - Methods and tools to assess zero emission buildings and advanced technologies.** Improvement of methods and tools to assess the energy performance of buildings and building components, toward the climate-neutral building target.
- **Session 3 - Capacity building and training perspectives.** Innovative education and training perspectives were covered in this session to allow public authorities, ESCOs, technicians, and end-users to develop advanced skills and competencies in the context of transition to low-carbon societies.

The workshop was carried out as a hybrid event, with participants both online and in-presence at the Energy Center House of the Politecnico di Torino, Turin (Italy). The fact that the TIMEPAC-22 received more than twenty abstracts was quite remarkable. The workshop attracted a total number of 60 participants. To facilitate attendance, the workshop was free of charge.

This document contains the programme of the workshop, the programme and the abstracts of the presentations, which can be found on the project's web page¹. It ends with some concluding remarks on the results and on future prospects that will be taken into account in the next workshop to take place in Vienna, in the fall of 2023.

¹ <https://timepac.eu/workshop/timepac-2022/>

1 Introduction

The overall objective of the TIMEPAC Towards Innovative Methods for Energy Performance Assessment and Certification of Buildings, is to foster the implementation of a more holistic approach to energy certification of buildings by considering:

- a. the overall cycle of EPC related data, from generation to storage, to analysis and exploitation, throughout the building lifecycle, from design, to construction and operation,
- b. that buildings are part of a larger ecosystem which includes energy and transport networks and the built environment, and
- c. that buildings are dynamic entities, continuously changing over time.

TIMEPAC workshops are vital elements of the project's communication and dissemination strategy. The TIMEPAC series of workshops began in 2019² and has been followed by two workshops held in Ljubljana³ (2021) and Torino⁴ (2022), organized by the Jožef Stefan Institute (JSI) and the Politecnico di Torino (POLITO), respectively. The TIMEPAC workshop series will be then continued with a workshop in Vienna (2023) that will be organised by the Institute for Sustainable Energy and Resources Availability (SERA).

The objective of the TIMEPAC workshops series is to provide a platform for energy efficiency experts, researchers and those interested in learning about sustainability in the building sector, to present and exchange their experiences, results, research progress and to discuss the state of the art, as well as to determine the future directions and priorities in the various areas of energy performance of buildings. This includes the improvement and dissemination of knowledge on methods and indicators for energy performance assessment, policies for enhancing the deep renovation of buildings and technologies for increasing energy efficiency in the building sector, in economic, environmental, and social terms.

The scope of the TIMEPAC workshops covers the following areas:

- Formulation of a comprehensive energy policy framework for the deep renovation of EU building stock (potentials, models and tools, costs and benefits, financial and regulatory mechanisms, trends, and predictions, etc.),
- Methods for energy performance assessment comparisons and measurements methodologies,
- Deep energy renovation of buildings as a driver for innovation and the creation of employment,
- New trends and developments in modelling and energy performance certification of buildings,
- Smart energy services (technology development, knowledge transfer, installation, maintenance, national, regional, and municipal policies),
- Big data analysis,
- Energy communities, decarbonisation and sector coupling (integration of infrastructure, new trends in planning future energy systems, integration of renewable energy heat/cold supply, high efficient cogeneration, heat pumps, utilisation of excess heat and integration with district heating network, green hydrogen, etc.),
- Regional planning and cooperation,
- New trends in energy performance contracting and verification of energy savings,
- Education and training in energy efficiency and deep renovation of buildings,
- Urban planning and the integration of renewable energy sources in buildings,
- Smart energy networks and advanced storage systems in buildings.

² <http://timepac2019.blogspot.com/>

³ <https://timepac.eu/workshop/timepac-2021/>

⁴ <https://timepac.eu/workshop/timepac-2022/>

The overarching theme of TIMEPAC-22 International Workshop was “Enhancing energy performance certification to drive the deep renovation of Europe’s building stock”. In order to ease the participation of both speakers and participants, the workshop was held in a hybrid format with participants on-line and in-person.

The workshop was advertised through various communication channels: project web site (Figure 1), social media (Figure 2 and Figure 3), web sites of partner organisations, and personal communications.

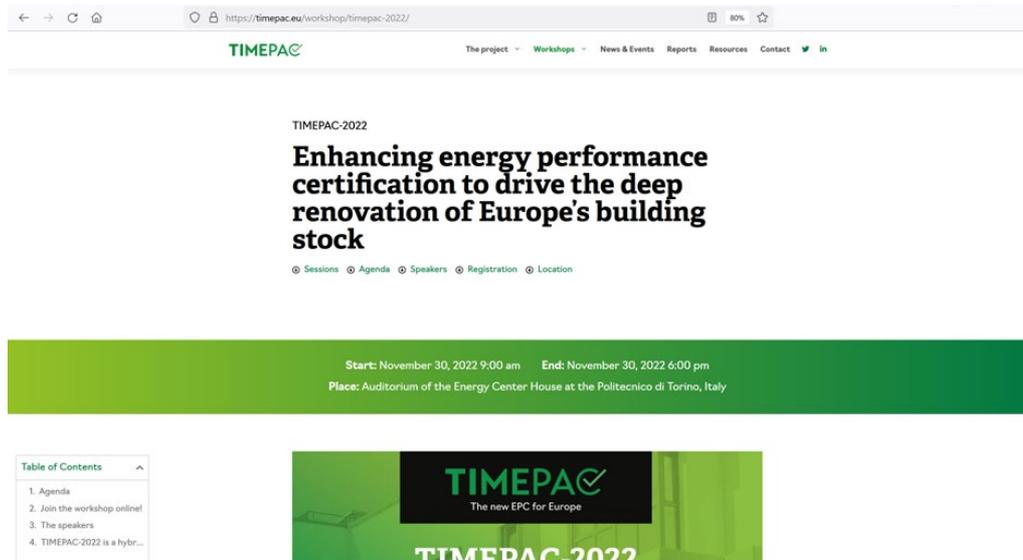


Figure 1. Entry page of the TIMEPAC-22 Workshop



Figure 2. Twitter post to announce the TIMEPAC-22 Workshop



Figure 3. LinkedIn post to announce the TIMEPAC-22 Workshop

TIMEPAC workshops are vital elements of the project’s communication and dissemination strategy. The event was covered by the TIMEPAC social media channels and contributed to giving visibility to the project. In the event promotion period, from 19th October to 1st of December, the TIMEPAC Twitter channel generated 17 tweets (2,300 impressions and 87 likes) related to the event. On LinkedIn during the same period, the channel generated 11 event related posts (2,700 impressions, 171 “reactions” or “likes” and 37 reposts).

There were 60 persons registered in the workshop, 46 attending in-person and 14 online, which was more than expected (at least 50 participants) (Figure 4).



Figure 4. TIMEPAC-22 hybrid workshop in-person and on-line

2 Workshop programme

The programme of the TIMEPAC-22 International Workshop was divided into three sessions:

- **Session 1 - Enhanced EPC in the framework of legislative evolution.** This session explored new EPBD regulations and strategies for the EPC enhancement through a dynamic, flexible, and holistic energy certification process to boost the deep renovation of EU building stock.
- **Session 2 - Methods and tools to assess zero emission buildings and advanced technologies.** Improvement of methods and tools to assess the energy performance of buildings and building components, toward the climate-neutral building target.
- **Session 3 - Capacity building and training perspectives.** Innovative education and training perspectives were covered in this session to allow public authorities, ESCOs, technicians, and end-users to develop advanced skills and competencies in the context of transition to low-carbon societies

A detailed programme is shown in Table 1.

Table 1. Programme of the workshop on 30 November 2022

8:30 - 9:00	Registration and networking
Opening Session	
Chair: Vincenzo Corrado, Department of Energy “Galileo Ferraris”, Politecnico di Torino, Italy	
9:00 - 9:05	Welcome address - Marco Perino, Head of Department of Energy “Galileo Ferraris”, Politecnico di Torino, Italy
9:05 - 9:20	The TIMEPAC project: envisioning the upcoming energy performance certification processes - Leandro Madrazo, ARC Engineering and Architecture La Salle, Spain
9:20 - 9:50	EU Green Deal, Renovation Wave, Fit for 55 by 2030, Repower EU plan drivers for the EPBD revision in 2022, will it affect the use and revision of the set of EPB standards? - Jaap Hogeling, EPB Center, The Netherlands
Session 1 - Enhanced EPC in the framework of legislative evolution	
Chair: Álvaro Sicilia, ARC Engineering and Architecture La Salle, Spain	
9:50 - 10:05	EPBD evolution and its future application in Spain - Aitor Domínguez, Spanish Institute for Diversification and Energy Saving (IDAE), Spain
10:05 - 10:20	Energy Performance of Buildings: Policy framework and recent developments - Nicos Hadjinicolaou, Ministry of Energy, Commerce and Industry of Republic of Cyprus, Cyprus
10:20 - 10:35	The EPC regional system and the professional perspective about its enhancement - Silvio De Nigris, Regione Piemonte, Italy
10:35 - 10:50	The energy performance of the Italian building stock - results from the National Report on Building Energy Certification - Francesca Pagliaro, Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Department Unit for Energy Efficiency, Italy

10:50 - 11:05	Operational data integration to enhance energy performance certificates - Giovanna De Luca, Department of Energy “Galileo Ferraris”, Politecnico di Torino, Italy
11:05 - 11:35	Coffee break
11:35 - 11:50	The Renovation Passport - example of implementation in Austria - Susanne Geissler, Institute for Sustainable Energy and Resources Availability (SERA), Austria
11:50 - 12:05	Boosting up the replacement actions of the heating systems through campaigns and further improvement of an EPC scheme - Gašper Stegnar - Jožef Stefan Institute, Energy Efficiency Centre, Slovenia
12:05 - 12:20	The H2020 X-tendo project - Fabio Zanghirella, Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Department Unit for Energy Efficiency, Italy
12:20 - 12:35	EUB SuperHub Platform: a one-stop shop platform and an e-passport for the next generation EPC - Andrea Moro, iiSBE Italia R&D, Italy
12:35 - 12:45	Discussion and wrap-up of Session 1
Session 2 - Methods and tools to assess zero emission buildings and advanced technologies Chair: Ilaria Ballarini, Department of Energy “Galileo Ferraris”, Politecnico di Torino, Italy	
12:45 - 13:00	Exploiting energy performance certificates through Artificial Intelligence for supporting the energy decision making process in buildings - Alfonso Capozzoli, Department of Energy “Galileo Ferraris”, Politecnico di Torino, Italy
13:00 - 13:15	EN-TRACK the “One-stop-shop” platform for building’s energy management - Oriol Escursell, Catalan Institute for Energy (ICAEN), Spain
13:15 - 14:15	Lunch break
14:15 - 14:30	Landscape mapping of adaptive building skin - prevailing solutions in the market and in research - Magdalene Charalambous, Adaptive Architecture Systems, Cyprus
14:30 - 14:45	A tool for defining an annual public sector building renovation plan - Ilja Drmač, Energy Institute Hrvoje Požar, Croatia
14:45 - 15:00	Selection of the optimal solution for deep energy renovation of a building - Ružica Budim, Energy Institute Hrvoje Požar, Croatia
15:00 - 15:15	How to connect a BIM architectural model with the EPC - Benjamin Gonzalez, CYPE Ingenieros, Spain
15:15 - 15:30	The complex and delicate design balance necessary to design and build a NZEB with BIM approach: a case study - Giorgio Bo, Prodim s.r.l., Italy

15:30 - 15:45	A comprehensive approach to decarbonising and improving the performance of district heating systems - Jure Čižman, Jožef Stefan Institute, Energy Efficiency Centre, Slovenia
15:45 - 16:00	Smart2B: The development of Smart Ecosystem to assess and optimize buildings performance - Nuno Mateus, Energias de Portugal (EDP), Portugal
16:00 - 16:10	Discussion and wrap-up of Session 2
16:10 - 16:40	Coffee break
Session 3 - Capacity building and training perspectives	
Chair: Boris Sučić, Jožef Stefan Institute, Energy Efficiency Centre, Slovenia	
16:40 - 16:55	Challenges in creation of a curriculum for target-oriented trainings for improving energy performance of buildings - case study Slovenia - Boris Sučić, Jožef Stefan Institute, Energy Efficiency Centre, Slovenia
16:55 - 17:10	CV definition of the Energy Efficiency Expert in the construction sector in the context of the Erasmus+ EEE project - Matteo Trichilo, P-Learning s.r.l., Italy
17:10 - 17:25	From ideas to complex modelling and implementation - local energy agency as enabler of innovative projects - Vanja Cencič, Goriška Local Energy Agency (GOLEA), Slovenia and Boris Sučić, Jožef Stefan Institute, Energy Efficiency Centre, Slovenia
17:25 - 17:40	Empowering Energy and Climate Action Plans SECAPs in a wide crossborder area - Nicolò Tudorov, Autonomous Region Friuli Venezia Giulia, Italy
17:40 - 17:50	Discussion and wrap-up of Session 3
17:50	Closing of the workshop

3 Abstracts

This chapter contains the accepted abstracts, ordered according to the programme schedule.

Opening Session

[The TIMEPAC project: envisioning the upcoming energy performance certification processes](#)

Leandro Madrazo

ARC Engineering and Architecture La Salle, Barcelona, Spain

TIMEPAC⁵ is a Coordination and Support Action project in which a consortium of 14 organisations from seven European countries including research groups, public certification bodies, local energy agencies and consultancies, a software developer and a communication agency, are exploring ways to enhance the energy certification of buildings. The action started in July 2021 and will last three years.

TIMEPAC is one of the on-going EU-funded research projects on the implementation of the next generation of energy performance certification, as formulated in the recast of the Energy Performance of Buildings Directive (EPBD)⁶ currently being negotiated by the European Parliament and the European Council as part of the “Renovation Wave” strategy⁷ and the “Fit for 55” package⁸. This review, together with the recast Energy Efficiency Directive⁹, aims to provide Member States with more effective certification tools to help them achieve a zero-emission building stock by 2050.

Buildings are not isolated objects, but an integral part of the built environment; they consume energy but can also produce it and feed it back into the electric grid. Buildings are subject to continuous changes throughout their lifetime, and their energy performance is related to the uses of their occupants and the comfort levels they set. Consequently, their certification cannot be a single action, but a continuous assessment process that takes into account the actual consumption of the building as well as the successive renovations that the building undergoes over time.

To move from a unique, static certification to a comprehensive, dynamic assessment over time, it is necessary to collect building data from multiple sources: energy consumption, indoor comfort, and renewable energy production, among others. Furthermore, to enable the multiple parties involved in the certification process to make use of this data, we need a continuous and seamless flow throughout the whole process of generating, storing, analysing and exploiting energy certification data (Figure 5).

⁵ <https://timepac.eu/>

⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0802>

⁷ [https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en#:~:text=The%20Renovation%20Wave%20initiative%20builds,and%20climate%20plans%20\(NECPs\)](https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en#:~:text=The%20Renovation%20Wave%20initiative%20builds,and%20climate%20plans%20(NECPs))

⁸ <https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/>

⁹ https://www.euractiv.com/wp-content/uploads/sites/2/2022/07/EED_Final-Compromise-Amendment.pdf

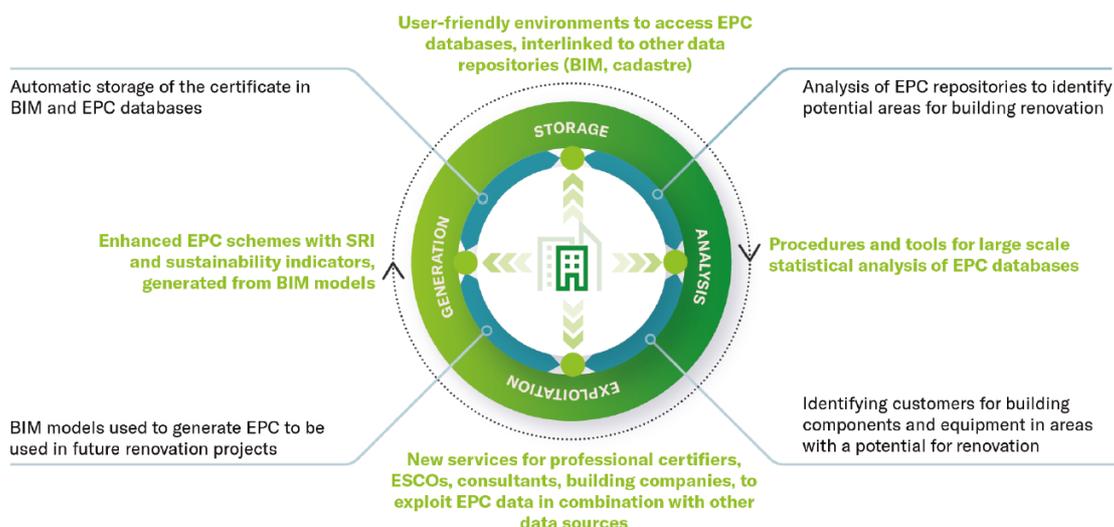


Figure 5. TIMEPAC’s approach to the EPC data flow

The goal of TIMEPAC is to facilitate the change towards the new energy performance certification which is envisioned in the EPBD recast for the multiple stakeholders involved: professional certifiers, energy agencies, energy auditors and consultants, ESCOs, architects, engineers, real estate agencies, construction companies, owners and administrations. Specifically, the objectives of the project are:

- To increase the quality and reliability of EPC schemas
- To enhance EPCs with sustainability and smart readiness indicators
- To integrate EPC databases with other data sources in order to improve the efficiency and reliability of the certificates
- To increase awareness of the need to have EPCs enhanced with other data sources to foster their exploitation
- To provide training materials based on the procedures envisioned by TIMEPAC

To achieve these objectives, we are applying a future scenario methodology for certification stakeholders to make use of improved EPCs with more accurate and reliable data. To this end, we are exploring the capabilities offered by digital technologies, such as the digital logbook, building repositories and EPC databases while using advanced analytical tools to deliver new services based on the enhanced EPC data. The five Transversal Deployment Scenarios (TDS) which are considering are:

1. Generating enhanced EPCs with BIM data. To facilitate the generation of EPCs from BIM models in a bid to increase the quality and reliability of the EPCs and to create guidelines for EPC generation from BIM data.
- 2 - Enhancing EPC schemas through operational data integration. To improve the accuracy and reproducibility of all the EPC assessment procedure using data obtained from energy meters, building automation and control systems.
- 3 - Creating Building Renovation Passports from data repositories. To update EPCs from the information facilitated by the building renovation passports over time, including relevant data obtained from the building inspections, and to use BIM technologies to create digital logbooks.
- 4 - Integration of smart readiness and sustainability indicators in the EPC. To enhance EPCs with the information provided by sustainability assessments and reporting frameworks (i.e. Level(s)) as well as the Smart Readiness Indicator (SRI).
- 5 - Large scale statistical analyses of EPC databases. To exploit the information provided by the enhanced EPCs to carry out large scale deep renovation programmes, providing local authorities,

ESCOs, and real estate owners with a methodology to perform reliable refurbishment scenario analyses of the building stock.

These five scenarios are being developed simultaneously in an interlinked way by project partners in six European countries: Austria, Croatia, Cyprus, Italy, Slovenia, and Spain. The next step will be to discuss the scenarios with practitioners in the different certification fields for feedback. Finally, the TIMEPAC Academy will offer a set of materials and courses to train the next generation of professionals on how to effectively use the new energy efficiency certification processes.

[EU Green Deal, Renovation Wave, Fit for 55 by 2030, Repower EU plan drivers for the EPBD revision in 2022, will it affect the use and revision of the set of EPB standards?](#)

Jaap Hogeling

EPB Center, Rotterdam, The Netherlands

Buildings are acknowledged as one of the key focus areas for the European Green Deal and more specifically the Renovation Wave Strategy, whose aim is to at least double the annual renovations of EU building stock with focus on increasing deep renovations to 3%. This is the basis for the urgent revision of EPBD (version 2018) to direct the national renovation strategies to achieve a decarbonised building stock by 2050.

The current EPBD reversion proposal includes new elements such as the concept of NZEB (Nearly Zero Energy Building) to ZEB (Zero Emission Building), more attention to (MEPS) Minimum Energy Performance Standards (Requirements), more attention to the Smart Readiness Indicator (SRI) of buildings and the use of renewables. A step-by-step policy towards a zero-carbon building stock by 2050 also requires a study of all the live embodied carbon. More attention to the IEQ in buildings by referring to EN 16798-1. The introduction of the possibility of the use of hourly calculation procedures to assess the asset rating of buildings, an essential step for properly rewarding on-site renewables and the level of grid-interaction of building systems. Hourly calculations are necessary to assess the real use of non-renewable energy use instead of the disguised use of non-renewable energy based on monthly or annual averages (=fake zero carbon emission). Hourly calculations are also needed for proper IEQ evaluation and the implementation of hourly systems such as heat pumps, solar protection, smart controlled systems etc. The introduction of the use of measured operation rating to be included in the EPC (Energy Performance Certificate) would result in a reduction in the performance gap. More attention to measuring and control devices for monitoring IAQ.

These new EPBD elements together with the analyses of the current use of the set of EPB standards are expected to be incorporated into new strategies, such as those under the standard Systematic Review process will lead to an update of many of the EN and EN-ISO standards published pre-2017 as part of the EPB set of standards, see www.epb.center for a complete overview.

Session 1 - Enhanced EPC in the framework of legislative evolution

[EPBD evolution and its future application in Spain](#)

Aitor Domínguez

Spanish Institute for Diversification and Energy Saving (IDAE), Madrid, Spain

With the objective set for 2050 to decarbonize the building stock, it is necessary to define the path to achieve this ambitious goal. The review of the Energy Efficiency in Buildings Directive has been entrusted with this task, and work is currently underway to publish an update that organizes and reorients the efforts of all the Member States. Spain has to be one of the main actors for the achievement of these objectives, and intensive work is currently being done to adapt and facilitate both the regulatory aspects and the promotion of the energy rehabilitation of the building stock. The coming years will have a great impact on the reduction of building emissions, and it is necessary to find a way to increase awareness and interest about the need to act on buildings to improve their energy characteristics.

[Energy Performance of Buildings: Policy framework and recent developments](#)

Nicos Hadjinicolaou

Ministry of Energy, Commerce and Industry of Republic of Cyprus, Nicosia, Cyprus

The Energy Union and the framework of policy for energy and climate, with 2030 as time-scale, establish ambitious commitments for further reductions of greenhouse gas emissions by at least 40% on 1990 levels before 2030, an increase in the percentage of renewable energy consumed and the energy savings corresponding to the objectives set by the Union, in order to reinforce energy security, competitiveness and sustainability. Buildings are at the heart of the energy efficiency policy, as they account for almost 40% of the final energy consumption at a Union level and 30% at national level. The Energy Performance of Buildings Directive (EPBD) introduced in national legislation in 2006, provided the framework for improving the energy performance of the building sector. Current and future policies and measures will be presented as the vision is to decarbonize building sector by 2050.

[The EPC regional system and the professional perspective about its enhancement](#)

Giovanni Nuvoli, and Silvio De Nigris

Regione Piemonte, Turin, Italy

The energy performance certification (EPC) of the buildings as a way to boost the home renovation market requires its enhancement in terms of information included and overall structure. A greater complexity of the procedure and more details in terms of information included in the EPC would need more and better qualified and skilled professionals. In Italy a survey among certifiers has been launched by ENEA (The National Energy and Environmental Agency) in 2022. More than 6.700 professionals replied, providing details from the point of view of who is implementing the regulations in reality and who is providing a service on the market for final users. Their remarks should be taken into consideration when defining the new set of skills needed. Besides, the survey highlights the limits and constraints that exist for the enhancement of the EPC.

[The energy performance of the Italian building stock - results from the National Report on Building Energy Certification](#)

Francesca Pagliaro

Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Department Unit for Energy Efficiency, Rome, Italy

EPC is a powerful tool to predict potential energy savings and scenarios and to guide decision-makers in the choice of suitable energy policies. The Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) evaluates and analyses the information coming from EPCs collected in the Italian Informative System on Energy Performance Certificates (SIAPE). The results are published every year in the National Report on Building Energy Certification which is a work developed in 2020 with the collaboration of the Italian Thermotechnical Committee (CTI) and the support of Regions and Autonomous Provinces. The third edition of the Report was published in November 2022 and shows a detailed analysis of the implementation at the local and national levels of energy certification by evaluating the information from EPCs issued in the previous year and other fundamental aspects, such as the mandatory controls on EPC data and the development of the relevant laws and standard in the national and European contexts. One of the novelties in this edition is the questionnaire distributed to energy assessors to understand and analyse their points of view on the strengths and weaknesses of the current energy certification strategy.

[Operational data integration to enhance energy performance certificates](#)

Giovanna De Luca, Franz Bianco Mauthe Degerfeld, and Vincenzo Corrado

Department of Energy “Galileo Ferraris”, Politecnico di Torino, Turin, Italy

In the last years, the EPC has been recognised as an instrument capable of influencing both the building market and the future refurbishment scenarios of the existing building stock. To ensure accurate and reliable energy performance evaluations, a robust EPC generation process is therefore of foremost importance. However, one of the limitations of the existing certification processes is the so-called “performance gap”, namely the difficulties in guaranteeing a match between the actual building energy consumption and the standard performance provided by the EPC. Within the TIMEPAC project, aimed at improving the existing processes, the enhancement of the EPC scheme is addressed in a transversal deployment scenario (TDS2), through operational data integration. The use of a calibrated building energy model against monitored data to generate the EPC will guarantee the reliability of the input data used to assess the building energy performance, and the replacement of standard users with actual users will increase the accuracy of the evaluations. Therefore, the proposed enhanced EPC, currently under development, will provide an improved data quality. The enhanced EPC will also address a holistic and integrated performance assessment approach, including a wider set of parameters relative to different evaluation domains, such as indoor environmental quality, environmental sustainability, smart-readiness, and cost-effectiveness. The current development status of the enhanced EPC, including the guidelines to correctly integrate operational data into energy performance evaluations, will be presented in this work.

[The Renovation Passport - example of implementation in Austria](#)

Susanne Geissler

Institute for Sustainable Energy and Resources Availability (SERA), Vienna, Austria

For many years, the renovation rate has fallen short of expectations. Against the background of ambitious targets such as envisaged by the Green Deal and stipulated in the European Climate Law, major efforts are needed to make progress. In this respect, the Energy Performance of Buildings Directive (EPBD, Directive 2010/31/EU, amended by Directive (EU) 2018/844) is the most important regulatory instrument in the building sector, and a recast is planned to take into account the tightened requirements. For example, the instrument of Renovation Passport will be specified in

much more detail under the proposed recast EPBD and is much more ambitious than the currently voluntary version of the Building Renovation Passport. The recast proposal suggests that a renovation plan for a step-wise renovation of a building is to be developed in order to achieve the zero-emission target by 2050. There are certain requirements for developing the renovation plan, for example an on-site visit, collection of energy consumption data, and calculation of savings and costs. Austria has implemented the current voluntary approach of the Building Renovation Passport and some provinces have started the practical implementation. The analysis of the expected changes through the recast of the EPBD has shown that elements of the new Renovation Passport approach are already in place in the province of Salzburg, namely in the field of energy advisory services. The existing tools and database for EPC and other building-related data can be further developed to create and store renovation passports and to track the implementation of renovation measures in the database. This conference contribution explains the technical concept how this is implemented and which elements still need to be developed.

[Boosting up the replacement actions of the heating systems through campaigns and further improvement of an EPC scheme](#)

Gašper Stegnar, and Tadeja Janša

Jožef Stefan Institute - Energy Efficiency Centre, Ljubljana, Slovenia

H2020 REPLACE aims to boost the phase-out of inefficient and old heating and cooling systems. The project implements replacement campaigns, which include activities that shall inform consumers about sustainable heating solutions and motivate them to replace their fossil fuelled or any old, inefficient heating systems. Twelve pilot regions tailor-made action plans that define specific activities/measures, time-frames, stakeholders involved and all other necessary details for the actual implementation of the campaign. In addition, local media cooperation strategies to promote the replacement campaign are part of the action plans. The presentation will present an efficient approach of replacement implementations across 10 EU countries. Furthermore, it will focus also on project tools, e.g., heating replacement calculator, that could aid the improvement of an EPC scheme.

[The H2020 X-tendo project](#)

Fabio Zanghirella

Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Department Unit for Energy Efficiency, Rome, Italy

The H2020 X-tendo project developed and tested 10 next-generation EPC features in 9 countries around Europe covering 40% of the EU building stock, with the main goal of supporting public authorities to properly implement, well manage and organize next EPC generations. The 10 developed EPC features can be divided into 5 “innovative energy performance certificate indicators” (e.g., smart readiness, district energy, outdoor air pollution, real energy consumption, and comfort), and 5 “innovative handling energy performance certificate data” (e.g., EPC databases, enhanced recommendations, building logbook, one stop shop, financing options). The main outcome of the project is a toolbox providing, for each of the 10 EPC features: an approach based on good practice examples, methodological approaches, calculation procedures, implementation guidelines and recommendations. An overview of the toolbox and of the developed EPC features will be shown, presenting the main conclusions of the project and the main policy recommendations obtained.

[EuB SuperHub Platform: a one-stop shop platform and an e-passport for the next generation EPC](#)

Andrea Moro

iiSBE Italia R&D, Turin, Italy

The EU Energy certification of buildings (EPC) introduced in 2002 (EPBD (2002/91/EC)) is recognised as a key instrument in making it possible to achieve Europe's energy and climate policies. The main objective of the EuB SuperHub H2020 project is to raise the disruptive market potential of EPCs by leveraging on the powers of the 4.0 era and digital twin technology to transform the process of storing, maintaining and communicating the EPC. The EuB SuperHub project is designing an improved model of certification scheme and a set of tools to enable the creation of a demand-driven market by addressing the needs of multiple stakeholder groups with an online hub (one-stop shop) platform that uses a transnational common set of performance indicators (KPIs). To compare and aggregate the performance reached by buildings certified in different countries with different schemes, the project is designing a transnational reporting document, the e-Passport, as a complementary document to the existing label/certificate issued by certification systems. The EuB SuperHub e-Passport will contribute to leverage new investments in energy-efficient and sustainable buildings by ensuring trust, better quality and easier transnational comparability in Europe, and will be connected to existing national financial schemes for sustainable buildings like grants, subsidies, tax incentives and low-interest loans. The digital e-Passports will be transparent, reliable, and user-friendly and provide accurate and valuable information for later renovation as well as end-of-life solutions. The EuB SuperHub platform and e-Passport goal is to tie the "distributed" systems, assessment schemes and market actors under a common hub (one-stop shop) to raise the impact and value of EPCs.

Session 2 - Methods and tools to assess zero emission buildings and advanced technologies

[Exploiting energy performance certificates through Artificial Intelligence for supporting the energy decision making process in buildings](#)

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EPC data sets are currently great sources of information for addressing different tasks in the context of energy decision making in the building sector. The interest in energy performance assessment is increasing, especially in terms of estimating how the combination of different features can affect the energy demand in buildings and evaluate the feasibility and impact of energy refurbishment plans. In this context, with the rapid growth of stored and open EPC data sets and the necessity to extract knowledge from them to improve building performance, AI-based approaches are becoming more and more prominent. The talk discusses the potentialities of open data and AI for supporting the decision-making process in the energy and building field by examining practical applications in the framework of the research activities conducted by the research Lab BAEDA at Politecnico di Torino. With specific reference to the EPC open dataset of Piedmont Region (Italy), different use cases are analysed, considering the following objectives i) robust extraction of reference values and trends for primary energy demand and features of buildings, ii) identification of advanced multi-variate energy performance benchmarks, iii) definition of data-driven models to estimate the energy demand of buildings and evaluate potential retrofit scenarios. The talk also addresses the future challenges in this field of application with particular reference to interpretability and explainability of AI-based decision support systems to allow their fully exploitation by building experts.

[EN-TRACK the “One-stop-shop” platform for building’s energy management](#)

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One of the principal obstacles to increasing energy efficiency investments (EEI) is the lack of statistical data on the actual energy and their respective cost savings. Data are still hard to access because of decentralized and different formats. Consequently, only a small part of these can be used to produce reliable empirical evidence on the performance of the EEI. EN-TRACK is tackling this challenge by enabling an interoperable ecosystem of data and tools supporting building refurbishment decision-making, putting it into practice with the financial sector. EN-TRACK builds on an existing infrastructure enabling massive data gathering, making the data comparable and interoperable with other existing databases, analysing these data and offering relevant results to key stakeholders. This will support better (more informed, more transparent and faster) decision-making, contribute to the de-risking of investments in energy efficiency in buildings and facilitate process of closing investment deals. The functionalities start with a repository of building information and energy efficiency actions implemented and add benchmarking functionalities to compare current performances to detect the candidate buildings for energy efficiency actions.

[Landscape mapping of adaptive building skin - prevailing solutions in the market and in research](#)

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Adaptive facades provide buildings with the flexibility to respond to variable weather conditions and occupant preferences. They are recognized as a promising design concept for achieving low-energy building operation. The interest in adaptive facades is therefore growing steadily. In the past

decades, many companies offering building skin components and systems, added to their catalogues special façade solutions that are smart, adaptive or sustainable or all three at the same time. A market research study as carried out by members of Adaptive Architecture Systems with the aim of investigating the advanced façade solutions landscape in the building skin market and research field, that can enhance the energy efficiency of the buildings. This research explores solutions that currently exist in the market, and also includes research applications and ideas that have the potential to become market leaders in the next years. It also refers and analyses bespoke adaptive solutions and systems in signature projects and buildings around the world. The presentation of this research aims to inform the participants about the European landscape of advanced building skin solutions. These solutions have the potential to transform building stock towards energy efficiency and climate resilience through renovation.

[A tool for defining an annual public sector building renovation plan](#)

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The tool for defining the annual plan for the renovation of public sector buildings (from now on the Tool) was developed as part of the activities in the IMPULSE MED project (Integrated Support for Energy Efficiency Management in Mediterranean Public Buildings). The purpose of the IMPULSE project was to introduce an integrated support system to manage the planning of the energy-efficiency renovation of public buildings. The incapacity of public administration to develop and implement plans to improve energy efficiency in its public buildings represents a major challenge for the project. Energy efficiency and Climate action plans (SECAPs) at the local level are either missing or incompetent. The fundamental problem is the lack of data available on energy consumption and the condition of buildings owned by local (regional) self-government units. In response to these challenges, the IMPULSE project has developed the Tool based on the collected data on buildings and applied methodology (building typology, energy audit for ambassador building with four levels of refurbishment, and result interpolation) enables local/regional authority to plan the renovation of buildings. The Tool is to support public administration bodies in drafting annual refurbishment plans for the commitments made by Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, which requires Member States to renew each year from 1 January 2014 3% of the total floor area of heated and/or cooled area owned and used by the central government. Within this project, the Hrvoje Požar Energy Institute was a technical partner of the City of Osijek in Croatia and a technical consultant to the City of Mostar in Bosnia and Herzegovina.

[Selection of the optimal solution for deep energy renovation of a building](#)

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The great potential for the reduction of CO₂ emissions lies in the deep energy renovation of buildings that exploits the full potential of improving energy efficiency in buildings to maximize energy savings and minimize energy costs. However, in addition to the technical parameters, it is necessary to analyse the willingness of the client to pay for such deep energy renovations. This paper presents a methodology applicable to all types of buildings that in a relatively short time provides an optimal solution that meets both parameters - technical and economic, while satisfying the legal requirements. The method was tested by simultaneous use of DesignBuilder (which uses EnergyPlus as its dynamic simulation engine), Python and SQL programming language on an office building in the city of Zagreb, where a total of 720 combinations of building deep energy renovation were analysed. In the analysed case, it was proved that the application of this methodology results in obtaining the output values 20.51 times faster than the classical input of all combinations of deep

energy renovation of the building in software tools. In addition, the probability of human error is much lower by applying this methodology given large amount of input data.

[How to connect a BIM architectural model with the EPC](#)

Benjamin Gonzalez, Ane Ferreiro, and Pablo Gilabert
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Building Information Modelling (BIM) is a methodology that aims to cover all the phases and processes of construction with the objective of digitizing this sector as much as possible, thus saving time and costs for the different agents involved. With the emergence of BIM, the communication between architectural model and energy simulation (and EPC as well) is a requirement of the construction sector. As we know, any communication problem is in fact a problem of interoperability between different software solutions which, whereas in the past they could work independently, they are now forced to understand each other. The conversion of an architectural model (BIM), composed of elements such as walls, floor slabs, roofs, windows, doors, etc. to a simulation-ready model (SIM), composed of surfaces, edges, volumes, boundaries, etc. has generated a clear bottleneck because the architectural modelers (Revit, Archicad, Allplan, CYPE Architecture) do not define the information in a way that is understandable to the calculation engines. This presentation will show a tool (Open BIM Analytical Model) able to interpret BIM models in IFC, generated in different modelling software, and to generate a refined analytical model adjusted to the needs of the different simulations, including the EPC.

[The complex and delicate design balance necessary to design and build a NZEB with BIM approach: a case study](#)

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Since its introduction in Directive 2010/31/EU, recast of the Energy Performance Building Directive EPBD 2002/91/EC, the concept of a nearly zero energy building or NZEB is increasingly gaining importance in the professional lives of designers, builders, and property owners: buildings characterized by very high energy performance both in terms of external envelope and plants and whose energy needs are covered by renewable sources to a great extent. We are now close to one of the most important events resulting from the introduction of this revolutionary directive: from 31 December 2020 in fact all new buildings will have to be classified NZEB. In fact, the design of an NZEB requires an integrated approach that takes into account different engineering disciplines - civil and plant engineering - and a delicate balance between the possible choices and design strategies. The purpose of this report is to highlight the criticalities found in obtaining the NZEB classification and the A4 energy class according to Ministerial Decree 26/6/15 through the presentation of a case study. In this context, the use of BIM methodology from the earliest design stages and its subsequent application in the construction phase is of great help in order to facilitate the interaction between the different design disciplines that contribute to obtaining the NZEB classification. The case study under analysis examines an existing building located in Genoa, Italy, which has been completely renovated re-using only the existing structures. The building has undergone major renovations and has become the new headquarter of an international company with the following internal uses: car park entrance, fitness area, a conference room, offices and a restaurant.

[A comprehensive approach to decarbonising and improving the performance of district heating systems](#)

Jure Čižman

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Today, heating accounts for about half of the energy used in the EU, and despite extensive efforts to renovate public and private buildings, heat is expected to still account for the largest share of energy demand in the future. Especially in urban, densely populated areas, district heating systems (DHS) play a crucial role in covering energy needs, but many of them also need to be significantly modernised in order to serve this purpose in an efficient and sustainable way during the next decades. Modernisation of DH systems is an iterative process that requires a set of integrated technical steps and priorities to be followed. The KeepWarm project has identified and proven numerous benefits to be gained from strategic DHS modernisation, as well as the practical options for a structured approach to implementing such improvements. The main challenges for the decarbonisation of DH systems in several Central European countries will be presented and the KeepWarm approach to DH improvement will be described, providing an overview of key elements such as capacity building activities, business model development and the integration of viable retrofits into key strategies and plans.

[Smart2B: The development of Smart Ecosystem to assess and optimize buildings performance](#)

Nuno Matues

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Smart2B is a project funded by the European Commission under the Horizon Europe 2020 programme. The Smart2B will address the existing barriers of smartness upgrades for existing buildings through the development of new software and hardware solutions to manage and control legacy equipment and smart appliances in an automated manner. The project will develop and demonstrate solutions that, regardless of the building type, can integrate the Internet-of-Things (IoT) and legacy devices into existing smart building devices and energy management platforms. The main developments of the projects were presented, consisting in a whole smart ecosystem, comprising:

- Smart2B devices: Integration of different types of legacy equipment, smart appliances and IoT sensors,
- Smart2B platform: a smart readiness platform for seamless integration of devices & data, equipped with automated data analysis capabilities, including statistical/machine learning, big data analytics, predictive analysis, and AI,
- Smart2B services: user-centred services to improve the smartness of existing buildings, including energy efficiency, indoor comfort, Smart Performance Assessment & Advisor and energy flexibility services.

In addition, a dynamic demo of the Smart2B app was also presented. This app-based interface will be able to meet occupant preferences, display measured energy consumption of devices, and monitor indoor environment conditions, thereby creating a user-centred version of the control and information services.

The Smart2B ecosystem demonstrated its capability to assess and optimize the performance of the buildings, upgrading their smartness and also making use of aggregation of flexibility through the involvement and active participation of the users.

Session 3 - Capacity building and training perspectives

[Challenges in creation of a curriculum for target-oriented trainings for improving energy performance of buildings – case study Slovenia](#)

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This presentation provides a comprehensive description and detailed specification of the curriculum for the two training and educational activities connected with the Life IP Care4Climate project that have been implemented in Slovenia. Selected training activities are connected with the energy renovation of buildings and energy management in the public sector. Bearing in mind the implementation context, training and educational materials were enriched with the know-how and good practices that have already been successfully applied around Slovenia. In order to ensure the desired level of quality for all envisioned training and educational activities, participants rate every lecture and practical exercise, and the feedback information is given to the lecturers in order to motivate them to constantly improve their lectures and performance. The vast majority of the lecturers are practitioners coming from industry, albeit the public and private sector, who deal with energy related issues on a daily basis. Additionally, regular interviews with selected participants were carried out. The main objective of these interviews was to explore the main barriers for the implementation of the real-life projects and to check how the education and training program can be improved in terms of content, organization and additional offers to maintain the network of participants after completing the program and to provide them with up-to-date knowledge. After three years of project execution, it is clear that envisioned and implemented educational and training activities of the Life IP Care4Climate project can serve as a platform for mobilizing citizens, raising awareness and capacity building for improving energy efficiency and supporting transition towards climate neutral society.

[CV Definition of the Energy Efficiency Expert in the construction sector in the context of the Erasmus+ EEE project](#)

Matteo Trichilo

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At the dawn of 2020, research findings estimated that buildings in the EU were responsible for 40% of our energy consumption. Nevertheless, the profession of energy efficiency expert in the construction sector was not considered in schools and places of institutional learning as a career opportunity. Moreover, SMEs in the construction sector usually cannot afford to have consultants specifically dedicated to the application of energy efficiency solutions. These and other elements have led to the proposal of the Erasmus+ Energy Efficiency Expert project, which started at the end of 2020 and will end in February 2023. The main objective of the project was to develop a VET training online dedicated to trainers in order to enhance their ability to transfer to the construction sector professionals all the technical, digital, environmental, entrepreneurial, and financial knowledge and skills needed during the life cycle leading to the construction of energy-efficient buildings. Further objectives of the project were to define the CV of the expert in the field of energy efficiency in the construction sector (a figure who was then able to combine technical knowledge and competence, with entrepreneurial mindsets and financial skills) and create an interactive geographical map showing the best cases of innovative techniques and tools related to the energy efficiency of buildings. The speech of 30 November focused on presenting the results and the main elements of innovation of the Intellectual Output 1 of the project, the CV Definition of the Energy Efficiency Expert in the construction sector, which was developed through a process of collaboration between experts from the six project partners and with input from all stakeholders from 5 different European countries.

[From ideas to complex modelling and implementation – local energy agency as enabler of innovative projects](#)

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Barriers to exploit the full potential of the energy efficiency measures in the Mediterranean Region are universal and not much different to those of non-Mediterranean EU countries. This presentation provides a description of how local energy agencies in partnership with research institutes can act as enablers and support local investments in energy efficient technologies and raising public awareness on the importance and benefits of energy savings, which will directly benefit the local community in terms of employment, income from savings, energy security, higher quality of housing and a cleaner environment. In this context, a research institutes deals with complex modelling and a local energy agency. Due to its strong but independent and neutral local connections, the research institute seeks to secure partnerships with the most important local stakeholders to exchange information, ideas and to enable more efficient workflow towards actual implementation of complex projects. Joint activities resulted in creation of advanced energy community in one of the municipalities in which local energy agency acts as an energy manager. Also, it is expected that performed activities will encourage other municipalities in the same region to participate in future projects of rehabilitation of public and private buildings. We strongly believe that implementation of innovative projects based on complex modelling and simulation of potential future situations have a potential to significantly improve overall resource efficiency and trigger comprehensive implementation of sustainable energy solutions at the local, regional, national and EU level.

[SECAP Project](#)

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SECAP project was a Strategic Project financed by Interreg Italy-Slovenia program which lasted 42 months (2018-2022). It involved 10 partners from both Italy and Slovenia. Its overall objective was to promote the sustainable development of the cross-border territory, encouraging strategies for low carbon emissions, in particular in the urban area, creating adaptation and mitigation measures and thus contributing to the improvement of the quality of life of the territories involved. The project offered support to Municipalities for the implementation of sustainable energy and climate adaptation policies, which are reflected in the transition from SEAP to SECAP. The main results of the SECAP project were:

- 8 SECAP documents, with unified assessments of climate change vulnerability (CCV)
- A study on the impact of climate change on the Program Area with methodological and EIB reports for the Municipalities involved
- Cross-border guidelines for municipalities
- Draft Cross-border mitigation and adaptation strategy
- Collection of good practices
- Two pilot projects - energy efficiency and climate adaptation interventions on two buildings: Casa dell'Energia (Mirano) and KrpanovDom (Pivka)
- Two feasibility studies: (i) Energy Audit of the Revoltella museum (Trieste); study of the potential for heat recovery from municipal wastewater (Kranj); (ii) Air quality measurement (smart city Kranj) and energy consumption monitoring (Log - Dragomer)

4 Conclusion and future outlook

Two out of the cluster projects ([EUB SuperHub](#) and [X-tendo](#)) formed part of the workshop. Additionally, four other H2020 projects were present ([REPLACE](#), [EN-TRACK](#), [KeepWarm](#), and [Smart2B](#)). In the discussions that followed the presentations in the three sessions, a number of questions were asked that gave rise to very interesting topics and discussions. The main themes are summarised below:

- **Data quality.** For TIMEPAC, as well as for the other sister projects participating in the workshop (X-tendo and EUB SuperHub), the EPC data quality checking procedure is key for the next generation energy certification. There is a wide range of possible improvements in this respect that will have an impact on the structure and management of regional and national EPC databases, extensively discussed in the X-tendo and TIMEPAC projects, and on the generation of more accurate and reliable energy certificates.

The creation of effective procedures for checking the reliability and quality of existing EPCs, based on standards and the attribution of scores applied to EPC data, play an important role in improving the energy certification. The generation and updating of energy certificate data using BIM models for existing and new buildings could lead to an improvement of the quality of EPC data.

- **The evolution of the EPC.** TIMEPAC envisages an EPC that will be the outcome of a flexible and dynamic certification process, rather than just a document reflecting the energy performance of the building at a given point in time. The enhanced EPC will provide reliable and accurate information to other actors. In addition, future EPCs will integrate other indicators (SRI, sustainability) to assess the overall sustainability of the building (economic, social and environmental). In this future scenario, where EPCs will coexist with smart readiness and sustainability indicators, the EPC could lose its original meaning and become just another set of information complemented by other data sources. Therefore, the enhanced EPC might become a digital record in a database which is regularly updated and interlinked to other data sources.
- **The integration of new methodologies in EPC.** Although the current review of EPCs focuses mainly on their methodology, it is important to consider the end-users' perception of their value. Unfortunately, energy performance certification is often seen as a legal obligation, which should cost the user as little as possible. For EPCs to be recognised by the public as a useful tool for improving the performance of buildings, it will be necessary to increase their quality and also their cost, so that professional certifiers are adequately remunerated for carrying them out.

Finally, the TIMEPAC consortium expresses its gratitude to all authors for their interest in the workshop and for their valuable contributions. The next TIMEPAC-23 workshop will take place in Vienna (Austria), organized by the Institute for Sustainable Energy and Resources Availability (SERA).