ePANACEA

Smart European Energy Performance Assessment & Certification

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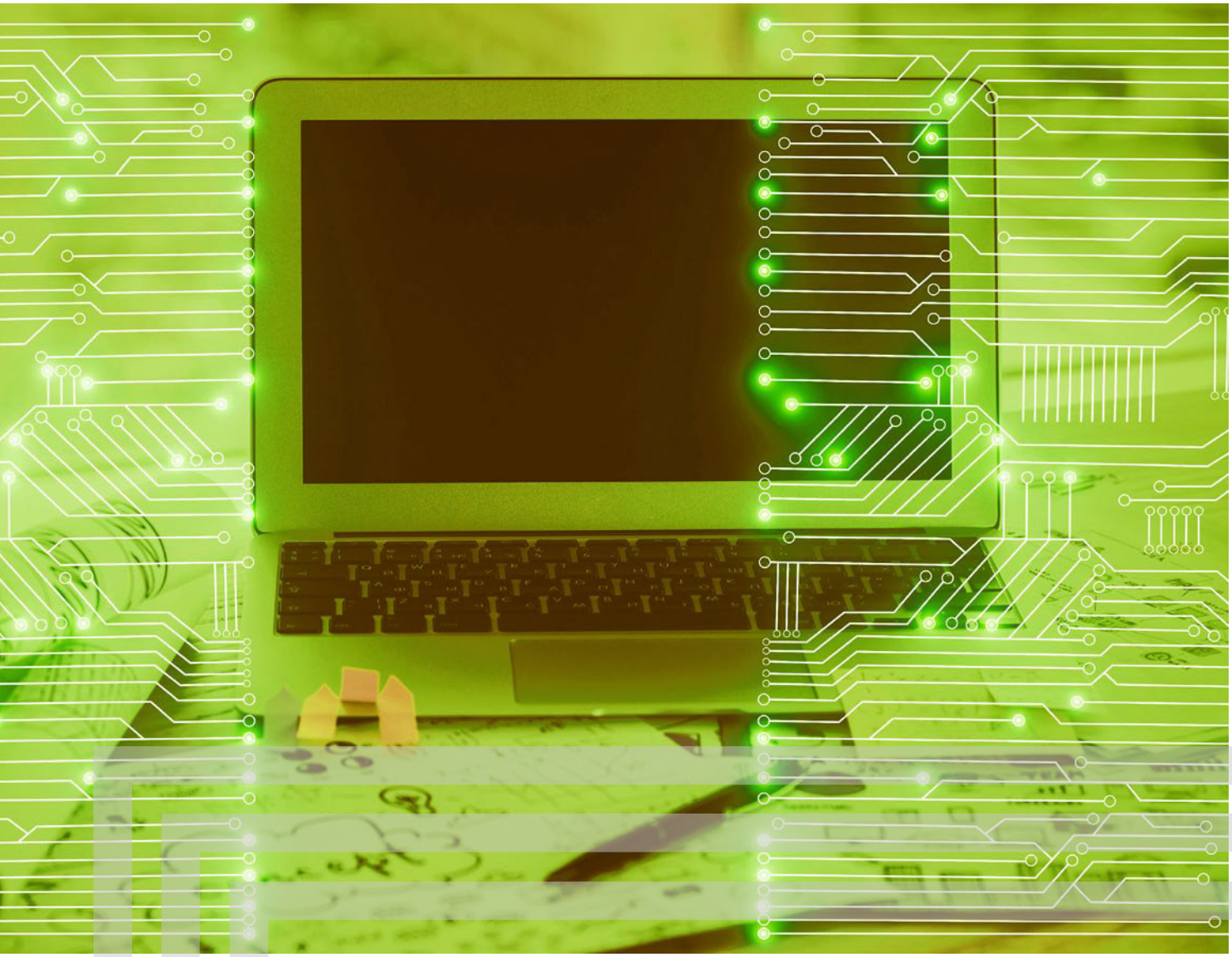

Compendium of Testing and Demonstration Board (TDB) Meetings

Version 3, updated in December 2021

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HISTORY OF CHANGES

Version	Month Year	Organisation	Comments
V1	June 2020	EASt	First version of D5.1 published
V2	March 2021	EASt	Updated with TDB activities (M2-M10)
V3	December 2021	EASt	Updated with TDB activities (M10-M19)

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OVERVIEW OF THE ePANACEA PROJECT

After 10 years of track record, the current EPCs schemes across the EU face several challenges which have led to a not full 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 energy performance assessment and certification of buildings that can overcome the above-mentioned challenges. The vision is ePANACEA becoming a relevant instrument in the European energy transition through the building sector.

ePANACEA comprises the creation of a prototype (the Smart Energy Performance Assessment Platform - SEPAP) making use of the most advanced techniques in dynamic and automated simulation modelling, big data analysis and machine learning, inverse modelling or the estimation of potential energy savings and economic viability check.

A relevant part of the project is to have a fluent dialogue with European policy makers, certification bodies, end-users and other stakeholders through two types of participatory actions: a feedback loop with policy makers, carried out through the so-called Regional Exploitation Boards (REBs) covering EU-27+Norway+UK on the one hand, and dialogue with end-users, established by means of specific thematic workshops, on the other.

Thanks to these participatory actions, the acceptance of the ePANACEA approach will be tested and validated in order to become aligned with and meet the needs of national public bodies, end-users and other stakeholders.

ePANACEA will demonstrate and validate reliability, accuracy, user-friendliness and cost-effectiveness of its methodology through 15 case studies in 5 European countries.

EXECUTIVE SUMMARY

This document is a compendium of background information about ePANACEA's methodology, the composition and objectives of the various boards, as well as of the outcomes from the meetings established between members of ePANACEA's Testing and Demonstration Board (TDB). The document will be updated after each TDB meeting.

Currently, the report includes the conclusions from the first (June 2020), second (February 2021) and third (October 2021) TDB meeting. In addition, two exemplary case studies for the testing and validation activities as well as a preliminary list with the chosen case studies are included in the annex. The chosen buildings are very different (type of building, climatic area, housing technologies, users, etc.). The ePANACEA methodology will be tested with a big range of building typologies in order to create validated assessment methods with high reliability and broad applicability.

GLOSSARY

TDB	Testing and Demonstration Board
BACS	Building Automation and Control System
EPC	Energy Performance Certificate
HVAC	Heating, Ventilation and Air Conditioning
LOI	Letter of Intent
REB	Regional Exploitation Board
RES	Renewable Energy Sources
SEPAP	Smart Energy Performance Assessment Platform

1. DESCRIPTION OF THE TESTING AND DEMONSTRATION BOARD

ePANACEA's methodology aims to contribute to the harmonisation of energy performance assessment and certification of buildings across the European Union, enhancing market trust and user friendliness in terms of clarity and accuracy of the information provided. ePANACEA explores several innovative approaches to assess the energy performance of buildings in a modular way, making it suitable for all possible typologies and for cases of different complexity:

- Assessment method 1 deals with smart & performance data-driven building energy performance assessment.
- Assessment method 2 will provide a simplified method based on a monthly calculation interval.
- Assessment method 3 will demonstrate the advanced & automated simulation modelling (based on dynamic and calibrated simulations).

All these three assessment methods will be demonstrated and validated in five European pilot countries (Austria, Belgium, Finland, Greece and Spain) through 15 real case studies. A wide network of European building owners and managers that have expressed their commitment to provide necessary data for demonstration activities has been established. These demonstration actions pave the way for an efficient roll out of the methodology across the EU.

With these specific objectives, the Testing and Demonstration Board (TDB) formed by technical partners of the ePANACEA consortium will allow the validation of the methodology from both the technical (including cost-effectiveness) and the political point of view, through dialogue with national/regional energy agencies in the five pilot countries (most of them members of the project consortium).

As shown in Figure 1the TDB consists of five pilot countries, led by the responsible national partners:

- Austria: EASt (overall lead) and TUW
- Belgium: VITO
- Greece: CRES
- Spain: CENER and IDAE
- Finland: VTT

In detail, the leading institutions of the TDB are:

Energy Agency of Styria (EASt)

The Energy Agency of Styria (EASt), founded in 1982, (formerly: LEV – LandesEnergieVerein) is the regional energy agency of the Province of Styria, Austria. The mission of the Agency is to increase energy efficiency and use of renewable, domestic sources of energy in the interest of the Climate and Energy Strategy of the Province of Styria. Additionally, EASt manages the Official EPC database of Styria (ZEUS database).

Technical University of Vienna (TUW) – supporting EASt

The Energy Economics Group (EEG) is within the Institute for Energy Systems and Electric Drives at Vienna University of Technology (Austria). EEG has managed and carried out many international as well as national research projects funded by the European Commission, national governments, public and private clients in several fields of research, especially focusing on renewable and new energy systems.

Vlaamse Instelling Voor Technologisch Onderzoek N.V (VITO)

VITO is a leading independent research organisation in the area of clean technologies and sustainable development located in Flanders, Belgium. It provides knowledge and technological innovations that facilitate the transition to a more sustainable society. By cooperation, expansion and development of expertise VITO can make smarter use of existing sustainable solutions and develop new technologies.

Centre for Renewable Energy Sources and Saving (CRES)

Founded in September 1987, CRES is a public entity supervised by the Ministry of Environment and Energy in Greece and is active in the fields of Renewable Energy Sources (RES) and Energy Efficiency (EE). Its primary aim is to promote technological applications in the RES/EE fields both at a national and international level.

National Renewable Energy Center (CENER)

The National Renewable Energy Centre (CENER) is a technology centre, specialised in applied research and in the development and promotion of renewable energy sources in Spain.

Instituto para la Diversificación y Ahorro de la Energía (IDAE) – supporting CENER

IDAE is the Spanish National Energy Agency and contributes to fulfilling Spain's objectives and commitments regarding improvements in energy efficiency, renewable energy sources and other low carbon cost technologies. This constitutes the strategic framework of the Agency's activities.

Technical Research Centre of Finland (VTT)

VTT Technical Research Centre of Finland Ltd is a state owned and controlled, non-profit, limited liability company established by law and operating under the ownership steering of the Finnish Ministry of Employment and the Economy.

The above-mentioned partners are responsible for the preparation, conduct and reporting of the testing, evaluation and validation of the ePANACEA methodology through the case studies in five pilot countries (see Figure 1).

All three innovative assessment methods (M1, M2, M3), developed in ePANACEA will be tested in each pilot country through 3 case studies, using the innovative SMART ENERGY PERFORMANCE ASSESSMENT PLATFORM (SEPAP). Developing and using the SEPAP will enable the testing and validation of the ePANACEA methodology, will demonstrate the possibility of convergence of Energy Performance Certificate (EPC) procedures and cloud-based storage of related data. The overall objective of the testing is to validate the decision matrix (accuracy and uncertainty analysis for each method) developed within ePANACEA.

As shown in Figure 1, the responsible national members of the TDB also act as the main interface between the project and the members of the 5 Regional Exploitation Boards (REBs). The REBs aim to establish a fluent dialogue with different European stakeholders, with special focus on national/regional policy makers and certification bodies, which are directly involved in the implementation of the different EPC schemes and are responsible for the development of energy regulations in their own regions/countries. Regular communication with and feedback transfer from and to the REBs will be maintained during the project duration and guaranteed by the TDB members. The REB members are organised according to their geographical location and will be involved in the definition of the assessment methodology and EPC schemes, in the evaluation of their potential replication and in supporting local dissemination actions. The REB activities will include at least 3 face-to-face meetings and 2 survey campaigns each, allowing the establishment of a feedback loop with those predefined key stakeholders (i.e., a bi-directional knowledge transfer). A special "members only" section of the ePANACEA website is developed in support of engagement within the REBs. Invited REB members are provided with a unique username and password.

In addition to the testing and demonstration actions and the exchanges within the REBs as described above, other stakeholders, and in particular EPC end users, are involved and expected to contribute their input and feedback to the EPC methodology through user perception workshops and feedback surveys. Recruitment of participants for these activities is mainly based on contacts with the owners of the case study buildings (described in chapter 2.4).

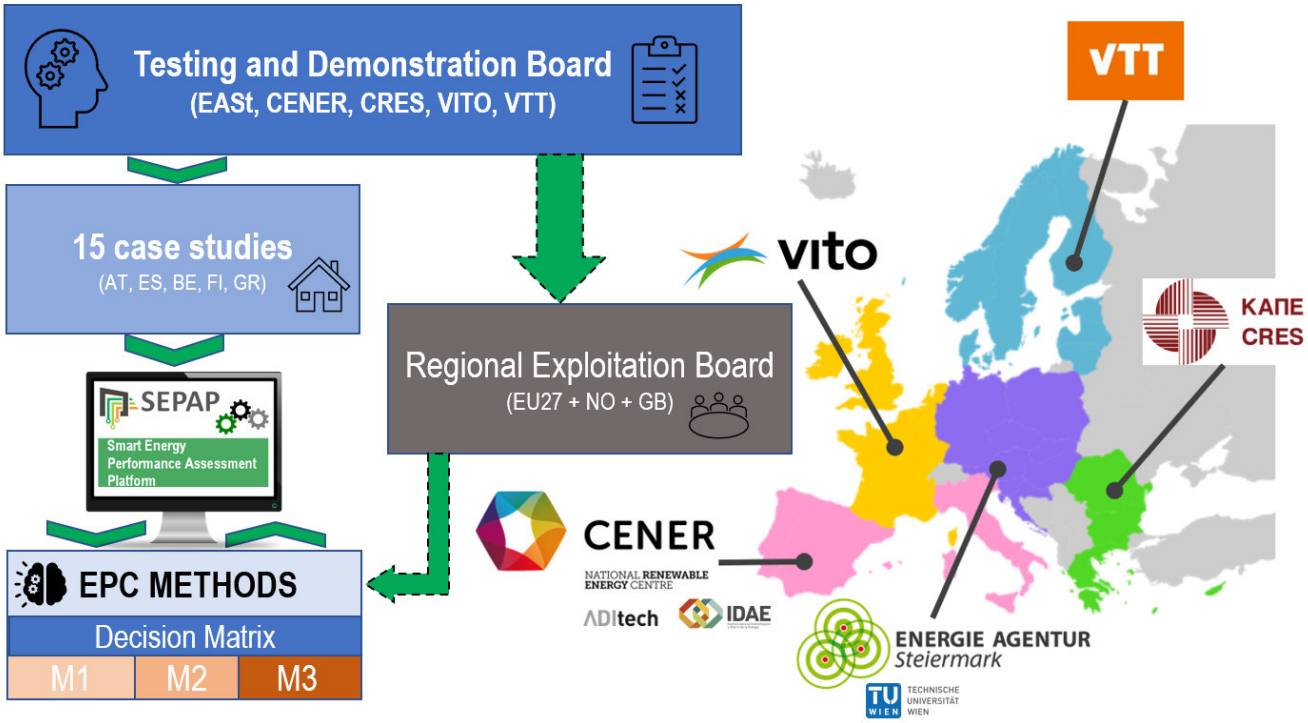


Figure 1: Overview of the workflow of ePANACEA's Testing and Demonstration Board.

2. THE TESTING PROCESS

The following chapter gives an overview on how the testing of the developed methodology will be performed by the TDB. It describes the EPC methodology development, the SEPAP and the testing phases as well as the already obtained pool of possible case study buildings.

2.1. The methodology

The holistic, accurate, flexible and modular methodology for building energy performance assessment and certification developed under the ePANACEA project is based on three assessment methods (Figure 2) plus a decision matrix:

- ✓ M1: Assessment method 1: Smart & performance data-driven energy performance assessment.
- ✓ M2: Assessment method 2: Simplified method based on a monthly calculation (ISO 52016) interval and its calibration.
- ✓ M3: Assessment method 3: Advanced & automated simulation modelling based on an hourly calculation (ISO 52017) and its calibration.

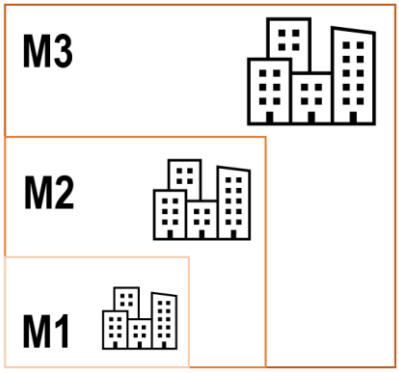


Figure 2: The relation between ePANACEA's three assessment methods.

The vision for the modular and flexible methodology development is an evolution of the three assessment methods from the more simplistic to the more complex one, according to the building and/or assessment requirements, e.g., innovative energy assessment with compliance of accuracy and standard requirements, integration of smart and novel technologies or use of real measured data. A graphical overview of the three methods and responsible partners is shown in Figure 3.

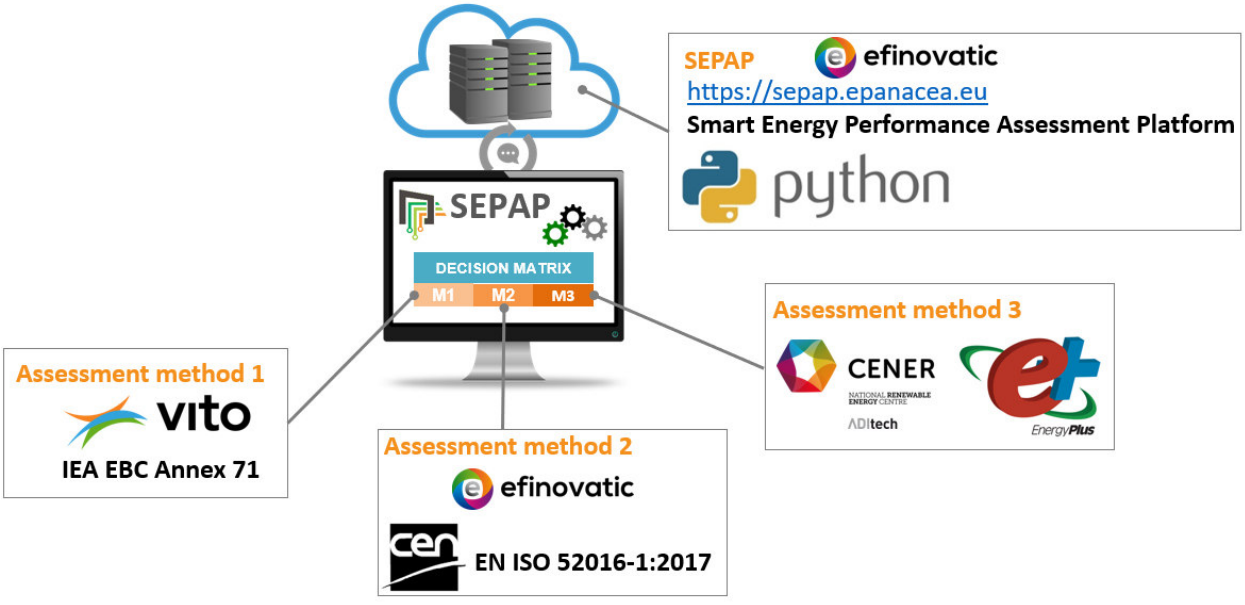


Figure 3: Overview on ePANACEA's three assessment methods and responsible partners (source CENER). November 2021

Each assessment method can include techniques stemming from a lower complexity level. The following synergies between the three assessment methods will be exploited:

- Use of monitoring data
- Data acquisition
- Advanced user behaviour modelling
- Sensitivity analysis
- Semi-automated calibration based on machine learning techniques
- Inclusion of novel and smart technologies

The objective of the TDB is to test these three assessment methods on 15 different case buildings in the five pilot countries. The analysis of accuracy and uncertainty of each assessment method will enable the development of a decision matrix for the selection on the most suitable assessment method according to the specific building characteristics and the required accuracy level.

2.2. Smart Energy Performance Assessment Platform

The SEPAP (Smart Energy Performance Assessment Platform) will be a cloud platform used to build a common framework for the energy performance assessment and certification in Europe, implementing the three assessment methods described above. The TDB will validate the three assessment methods through the SEPAP. The platform is intended to be user-friendly and multi-lingual and to have a support and user-assistance module. The platform will include the decision matrix which will allows the building auditors to automatically choose between the three assessments methods, according to certain building types and characteristics (e.g., heating/cooling demand, complexity of the technical systems, on-site electricity generation, etc.). The SEPAP will be the tool for implementation of artificial intelligence and machine learning techniques, which will coordinate the calibration of the building model according to the possibilities of each methodology. In this way, the platform will learn from the adjustments that technicians etc. made and comes closer to replicating reality over time and become able to self calibrate.

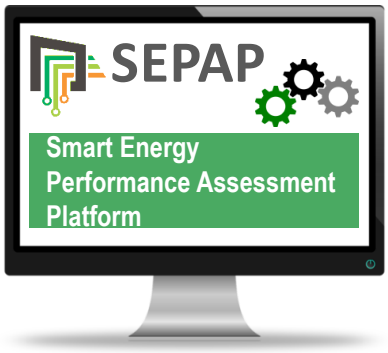


Figure 4: SEPAP

Currently, the SEPAP development is in progress. The basic structure was implemented and is constantly being revised. The platform is accessible using personal credentials under sepap.epanacea.eu. Figures 5 and 6 shows some exemplary screenshots from the platform, giving an overview on the basic structure (under development).

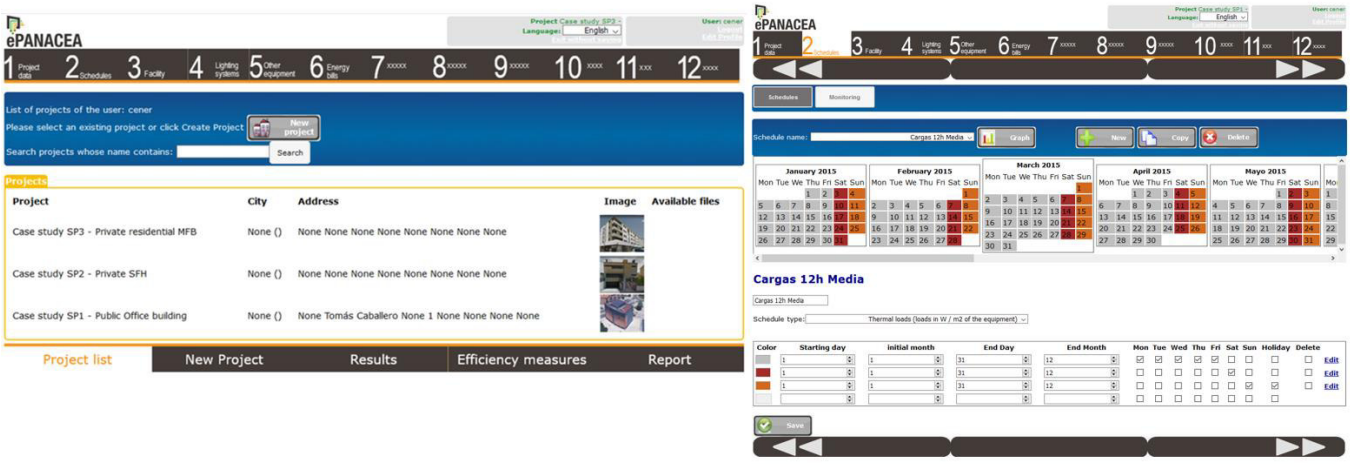


Figure 5: Exemplary screenshots from ePANACEA's SEPAP (under development), March 2021.

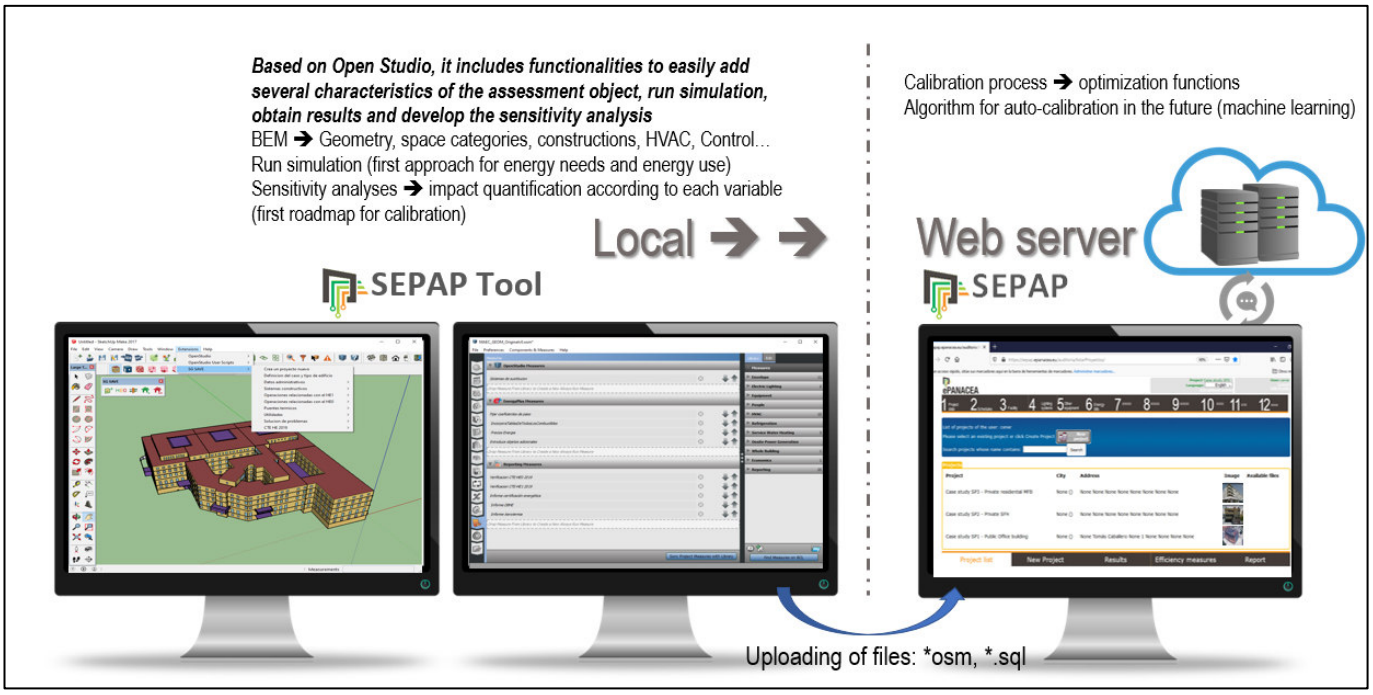


Figure 6: ePANACEA's SEPAP structure for assessment method number 3 with local application, and the SEPAP web application (source: CENER), November 2021.

2.3. The phases of testing

As already mentioned, the ePANACEA methodology will be demonstrated and validated in five European pilot countries through 15 real case studies. A wide network of European building owners and managers that have expressed their commitment to provide necessary data for demonstration activities has been established. These demonstration actions pave the way for an efficient roll-out of the methodology across the EU.

The demonstration of the energy assessment and certification methodology is organised in three phases as displayed in Figure 7.

The first phase covers the case study preparation. In this phase, 15 buildings will be chosen from a pre-selected group of buildings (see Table 1). Twenty-one (21) building owners and managers already expressed their commitment to provide the necessary data for testing and validation activities, covering approx. 7.000 different buildings (see Table 2). The TDB will select the appropriate case study buildings guided by the methodology requirements concerning data and/or technology availability (e.g., measured data, RES on-site, BACS, etc.). The activity will be developed in close cooperation with the owners, managers and building end users and, where relevant, energy providers or other stakeholders. The case studies will include 15 buildings covering a wide range of external characteristics such as climate zones, country specific cultural, social and economic characteristics as well as different data availability.

The second phase builds on phase one and delivers a detailed plan for the steps in the testing and validation of the methodology for each case study. The plan will consist of the activity schedule, descriptions of selected case studies, milestones and expected outcomes. Within this task, progress of the building energy assessment and certification methodology will be continuously monitored.

Data collection as well as the testing and validation of the ePANACEA energy assessment and certification methodology takes place during **the third phase**. The focus is on validating of the methodology in real conditions, identifying bottlenecks and improvement of the assessment methodology. The methodology will be updated according to the outcomes of the demonstration

activities. In addition, this testing will provide feedback to the SEPAP comprising the validation of the decision matrix. Demonstration and validation activities will also include cost analysis, assessment time consumed, and expertise of the technicians needed to perform each module on a specific building type.

The results of the testing phases will be summarised in the "evaluation report of ePANACEA methodology". It will draw up a cross analysis, from both a qualitative and a quantitative point of view, with respect to the existing EPC schemes in each pilot country. Additionally, the results will be reviewed from a qualitative point of view on an international level in close cooperation with the targeted stakeholders.

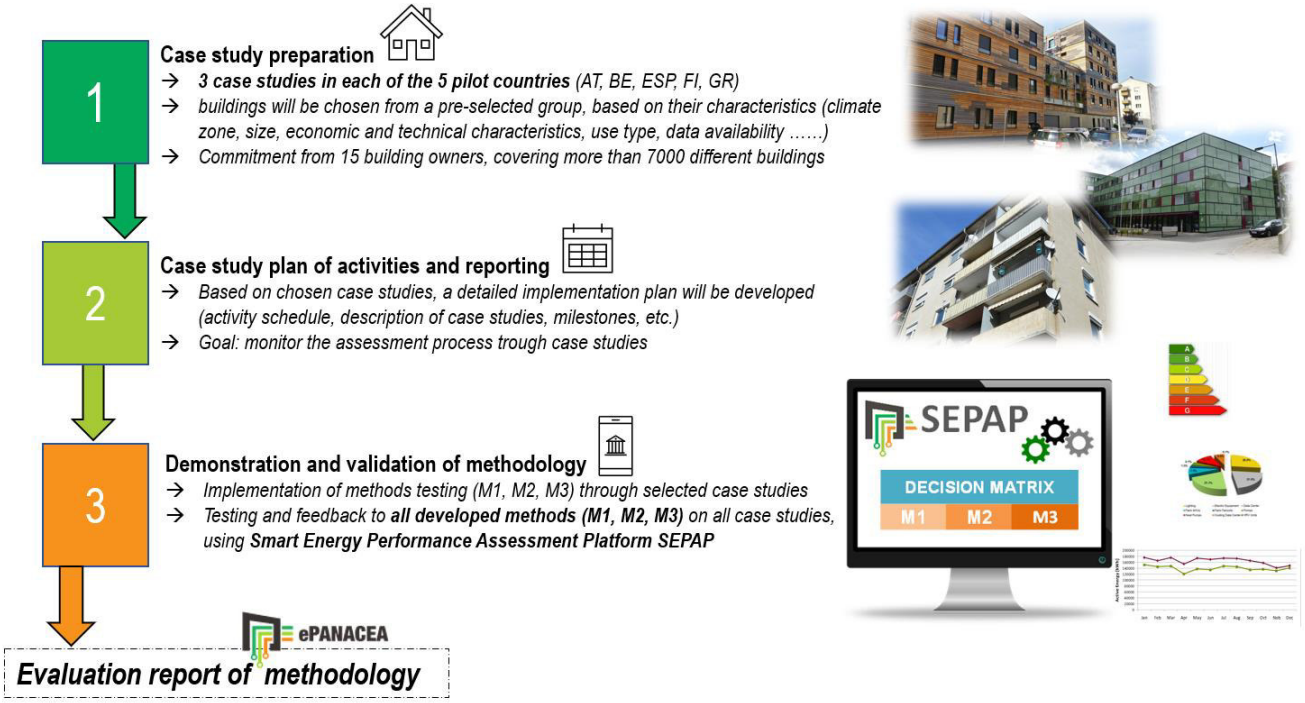


Figure 7: ePANACEA's phases of testing.

2.4. The case study buildings

Testing with real case studies ensures the practical feasibility of the ePANACEA methodology. All three ePANACEA assessment levels will be tested on 15 buildings (3 per pilot country).

As already mentioned, the selection of the case buildings will be done considering the ePANACEA methodology requirements as well as in close collaboration with the building owners. Furthermore, the key stakeholders involved in this process will be informed on further requirements and activities where their input is expected, e.g., in exploring user perceptions or methodology development. Table 1 gives an overview of the Letters of Intent (LOI) from building owners already collected during the last months.

Table 1: Overview of Letters of Intent (LOIs) collected from building owners.

Pilot country	Numbers of LOIs received	Short description of available building stock
Austria	8	public educational buildings, residential buildings, apartment blocks, offices, single family houses, public administrative buildings
Belgium	3	residential buildings, large dwellings, office buildings
Greece	6	office buildings, public administrative buildings, public educational buildings, municipal buildings
Spain	2	public buildings, including residential, office, educational buildings and hospitals
Finland	2	public buildings including non-residential buildings, office buildings, educational buildings
Total	**21**	**Approx. 7.000 different buildings**

Together, the buildings presented in Table 1 represent a building stock of more than several thousand buildings and utilisation units. The relevant building owners already expressed their commitment to provide the necessary data. The diversity of building characteristics in terms of climate conditions, size, building type, energy aspects, renewables on site, data availability etc., is shown in Table 2.

Table 2: Overview of building characteristics of the potential case studies.

Building characteristics		Pilot Country				
		AT	BE	GR	ES	FI
Climate	Atlantic		x		x	
	Mediterranean			x		
	Continental	x				
	Boreal					x
	Alpine	x				
Size	<500 m²	x	x	x		
	500-2.000 m²	x	x	x	x	
	>2.000 m²		x	x	x	x
Type	Single-family houses	x	x			
	Multi-family apartments	x	x		x	
	Offices	x	x	x	x	x
	Educational buildings	x		x	x	x
Energy need	Heating (& Domestic Hot Water)	x	x	x	x	x
	Heating (& Domestic Hot Water) & Cooling	x	x	x	x	
HVAC	Low complexity	x	x		x	
	Medium complexity	x	x	x		x
	High complexity		x	x	x	
RES on site	No	x	x	x	x	x
	Yes	x	x	x	x	
BACS	Low complexity	x	x	x	x	
	Medium complexity	x	x			x
	High complexity	x	x		x	
Data availability	Low	x	x			
	Medium	x	x	x		
	High	x	x	x		x
	Very high		x		x	

***HVAC**: low complexity - covering heating and domestic hot water demand with only one system (e.g., individual boilers or central heating boiler), high complexity - covering heating, cooling and domestic hot water demand with a mix of different technologies with different fuels; **Data availability**: low - design data, medium - design data, utility bills, weather data, high - design data, utility bills, weather data, short-term measurements, very high - design data, utility bills, weather data, short-term measurements, smart meters data; **RES on site**: Renewable energy sources on site; **BACS**: Building automation and control system*

3. THE TESTING AND DEMONSTRATION BOARD (TDB) ACTIVITIES

In order to ensure a fluent dialogue and continuous progress in the testing activities, the TDB will meet several times (whether online or during personal meetings). The main conclusions and next steps of each meeting are shortly presented in this section.

This section will be updated after each TDB meeting.

3.1. Conclusions from the first TDB meetings in June 2020

The first round of meetings of the TDB took place online in two steps, one on 23 June 2020 and another on 15 July 2020. The main objective of these online meetings was to generate a common understanding among the TDB members about their tasks in terms of validating the ePANACEA methodology and about the REBs. The responsible national partners from the TDB act as main interface between ePANACEA and the 5 REBs.

Decisions were made on the next steps, upcoming activities, necessary functionalities of the TDB & REB members only section at the ePANACEA webpage, the first REB meetings and how to approach existing institutions which already signed a LOI for being REB members. Additionally, a framework for the content of the first REB meeting as well as organisational questions were discussed and clarified.

The main conclusion from these first meetings were:

- Organise periodical online meetings from September in order to ensure the progress of the activities.
- Organise the first REB meeting by the end of 2020, including a backup plan for an online meeting due to the corona crisis.
- The TDB will contact possible REB members to inform them about ePANACEA.
- Necessary functionalities for the TDB (& REB) only section on the ePANACEA website, such as access control and user password, exchange of documents, calendar with milestones, FAQ and library section.

The main activities to be undertaken in the next months included:

1) Gathering relevant data from possible case studies and therefore identifying which data should be collected
2) Clarifying how the data should be collected (e.g., templates, web private area, other)
3) Selection criteria approach (definition of key variables)
4) Agreement on timeline (deadline for data gathering, deadline for definition of the selection criteria, deadline for the final selection of cases, etc.).

3.2. Conclusions from the second TBD meeting in February 2021

Between July 2020 and January 2021, the main activities of the TDB revolved around the organisation of the five REBs and related meetings, which took place in November and December 2020. More information about the meeting participants and conclusions from the five REB meetings is available here. In total, 48 highly relevant institutions with 52 representatives from 23 different countries discussed innovative features, smart and novel technologies and increasing user friendliness of EPCs.

Since the ePANACEA methodology development is progressing, the second TDB meeting, which took place on 16 February 2021, mainly focused on required building data from the five pilot countries. It was agreed that the data collection for the buildings in the pilot countries will start earlier than originally planned, because it will be necessary for the ePANACEA methodology development in the upcoming months (see Figure 8).

What	Lead	Who?	2020							2021												2022		
			June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March
Case study preparation	EASt	TDB																						
Case study activity and reporting plan	EASt	TDB																						

change in timeline
original timeline

Figure 8: Timeline of case study preparation.

As described in Figure 8, the preparation phase will be used to choose the exact case study buildings. For the ePANACEA methodology development it was agreed to collect data from at least one case study per pilot country with high data availability until the end of May 2021 or August 2021, depending on availability of historical measurement data.

Led by CENER, a criterion set for case studies' selection and data requirements was developed and discussed with the TDB members, based on the different categories provided in Table 2. The purpose of data gathering and monitoring data is to collect input for the development of ePANACEA Assessment Method 1 (chapter 2.1), which will ease the implementation of EPCs through the use of actual building performance data. Additionally, data from the case studies are needed to calibrate ePANACEA Assessment Method 2 and ePANACEA Assessment Method 3. The ePANACEA methodology with its three Assessment Methods has a high level of innovation, which will contribute to a more accurate and cost-effective energy assessment and certification of buildings. The use of actual consumption data and actual performance data (e.g., indoor temperatures) is necessary to develop more accurate models which can reduce the gap between energy performance simulation and real performance of buildings.

The criteria set for the case study selection are divided into 6 categories:

1) Number of case studies
    - ePANACEA will demonstrate and validate reliability, accuracy, user-friendliness and cost-effectiveness of the ePANACEA methodology through 15 case studies in 5 European countries. All three Assessment Methods will be tested on 15 building cases (3 per pilot country) by the TDB members.
2) Climatic zone
    - The objective is to cover as many European climatic zones as possible (e.g., Atlantic, Mediterranean, Continental, Boreal and Alpine). The different zones and the location of the pilot case studies are shown in Figure .
3) Location of the case studies
    - Ideally the location of the case studies should be near to the TDB members' headquarters, since visits and some on-site measurements will be needed.
4) Building type
    - Building types can be divided into residential and non-residential buildings. For ePANACEA, single-family houses, terraced houses, multi-family buildings, office buildings or educational buildings will be chosen as testing objects. It is recommended that TDB members choose building types with different complexities.
5) HVAC, RES and BACS
    a. The objective is to cover representative technical building systems and technologies. The aimed is to test at least 2-3 smart buildings or homes that incorporate a broad number of these technologies, such as heat pumps, mechanical ventilation, solar thermal energy, solar PV energy or BACS.
    b. A good exercise is to take into account a definition for reference buildings (i.e., building age, thermal parameters and building systems) at pilot country level.
6) Data availability
    - The case study data were divided into mandatory data and useful additional data, whereby.

Mandatory data:

i. Energy Performance Certificate and related documentation of the building
ii. Weather data from near weather station
iii. Electricity consumption (gathered from utility bills, portable electricity meters or utility servers)
iv. Heat consumption (gathered from utility bills or energy meters)
v. Indoor temperature ((different internal zones, at least measured in the day- and night-zone for residential buildings, and occupied/unoccupied zones for non-residential buildings): this data could be easily gathered via t[a]/HR dataloggers
vi. Information about occupants (heating schedule and presence or type of occupants in order to generate a default occupancy profile); this data could be gathered via online-surveys or interviews with building owner/managers

b. Useful additional data:
i. Building surface temperatures and heat fluxes from thermography, infrared thermometer or transmittance meter
ii. Indoor temperatures in adjacent zones such as neighbouring dwellings or adjacent unheated volumes (garage, attic, etc.)
iii. Airtightness of the building/dwelling: measured by means of a pressurisation test (Blower Door Test)

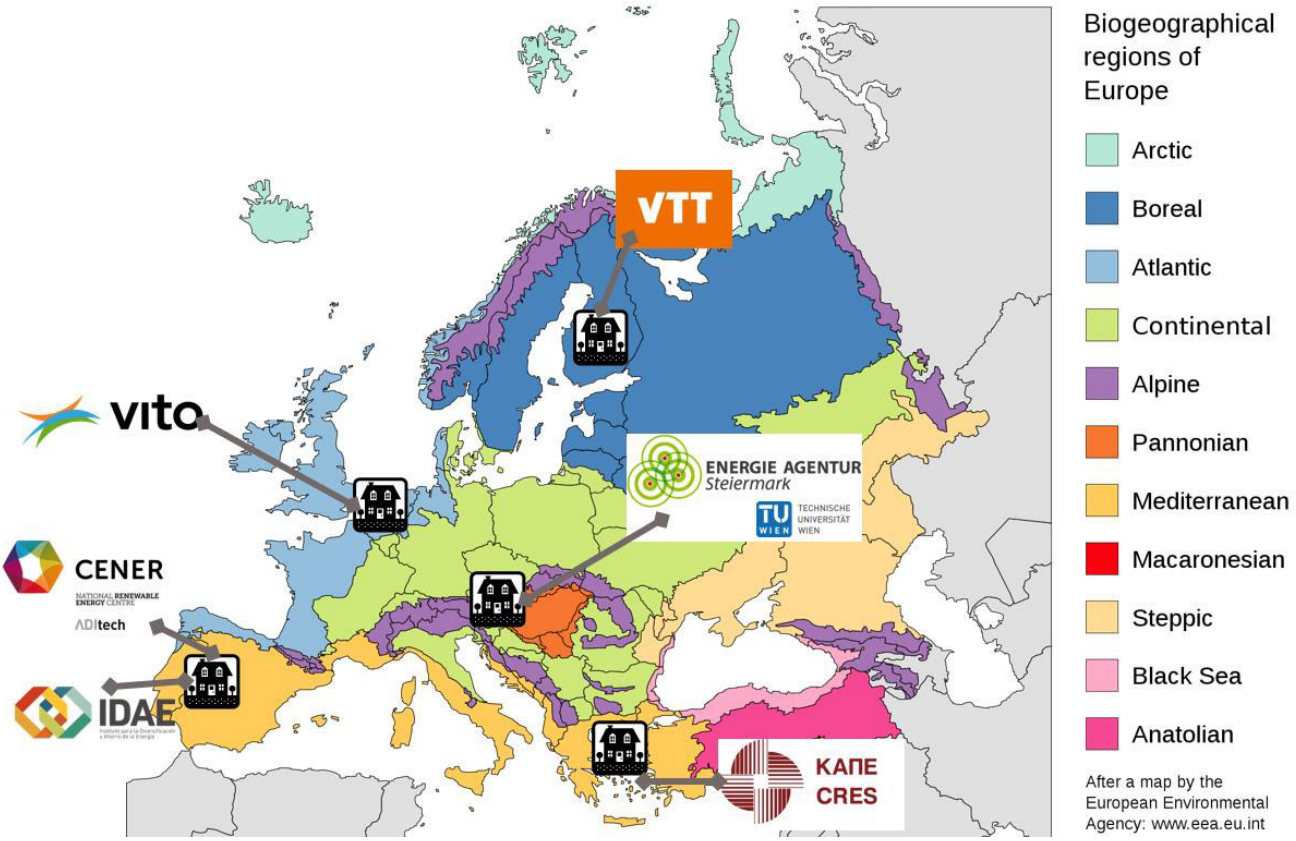


Figure 9: Overview of climatic zones of the ePANACEA pilot countries, based on a map created by Júlio Reis - Made with Inkscape from Image: Biogeographical Regions Europe - Map (intl).png by the European Environmental Agency, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=804348

The length of the energy consumption data (electricity, heat, etc.) depends on the frequency of the data. For high resolution data (less than 1 hour), a length of 4 weeks would be sufficient. Energy consumption with a daily or weekly frequency should be collected for a period of 15 weeks. If energy consumption data are available on a monthly basis, it would be sufficient to have approx. 2-3 years of data material. The length and frequency of data availability will imply short-term or long-term calibration processes as well as different levels of accuracy.

For the data collection, a short template was developed, which includes important information about the case studies. The template, filled with exemplary case studies from Austria and Spain, is attached in the annex. The exemplary buildings are very different (type of building, climatic area, housing technologies, users, etc.). The ePANACEA methodology will be tested with a big range of building typologies in order to create validated assessment methods with high reliability and broad applicability.

The steps to be undertaken next by the TDB in the upcoming months are shown in Table 3.

Table 3: Overview of the next steps to be undertaken by the TDB until month 19.

What	When
Development of a short list with buildings with high/very high data availability of all pilot countries	April 2021
Pre-selection of case studies from list	April 2021
Preparation of consent form for building owners/managers and building occupants for the data collection process	April 2021
Check and final selection of one case study per pilot country	May 2021
Data gathering and data exchange for one case study per pilot country	May, August 2021
Selection of two more case studies per pilot country and data collection	December 2021

3.3. Conclusions from third TDB meeting in October 2021

Between February 2021 and November 2021, the main activities of the ePANACEA TDB revolved around the development of a short list with buildings for the testing process, definition of buildings for the testing process and data collection for one case study per pilot country. Additionally, the 2nd round of REB meetings is currently being prepared by TBD members.

In detail, the following activities were carried out under the lead of EASt with support from the TDB members in the past nine months:

- Development of a short list with possible case studies for each pilot country
- Pre-selection of relevant case studies per pilot country and discussion of selected case studies among the TDB members. Conclusions from preliminary list:
    - Several building typologies present from different climatic regions
    - Different construction types and energy classes available
    - Different types of HVAC systems available:
        - Heating: Condensing gas boilers, district heating, heat pumps (air, soil...), biomass boiler, oil boiler
        - Central ventilation systems, etc.

        - Free cooling, cooling with heat pumps, etc.
    - Four buildings with high/very high data availability from past periods
- Set up of data exchange platform for TDB members for the case studies by EASt
- Creation of detailed data collection template by EASt
- Check and final selection of one case study per pilot country
    - Preparation of consent form for building owners/managers and building occupants for the data collection process
    - Data gathering and data exchange for one building per pilot country until 1 August 2021 (see Table 4)
- Signing the consent form with EFINOVATIC for the use of the SEPAP by all TDB members for the upcoming testing process
- Meetings with WP4 partners about
    - The preparation of the upcoming deliverable D5.2 Demonstration activity plan of each country (due date January 2022)
        - This deliverable includes a detailed action plan for the testing and validation of the methodology for each case study. The plan consists of an activity schedule, a description of selected case studies, milestones and expected outcomes.
        - A template for the case study plan of activities was developed by EASt and will be completed by the TDB members by beginning of December 2021.
    - The preparation for publishing of case studies on the ePANACEA webpage (development of a relevant template, discussion on the appearance of the case studies in the ePANACEA webpage in close cooperation with SYMPRAXIS)

As mentioned, data from five buildings were already collected by the beginning of August 2021 in order to support the WP4 methodology development (for details on which type of data have been collected see chapter 3.2.). Table 4 gives an overview on these case studies.

Table 4: Overview of the 5 selected case study buildings.

Country	Case study No.	Building typology	Year of construction	National EPC rating for primary energy demand	Data availability
Austria	AT-01	Multi-family building	2018	Class B (106,65 kWh/m²year)	Very high (less than one hour frequency)
Belgium	BE-01	Single family house	1982	Class D (306 kWh/m²year)	Low (monthly data)
Finland	FI-02	Educational building	2019	Class B (99 kWh/m²year)	High (one hour frequency)
Greece	GR-01	Apartment in multi-family building	1976	Class C (197,6 kWh/m²year)	Low (monthly data)
Spain	SP-02	Single family house	2005	Class C (148,43 kWh/m²year)	Low (monthly data)

During the third TDB meeting in October 2021, the achieved progress of the past months was presented as described above, and next steps have been discussed. A preliminary list of the 15 case studies chosen by the TDB members is attached in chapter 5. The agreed next steps are shown in Table 5.

Table 5: Overview of next steps until September 2022

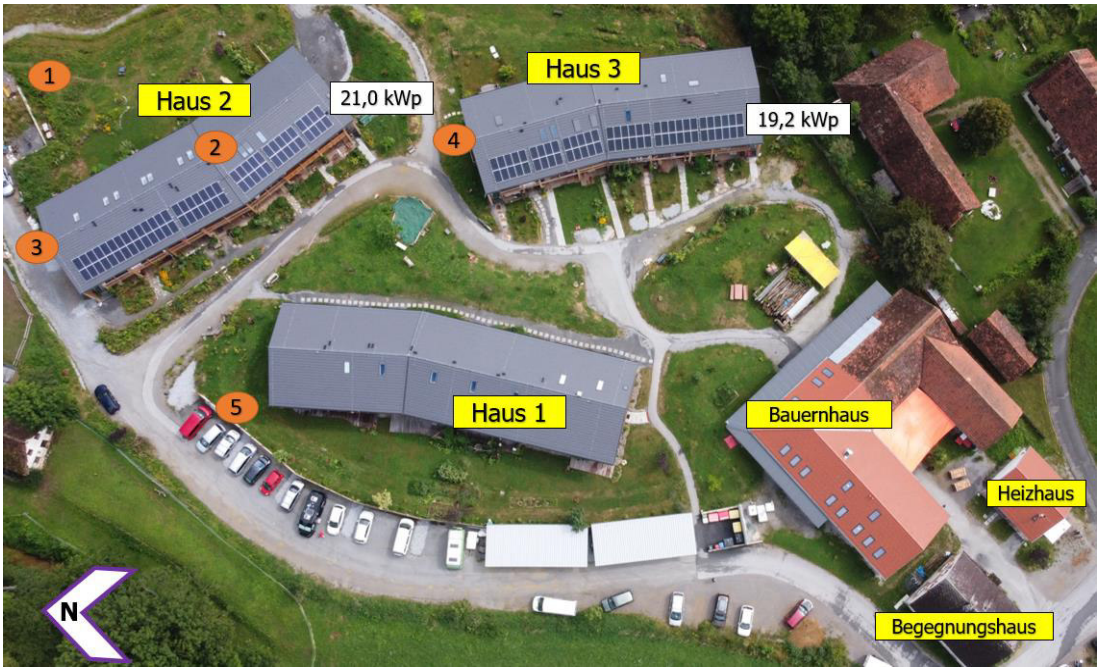
What	When
Selection of two more case study buildings per pilot country	December 2021
Signing of consent form with building owners/managers and building occupants for the 10 case study buildings in pilot countries	December 2021, January 2022
Development of case study plan of activities for each case study building by TDB members	December 2021
Completion of D5.1, update in month 19	December 2021
Completion of D5.2 “Case study plan of activities” by EASt with input from all TDB members	January 2022
Publication of case studies at ePANACEA webpage	January and February 2022
Data collection for all case studies (historical data or actual measurement data)	30.06.2022 (latest by 31.08.2022)
Start of testing process	June 2022
Update of D5.1	September 2022

4. ANNEX – CASE STUDIES FROM AUSTRIA AND SPAIN

Overview of the Austrian case study AT-01

Pilot Country	Austria
Case study number (e.g. AT-1, AT-2, AT-3…)	AT-01
Name of building (e.g. Private Single Family Home…)	Multi-family building "Haus 3"
Building address (Zip code and city)	AT-8063 Eggersdorf
Year of construction	2018
EPC rating for primary energy demand (if available)	B (106,65 kWh/m²year)
Climate	Continental
Building typology	Multi-family house
General data availability	Very high (less than 1 hour)
Available data from past periods	yes, very high frequency
Main data source (e.g. smart meters, utility servers…)	Own energy meters for heat, electricity etc. as well as weather data and indoor climate data 5 min. resolution for all data
Location of nearest weather station or source of weather data	Weather station installed nearby (~100 m distance)
Number of users/occupants (estimation)	8 flats, approx. 27 residents (adults and children)
Construction type (light construction: primarily wooden construction, no brick walls, plasterboard walls inside; moderate construction: combination of light materials (e.g. wood, plasterboard walls..) and heavy materials (e.g. brick walls); heavy construction: inside and outside primarily brick walls, concrete walls, use of other heavy materials)	Light construction
Size of building (gross floor area) in m²	742,6
Surface area of conditioned gross volume in m²	1 584,61 m² (3 038,17 m³)
Energy need	Heating (& Domestic Hot Water)
HVAC (main heating system, cooling system, e.g. condensing gas boiler….)	150 kW biomass boiler with 3 m³ storage tank, no cooling facility or ventilation system
Domestic hot water preparation	if others, please specify as comment
Comment domestic hot water preparation	Winter period: centralized with heating system; summer period: decentralized 100% electric
RES on site (e.g. 10 kWp PV system plus 10 kWh battery storage, 30 m² solar thermal system...)	40,2 kWp PV system with 47,2 kWh net storage capacity

BACS	high complexity
Other important building characteristics or data characteristics	Settlement with 3 new residential buildings (HAUS 1, HAUS 2, HAUS 3) plus two renovated buildings; indoor room temperature data available from 8 flats in building No 3
Available pictures	



(1): weather station, (2) basement with lithium-ion batteries, (5) EV charging station

Overview of the Spanish case study SP-01

Pilot Country	Spain
Case study number (e.g. AT-1, AT-2, AT-3…)	SP-01
Name of building (e.g. Private Single Family Home…)	Public office building
Building address (Zip code and city)	Tomás Caballero, 1, 31006 Pamplona (Navarra)
Year of construction	1994
EPC rating for primary energy demand (if available)	No renewable primary energy indicator: 386,59 kWh/m^2 GHG emissions indicator: 89,1 kgCO_2/m^2 Class/Label: C
Climate	Atlantic
Building typology	Office building
General data availability	High (1 hour for all data)
Available data from past periods	yes, low frequency
Main data source (e.g. smart meters, utility servers…)	BMS
Location of nearest weather station or source of weather data	700 m
Number of users/occupants (estimation)	230
Construction type (light construction: primarly wooden construction, no brick walls, plasterboard walls inside; moderate construction: combination of light materials (e.g. wood, plasterboard walls..) and heavy materials (e.g. brick walls); heavy construction: inside and outside primarly brick walls, concrete walls, use of other heavy materials)	Light construction
Size of building (gross floor area) in m²	5.446,60
Surface area of conditioned gross volume in m²	4.744 m^2 x 2,65 m (approx) = 12.571,6 m^3
Energy need	Heating (& Domestic Hot Water) & Cooling
HVAC (main heating system, cooling system, e.g. condensing gas boiler….)	Main system: heat pump for heating & cooling
Domestic hot water preparation	centralized, separated from heating system
RES on site (e.g. 10 kWp PV system plus 10 kWh battery storage, 30 m² solarthermal system...)	27 kWp (since 2017)
BACS	medium complexity
Other important building characteristics or data characteristics	
Available pictures	

5. ANNEX - PRELIMINARY LIST OF CASE STUDIES

Preliminary list of case studies, December 2021; feasibility will be evaluated during the testing process

	Case study number	Signed Consent	Data collected	Name of building	Building address (Zip code and city)	Year of construction	EPC rating for primary energy demand	Climate	Building typology	General data availability
Austria	**AT-01**	x	x	Multi-family building	AT-8063 Eggersdorf	2018	B (106,65 kWh/m²year)	Continental	Multi-family house	Very high (less than 1 hour)
	AT-02	x	x	Office building	AT-7423 Pinkafeld	2015	222,40 kWh/m²year	Pannonian	Office building	Very high (less than 1 hour)
	AT-03	x	in progress	Community building	AT-8063 Eggersdorf	1940	No EPC available	Contintenal	Office building	Very high (less than 1 hour)
Belgium	**BE-01**	x	x	Vinkenhof	2590 Berlaar	1982	D-306 kWh/m²year	Atlantic	Single family house	Low (monthly data)
	BE-02	x	in progress	Multi-family building - flat	2290 Vorselaar	1979	B-141 kWh/m² & A-83 kWh/m²	Atlantic	Multi-family house	Low (monthly data)
	BE-03	x	in progress	Terraced house	9040 Gent	1904	B-156 kWh/m²year	Atlantic	Single family house	Very high (less than 1 hour)
Finland	**FI-01**	in progress	in progress	Energy efficient office building					Office building	Very high (less than 1 hour)
	FI-02	x	x	School Eklöfska skolan	06750 Tolkkinen Porvoo	2019	B, 99 kWh/m²year	Boreal	Educational building	High (1 hour for all data)
	FI-03	in progress	in progress	School					Educational building	High (1 hour for all data)
Greece	**GR-01**	x	x	Apartment in Multi Family Building – 2nd floor	17341, Ag. Dimitrios - Attiki	1976	Class: C 197,6 kWh/m² year	Mediterranean	Multi-family house	Low (monthly data)

	GR-02	x	in progress	Office building	190 09, Pikermi – Attiki	2001	Class: B 170,8 kWh/m^2 year	Mediterranean	Office building	Low (monthly data)
	GR-03	x	in progress	Municipal Office building	17343 Ag. Dimitrios – Attiki	1970	No EPC available	Mediterranean	Office building	Low (monthly data)
Spain	**SP-01**	x	in progress	Public office building	Tomás Caballero, 1, 31006 Pamplona (Navarra)	1994	Class C: 386,59 kWh/m^{2}year	Atlantic	Office building	High (1 hour for all data)
	SP-02	x	x	Private residential building (Single family home)	31486 Egües (Navarra)	2005	Class C: 148,43 kWh/m^{2}year	Atlantic	Single family house	Low (monthly data)
	SP-03	x	in progress	Private residential building (Multifamily block)	31006 Pamplona (Navarra)	2009	Class C: 15,2 kgCO_2/m^{2}year	Atlantic	Multi-family house	Low (monthly data)

6. REFERENCES

6.1. Table of Figures

6.2. Table of Tables