TIMEPAC

Towards Innovative Methods
for Energy Performance Assessment and Certification of Buildings

Deliverable 5.6

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Executive Summary

This is a report of the TIMEPAC-21 workshop **"Dynamic EPC as enabler of Smart Energy Services – Energy Efficiency, Integration of RES in Buildings and Demand Response"** organized by the Jožef Stefan Institute (JSI) that took place online on December 14th and 15th 2021.

The workshop was divided into three sessions:

- **Session 1 - Legislative context and requirements for deep renovation of EU building stock.** This session analysed the legislative context and requirements for the deep renovation of the EU building stock that has been included in National Energy and Climate Plans and National Long-Term Renovation Strategies.
- **Session 2 - Enhancement of EPCs with the integration of other data sources.** This session dealt with the enhancement of EPCs with the integration of other data sources (BIM, sensors, smart meters, energy management, etc.).
- **Session 3 - Management of active buildings and the use of innovative technologies in order to enable smart energy services.** The third session was dedicated to the management of active buildings and the use of innovative technologies in order to enable smart energy service

The workshop was carried out as a hybrid event with participants online while representatives of the Jožef Stefan Institute and the Ministry of Infrastructure of Slovenia were present in Ljubljana. The fact that the TIMEPAC-21 received twenty abstracts was quite remarkable. The programme attracted 68 participants; 50 and 60 of whom constantly attended all the workshop session. In order to attract more attendees, the access to the workshop was free of charge.

This document contains the programme of the workshop, the agenda of the interventions and the abstracts of the presentations, which can be found on the project's web page. It ends with some concluding remarks on the results and on future prospects, which will be taken into account in the next workshop.

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 2019 (http://timepac2019.blogspot.com/) and will continue with three workshops to be held in Ljubljana (2021), Torino (2022) and Vienna (2023) organized by Jožef Stefan Institute, Politecnico di Torino and SERA, respectively.

The objective of the TIMEPAC series of workshops 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.

The overarching theme of TIMEPAC-21 workshop was "Dynamic EPC as enabler of Smart Energy Services – Energy Efficiency, Integration of RES in Buildings and Demand Response". Due to the situation caused by the pandemic in Europe in December 2021, the workshop planned to take place in Ljubljana was held as a hybrid event, with most of the participants joining online sessions with the exception of two Slovenian partners (Jožef Stefan Institute, organizer of the workshop, and the Ministry of Infrastructure).

TIMEPAC workshops are vital elements of the project's communication and dissemination strategy. The workshop was advertised through various communication channels: project web site (Figure 1), social media (Figure 2), web sites of participating organisations, and personal communications).

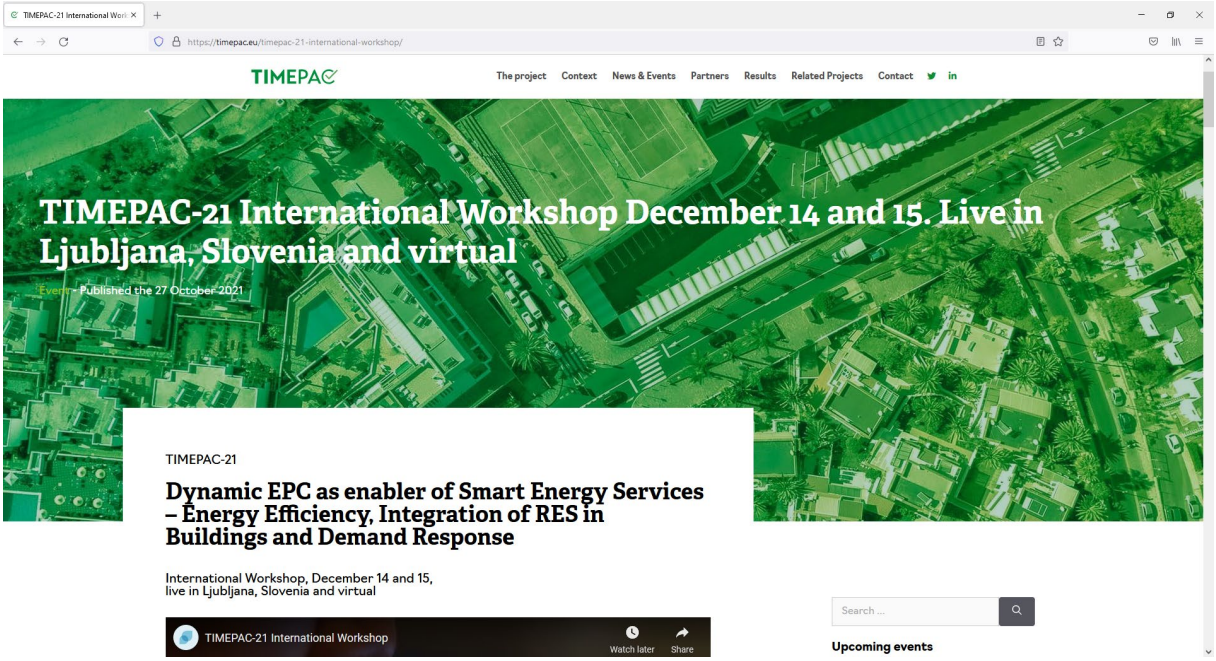

Figure 1. Entry page of the TIMEPAC-21 workshop

Figure 2. Twitter post to announce the workshop

2 Workshop programme

The programme of TIMEPAC-21 workshop was divided into three sessions:

- **Session 1 - Legislative context and requirements for deep renovation of EU building stock.** This session analysed the legislative context and requirements for the deep renovation of the EU building stock that has been included in National Energy and Climate Plans and National Long-Term Renovation Strategies.
- **Session 2 - Enhancement of EPCs with the integration of other data sources.** This session dealt with the enhancement of EPCs with the integration of other data sources (BIM, sensors, smart meters, energy management, etc.).
- **Session 3 - Management of active buildings and the use of innovative technologies in order to enable smart energy services.** The third session was dedicated to the management of active buildings and the use of innovative technologies in order to enable smart energy service

A detailed agenda of the TIMEPAC-21 workshop is shown in Tables 1 and 2.

Table 1. Detailed agenda of Tuesday, December 14th, 2021

11:30 – 12:00	Registration and coffee/networking (hybrid)
Plenary Session Moderator: Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
12:00 – 12:10	**Welcome and opening speech** – Stane Merše, Head of the Energy Efficiency Centre, Jožef Stefan Institute, Slovenia
12:10 – 12:30	**Presentation of the TIMEPAC project, goals and objectives** – Leandro Madrazo, TIMEPAC coordinator, ARC Engineering and Architecture La Salle, Spain
Session 1 - Legislative context and requirements for deep renovation of EU building stock Moderator: Jure Čižman, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
12:30 – 12:50	**Energy renovation of buildings in the framework of the Slovenian NECP and Long-term renovation strategy** – Erik Potočar, Ministry of Infrastructure, Slovenia
12:50 – 13:10	**Austrian goals on deep energy renovation of buildings, policy instruments, major barriers and future challenges** – Sabine Kamill, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Austria
13:10 – 13:30	**Croatian approach on deep energy renovation of building stock** – Nevena Štrbić, Ministry of Physical Planning, Construction and State Assets and Vesna Bukarica, Energy Institute Hrvoje Požar, Croatia
13:30 – 13:50	**The role of EPC data in the development and the assessment of energy efficiency policy - case study of SIAPE** – Francesca Pagliaro, ENEA, Italian

	National Agency for New Technologies, Energy and Sustainable Economic Development, Italy
13:50 – 14:00	Discussion
14:00 – 14:30	Coffee break and networking
Session 1 - Legislative context and requirements for deep renovation of EU building stock Moderator: Jure Čižman, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
14:30 – 14:50	**Setting Building Renovation Passports (BRPs) up for success: frameworks, measures and elements in support of stepwise deep renovation of the EU building stock** – Alexander Deliyannis and Marianna Papaglastra, Sympraxis Team (iBRoad/iBRoad2EPC projects' coordinator), Greece
14:50 – 15:10	**ENERPAT/ENERHAT: Integration of EPCs with other data sources to promote building retrofitting** - Leandro Madrazo, ARC Engineering and Architecture La Salle Ramon Llull University, Barcelona, Spain and Ainoha Mata, ICAEN Catalan Institute for Energy, Spain
Session 2 - Enhancement of EPCs with the integration of other data sources Moderator: Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
15:30 – 15:50	**Integrating EPC data with cadastre to foster residential building retrofitting programmes in the implementation of SECAPs - The RETABIT project** – Álvaro Sicilia and Anna Noguer, ARC Engineering and Architecture La Salle, Spain
15:50 – 16:10	**Data-driven Energy Performance Assessment Methods in the H2020-Project ePANACEA** – Evi Lambie, Unit Smart Energy and Built Environment, VITO, Belgium
16:10 – 16:30	**Enriched set of KPIs in Next-generation Dynamic Digital EPCs for enhanced quality and user awareness (D^2EPC) project** – Paris A. Fokaides, Frederick University, School of Engineering, Cyprus
16:30 – 16:50	**Analysis and validation of EN ISO 52016-1 and its Italian National Annex** – Franz Bianco Mauthe Degerfeld, Department of Energy "Galileo Ferraris", Politecnico di Torino, Italy
16:50 – 17:00	Discussion and wrap-up of the Session 2

Table 2. Detailed agenda of Wednesday, December 15th, 2021

9:15 – 9:30	**Summary of the first day and brief overview of next sessions** – Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia
Session 2 - Enhancement of EPCs with the integration of other data sources Moderator: Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
9:30 – 9:50	**Innovative performance indicators for next generation EPC developed within H2020 X-tendo project** – Jan Verheyen, Unit Smart Energy and Built Environment, VITO, Belgium
9:50 – 10:10	**OpenDataSantCugat: A platform to integrate the city's building energy information with public data** - Álvaro Sicilia and Leandro Madrazo, ARC Engineering and Architecture La Salle, Spain
10:10 – 10:30:	**Hourly simplified calculation to identify cost-optimal energy requirements for the Italian building stock** – Matteo Piro, Department of Energy "Galileo Ferraris", Politecnico di Torino, Italy
Session 3 - Management of active buildings and the use of innovative technologies in order to enable smart energy services Moderator: Gašper Stegnar, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
10:30 – 10:50	**Smart energy services for buildings: ebalance-plus and AICREDITS technologies** – Gloria Calleja, CEMOSA, Spain
10:50 – 11:10	**H2020 REPLACE - Advanced models and approaches for making heating and cooling more efficient, economically resilient, clean and climate-friendly** – Gašper Stegnar, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia
11:10 – 11:30	**Challenges in deep renovation of buildings - from the idea to complex simulation model** – Marko Bišćan, Energy Institute Hrvoje Požar, Croatia
11:30 – 12:00	Coffee break and networking
Session 3 - Management of active buildings and the use of innovative technologies in order to enable smart energy services Moderator: Gašper Stegnar, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia	
12:00 – 12:20	**H2020 CREATORS - Local energy communities as a platform for sector coupling and connecting industry with the neighbouring communities** - Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia
12:20 – 12:40	**Lessons learned and future challenges in the application of European Local ENergy Assistance (ELENA) - case study Primorska, Slovenia** – Rajko Leban, Goriška local energy agency – GOLEA, Slovenia
12:40 – 13:00	**The Energy Performance Certificates in Catalonia and the Grants for Building Renovation** – Ainhoa Mata, Catalan Institute for Energy- ICAEN, Spain

13:00 – 13:20	**Streamlining savings from BACS within the EED framework (H2020 StreamSAVE)** – Kelsey van Maris, VITO/Energyville, Belgium
13:20 – 13:30	Discussion and wrap-up of the Session 3
13:30 – 13:45	**Closing speech – Future outlook of TIMEPAC events** – Boris Sučić, Jožef Stefan Institute – Energy Efficiency Centre, Slovenia

3 Abstracts

This chapter contains the accepted abstracts listed according to the programme schedule. A link to the presentation is included in the abstract title.

Plenary Session

TIMEPAC: Towards Innovative Methods for Energy Performance Assessment and Certification of Buildings

Leandro Madrazo
ARC Engineering and Architecture La Salle, Ramon Llull University, Barcelona, Spain

TIMEPAC is a coordinated support action co-financed by the Horizon 2020 programme of the European Union which aims to improve existing energy certification processes, by moving from single and static certification to more holistic and dynamic approaches. To do so, we need to consider a) the data generated in the overall energy performance certification process, from generation to storage, to analysis and exploitation, and throughout the entire building lifecycle, from design, to construction and operation, b) that buildings are part of the built environment, which includes energy distribution and transport networks, and c) that buildings are dynamic entities, continuously changing over time. The project objectives are to foster the integration of data from various sources (including EPC databases) to have more effective EPCs, to use of EPC as a tool to facilitate building renovation, to create new assessment frameworks which include sustainability indicators, and to enhance existing EPC schemas with Smart Readiness Indicators applying international standards. The new holistic and dynamic approach will be developed in five Transversal Deployment Scenarios (TDSs) across the six participating European countries. The TIMEPAC online training platform will be developed to act as a showcase of the enhanced EPC schemas and associated methods and will help to disseminate the project results, to increase awareness on the value of EPC for building retrofitting, and to demonstrate the potential of their application on a European scale.

Session 1 - Legislative context and requirements for deep renovation of EU building stock

Energy renovation of buildings in the framework of the Slovenian NECP and Long-term renovation strategy

Erik Potočar
Republic of Slovenia, Ministry of Infrastructure, Energy Directorate, Ljubljana, Slovenia

Slovenia has adopted the long-term energy renovation strategy, which defines a comprehensive set of measures to decarbonise the national building stock until 2050. The key targets for 2030 are defined in the National energy and climate plan (NECP). The two most ambitious goals of the Slovenian NECP regarding buildings are to reduce greenhouse gas emissions in buildings by at least 70%, and for renewable energy sources to account for at least two thirds of energy use in buildings by 2030. Both strategical documents are prepared in accordance with the European Union's key objective – putting energy efficiency first, as energy savings are the most sustainable way to reduce greenhouse gas emissions.

According to the Long-term energy renovation strategy, 74% of single-family homes and 91% of multiapartment buildings should be renovated. This would result in the reduction of final energy consumption by 45% and CO_2 emissions by almost 75% from 2005 levels. The 2050 vision is to come close to net zero emissions in the building sector by using low-carbon and renewable materials in renovation and by focusing on heating with renewables technologies. Slovenia will strive to reduce its dependency on fossil energy sources to the greatest extent possible, by gradually phasing out their use with great emphasis on increasing energy efficiency and greater use of renewable energy sources.

Austrian goals on deep energy renovation of buildings, policy instruments, major barriers and future challenges

Sabine Kamill
Republic of Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Division VI – Climate and Energy, Department VI/6 – Energy Efficiency and Heating, Vienna, Austria

Since 2005, greenhouse gas emissions in the buildings sector (residential buildings and private and public service buildings) in Austria have decreased by -36%. A variety of effective measures have contributed to this, in particular the switch from fossil-fuelled heating systems to climate-friendly alternatives and district heating systems on the basis of renewables, the thermal renovation of existing buildings built during particularly energy-inefficient construction eras (before 1980) and the gradual increase in construction regulations for new buildings and deep renovations. However, buildings are still responsible for around 8 million metric tons of CO_2 equivalents annually and the latest statistical data is indicating that GHG emissions in the buildings sector are stagnating.

Even though EU Climate Law envisages climate neutrality in 2050 at EU level, the Austrian goal is to reach climate neutrality by 2040. In close cooperation with the federal states, the federal government is developing an Austrian heating strategy with the goal of completely decarbonizing the heating market. This presentation provides comprehensive insights into the Austrian goals on deep energy renovation of buildings, policy instruments, major barriers and future challenges. The new Heating Strategy provides systematic framework for reaching climate neutrality in this sector. The intention is to gradually phase-out fossil energy by 2040. For this purpose a national ban on the installation of central oil and coal boiler in new buildings has been in force since 1.1.2020. However, there are also many barriers such as the shortage of personnel and skilled workers that must be successfully overcome in order to reach climate neutrality by 2040.

Croatian approach on deep energy renovation of building stock

Irena Križ Šelendić [a], *Nevena Štrbić* [a], *Toni Borković* [b] and *Vesna Bukarica* [b]
[a] Republic of Croatia, Ministry of Physical Planning, Construction and State Property, Zagreb, Croatia
[b] Energy Institute Hrvoje Požar, Zagreb, Croatia

The Long-Term Strategy for the Renovation of the National Building Stock of the Republic of Croatia by 2050 is crucial for the use of renewable energy sources in building construction, which, through the near zero energy building request for new buildings and the renovation of existing buildings, includes the obligation to cover a substantial portion of primary energy for the building by using renewable energy sources at the location of the building or in its immediate vicinity. Additional important element of the Strategy is the introduction of new measurable indicators of the energy renovation of buildings, which will strengthen the process of conversion of the stock into nearly zero-energy buildings. The Strategy was formally adopted by the Croatian Government in December 2020. The focus is on the first decade and the main objective is to stimulate a substantial increase of the renovation rate and the transition to energy efficient and decarbonised building stock. The current energy renovation rate of 0.7% per year will gradually rise to 3% over the 2021-2030 period, with a 10-year average rate of 1.6%. Envisaged increase of annual renovation rate:

- **1** % in 2021 and 2022 -> **1.5** % in 2023 and 2024 -> **2.0** % in 2025 and 2026 -> **2.5** % in 2027 and 2028 -> **3** % in 2029 and 2030,
- from 2031 till 2040 **3.5** %,
- From 2041 till 2050 **4.0** %.

In this presentation, the Croatian approach on the deep energy renovation of building stock is presented and elaborated. It is clear that integrated approach (full-scale energy efficiency and RES at the same time) would be optimal solution for decarbonization of building sector but the major intermediate challenge is to provide secure and sustainable financing for the renovation of buildings affected by earthquakes (Zagreb and Petrinja regions) which requires very expensive constructive renovation (seismic retrofit).

The role of EPC data in the development and the assessment of energy efficiency policy – case study of SIAPE

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

According to the Italian National Energy and Climate Plan, the significant potential for improving energy efficiency in the building sector may be better exploited through measures aimed at the energy renovation of buildings and neighbourhoods, together with the structural renovation, earthquake-proofing, technical systems upgrading and refurbishment. Increasing the knowledge about the buildings and estimating the evolution of their energy performance is crucial to reach ambitious targets. EPC registers are powerful tools that can perform these evaluations as they make it possible to combine all the EPC data and compare them with the building requirements issued by law over time.

In this presentation, the role of EPC data in the development and the assessment of the Italian energy efficiency policy in buildings is described. The Italian Informative System on Energy Performance Certificates (SIAPE) is the national tool used to collect the EPCs issued for buildings and building units. The energy performance of the Italian building stock is expressed through the main Energy Performance Indices (Global Energy Performance Index (sum of the non-renewable and renewable components) and Calculated CO2 emission) shown in the EPC by energy label (from A4 to G). If the EPC data is available the impact of the application of energy performance strategies can be analysed through the analyses of the purpose for EPC issuing. This parameter enables us to evaluate the effects of the minimum requirements set by law for new buildings, major and minor

renovations. Additionally, the impact of the energy efficiency regulation can be investigated by analysing the evolution of the energy performance indices by construction period. SIAPE will become one of the main data sources of the national portal on building energy efficiency which is planned to be developed by ENEA in the next three years. This new portal will be implemented with additional functionalities for citizens, companies, and public authorities providing new and extensive tools for data analyses including decision support systems for predictive scenario development and energy policy monitoring.

Setting Building Renovation Passports (BRPs) up for success: frameworks, measures and elements in support of stepwise deep renovation of the EU building stock

Alexander Deliyanni, Marianna Papaglastra
Sympraxis Team, Athens, Greece

In the light of the ambitious Renovation Wave and 2050 climate targets, Building Renovation Passports and associated tools have become subjects of growing interest and discussion with more and more relevant initiatives springing up across Europe.

To help homeowners, the Horizon 2020 iBRoad (2017-2020) project worked on the Building Renovation Passport concept, developing and testing an Individual Building Renovation Roadmap, which provides a customised long-term (5-30 years) renovation plan. This is further supported by a Digital Building Logbook –a repository of information such as building plans, works implemented, energy consumption and generation, etc. The Roadmap is developed by a trained energy auditor, following an on-site building assessment and an interview with the homeowner. The auditor uses iBRoad's software to present a step-by-step improvement plan, considering both mandatory maintenance and other requirements as well as the homeowner's needs, preferences and own means, and available financing options. iBRoad's methods and tools were successfully tested in Bulgaria, Ireland, Poland and Portugal –plus Germany for the Logbook. Feedback has been positive and confirms the usefulness for both homeowners and professional auditors.

The iBRoad2EPC project (2021-2024) builds on the achievements of iBRoad, broadens the scope of the concept to multi-family and public buildings and adapts it to national EPC schemes, to prepare the rollout of next generation EPCs in Bulgaria, Greece, Poland, Portugal, Romania and Spain.

iBRoad2EPC's presentation will review the wider context of Building Renovation Passports and bring forward a number of such supportive frameworks, measures and elements facilitating deep (stepwise) renovation of the European building stock. Counter-examples and sub-optimal situations will also be highlighted, as well as the potential for improvement of existing initiatives. Finally, a link will be available with the strategies and policies agreed or under discussion in the EU context.

ENERPAT/ENERHAT: Integration of EPC with other data sources to promote building retrofitting

Leandro Madrazo[a] and *Ainoha Mata*[b]
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[b] Catalan Institute for Energy (ICAEN), Barcelona, Spain

The aim of the ENERSI research project, carried out with the support of the Spanish National Research Plan 2014-17, was to develop an online platform that enables the creation of data-driven energy assessment services based on the integration and subsequent analysis of integrated energy-related data. These services would help stakeholders in the field of building energy efficiency to take well-informed decisions in their respective decision-making realms. The platform developed in this project integrates energy related data from multiple sources (energy performance certificates, cadastre, building audits, geographic data and socioeconomic data) using Semantic Web technologies. Based on this integrated data we created two online tools: ENERHAT, which provides

building owners with the information which can help them to take decisions concerning the refurbishment of a single building or dwelling, and ENERPAT, to help the city know the status of the building stock in an urban area in order to develop large-scale renovation programmes. Our experience with the development of these tools highlighted the importance for public agencies in charge of collecting building data – for example, energy performance certificate and building audits– to facilitate information to the public in an open format, so that third parties – researchers, companies- can create new services and tools that contribute to the renovation of the building stock.

Session 2 - Enhancement of EPCs with the integration of other data sources

Integrating EPC data with cadastre to foster residential building retrofitting programmes in the implementation of SECAPs – The RETABIT project

Álvaro Sicilia and *Anna Noguer*
ARC Engineering and Architecture La Salle, Ramon Llull University, Barcelona, Spain

Building renovation is a key objective of the European Green Deal, in particular of the Renovation Wave initiative. The RETABIT project (www.retabit.es) – co-financed by the Spanish Ministry of Science and Innovation – will develop a service platform to assess the status of buildings in an urban area and their potential for renovation, to elaborate possible retrofitting scenarios based on multidimensional indicators, and to monitor the impact of their implementation over time. The first step in the platform development is to integrate urban data from open data sources (e.g., energy performance certificates, cadastre) and from the pilot cites (e.g., building permits, and surveys). Integrating urban data is a challenge because data are disparate, dispersed, and is available in multiple formats and granularities. Semantic Web technologies (i.e., ontologies, RDF, and SPARQL) are plausible solutions to integrate these heterogeneous energy related data. As the first step in the development of the platform, we have integrated energy certificates and data from the cadastre sources in more than 900,000 records. We have identified inconsistencies in data with regard to climate zone (~20%), floor area (~10%), construction year (~12%), city names (~6%) and postal codes (~5%). In order to find other inconsistencies, we will need to integrate other data sources such as census, building technical inspections and energy bills, among others.

Data-driven Energy Performance Assessment Methods in the H2020-Project ePANACEA

Evi Lambie and *Yixiao Ma*
Unit Smart Energy and Built Environment, VITO, Mol, Belgium
EnergyVille, Genk, Belgium

The current EPC schemes across the EU face several challenges which have led to the incomplete accomplishment of their initial objectives: lack of accuracy, a gap between theoretical and real consumption patterns, absence of proper protocols for inclusion of smart and novel technologies, little convergence across Europe, lack of trust in the market and very little user awareness related to energy efficiency.

The objective of the ePANACEA project is to develop a holistic methodology for the energy performance assessment and the certification of buildings that can overcome the above-mentioned challenges. This holistic method consists of three energy assessment methods, which are demonstrated and validated regarding reliability, accuracy, user-friendliness and cost-effectiveness through 15 case studies in 5 European countries.

In this session, one of the energy assessment methods developed in ePANACEA is presented. Starting from in-situ monitoring data, the energy performance of a building is quantified. Depending on the level of detail of the available data set different approaches are applied, going from normalization and calibration of yearly energy uses to advanced statistical analysis of detailed hourly data sets. If only yearly data is available, this data is normalized towards a default outdoor climate and user behaviour. If more detailed data is available – not only on energy use but also indoor climate - advanced statistical methods can be used to identify the heat loss coefficient.

Enriched set of KPIs in Next-generation Dynamic Digital EPCs for enhanced quality and user awareness (D^2EPC) project

Paris A. Fokaides
Frederick University, School of Engineering, Nicosia, Cyprus

Next-generation Dynamic Digital EPCs for enhanced quality and user awareness (D^2EPC) project, is a EU funded innovation action (Grant agreement ID: 892984) which aims to introduce and demonstrate innovative approaches for the operational and regular assessment of building energy performance, through cutting-edge digital design and monitoring tools and practices. D^2EPC aspires to deliver the next-generation EPCs framework, based on a set of novel and user-friendly, holistic and human-centric indicators, which cover significant aspects of buildings energy performance including smartness, sustainability, environmental, human comfort and financial aspects. D^2EPC will be based on Level 3 6D-BIM literacy, integrating smart meters real-time data and activities profiling into the calculation process through digital twins. 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.

In this presentation, the set of the Key Performance Indicators (KPIs) which are envisioned for the indicators enhanced EPCs will be presented and elaborated. Asset and operation indicators will be introduced, aiming to present the significance of enriched information for next generation EPCs, as well as the importance of buildings dynamic assessment.

Analysis and validation of EN ISO 52016-1 and its Italian National Annex

Franz Bianco Mauthe Degerfeld, Matteo Piro, Ilaria Ballarini and *Vincenzo Corrado*
Department of Energy "Galileo Ferraris", Politecnico di Torino, Torino, Italy

In recent years, as part of the framework defined by the Energy Performance of Buildings Directive 2010/31/EU, as amended by Directive 2018/844, new procedures for the assessment of the energy performance of buildings were developed and published in technical standards. In 2018, a new simplified dynamic calculation method of the energy performance of buildings was introduced by EN ISO 52016-1. Each European country, as stated in the standard itself, would be able to improve and add partial variation through a National Annex. Italy has developed a set of enhancements, currently under approval, with three main modelling variations. The aim of the present work is to perform a validation of the standard; the influence of the standard assumption and the Italian improvements was assessed by comparing the results, in terms of energy need for space heating and space cooling. The analysis followed a case study approach, selecting a residential building located in Northern Italy as a reference building. The calculations were performed through the use of EnergyPlus and a MS Excel sheet developed for this specific purpose. The results show significant variation; furthermore, the influence of the different implementations reveal different outcomes depending on the considered season. This analysis is part of a wider validation procedure that turns out to be of great importance in view of Italian legislative updates for the renovation of the building stock.

Innovative performance indicators for next generation EPC developed within H2020 X-tendo project

Jan Verheyen [a] , *Irena Kondratenko* [a], *Guillermo Borragán Pedraz* [a], *Sheikh Zuhaib* [b], *Vivian Dorizas* [b], *Jerzy Kwiatkowski* [c], *David Schmidinger* [d], *Marcus Hummel* [d], *Iná Eugenio Noronha Maia* [e] and *Lukas Kranzl* [e]
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To achieve the EU long-term decarbonization objectives by 2050, the renovation rates in the building sector – currently about 1%[1] - should be increased. Energy performance certification (EPC) is an important tool to raise awareness on building energy performance and the need for renovation. The H2020 project X-tendo[2] aims to support public authorities in the transition to next-generation energy performance certification (EPC) schemes, including improved compliance, reliability, usability and convergence. The key output is a free online knowledge hub including a toolbox with 10 innovative EPC features to improve and future-proof existing EPC schemes. These are categorized in 2 main groups; EPC indicators and EPC data handling functionalities. This contribution briefly presents the 5 EPC indicators built on the aspects of smart readiness, comfort, outdoor air pollution, real energy consumption and district energy to be integrated into existing EPCs. The toolbox content includes an overview of the context and ratio behind the indicators as well as the methodological concepts and calculation tools, developed within a quality assurance framework. Finally, next steps focus on the publication of implementation guidelines with an indication of the replicability potential for Member States based on the results of the ongoing in-building testing of the indicators.

OpenDataSantCugat: A platform to integrate the city's building energy information with public data

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Building related data in the municipality of Sant Cugat del Vallès (Barcelona) is segregated and dispersed among departments and supra-municipal public administrations. For example, building permits, building equipment inspections, building energy certificates, building technical inspection and water consumption, are managed by different city departments. The consequences of this dispersion of the data are twofold: 1) It hinders the communication between city departments, and, 2) It prevents citizens and companies from exploiting public data. OpenDataSantCugat is a platform that integrates data generated by municipal departments (e.g., building permits, facilities inspections, water consumption) and data provided by public bodies (e.g., energy performance certificates, building inspections, cadastre, solar radiation maps) to facilitate data management within a department and across departments, and to provide citizens and businesses with access to the public data they might need. The integrated data is provided in the form of maps, tables and reports, and is aggregated at different scales (city, neighbourhood, block and building). Users -city administrators, citizens and companies- can create scenarios suited to their needs, combining data and applying a diversity of tools to obtain insights. The experience after the development of this open data platform confirms that municipalities need this kind of tools to improve their work

[1] Zangheri, P. et Al.; 2021; Progress of the Member States in implementing the Energy Performance of Building Directive; Publications Office of the European Union; Luxembourg; 2021.

[2] https://x-tendo.eu/; GA n°: 845958 — X-tendo — H2020-LC-SC3-2018-2019-2020/H2020-LC-SC3-EE-2018;

processes (within the city departments, and between the different public bodies), and to promote open governance with the cooperation with citizens and companies.

Hourly simplified calculation to identify cost-optimal energy requirements for the Italian building stock

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Directive 2010/31/EU (EPBD recast) to promote the renovation of European building stock requires Member States to define minimum requirements for the energy performance of buildings according to cost-optimal levels. This work, in the wake of a collaboration with the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, aims to update the cost-optimal procedure by applying the simplified hourly calculation model introduced by UNI EN ISO 52016-1, in the place of the monthly calculation, according to the UNI EN ISO 13790. The simplified hourly calculation model is also implemented according to the specifications of the Italian National Annex of the standard, aiming at assessing the solar gains and the infrared heat exchange with the sky vault more accurately. The methodology has been applied to 26 reference buildings representative of the Italian building stock that differ in terms of climatic zone, construction period, and intended use. For all reference buildings, global costs and cost-optimal packages of energy efficiency measures have been derived to analyse the differences of the energy needs for space heating and space cooling assessed on an hourly and on a monthly basis. The comparative analysis shows slight differences in the results of the global cost and in the package of energy efficiency measures. This difference is mainly attributable to the heat conduction models presented in the standards.

Session 3 - Management of active buildings and the use of innovative technologies in order to enable smart energy services

Smart energy services for buildings: ebalance-plus and AICREDITS technologies

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In the context of Energy Efficiency and Demand Response, CEMOSA presents two innovative smart building services that are currently under development: The **ebalance-plus project** aims at developing solutions to manage the energy flexibility of buildings to be ready for future energy balancing or local flexibility markets. The solution is based on the virtual power plant (VPP) concept and aims at deploying services that can manage building loads like lighting system, power inverters and the air-conditioning and ventilating system to provide services to the grid (demand response) and reduce energy costs or CO_2 emissions (energy efficiency). This solution is integrated in a comprehensive platform that connect customers and electric market players in a collaborative solution to reduce energy losses in electric grids and increases the whole reliability. The AICREDITS project aims at broadening the approach of common static energy audits by periodically evaluating Energy Conservation Measures (ECMs) and continuously scoring the energy performance of the buildings and the energy behaviour of the buildings' users. The solution is based on designing and developing a reliable Building Digital Twin that will reduce the energy performance gap by applying artificial intelligence methods along the whole procedure of energy audits and across the building life cycle. The platform is supported with a specific monitoring system that will measure energy, environmental and user behaviour parameters and generates recommendations and potential scenarios to improve the energy efficiency, supporting building owners and facility managers.

H2020 REPLACE - Advanced models and approaches for making heating and cooling more efficient, economically resilient, clean and climate-friendly

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In order to meet the climate change target of limiting global warming to 1.5 °C as well as the target of a full decarbonisation by 2050, systems for space heating based on fossil fuels must be phased out as soon as possible. This applies to oil boilers, but also to natural gas boilers, as well as to the supply of district heating based on fossil fuels. Current fossil fuel heating sources need to be replaced by a broad mix of different renewable energy sources.

This work introduces the EU H2020 project REPLACE which aims to boost the phase-out of inefficient and old heating and cooling systems by targeting consumers, investors/owners as well as intermediaries (installers, plumbers, and chimney sweepers) and helps them to make informed decisions. This will be achieved through various promotional campaigns in 9 European countries and web-based platforms.

Furthermore, when dealing with the replacement of a technical system in an energy complex building, an advanced approach as well as energy model are needed. Studies show that dynamic simulation tool is an accurate and reliable method to simulate the energy performance of the studied systems that is to be replaced. Dynamic energy models are the most accurate and reliable in terms of building performance depicting and characterization. Presentation will give an insight into several case studies and further options offered by the dynamic simulations.

Challenges in deep renovation of buildings – from the idea to complex simulation model

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Energy Institute Hrvoje Požar is in the process of deep retrofit of the EIHP office building with state-of-the-art technologies financed by Energy and Climate Change (ECC) Programme. To optimize the new building solution, energy audit was performed, collecting key data on energy systems, building envelope, energy consumption and electricity consumption measurements targeting specific systems. Collected data was transferred to calculation software to form detailed dynamic consumption building model. Using building model, python, design builder and energy+, detailed calculations were performed to find optimal solution from 720 combinations. Analysis was done by comparing model consumption data for 12 different energy efficiency measures on building envelope, 4 different heating system solutions, 3 cooling solutions, 3 lighting system solutions and PV system. Calculations provided energy consumption for specific combination and by applying energy costs, investment costs and maintenance costs, global costs were derived (cost optimal analysis). Additional considerations (such as legal limitations, environmental impact etc.) were applied for final multi-criteria analysis to find optimal solution for deep retrofit of the EIHP office building. Final results defined that additional thermal insulation of building, new LED lighting, PV system integrated in the roof and part of façade, and water source heat pump for heating and cooling is optimal solution.

H2020 CREATORS – Local energy communities as a platform for sector coupling and connecting industry with the neighbouring communities

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In the context of reaching energy and climate targets defined in the Slovenian National Energy and Climate Plan, it has been recognised that smart energy communities have the potential to connect local inhabitants (municipalities), network operators (electricity, natural gas, district heating), energy intensive industry and energy service providers in a sustainable manner providing framework for implementation of advanced projects. H2020 project called CREATORS aims to enhance commercial readiness of Community Energy Systems and deliver the comprehensive set of professional services needed to support technical, financial and social processes during the entire life-cycle of the community.

This work provides an objective evaluation of challenges related with the future development of energy communities in Slovenia. More precisely, Slovenian expectations within the CREATORS project are closely linked with the development of expert and decision support systems for simulation, emulation and design of the future community energy system, where proper contractual models are also of large importance. Methods for on-line calculation and optimization of energy flows within the energy intensive company and at the level of community energy system will be targeted through the structure of energy cost centres. In the context of Slovenian Tier 1 pilot location (steel factory) the most important output parameters are available excess heat, available heat sinks within the factory, generated RES electricity, battery status and availability, available heat sink within the district heating system, energy use (costs) minimization, emission minimization, and stable operation of processes. In this context, dynamic EPCs will be crucially important to properly model buildings that are connected to the district heating system.

Lessons learned and future challenges in application of European Local ENergy Assistance (ELENA) – case study Primorska, Slovenia

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The establishment of the GOLEA Agency in 2006 was the result of a successful application to the Intelligent Energy Europe programme, which supported the establishment of a network of local energy agencies throughout the European Union. The mission of GOLEA Agency is to help municipalities in the Slovenian Primorska Region to continuously improve their energy efficiency and to support large scale implementation of renewable energy sources with the aim to achieve regional energy self-sufficiency.

At the moment GOLEA is acting as an energy manager in 22 municipalities in the western part of Slovenia (Primorska Region). Similarly, GOLEA is helping local municipalities to develop programmes and plans for efficient energy use at the local level (Slovenian version of the Sustainable Energy and Climate Action Plan). GOLEA's role is to spread management practices, provide information guidance, offer a range of services based on specific local and regional needs related with rational use of energy and implementation of projects for utilisation of renewable energy sources. In more than 250 buildings GOELA has implemented the energy management system which enables systematic collection of energy data and evaluation of energy performance which was fundamental for preparing good and sustainable deep energy renovation projects. This presentation provides key insights about GOLEA's work with the emphasis on Preparation and Mobilisation of Financing for Sustainable Energy Investments in Primorska Region Municipalities (ELENA Facility). GOLEA has established the Project Implementation Unit for the needs of the implementation of ELENA technical assistance. Together with the investment departments of the participating municipalities and their external experts, GOLEA actively supported creation of several sustainable energy projects with focus on Energy Performance Contracting. With the support of GOLEA participating municipalities achieved significant energy savings (22.34 GWh/year) and emission reductions (7,172 tCO_2/year).

The Energy Performance Certificates in Catalonia and the Grants for Building Renovation

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Buildings play a key role in the energy transition, and energy performance certificates (EPC) are a tool for understanding the state of the building stock.

The register of EPCs in Catalonia, managed by ICAEN, provides following functionalities:

- Certificate finder: energy label available.
- Hypermap: the energy qualifications of the buildings can be seen on a map.
- Open data: download data from buildings.

EPC takes a special role in the Next Generation fund. Grants in Spain has the following requirements:

- It is necessary to demonstrate a saving in non-renewable primary energy consumption of 30% with respect to the EPC.
- The percentage of aid increases depending on the reduction of fossil fuel consumption, to promote major energy rehabilitation.
- The principle of not causing significant damage to the environment must be complied with.

We have many challenges ahead:

- Unify the parameters of the EPC of the different countries of the European Union, and improve their quality.
- Measure up the environmental impact of building materials, taking advantage of the fact that buildings are increasingly being designed with BIM tools.
- Assess the multiple environmental impacts of buildings, in line with Level(s) and linked to the Building Renovation Passport (Directive (EU) 2018/844).

The private sector, the public and the citizenship must join forces to make the energy transition that will lead us to near-zero energy buildings (nZEBs) a reality, to decarbonize the economy, and finally to reduce our ecological footprint.

Streamlining savings from BACS within the EED framework (H2020 StreamSAVE)

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The H2020 project streamSAVE streamlines energy savings calculations in the framework of Article 3 and 7 of the Energy Efficiency Directive (EED) covering energy efficiency targets and national energy savings obligations, respectively. To this end, Priority Actions are selected: measures with high energy savings potential, which are considered a priority issue by Member States. One such topic is Building Automation and Control Systems (BACS), implying the need exists to estimate energy savings of BACS for heating, cooling, domestic hot water, ventilation and lighting across residential and non-residential sectors. However, as BACS cover a wide range of product types, it is a challenge for Member States to map the BACS already installed in the building stock. In addition, it is not easy to evaluate the energy consumption of buildings in terms of energy consumption per end-use type. In order to correctly estimate the energy savings, consistent and reliable data must be obtained, and baselines must be clearly defined. streamSAVE has developed a methodology to calculate the effect on final energy consumption of buildings, that occurs from installing or upgrading BACS. The project also prepared indicative calculation values on EU-level. Although these would preferably be adapted to national or regional circumstances, they could be used by Member States in case more specific data are not available. This methodology was presented to stakeholders and an online training module has been developed.

4 Conclusion and future outlook

The TIMEPAC consortium expresses its gratitude to all authors for having taken interest in the TIMEPAC-21 workshop and for their valuable contributions. The programme attracted 68 persons who registered in the workshop, which was more than expected (at least 50 participants). Between 50 and 60 persons attended all the workshop sessions (Figure 3).

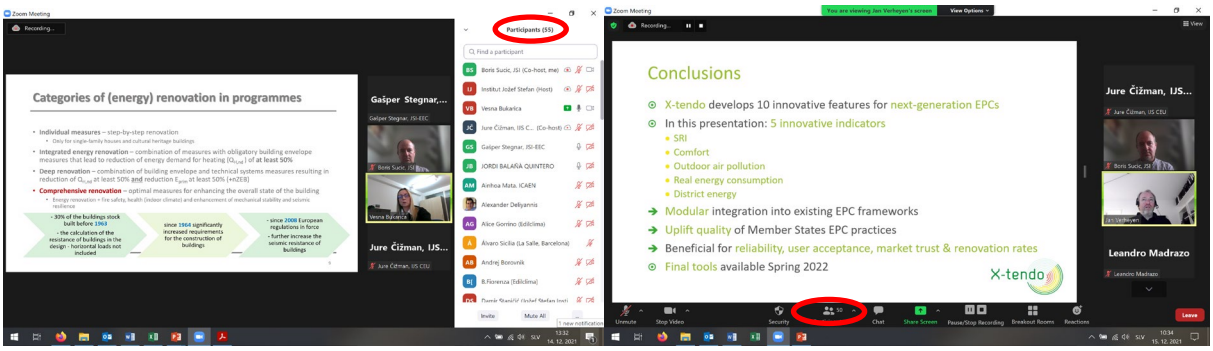

Figure 3. Screenshots from the workshop indicating number of active participants (14.12.2021 – left; 15.12.2021 – right)

Four out of ten cluster projects (iBRoad2EPC, X-tendo, D2EPC and ePANACEA) formed part of the TIMEPAC-21 workshop. Additionally, four other H2020 projects were present (REPLACE, CREATORS, StreamSAVE, and ebalanceplus). The event was covered by the TIMEPAC social media channels and contributed to giving visibility to the project. In the period from 3rd to 15th of December there were 22 posts on LinkedIn (7,000 impressions and 250 likes) and 15 tweets (3,300 impressions and 760 likes).

The next TIMEPAC-22 workshop will be organised in December 2022 by the Politecnico di Torino, Italy.