ePANACEA

Smart European Energy Performance Assessment & Certification

This project has received funding
from the European Union's HORIZON 2020
research and innovation programme
under grant agreement No 892421

Testing the ePANACEA methodology

Reports on case studies validation results of each pilot country

Version 1, June 2023

EASt – Energy Agency of Styria

www.epanacea.eu

Published and produced by: EASt with support from CENER, VITO, VTT, TU WIEN and CRES

Author(s): David Frick (EASt)

Reviewer(s): Elpida Polychroni (CRES), Marta Sampedro (CENER), María Fernández (CENER)

Layout: SYMPRAXIS

Cover image: Depositphotos.com / ivanov.aa.irk@gmail.com / Sympraxis Team

Dissemination level: Public

Website: www.epanacea.eu

Project duration: June 2020 – October 2023

Grant Agreement: 892421 – ePANACEA – H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-EE-2019

Coordinator:

CENER
NATIONAL RENEWABLE ENERGY CENTRE
ADItech

Project Partners:

efinovatic
VTT
TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna | Austria
ΚΑΠΕ CRES
vito
ENERGIE AGENTUR Steiermark
izes gGmbH Institut für ZukunftsEnergie- und Stoffstromsysteme
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
IDAE Instituto para la Diversificación y Ahorro de la Energía
TEAM sympraxis

HISTORY OF CHANGES

Version	Month Year	Organisation	Comments
V1	July 2023	EASt	

TABLE OF CONTENTS

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 was tested and validated in order to become aligned with and meet the needs of national public bodies, end-users and other stakeholders.

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

EXECUTIVE SUMMARY

This report presents the findings and outcomes of the case studies conducted within the ePANACEA project, which aimed to test the three energy performance methods. The objective was to assess the effectiveness and applicability of these methods in various real-world scenarios across the partners' countries. The report provides an overview of the selected cases, outlines the methodology and validation process, describes the activity schedule for testing, explains the data collection process, and details the testing procedures.

The testing phase encompassed 15 cases distributed among the five partners' countries. Each case represented a unique energy performance scenario, allowing for a comprehensive evaluation of the three methods. The testing followed a systematic approach, adhering to a predefined schedule and employing standardized assessment templates.

Data collection was a crucial aspect of the testing process, enabling a robust analysis of the methods' performance. The report highlights the procedures implemented for collecting relevant data, ensuring accuracy, consistency, and completeness. The collected data served as the basis for evaluating the methods' efficacy and identifying any areas for improvement.

To facilitate the testing process, a user guide was developed, providing comprehensive instructions and guidelines to the participants. Timetables were established to ensure efficient coordination and adherence to the testing schedule. Furthermore, supporting processes were implemented to address any technical challenges or issues encountered during the testing phase.

The assessment template played a pivotal role in extracting meaningful results from the testing activities. The template captured valuable feedback about the methods from the participants, highlighting their strengths, weaknesses, and potential areas of enhancement. Additionally, a comparative analysis was conducted, allowing for a comprehensive evaluation of the three methods' performance across the different cases and partner countries.

Overall, the results obtained from the assessment template provided valuable insights into the effectiveness and suitability of the three energy performance methods. The report summarizes these results, offering a comprehensive overview of the feedback received and the comparison between the methods. The findings serve as a foundation for further refinement and development of the methods, ensuring their optimal utilization and implementation in future energy performance projects.

GLOSSARY

TDB	Testing and Demonstration Board
BACS	Building Automation and Control System
EPC	Energy Performance Certificate
GFA	Gross Floor Area
HVAC	Heating, Ventilation and Air Conditioning
LOI	Letter of Intent
REB	Regional Exploitation Board
RES	Renewable Energy Sources
SEPAP	Smart Energy Performance Assessment Platform
EQF	European Qualification Framework
API	Application Programming Interfaces

1. EPANACEA ASSESSMENT METHODS

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 1) 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.

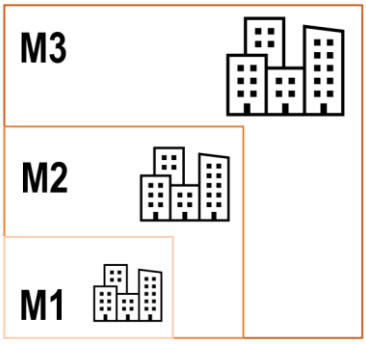

Figure 1: The relation between ePANACEA's three assessment methods

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 2.

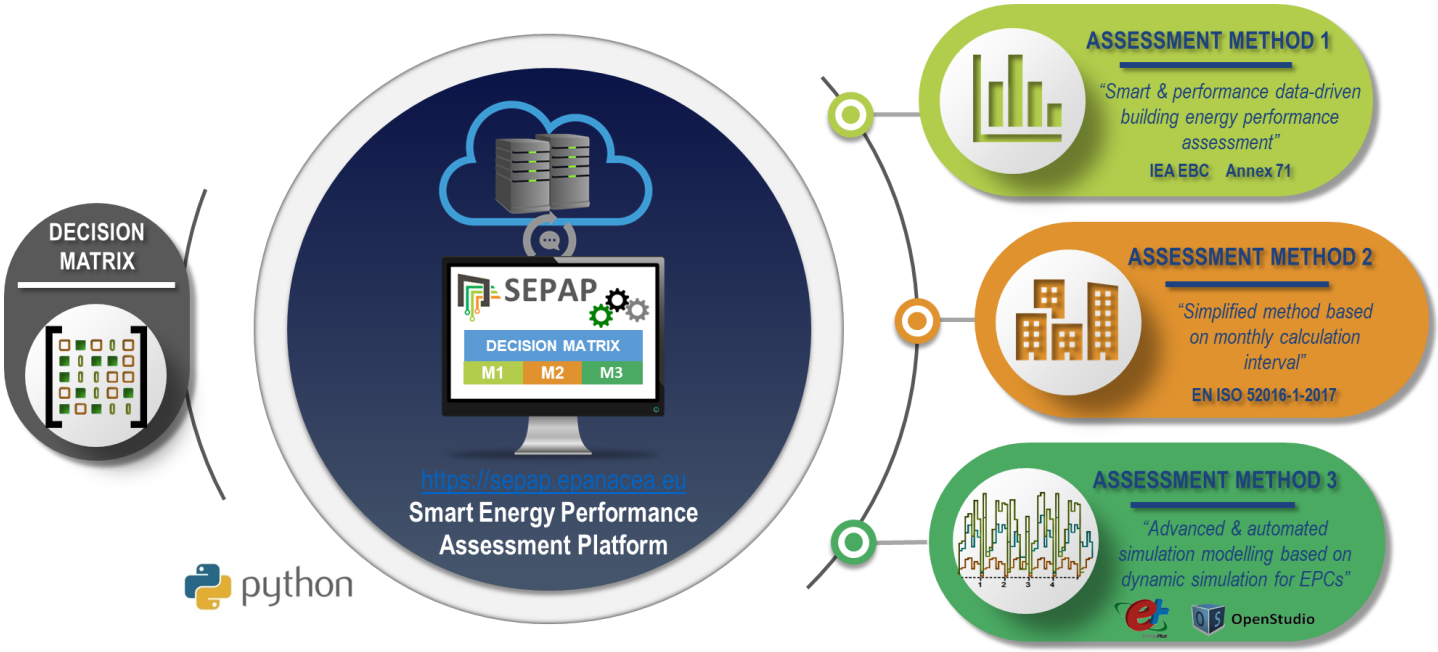

Figure 2: Overview on ePANACEA's three assessment methods. Source:CENER, May 2023

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 first module uses on-board monitored (OBM) data, leveraging the increasing smart dimension of the energy management systems of the buildings, and inverse modelling approaches to assess the building energy performance.

The second module is based on the monthly method of ISO 52016, considering the smart technologies increasingly present in the buildings, artificial intelligence and machine learning for automated assessments as well as advanced models of the occupation profiles.

Finally, the third and more complex module of the ePANACEA methodology is the advanced & automated simulation modelling based on dynamic simulation for EPCs. Advanced dynamic simulation techniques allow a high level of accuracy as well as quality outputs, including:

(i) the prediction of building energy performance (e.g. corrected by climate),
(ii) desegregation of consumption per energy service and/or type of fuel,
(iii) identification of energy efficiency measures and
(iv) estimation of potential energy savings and economic viability calculation.

2. OVERVIEW OF SELECTED CASES

The purpose of data gathering and monitoring is to collect input for the development of ePANACEA Assessment Method 1, 2 and 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.

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

The selection of the case buildings is done taking into account the requirements of the ePANACEA methodology as well as in close cooperation with the building owners. In addition, the main stakeholders involved in this process will be informed about other requirements and activities where their input is expected, such as user perception research or methodology development.

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.

A criterion set for case studies' selection and data requirements was developed, based on the different categories provided in

Table 1. 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 criteria set for the case study selection is described in report “Compendium of TBD meetings”.

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 testing Assessment method 1 the data (electricity, gas, solar radiation, indoor and outdoor temperature etc.,) need to be available for the same period with the same frequency (either monthly, daily or hourly data). The other methods will be able to deal with different data qualities.

Table 2 lists all selected case studies of the individual countries that meet the previously described criteria. These case studies have been selected by the TDB and have been considered as the most potential to develop and test the ePANACEA methods. The case studies are listed in the table with their characteristics. If obstacles arise during testing or data collection, the case studies can be modified.

Table 1: Overview of building characteristics of the 15 selected case studies.

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

***GFA**: gross floor area, **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*

Table 2: List of case studies, May 2023

	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	x	Community building	AT-8063 Eggersdorf	2018	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	x	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	x	Terraced house	9040 Gent	1904	B-156 kWh/m²year	Atlantic	Single family house	Very high (less than 1 hour)
Finland	**FI-01**	x	x	Energy efficient office building	00940 Helsinki	2011	A, 72 kWh/m2, 2018	Boreal	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	x	x	School (Keinutien ala-aste)	00940 Helsinki	2016	B, 130 kWh/m2, 2013	Boreal	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	x	Office building	190 09, Pikermi – Attiki	2001	Class: B 170,8 kWh/m^2 year	Mediterranean	Office building	Low (monthly data)
	GR-03	x	x	Municipal Office building	17343 Ag. Dimitrios – Attiki	1970	Class: D 369kWh/m2 year	Mediterranean	Office building	Low (monthly data)
Spain	**SP-01**	x	x	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	X	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)

3. METHODOLOGY FOR TESTING AND VALIDATION

Data collection, testing and validation of the ePANACEA methodology for energy assessment and certification took place in the third testing phase of the ePANACEA project. The focus is on validating the methodology under real conditions, identifying bottlenecks and improving the assessment methodology. The methodology will be updated according to the results of the demonstration activities. In addition, these tests will provide feedback to SEPAP that will include the validation of the ePANACEA decision matrix. This decision matrix will provide guidance or recommendations on the most suitable method to use for a specific building type, providing reasonable accuracy and uncertainty levels.

The demonstration and validation activities will also include a cost analysis, assessment time, and technician expertise required to perform each methods on a specific building type.

The results of the test phases described in this report are summarized in the "ePANACEA Methodology Evaluation Report". This report will provide an evaluation from different perspectives (theoretical, practical, economical and technical point of view). The demonstration of all methods on all 15 cases will provide a comparison of methods for a specific building type under real conditions.

Additionally, the Methodology report will provide a cross analysis from both a qualitative and quantitative perspective in relation to the existing EPC systems in each pilot country and by considering national differences regarding climatic, cultural, social and political context. In addition, the results from a qualitative perspective will be reviewed at the international level in close collaboration with the stakeholders concerned.

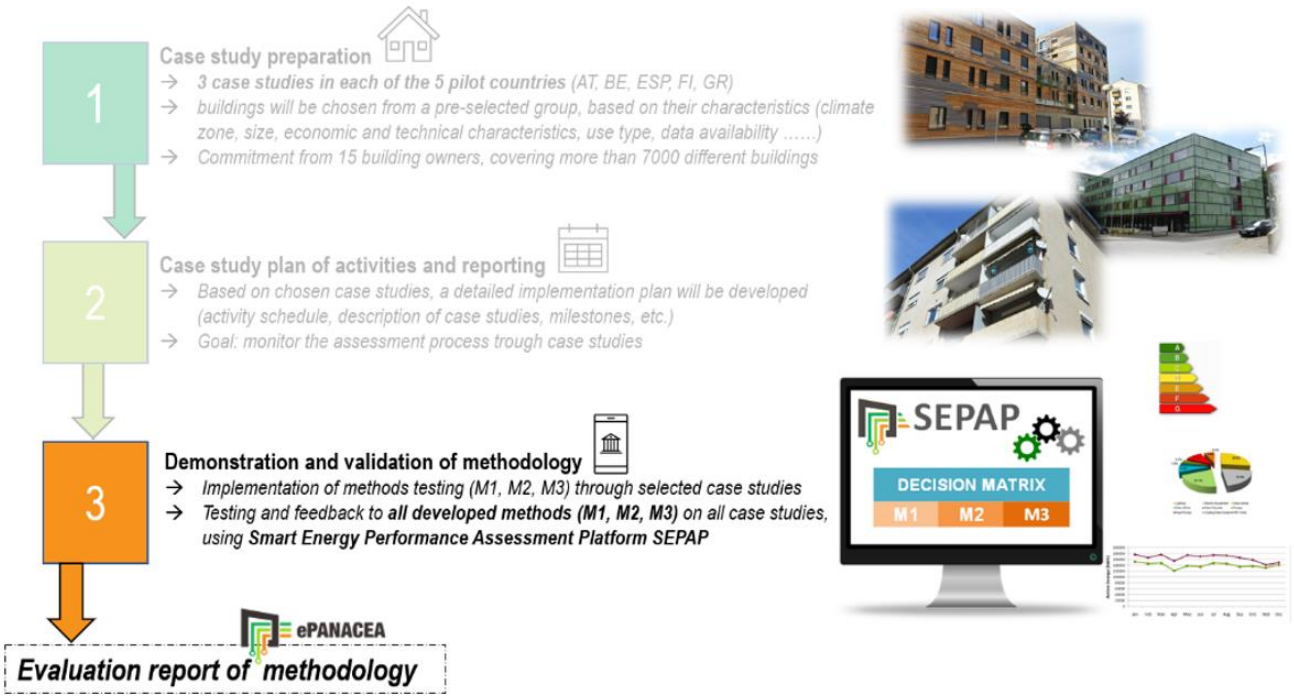

Figure 3: ePANACEA's phases of testing

3.1. Activity Schedule

The activity schedule developed in ePANACEA is a work plan that guides the testing process of the ePANACEA methodologies. It is divided into phases and is supported by milestones. The schedule spans from the preparation of the case studies to the collection of results. There are 15 case studies included in the schedule. Unfortunately, the schedules had to be remade and the testing process itself changed a lot. Exemplary an updated activity schedule for Austria is shown in Figure 4.

Case study plan of activities - AT-1 (Austria)

Case study number	AT-1
Country:	Austria
Partner:	EASt
Case study description:	
Multi-family building (light construction) on the countryside with 8 flats and approx. 27 residents; very high data availability with measurement data (heat, electricity, temperatures, etc) of less than 1 hour, 150 kW biomass boiler and 40,2 kWp PV system incl. 47 kWh lithium-ion-battery storage	


© Energy Agency of Styria


© Ditz Fejer

Month of ePANACEA		2021												2022												2023						
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
Milestone	**Activity**	Jan	Feb	Mar	Apr	May	Ju	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Ju	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
	Collection of potential cases																															
M1	**Selection of case study (DL month 18!)**											!																				
M2	**Signed consent form**																															
M3	**Publication at ePANACEA webpage**																															
	Data collection																															
	Accompaying data (EPC, plans, blower door etc.)																															
	Measurement data for energy consumption, indoor temperature																															
M4	**Data collection finished**																															
M5	**Demonstration and validation activites (DL month 33!)**																															
	Testing Assessment method 1 (method ready in month 25)																															
	Testing Assessment method 2 (method ready in month 28)																															
	Testing Assessment method 3 (method ready in month 31)																															

Figure 4: Updated exemplary Case Study Plan of Activities

Method development delay and data collection delay let to a postponement of the testing process. All methods were also tested almost simultaneously. This did not only have disadvantages. There were synergies in data entry and the pilot country partners were already well versed in their case studies.

3.2. Data collection

The next step after the activity schedule is the collection of relevant data for the selected case studies. This includes accompanying data such as energy performance certificates (EPC), plans, blower door test results, etc. Measurement data for energy consumption and indoor conditions is also collected. For some test buildings, data was already available, while for others, measurement devices were installed to start the collection process. The collected data will be prepared for further analysis. To collect the data a template for data collection was prepared for all the pilot countries in line with the input parameters for the methods and filled in for all the case studies. In the annex in the Table there is

3.3. The testing process

As already described, the methodology developed within ePANACEA was demonstrated and validated in five European pilot countries through 15 real case studies. An extensive network of European building owners and managers has been established who have agreed to provide the data required for demonstration measures. These demonstration measures pave the way for an efficient roll-out of the methodology across the EU.

3.3.1. User Guide for Method Testing

For testing, the implementing partners got several information for the three methodologies to test their case studies. They were called “User Guide for Method Testing” and contained the following content:

Method 1 and Method 2:

- Platform
- Access credentials
- File name guidance
- Video Tutorial ePANACEA Method 1 of assessment - Tutorial - YouTube & ePANACEA Method 2 of Assessment - Tutorial - YouTube
- Input example

Method 3:

- Software
- Weather data
- File name guidance
- Video Tutorial: ePANACEA Method 3 of Assessment - Tutorial - YouTube
- Auto calibration
- Example Workflow documents

3.3.2. Timetable for testing

During the testing process the timetable for testing adapted and changed according to unforeseen needs. Below the two timetables for testing of Method 1 and 2 and Method 3 are shown in Figure 5.

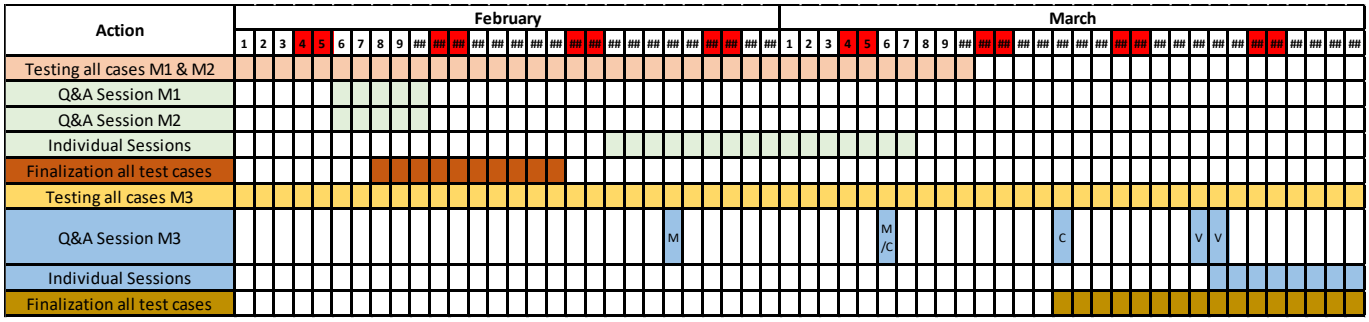

Figure 5: Timetable for Testing Process of all Methods (M…methodology, C…calibration, V…validation)

3.3.3. Supporting process

During the Testing Process it was seen that the implementing partners needed additional support by the method developers. Therefore, different kinds of supporting services were created to answer questions and assist the implementing partners in modelling their case studies in the SEPAP platform (M1 and M2) or model and calibrate in SketchUp2022 and Open Studio (Method 3). There was also a FAQ sheet created where partners could individually input their questions. Method developers then answered directly, or questions were answered in the Q&A online sessions.

- Q&A Sessions M1: a two-hour consultation online with the method developer where open questions could be answered. Questions and answers are collected in the FAQ sheet.

- Q&A Sessions M2: a two-hour consultation online with the method developer where open questions could be answered. Questions and answers are collected in the FAQ sheet.
- Individual Sessions M1 and M2: there was still the need to clarify open questions and the developers looked into detail on selected case studies in the SEPAP tool.
- Q&A Sessions M3 Modeling: These sessions had a modelling focus to assist the implementing partners to get the model for geometry and HVAC running in the Open Studio Application. Questions and answers are collected in the FAQ sheet.
- Q&A Sessions M3 Calibration: These sessions had a calibration focus to get the models being calibrated in the Parametric Analysis Tool. Questions and answers are collected in the FAQ sheet.
- Individual Sessions M3 Calibration: The calibration process was quite challenging for the implanting partners so individual sessions were necessary to get problems solved within the calibration process of the case studies.

3.3.4. Assessment Template

An assessment template for standardized data collection was provided to the implementing partners. It was necessary for a testing process involving 15 case studies for several reasons:

- Consistency: Standardized templates ensure consistency in data collection across all case studies. It allows for uniformity in the types of information collected, the format of data, and the criteria used for assessment. This consistency facilitates accurate and reliable comparisons and analysis of the results.
- Comparable analysis: With a standardized template, data from different case studies can be easily compared and analyzed. By having a consistent structure and format, it becomes simpler to identify patterns, trends, and insights across the different studies. This comparability enhances the overall understanding and interpretation of the results.
- Efficient data collection: Templates provide a structured framework for collecting relevant data points for each case study. They can include specific sections, fields, or questions that guide the data collection process. This streamlines the process, making it more efficient and reducing the likelihood of missing crucial information.
- Replicability: A standardized assessment template increases the chances of replicating the testing process in the future or in different settings. If the template is well-designed and comprehensive, it can serve as a blueprint for other researchers or practitioners who wish to conduct similar assessments. This replication enables the validation of results and the advancement of knowledge in the field.
- Quality control: By using a standardized template, researchers can establish quality control measures. The template can include guidelines and instructions for data collectors, ensuring that they follow consistent procedures and adhere to specific standards. This quality control helps to minimize errors, biases, and inconsistencies in the data collection process.
- Documentation and transparency: An assessment template provides a documented record of the data collection process. It serves as a transparent reference point that outlines the variables, indicators, and methodologies used. This documentation enhances transparency and enables others to understand and verify the research process, increasing the credibility and trustworthiness of the findings.

The feedback is structured in four categories:

- **Training:** Feedback about the training needs to learn to use the methods and the provided training materials.
- **Data gathering:** Feedback about the difficulties and effort and quality of the data needed for the methods.
- **Input:** Effort in time and qualification of testing personnel, design and user-friendliness.
- **Output:** Errors that occurred, usability, understandability and presentation of output, plausibility and effort compared to use.

The filled in assessment templates for all three methods and all 15 case studies is in the Annex of this document.

3.4. Feedback from testing process

The feedback was generated by analyzing the assessment templates filled in by the implementing partners testing the 15 case studies by using the three ePANACEA assessment methods. As they were standardized a comparison was possible and performed for each method and comparing the methods.

3.4.1. Feedback Method 1

3.4.1.1. Training and Training material

Method 1 had an average training period of 6,75h and it could be seen that complex buildings like offices and school had less training effort than residential buildings. The size of the building did not higher or lower the training needs.

Overall, the feedback about the training material for Method 1 is mixed. Some users found the tutorial videos to be very good and comprehensive. However, there were requests for more variations in examples and a step-by-step manual to accompany the videos. Users felt that the videos alone were not sufficient for individual use and that additional guidance was needed to successfully perform the calculations.

One user mentioned that the training videos covered the content well, but there was still a lot of work left for the user to fit the data from national energy certificates to SEPAP 1 and 2. Another user pointed out that the videos did not provide enough detail to follow the calculation steps precisely, potentially because the calculation was done in Method 2, which is used as input for Method 1.

There were also comments about the lack of important explanations in the training material, such as how to implement measured data files or the need to match dates of metered data, analysis periods, and invoices. Users expressed the need for complete information, including the required file formats and common errors.

However, it's worth noting that some users mentioned that the training became easier after a Q&A session, indicating that additional support or clarification sessions were beneficial. Overall, the feedback suggests that while the tutorial videos were appreciated, there is a demand for more detailed instructions and supplementary materials to enhance the learning experience.

3.4.1.2. Data collection

- Consent from occupants: Collecting data on indoor temperature has required consent from the occupants of the building in accordance with the GDPR. Obtaining this consent can be a challenge as not all occupants may be willing to provide it.
- Availability of data: The data required, such as energy consumption data per energy carrier and temperature, may be scattered and not readily available. This can make it difficult to gather the necessary information for analysis.
- Format of data: Creating files in the correct format, such as TiTe (indoor and outdoor temperature) and GHIall (radiation data), can be challenging. It requires technical expertise to ensure the data is organized and structured appropriately for analysis.
- Weather data availability: Access to actual annual weather data, including radiation and outdoor temperature, can be problematic if there is no accessible weather station nearby. This lack of weather data can limit the accuracy of the analysis.
- Measurement of indoor temperature: Obtaining actual indoor temperature measurements can be problematic, especially if there is no pre-existing system in place to record this data. While consent may have been obtained in the ePANACEA case studies, it is not always easy to acquire such measurements.
- Energy demand data: Collecting data regarding the energy demand of the building's services can be challenging. If the data is not readily available, technicians may need to calculate and collect the data manually. This process can be time-consuming and may require additional efforts.

- Communication and site visits: Effectively communicating with the maintenance responsible person(s) and conducting comprehensive discussions are necessary to gather accurate data. This process often involves site visits and direct interactions, which can add complexity to the data collection process.

Overall, the data collection process for Method 1 can be hindered by consent requirements, data availability and organization, weather data limitations, and the need for accurate energy demand information. These challenges can require additional efforts and resources to overcome during the testing process.

3.4.1.3. Input parameters

Overall, the feedback from the testing process of Method 1 highlights several potential improvements related to the input parameters. These include:

- Adding clear default schedules: The current schedules provided are either too detailed or not compliant with the required format. Clear and standardized default schedules should be included.
- Improving the approach to insert data into the upload files: The method of inserting data, such as TiTe (possibly related to temperature), needs improvement. The exact issues or suggestions for improvement are not specified.
- Adding more default values based on the building characteristic: The input parameters should include additional default values that are based on the specific characteristics of the building. This would help in providing more accurate and realistic results.
- Including outdoor and indoor hourly time series: The upload files should include outdoor and indoor hourly time series data. This would likely provide more accurate and detailed information for the analysis.

Furthermore, there is a recurring mention of the need for measured data. It is emphasized that having measured data is crucial, but the specific details or reasons for this requirement are not provided.

In summary, the comments highlight the need for clearer definitions of input parameters, the inclusion of appropriate default values and schedules, improvements in data insertion methods, and the importance of using measured data for accurate analysis.

3.4.1.4. Output parameters

- Clarification Needed: It is suggested that the output parameters should specify whether they concern kWh and whether they refer to final or primary energy. Additionally, it is recommended that the output should be further processed into the Energy Performance Certificate (EPC) template as developed in ePANACEA.
- Units and Acronyms: The comments emphasize the need to explain the units used in the output, as well as clarify the acronyms used in the tool. For example, the acronym "EU" should be clarified as energy usage.
- Visualization and Export: Some users suggest that it would be helpful to have a chart of the results directly in Method 1 or the ability to export/copy the results to an Excel or CSV file.
- Intended Use and Validation: The intended use of the results is questioned, and it is suggested that the fitting of the results to the original energy certificate was done through trial and error. The need for validating the results against real-world data is highlighted.
- Heating and Cooling Outputs: Users point out that there are no heating and cooling outputs available in the same project/model. Heating values for the entire year are provided, but cooling values are only available for months other than January and February.
- Comparison with M2 Results: It is mentioned that the correlation between the results of Method 1 (M1) and Method 2 (M2) should be established, and the specific values that can be compared should be identified.

- Discrepancies in Analysis Period: Users highlight that the analysis period does not match the date of the measured data, and the period of the bills entered also does not correspond to the measured data period. This discrepancy leads to incorrect calculations and data aggregation.
- Excessive Cooling Results: It is mentioned that the cooling results are excessively high, indicating a potential issue with the calculations or input data.
- Limited Scope of Results: The results are noted to only point to the value for a standardized certificate, indicating a need for more comprehensive and context-specific information.

Overall, the feedback comments highlight the need for improved clarification of units and acronyms, better visualization and export options, validation against real-world data, inclusion of heating and cooling outputs, addressing technical issues, ensuring consistency in the analysis period, and providing more comprehensive and context-specific results.

3.4.1.5. User friendliness and design

The feedback from the testing process of Method 1 indicates mixed opinions about its user-friendliness and design. Overall, it is considered good and clear, but there are several areas for potential improvement.

One common suggestion is to make a clear distinction between the input needed for Method 1 and Method 2, as well as for both methods. Users also mentioned that the language settings sometimes retain Spanish persistently when English is requested.

Specific improvements suggested include allowing user-defined input in Tab 8, particularly in the subtab Energy Needs, Default Schedules, DHW boiler, District heating, and Upload file composition. Additionally, the option for district heating is missing from the Facility -> HVAC selection.

Some users found the process of filling data complicated due to the menus and drop-down options. They suggested that having a visually appealing dashboard with tables or files/templates with a dedicated API for data transfer could simplify the filling procedure.

Other feedback included the need for clearer instructions on how to define heating with district heating and cooling, the importance of saving modifications or providing a warning when changing sheets, the slow process of adding energy bill data one by one, and the difficulty in debugging schedules that have cumulative effects on the results.

Multiple users mentioned that the HVAC system selection for a specific project should be more clear and user-friendly. Additionally, there was a complaint that although photovoltaic production data is entered, it does not appear in the results.

In summary, the feedback highlights the need for improvements in distinguishing input requirements, language settings, district heating options, user-defined input, visualization of data, and the clarity of HVAC system selection.

3.4.2. Feedback Method 2

3.4.2.1. Training and Training material

Method 2 had an average training period of 6,8h and it could be seen that the training need for different building types did not vary a lot. Also, the size of the building did not higher or lower the training needs.

Feedback about the provided training materials:

- The tutorial video is generally considered very good.
- One improvement suggestion is to add an explanation of the power loss and other related aspects in the "Other equipment" tab.
- More variations in examples are desired to enhance understanding.

- It is recommended to provide step-by-step instructions or a manual that covers all the necessary steps in detail, including the addition of windows and minimum requirements.
- The video lacked sufficient detail for users to successfully follow along and perform the calculations, such as adding windows and understanding the building envelope.
- Some users mentioned that the material is not presented in a professional documentation format, but it is relatively comprehensive.
- It is requested to provide a case study from start to finish to illustrate the application of the method.
- Users would like more explanation about the required input and a deeper understanding of the calculations and steps involved.

Overall, the feedback suggests a need for clearer explanations, more comprehensive documentation, and additional examples to enhance the training material for Method 2.

3.4.2.2. Data collection

- Communication and site visits: Data collection involves email/phone communication and site visits to gather the required information.
- Detailed inputs and information: The data collection process requires a significant amount of detailed inputs regarding the thermal envelope of the building, its thermal installations, lighting, equipment, and other relevant factors.
- Schedules: Gathering schedules related to energy consumption and other relevant factors can be challenging, and the default schedules provided by national building codes may not be sufficient. This requires additional effort to collect accurate schedules.
- Interface usability: The interface used for data collection may not always be intuitive or user-friendly, adding to the difficulties faced during the process.

Overall, the data collection process for Method 2 involves overcoming various challenges related to data availability, consent, organization, communication, detailed inputs, schedules, interface usability, and data format compatibility.

3.4.2.3. Input parameters

The feedback received during the testing process of Method 2 primarily emphasizes two key points: the importance of adding clear default schedules and the need for measured data.

Multiple comments were made regarding the inclusion of clear default schedules. It appears that there is a strong consensus among the testers that such schedules should be added to the method. The repetition of this comment three times suggests that it is considered a significant issue that requires attention.

Another recurring comment relates to the need for measured data. Testers seem to agree that the method should incorporate actual data for accurate and reliable results. This comment is also reiterated three times, indicating its importance.

Based on the provided feedback, it is evident that addressing these concerns regarding clear default schedules and the inclusion of measured data will be crucial for improving Method 2 during the testing process.

3.4.2.4. Output parameters

- The link to the EPBD board is appreciated, but more effort is needed in translating it to English.
- Some additional explanation should be provided that can be accessed on demand.
- The intended use of the results needs clarification, particularly if they are not meant for an Energy Performance Certificate (EPC).
- There is confusion about the discrepancy between energy consumption and fuel consumption in Method 1.

- The ability to copy the output to Excel is appreciated, but it would be more useful to have direct visualization within Method 2 itself.
- The units and short names used in the output need to be explained.
- There are questions about the translation of EPBD board outcomes and specific tabs related to energy needs and temperature.
- The correlation between results from Method 1 (M1) and Method 2 (M2) needs to be examined, and specific values that can be compared should be identified.

3.4.2.5. User friendliness and design

Overall, the feedback on the user-friendliness and design of Method 2 was mixed. Some potential improvements were suggested, such as adding the option for direct input of U-values of envelope components and the ability to insert windows in interior partitions vertically. It was also noted that the district heating option was missing.

Other comments mentioned specific issues with the interface, such as the inconsistency in saving mechanisms across different sheets and the difficulty in finding the "Add Window" button. The HVAC system selection for the specific project was deemed unclear and not user-friendly.

On a positive note, the geometry of the system and its similarity to the EPC (Energy Performance Certificate) calculation were not problematic. However, the scheduling aspect was challenging, and the interface was not always intuitive to use. The absence of the district heating option was mentioned multiple times as a drawback.

In summary, the feedback indicated a need for improvements in the user-friendliness and design of Method 2, particularly in relation to input options, HVAC system selection, saving mechanisms, and the visibility of certain features. Additionally, the absence of the district heating option was a recurring concern.

3.4.3. Feedback Method 3

3.4.3.1. Training and Training material

Method 3 had an average training period of 56h and it could be seen that the training need for different building types did not vary a lot. Also, the size of the building did not higher or lower the training needs.

- Multiple short videos with different examples are considered useful.
- Starting to use the tool without prior knowledge of SketchUp or OpenStudio is difficult.
- Some expertise on OpenStudio is needed to finalize the models.
- There is a need for a debugging manual and a course on how to use OpenStudio.
- More detailed information is required on what to do and how to debug unusual results.
- More details are needed on how to design the building and define the HVAC system.
- The documentation provided is of high quality but more complex compared to Methods 1 and 2 due to the complexity of the method itself.
- Lack of debugging information in the tutorial and the need for additional information when using different boundary conditions.
- No information on floor heating or other energy carriers besides gas explained in the tutorial.
- Request for an explanation of shading surfaces direction.

3.4.3.2. Data collection

- Geometry and Physical Data: The lack of information about the building's geometry and physical characteristics can difficult data gathering and implies lower accuracy for some output variables. This can include details about the thermal envelope, thermal installations, lighting, equipment, and other relevant aspects.
- Measured Energy Consumption: While energy consumption data is generally manageable to collect, there were instances where it was difficult to obtain consumption data for specific areas or cooling units within the building.
- Control Logic Information: Gathering information about the control logic, including setpoints and schedules, proved to be challenging. This aspect has a significant impact on the results but is hard to acquire.
- Detailed Schedules and User Behaviour: Obtaining detailed schedules and understanding user behaviour in an office building setting was difficult. This data is crucial for accurately assessing energy usage patterns and optimizing energy efficiency.
- Weather Data Availability and Cost: The availability of actual annual weather data, such as radiation and outdoor temperature, can be problematic if there is no accessible weather station nearby. Additionally, acquiring weather data may involve additional costs.
- Comprehensive Building Information: Detailed information about the building, including its thermal envelope, installations, lighting, equipment, and other relevant factors, can improve the accuracy of the results; however they can be challenging to collect.
- Energy Bills: The process of obtaining energy bills posed difficulties, especially when there was only one account or receipt for the entire field, including other buildings. This lack of granularity can make it challenging to separate and analyze energy consumption accurately.

Overall, the data collection process for Method 3 faced challenges in acquiring accurate and comprehensive information about the building's physical characteristics, control logic, user behaviour, and weather data.

3.4.3.3. Input parameters

- It would be helpful to have SI units as an option for utility bills, as it would make calculations easier. Currently, the use of therms as units is inconvenient.
- There were issues with importing existing ifc models, indicating that this functionality was missing or problematic.
- The availability of data was mentioned, but it was scattered and required email/phone communication and site visits to gather all the necessary information.
- Properly zoning the spaces is crucial for applying coherent improvement measures such as natural lighting controls. Accurate data on schedules, occupancy, and operation of the building is essential for pre-calibrating the model.
- There were repeated requests to use SI units throughout the process. Having to switch between two programs, Open Studio and SketchUp, and adding values multiple times was found to be annoying.

In summary, the feedback highlighted the need for improved automation of data extraction, the inclusion of SI units, better functionality for importing existing models, and streamlining the input process to enhance the user experience.

3.4.3.4. Output parameters

- Multiple errors occurred during the testing process, but they were resolved through communication.
- Units were sometimes missing in the parallel coordinate graph, suggesting a need for consistency.
- It was suggested to add thermal comfort as an output parameter.
- Sketchup frequently crashed, making debugging difficult.
- It was proposed to use kWh units instead of therms used in the billing tab of Open Studio
- Many errors were encountered, indicating the need for improvements.
- No outputs were generated by some partners because testing was not finished yet.
- The method was considered useful for decision-making in energy-efficient building retrofitting.
- Adjusting calendars and loads based on occupants' behaviors was identified as an important aspect.
- The output from the Open Studio process was clear, but the parametric analysis output depended heavily on the schedules used, which were often estimations. This lack of certainty on actual operational condicitos can lead to a challenging calibration procedure.
- Gathering retrospective user behavior data was difficult, particularly for addressing unexpected consumption peaks in winter.

3.4.3.5. User friendliness and design

- Templates: Several comments suggest that templates could be provided to assist users in filling out the necessary information.
- Missing district heating option: Users pointed out that the district heating option was absent, which is a significant limitation.
- Confusion and complexity: Users found the process confusing due to the many steps and input forms involved. They also mentioned that switching between the OpenStudio and SEPAP tools was not intuitive.
- Unclear tabs in the RUN: Users expressed confusion about which tabs in the RUN section should be filled in, indicating a lack of clarity.
- Knowledge requirement: Method 3 was considered more detailed than Methods 1 and 2, requiring users to have knowledge of building energy modelling for accurate input introduction.
- Issues with specific systems: Biomass and district heating were reported as not functioning properly. Users also found floor heating to be complicated and often not working as expected.

- OpenStudio complexity: The HVAC system in Method 3 was described as complex, requiring a significant amount of knowledge and time in OpenStudio, the modelling tool being used.

In summary, the feedback suggests that Method 3 has usability and design issues, including a lack of templates, confusion in filling out input forms, missing options, and complexity in handling specific systems. Improvements in user guidance, simplification of the process, and addressing the issues with specific features would enhance the user-friendliness of Method 3.

3.4.4. Comparison between the Methods

3.4.4.1. Training period and knowledge

It could be seen that average hours for training are almost the same in Method 1 and 2 and differ a lot compared to M3 where almost 7 times higher values are reported. That indicates the complexity of Method 3 compared to the other ones. The training need dependent on building type is for all tested building types almost the same except in Method 3 three where residential buildings seem to have less training need than the non-residential buildings. Compared to the traditional EPC the training effort is almost the same as Method 1 and Method 2 need. (Figure 6)

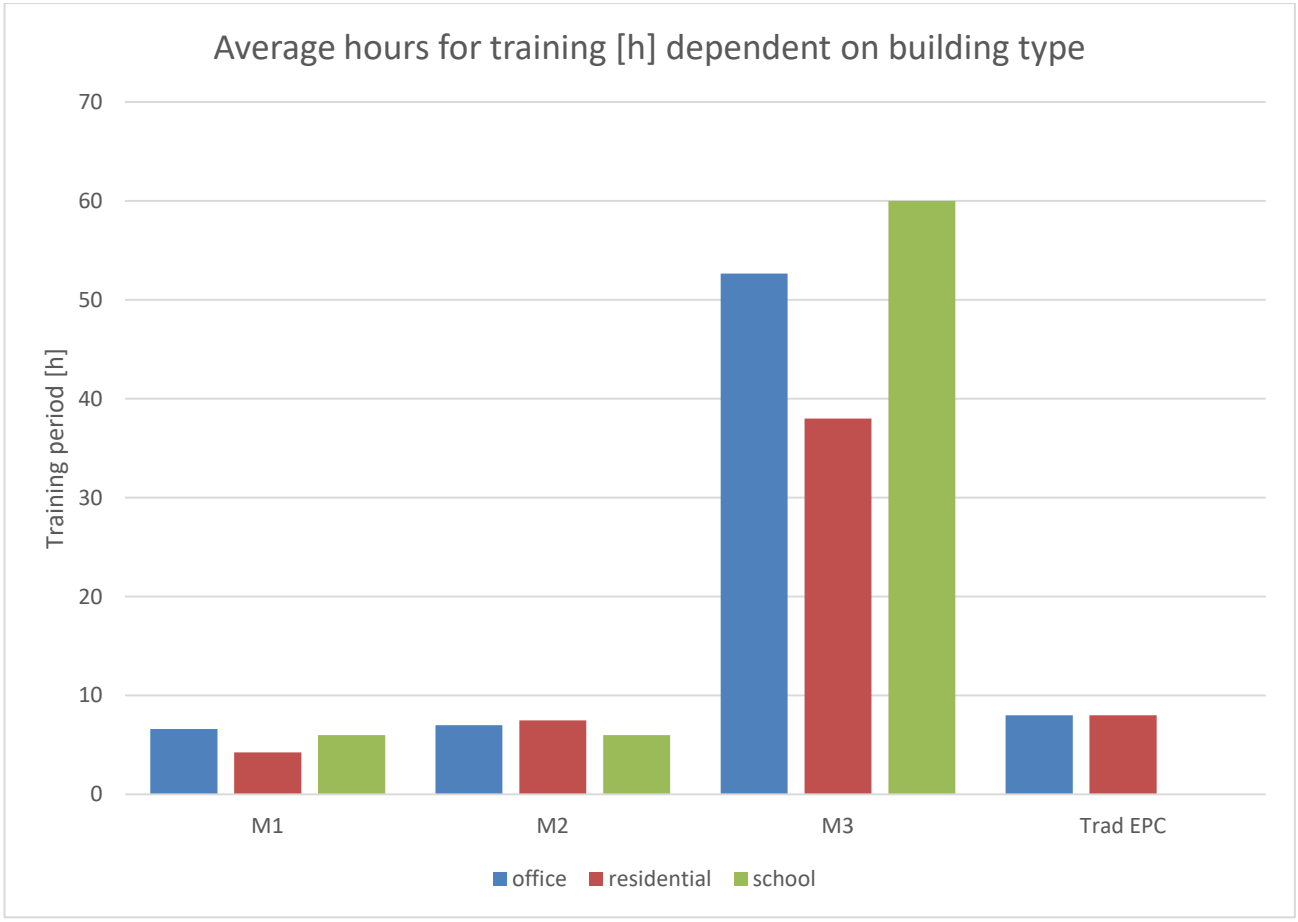

Figure 6: Average hours for training [h] dependent on building type

Regarding the learning curve effects it could be seen that the traditional EPC is rated best followed by Method 1 and Method 3. In general, all Methods have almost the same learning effects. The learning curve is a value between 1 [low] and 5 [high] and was given directly by the test persons of the methods. (Figure 7)

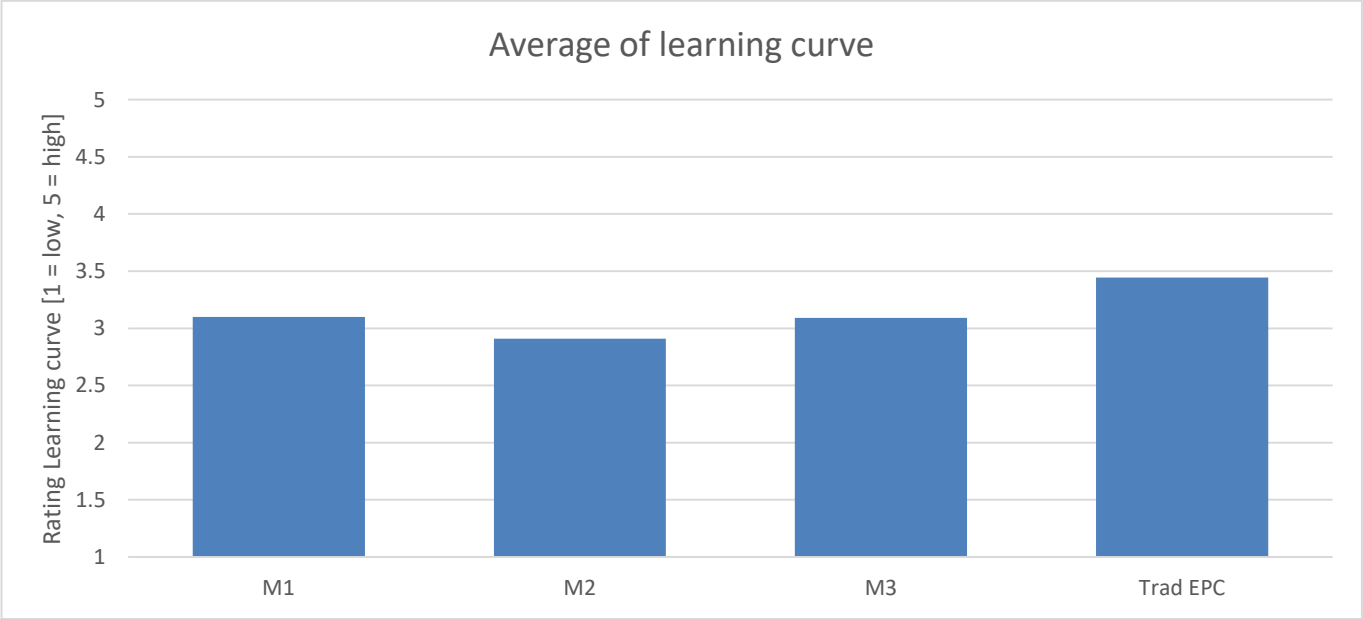

Figure 7: Average of learning curve [Rating 1 = low - 5 = high]

It can be also seen that the person that deals with the methods should in method 3 and the traditional EPC be educated at least on EQF level 6. One example of a profession in the building sector that calculates energy performance certificates and requires an education equivalent to EQF level 6 is a Building Energy Assessor or Energy Consultant. For the other methods EQF 5 is the minimum requirement. (Figure 8)

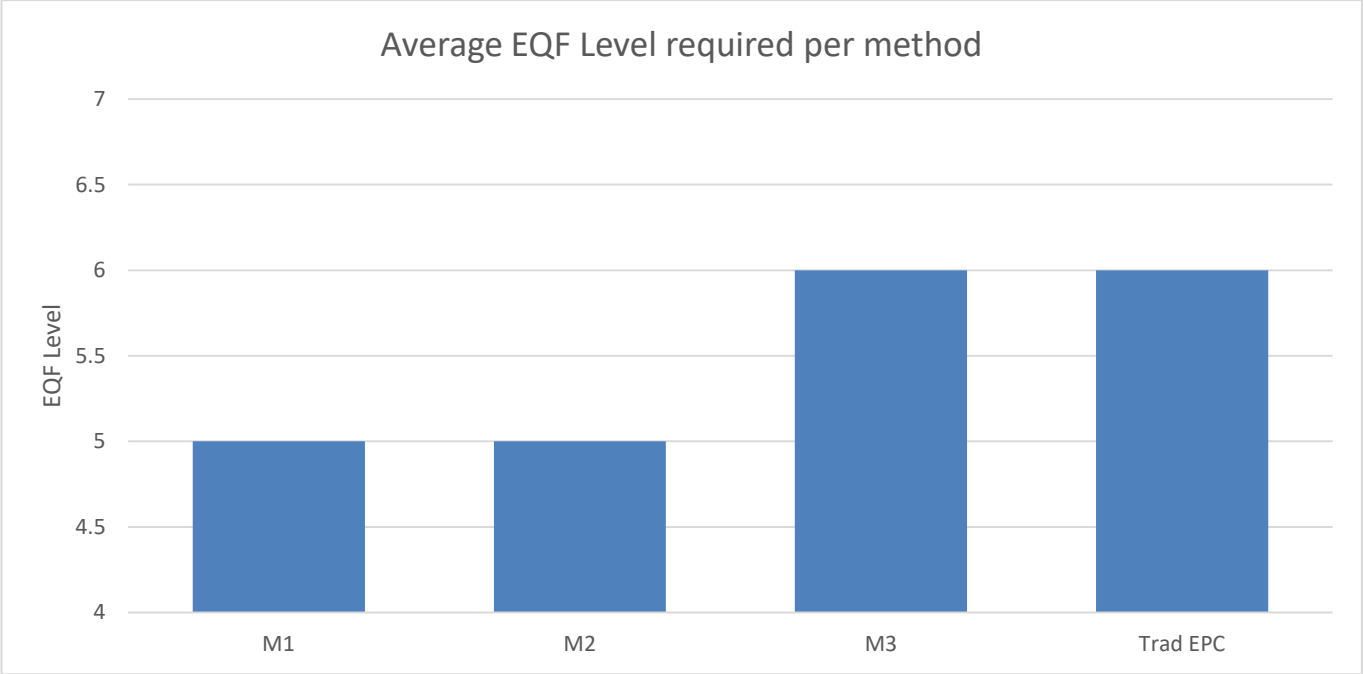

Figure 8: Average EQF Level required per method

3.4.4.2. Data gathering effort

It could be seen that the effort for data collection was the highest number in Method 3 followed by Method 2. (Figure 9) The building size had no linear influence on the time to collect calculation data. That means in that the data collecting effort is not dependent on building size and typology and more on data availability in general. (Figure 10)

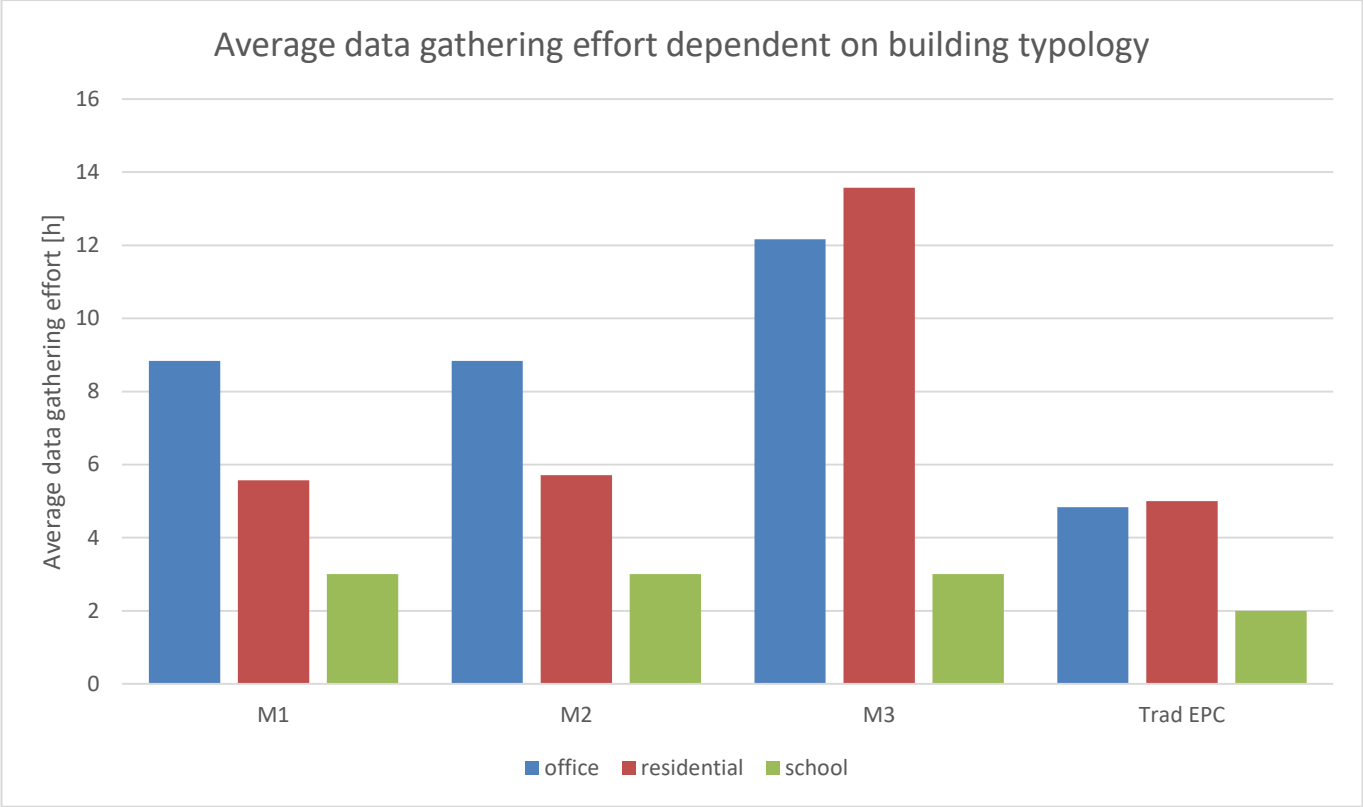

Figure 9: Average data gathering effort dependent on building typology.

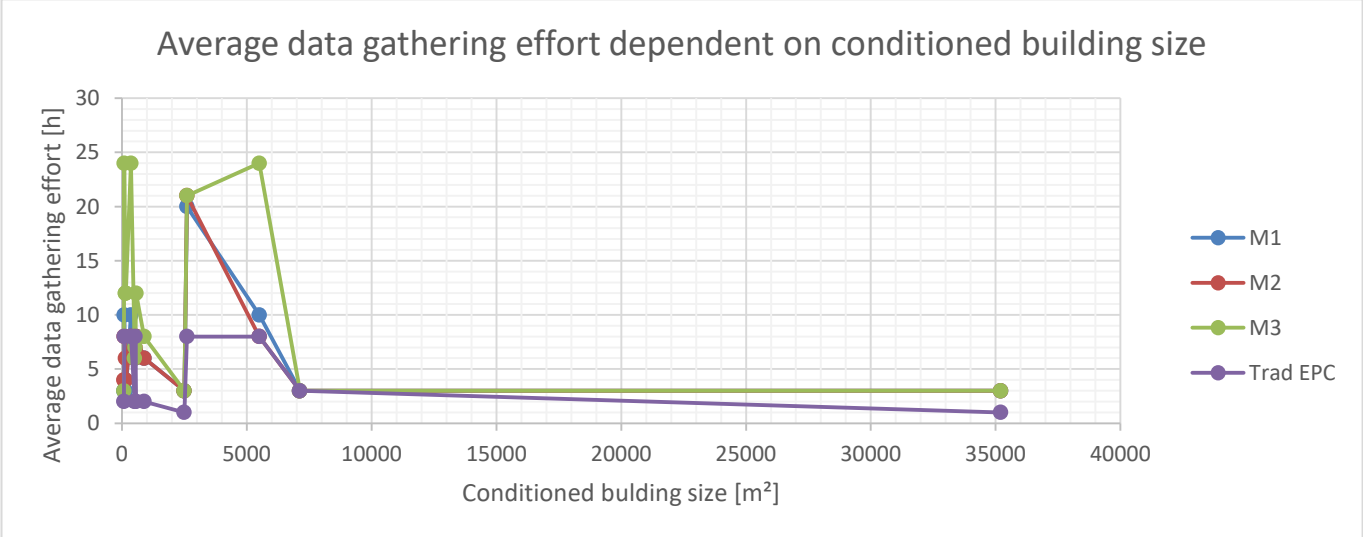

Figure 10: Data gathering effort dependent on conditioned building size

3.4.4.3. Output Comparison

It was seen that Method 3 has a very high effort to the use that can be gathered from the output variables. So it is time consuming but the output is valuable. This is also underpinned by the highest rating for the usability. Method 1 and Method 2 got almost the same ranking and it can be seen that the traditional EPC is probably the Method with the least effort compared to results. (Figure 11)

If we look at the plausibilitsy of the output it was seen that the output values from Method 1 and Method 3 seem to be the most plausible ones with a rating of average 3,25 that represents a medium ranking. Method 2 and the traditional EPC got a ranking around 2,7 which is below medium. So the ePANACEA methods perform slightly better than the traditional EPC methods. (Figure 12)

If we compare the usability of the output data all methods got in average around medium rating and Method 3 was rated best in usability. (Figure 13)

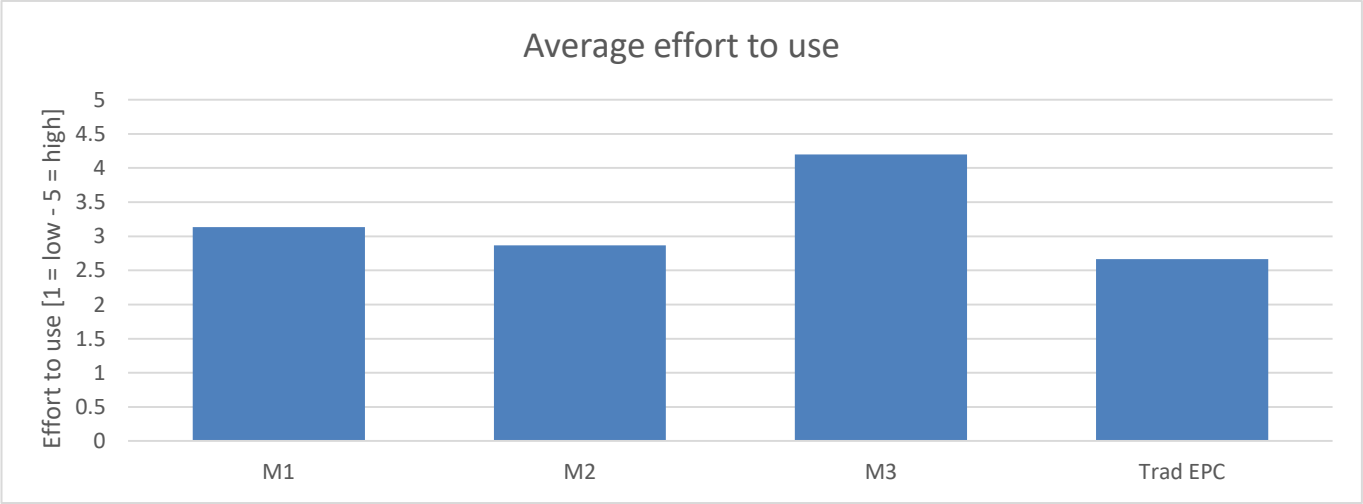

Figure 11: Average effort to use [Rating 1 = low - 5 = high]

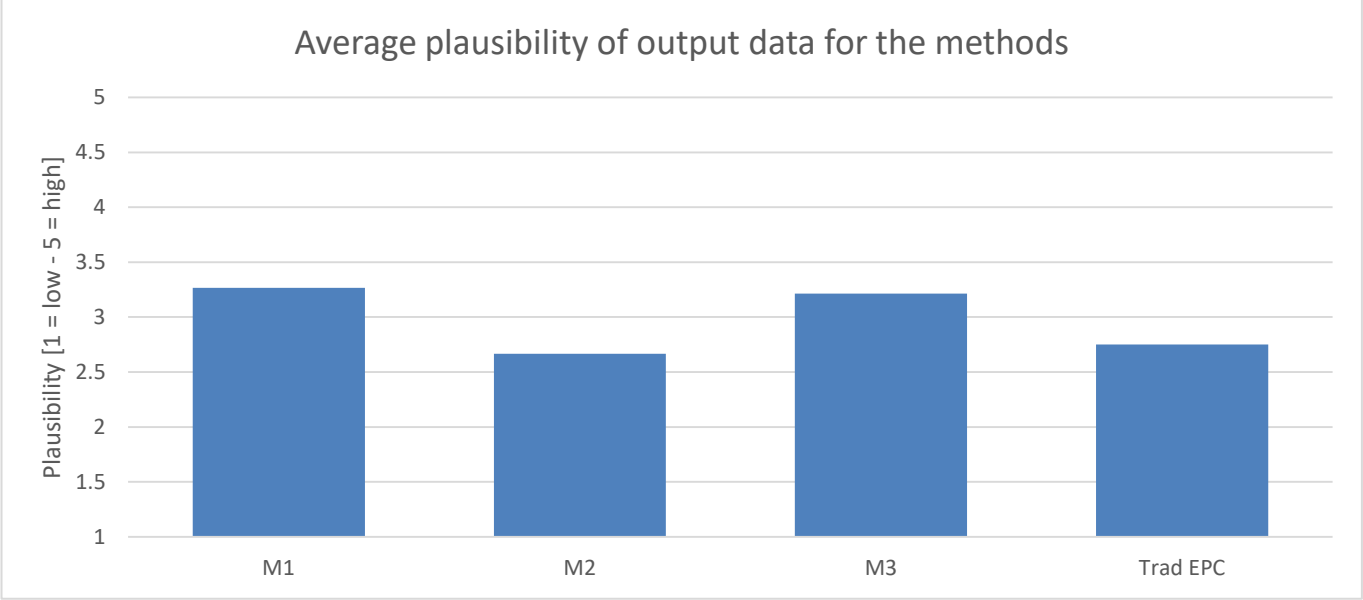

Figure 12: Average plausibility of output data

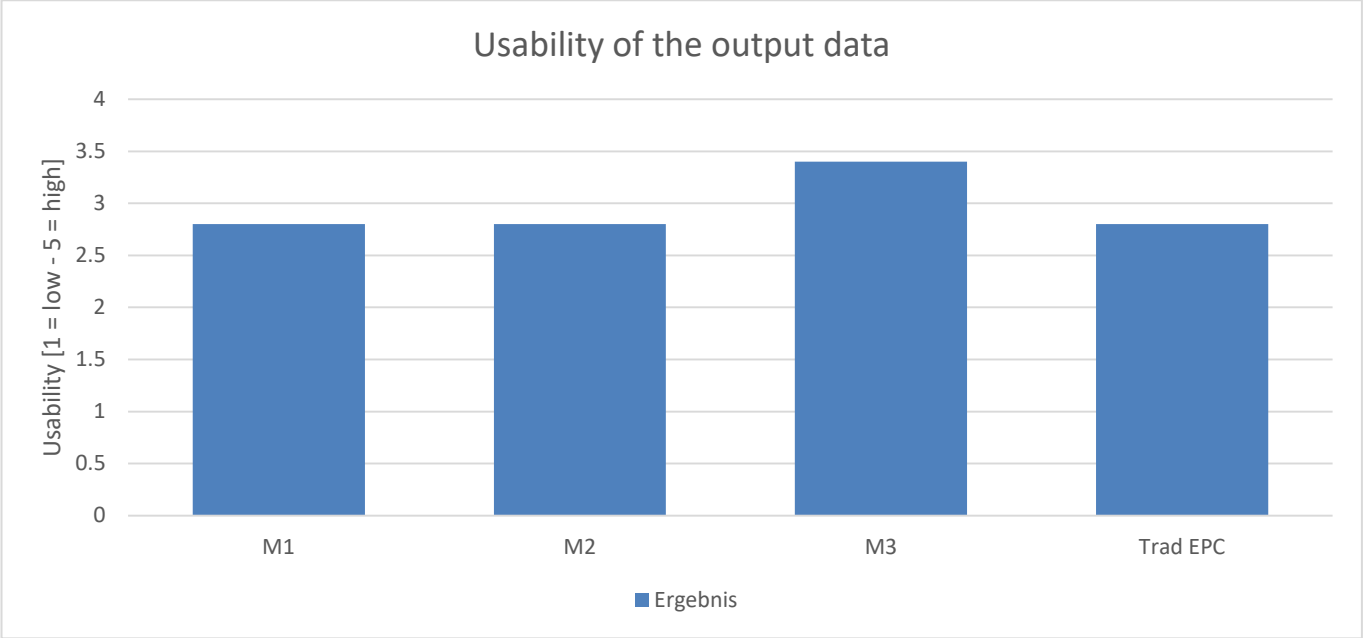

Figure 13: Usability of the output data

4. ANNEX

4.1. Data collection of 15 ePANACEA Case Studies

		Austria			Belgium			Finland			Greece			Spain		
		AT-01	**AT-02**	**AT-03**	**BE-01**	**BE-02**	**BE-03**	**FI-01**	**FI-02**	**FI-03**	**GR-01**	**GR-02**	**GR-03**	**SP-01**	**SP-02**	**SP-03**
Reference name								KYMP	Porvoo	Keinutie	GR_Residential-2	APE_v08	GR-03_V05	**Public office**	**SFH**	**apartment**
General information																
Typology	use	residential	office	office	residential	residential	residential	office	school	school	residential	office	office	*office*	*residential*	*residential*
Usefull floor area	m2	880	564	505	137	107	146.9	35213	2490	7123	75	527,05	2599,3	5500	355	90
Conditioned floor area	m2	880	564	505	137	99	146.9	35213	2490	7123	75	527,05	2599,3	5500	173	90
storeys	#	2	2	2	2	1	3	7	2	2	1	3	7	7+garage	3	1
Occupancy	#P	24	20	12	4	3	2 adults + baby	1500	180	620	4	16	190	230	5	3
Use Schedule		24h	12	12	24	24	24	12	12	12	24h	9h	8h	12h	24h	24h
Bills								24.7	24.7	24.7						
Annual electricity use	kWh	15 245	59295	33919	3000	1699	1359	2507633	336052	290286	4000,76	47510,6	163480	477 385,00	4286	2177,5
Annual gas use	kWh		40117		15000	5797	7432	-	-	-	-	-	63100	466 882,00	15469	2219
Annual DH use	kWh				N.A.	N.A.	N.A.	3776550	448600	783400	-	-	-	-		
Annual biomass use	kWh	59759,75		54156	N.A.	N.A.	N.A.	-	-	-	-	-	-	-		
Annual oil use	kWh				N.A.	N.A.	N.A.	-	-	-	7688,4	-	-	-		
Annual other fuel use	kWh				N.A.	N.A.	N.A.	DistrictCooling: 1241700	-	-	-	-	-	-		
Energy use for heating+DHW	**US therms**	2039,58	1369,18	1848,33	511,95	197,85	253,65	128892,49	15310,58	26737,20	262,40	0,00	2153,58	15934,54	527,95	75,73
HVAC																
Availability schedule		Residential Living	Office	Office + Weekend	Residential	Residential	Residential	heating always on	heating always on	heating always on				6:30h-20:00h		
DHW needs	l/day	1000	60	60	100	60	70	9980,066131	3701,13368	1293,811998						
Energy needs	H or H/C	H	H C	H	H	H	H	H/C	H	H	H/C	H/C	H/C	H/C	H/C	H

Total Heating capacity	kW	37,5	25	40	4,5	4,3	5,8	352,13	37,35	106,845	4	1st floor HP: 24,3, Ground floor HP: 21, Underground floor HP:35.2	350	328	35	
Heating generation	type	Central boiler	Condensting boiler	Central boiler	Central boiler	Central boiler	Central boiler	District heating	District heating	District heating	Central boiler	3 heat pumps (one HP per floor)	central boiler	4 x gas boiler	Gas boiler	2 x central boilers
Heating fuel		biomass	gas	biomass	Natural gas	Natural gas	Natural gas	District heating	District heating	District heating	diesel	electricity	Natural gas	Natural gas	Natural gas	DH/Natural gas
Heating setpoint	ºC	22	22	20	20	20	20	21	21	21	21	21	21	22	22	21
Economy heating setpoint??	ºC													-	17	17
Heat emission system	description	floor heating	floor heating/ fan coil	floor heating	Radiators	Radiators	Radiators	Hydronic ceiling radiative heat distribution	radiators	radiators	radiators	fan coils	radiators	4P-fancoil units	radiators	radiators
Total Cooling capacity	kW		45,3		N.A.	N.A.	N.A.	228773 kwh/y, 6 kw/m2/y	N.A.	N.A.	3,5	1st floor HP: 24,3, Ground floor HP: 17,7, Under ground HP: 35.2	Ground floor chiller: 61, 1st-2nd floor HP: 125, 3rd-4thfloor HP: 125, 5th floor, split units: 9	350		-
Cooling generation	type		HP		N.A.	N.A.	N.A.	District cooling	N.A.	N.A.	split unit	3 heat pumps (one HP per floor)	heat pumps, split units (as described in cell N28)	1 x Chiller		
Cooling fuel			electricity		N.A.	N.A.	N.A.	District cooling	N.A.	N.A.	electricity	electricity	electricity	Electricity	Electricity	-
Cooling setpoint	ºC		25		N.A.	N.A.	N.A.	26	N.A.	N.A.	26	26	26	25		
Cooling emission system	description		fan coil		N.A.	N.A.	N.A.	Hydronic ceiling radiative cool distribution	N.A.	N.A.	split unit	fan coils	split unit	4P-fancoil units		
Mechanical ventilation	Y or N		Y		N	N	N	Y	Y	Y	N	N	N	Y	N	Y
Air flow rate	m3/h		6,5 m³/h		N.A.	N.A.	N.A.	325332	30060	25596	-	-	-	20 000,00	-	
Heat recovery	Y or N		Y		N	N	N	Y: 78%	Y:82%	Y: 80%	N	N	N	Y	-	N
Lighting																
Power (mean peak)	kW							200	34,7	54,8	0,29	4,6	27,8	44		
Daylighting control	Y or N	n	n	n	N	N	N	y	n	n	N	N	N	Y	N	N
PV installation	Y or N				N	N	N									
PV power	kW				0	0	0									
Model																
Weather file for calibration		GRAZ 2020	HARTBERG 2020	GRAZ 2020	BEL_Sint.Katelijne.Waver_2019.epw	BEL_Sint.Katelijne.Waver_2019.epw	BEL_Melle_2019.epw	Helsinki Kumpula 2021	Helsinki Kumpula 2021	Helsinki Kumpula 2021	GRC_Athens_2019.epw	GRC_Athens_2019.epw	GRC_Athens_2019.epw	ESP_Pamplona_UPNA_2021.epw	ESP_Pamplona_UPNA_2021.epw	ESP_Pamplona_UPNA_2022.epw
Year for calibration		2020	2020	2020	2019	2019	2019	2021	2021	2021	2019	2019	2019	2021	2021	2022
floor area	m2	880	564	505	141	107	147.37	39404,43	2978	6172,56	85	527,05	2599,3	5466	355	116,82

Conditioned floor area	m2	880	564	505	141	97	147.37	39404,43	2978	6172,56	75	527,05	2599,3	5466	172,67	92,42
Thermal zones	number	12	3	2	12	7	5	14	12	6	2	7	13	43	14	9
Conditioned thermal zones	number	12	3	2	8	6	4	14	12	6	1	5	11	42	12	8
number zones contribution to reference size	number	12	3	2	10	6	4	14	12	6	2	7	13		12	

4.2. Assessment Template Training

Case Nr	Method	Typology	Conditioned floor area [m²]	Training period total [h]	Training on your own [h]	Training with expert supervision [h]	Learning curve	Quality of training material/tools	Recommendations for training materials/tools
BE-01	M1	residential	137	n.a.	n.a.	n.a.	n.a.	5	Very good tutorial videos!
BE-01	M2	residential	137	2	0	0	5	5	Very good tutorial video. Only one remark for improvement: add explanation of below part (on power loss etc…) in tab Other equipment
BE-01	M3	residential	137	8	12	0	2	4	Multiple short video of different examples can be useful
BE-01	Trad EPC	residential	137						
BE-02-3C	M1	residential	147	n.a.	n.a.	n.a.	n.a.	5	Very good tutorial videos!

BE-02-3C	M2	residential	147	2	0	0	2	5	Very good tutorial video. Only one remark for improvement: add explanation of below part (on power loss etc…) in tab Other equipment
BE-02-3C	M3	residential	147	8	8	0	2	3	Multiple short video of different examples can be useful
BE-02-3C	Trad EPC	residential	147						
BE-03	M1	residential	147	n.a.	n.a.	n.a.	n.a.	n.a.	More variations in examples
BE-03	M2	residential	147	2	0	0	2	n.a.	More variations in examples
BE-03	M3	residential	147	8	4	0	2	3	Multiple short video of different examples can be usefull
BE-03	Trad EPC	residential	147						
FI-01	M1	office	35213	6	5	1	4	3	· A lot easier after the QA-session.

FI-01	M2	office	35213	6	5	1	4	3	· Same as in method 1. All steps should be explained. E.g. Adding windows · When following the training video, there could be explained a full minimum input that is needed. Now it was a bit confusing, that no building envelope was described, and with such model the method did not calculate anything
FI-01	M3	office	35213	60	a lot	a lot	2	2	· Starting to use the tool is not so easy when no prior knowledge of sketchup or open studio · A lot knowledge on open studio needed to finalize the models
FI-01	Trad EPC	office	35213	0 * Of course there is long learning curve for the software, but it is not used only for the EPC.	0	0	4	5	EPC calculation shouldn't be separated from the real life energy management tools which have the best possible models.

FI-02	M1	school	2490	6	5	1	4	3	Step –by-step manual needed. The videos were not enough for first / individual use. The training videos (1 and 2) were very comprehensive in the presented content. However, there remains a lot remaining work for user for fitting the data from national energy certificate to the SEPAP 1 and 2.
FI-02	M2	school	2490	6	5	1	4	3	see M1
FI-02	M3	school	2490	60	A lot	A lot	2	2	Debugging manual needed. Course how to use open studio.

FI-02	Trad EPC	school	2490	*			4	5	
FI-03	M1	school	7123	6	5	1	4	3	· A step by step manual would be nice. The video did not present all steps in so detail that by just following them the calculation would work, however it is probably because the calculation is done in method 2 for the input of this method

FI-03	M2	school	7123	6	5	1	4	3	· A step by step manual would be nice. The video did not present all steps in so detail that by just following them the calculation would work e.g. how to add windows and what is the minimum requirement
FI-03	M3	school	7123	60	a lot	a lot	2	2	Quite much more detailed information on what to do and how to debug odd looking results needed
FI-03	Trad EPC	school	7123	*	*	*	4	5	
GR-01	M1	residential	75	5	2	0	3	4	-
GR-01	M2	residential	75	6	3	0	3	4	-
GR-01	M3	residential	75	20	8	10	4	3	More details how to design the building and how to define the HVAC
GR-01	Trad EPC	residential	75	-	15	8	3	3	Training programmes should be carried out

GR-02	M1	office	527	6	3	0	3	4	-
GR-02	M2	office	527	6	2+1	0	3	4	-
GR-02	M3	office	527	20	9	10	4	3	More details how to design the building and how to define the HVAC
GR-02	Trad EPC	office	527	-	15	8	4	3	Training programmes should be carried out
GR-03	M1	office	2599	6	3	0	3	4	-
GR-03	M2	office	2599	6	2+1	0	3	4	-
GR-03	M3	office	2599	20	9	10	4	3	More details how to design the building and how to define the HVAC
GR-03	Trad EPC	office	2599	-	15	8	3	3	Training programmes should be carried out

SP-01	M1	office	5500	1	8	1	2	1	The training material is rather poor and does not explain key issues such as how to implement measured data files or the need to match the dates of the metered data, the analysis period and the invoices entered. Complete the information with the files needed for the calculation, how to create them (what format they should be in) or frequent errors.
SP-01	M2	office	5500	8	16	2	2	3	Medium, it is not professional documentation but it is quite complete. Include a case study from start to finish
SP-01	M3	office	5500	16	32	10	4	4	High quality documentation, although more complex than in methods 1 and 2 because the method itself is more complex.
SP-01	Trad EPC	office	5500	8	16	2	2	5	High quality documentation because it is a national method
SP-02	M1	residential	355	1	8	1	2	1	The training material is rather poor and does not explain key issues such as how to implement measured data files or the need to match the dates of the metered data, the analysis period

									and the invoices entered. Complete the information with the files needed for the calculation, how to create them (what format they should be in) or frequent errors.
SP-02	M2	residential	355	8	16	2	2	3	Medium, it is not professional documentation but it is quite complete. Include a case study from start to finish
SP-02	M3	residential	355	16	32	10	4	4	High quality documentation, although more complex than in methods 1 and 2 because the method itself is more complex.
SP-02	Trad EPC	residential	355	8	16	2	2	5	High quality documentation because it is a national method
SP-03	M1	residential	90	1	8	1	2	1	The training material is rather poor and does not explain key issues such as how to implement measured data files or the need to match the dates of the metered data, the analysis period and the invoices entered. Complete the information with the files needed for the calculation, how to create them (what format they should be in) or frequent errors.
SP-03	M2	residential	90	8	16	2	2	3	Medium, it is not professional documentation but it is quite complete. Include a case study from start to finish
SP-03	M3	residential	90	16	32	10	4	4	High quality documentation, although more complex than in methods 1 and 2 because the method itself is more complex.
SP-03	Trad EPC	residential	90	8	16	2	2	5	High quality documentation because it is a national method

AT-0	M1	residential	880	10	6	4	4	2	· A lot easier after the QA-session.
AT-01	M2	residential	880	8	5	3	4	2	Explanation was provided on an example. Please explain needed input and more detail what is behind the calculation. Please explain more steps.
AT-01	M3	residential	880	100	80	20	2	3	No debug information. Method in tutorial is explained on a case. If other boundary conditions have to be used lot of questions and additional information is needed!
AT-01	Trad EPC	residential	880	n.a.	n.a.	n.a.	5	5	Good training materials provided by the software developers. A guide for assistance in calculation of EPC is also available
AT-02	M1	office	564	10	6	4	4	2	· A step by step manual would be nice. The video did not present all steps in so detail that by just following them the calculation would work, however it is probably because the calculation is done in method 2 for the input of this method
AT-02	M2	office	564	8	5	3	4	2	Explanation was provided on an example. Please explain needed input and more detail what is behind the calculation. Please explain more steps.

AT-02	M3	office	564	100	80	20	2	3	No debug information. Method in tutorial is explained on a case. If other boundary conditions have to be used lot of questions and additional information is needed! No floor heating in tutorial or other energy carrier besides gas explained
AT-02	Trad EPC	office	564	n.a.	n.a.	n.a.	5	5	Good training materials provided by the software developers. A guide for assistance in calculation of EPC is also available
AT-03	M1	office	505	10	6	4	4	2	· A step by step manual would be nice. The video did not present all steps in so detail that by just following them the calculation would work, however it is probably because the calculation is done in method 2 for the input of this method
AT-03	M2	office	505	8	5	3	4	2	Explanation was provided on an example. Please explain needed input and more detail what is behind the calculation. Please explain more steps.
AT-03	M3	office	505	100	80	20	2	3	Shading surfaces direction explanation.
AT-03	Trad EPC	office	505	n.a.	n.a.	n.a.	5	5	good training materials provided by the software developers. A guide for assistance in calculation of EPC is also available

4.3. Assessment Template Data Gathering

Case Nr2	Method3	Typology4	Conditioned floor area [m²]5	Data gathering effort	Difficulty to gather input data	Describe difficult data to collect	Comments to the input parameters
BE-01	M1	residential	137	4	1	Measured energy consumption data per energy carrier (from meter or – most likely – from billing) and outdoor and indoor temperature (also requires consent from occupants).	Potential improvements: Add clear default schedules. Improve approach to insert data into the upload files, such as TiTe. Only one remark for improvement: Attention: Use of schedule for Cooling 'Always 0' may be wrong as it does not comply to the format (should be temperature between 0°C and 100°C)
BE-01	M2	residential	137	6	1	Measured energy consumption data per energy carrier (from meter or – most likely – from billing) and outdoor and indoor temperature (also requires consent from occupants).	Add clear default schedules
BE-01	M3	residential	137	12	5	Geometry, physical data not available, Measured energy consumption	Adding templates
BE-01	Trad EPC	residential	137				
BE-02-3C	M1	residential	147	4	1	Measured energy consumption data per energy carrier (from meter or – most likely – from billing) and TiTe (also requires consent from occupants). Workaround for Ti in this case fixed value of 18°C.	Potential improvements: Add clear default schedules. Improve approach to insert data into the upload files, such as TiTe.

BE-02-3C	M2	residential	147	6	1	Measured energy consumption data per energy carrier (from meter or – most likely – from billing) and outdoor and indoor temperature (also requires consent from occupants).	Add clear default schedules
BE-02-3C	M3	residential	147	12	5	Geometry, physical data not available, Measured energy consumption	Adding templates
BE-02-3C	Trad EPC	residential	147				
BE-03	M1	residential	147	2	1	Measured indoor temperature, measured energy use	Potential improvements: Add more default values based on the building characteristic. Add clear default schedules. Improve approach to insert data into the upload files, such as outdoor and indoor hourly time series.
BE-03	M2	residential	147	2	1	----	Add clear default schedules
BE-03	M3	residential	147	12	5	Geometry, physical data not available, Measured energy consumption	Adding templates
BE-03	Trad EPC	residential	147				
FI-01	M1	office	35213	3	3	· Files TiTe, GHIall, photovoltaic production record: creating these files in right format	

FI-01	M2	office	35213	3	3		
FI-01	M3	office	35213	3	3	· All control logic (setpoints/schedules) information gathering is hard and has huge impact on the results	· Why space height must be given as parameter and not harvested from the 3d-model? · units of utility bills, a lot easier if a SI option would be available (instead of therms) · importing existing ifc models missing
FI-01	Trad EPC	office	35213	1	1	Best possible model exists and can be utilised as it is.	*

FI-02	M1	school	2490	3	3	Schedules are As earlier commented- the data exists but the details are not easy. If one really needs to know how the facility is consuming energy in year level. The visit and comprehensive discussions are needed with the maintenance responsible person(s). Just guesses based on national building code defaults.	The input parameters are numerous and need explicit definitions to ensure that the correct figures are in correct places and the schedules etc are as in real demo site. The schedules, for example are too much detailed parameters combined to the national certificate (in Finnish). The default usage for many parameters is 60% (e.g. lighting) => the use of these 60% values and use “always on” in SEWPAP tool was the trial. The idea is now to have the total yearly consumption to the same level. Secondly the 60 % schedule was used in SEPAP tool.
FI-02	M2	school	2490	3	3	Schedules are As earlier commented- the data exists but the details are not easy. If one really needs to know how the facility is consuming energy in year level. The visit and comprehensive discussions are needed with the maintenance responsible person(s). Just guesses based on national building code defaults.	
FI-02	M3	school	2490	3	3	see M1	

FI-02	Trad EPC	school	2490	1	1		
FI-03	M1	school	7123	3	3		

FI-03	M2	school	7123	3	3	· A lot detailed inputs needed, so information which are essential or default minimum model would be nice.	
FI-03	M3	school	7123	3	3	Information on detailed schedules	
FI-03	Trad EPC	school	7123	3	2		
GR-01	M1	residential	75	3	1	none	The need of having measured data
GR-01	M2	residential	75	4	1	none	The need of having measured data
GR-01	M3	residential	75	3	1	none	All the data was available
GR-01	Trad EPC	residential	75	2	1	none	-

GR-02	M1	office	527	6	1	The data were available but scattered	The need of having measured data
GR-02	M2	office	527	7	1	The data were available but scattered	The need of having measured data
GR-02	M3	office	527	7	1	Energy bills (one account/receipt for the whole field including other buildings)	The data was available but scattered
GR-02	Trad EPC	office	527	8	1	none	-
GR-03	M1	office	2599	20	3	Email/phone communication and site visit	The need of having measured data
GR-03	M2	office	2599	21	3	Email/phone communication and site visit	The need of having measured data
GR-03	M3	office	2599	21	3	Energy bills	Email/phone communication and site visit
GR-03	Trad EPC	office	2599	8	1	none	-

SP-01	M1	office	5500	10	3	The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. Obtaining actual indoor temperature measurements of buildings/spaces can be problematic. This is not the case in the ePANACEA case studies, as prior consent has been obtained from the property but this will not always be the case. It is necessary to have data regarding the energy demand of the building by services or if not available (which is common) it will be necessary for the technician to calculate and collect the data to calculate it (in this case the value of the energy demands is obtained from a previous work done by method 2).	
SP-01	M2	office	5500	8	3	Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	
SP-01	M3	office	5500	24	4	1/ The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. 2/ Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment. 3/ Collection of actual data regarding: temperature setpoints, schedules, occupancy, operational, lighting power and equipments,...	It is very important to correctly zone the spaces in order to be able to apply coherent improvement measures (natural lighting controls,...). It is also important to have actual data regarding schedules, occupancy and operation of the building in order to pre-calibrate the model.
SP-01	Trad EPC	office	5500	8	3	Collection of data relating to the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	

SP-02	M1	residential	355	10	3	The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. Obtaining actual indoor temperature measurements of buildings/spaces can be problematic. This is not the case in the ePANACEA case studies, as prior consent has been obtained from the property but this will not always be the case. It is necessary to have data regarding the energy demand of the building by services or if not available (which is common) it will be necessary for the technician to calculate and collect the data to calculate it (in this case the value of the energy demands is obtained from a previous work done by method 2).	
SP-02	M2	residential	355	8	3	Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	
SP-02	M3	residential	355	24	4	1/ The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. 2/ Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment. 3/ Collection of actual data regarding: temperature setpoints, schedules, occupancy, operational, lighting power and equipments,...	It is very important to correctly zone the spaces in order to be able to apply coherent improvement measures (natural lighting controls,...). It is also important to have actual data regarding schedules, occupancy and operation of the building in order to pre-calibrate the model.
SP-02	Trad EPC	residential	355	8	3	Collection of data relating to the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	

SP-03	M1	residential	90	10	3	The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. Obtaining actual indoor temperature measurements of buildings/spaces can be problematic. This is not the case in the ePANACEA case studies, as prior consent has been obtained from the property but this will not always be the case. It is necessary to have data regarding the energy demand of the building by services or if not available (which is common) it will be necessary for the technician to calculate and collect the data to calculate it (in this case the value of the energy demands is obtained from a previous work done by method 2).	
SP-03	M2	residential	90	8	3	Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	
SP-03	M3	residential	90	24	4	1/ The availability of actual annual weather data (radiation and outdoor temperature) can be a problem in case there is no accessible weather station nearby. 2/ Collection of data regarding the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment. 3/ Collection of actual data regarding: temperature setpoints, schedules, occupancy, operational, lighting power and equipments,...	It is very important to correctly zone the spaces in order to be able to apply coherent improvement measures (natural lighting controls,...). It is also important to have actual data regarding schedules, occupancy and operation of the building in order to pre-calibrate the model.
SP-03	Trad EPC	residential	90	8	3	Collection of data relating to the thermal envelope of the building, its thermal installations, lighting, equipment and other equipment.	

AT-01	M1	residential	880	6	3	Bring files TiTe, GHIall, photovoltaic production record in right format and gather this information was a challenge. Schedules on default otherwise there would be lot of effort to collect the schedule.	
AT-01	M2	residential	880	6	3	Geometry was no problem and similar to EPC calculation. Schedule challenging and interface not always intuitive to use	
AT-01	M3	residential	880	8	5	User behavior and setpoints is difficult to gather. Detailed information about the building is needed. Weather data costs money. Geometry was no problem. Consumption data ok to gather.	Please use SI units. Often values have to be added twice. Switching in two programs open studio and sketchup was annoying.
AT-01	Trad EPC	residential	880	2	1	no difficult data	
AT-02	M1	office	564	8	3	Bring files TiTe, GHIall, photovoltaic production record in right format and gather this information was a challenge. Schedules on default otherwise there would be lot of effort to collect the schedule.	The input parameters are numerous and need explicit definitions to ensure that the correct figures are in correct places and the schedules etc are as in real demo site.
AT-02	M2	office	564	8	3	Bring files TiTe, GHIall, photovoltaic production record in right format and gather this information was a challenge. Schedules on default otherwise there would be lot of effort to collect the schedule.	

AT-02	M3	office	564	12	5	User behavior and setpoints is difficult to gather in an office building. Detailed information about the building is needed. Weather data costs money. Geometry was no problem. Consumption difficult to gather for cooling unit	Please use SI units. Often values have to be added twice. Switching in two programs open studio and sketchup was annoying.
AT-02	Trad EPC	office	564	2	1	no difficult data	
AT-03	M1	office	505	6	3	Bring files TiTe, GHIall, photovoltaic production record in right format and gather this information was a challenge. Schedules on default otherwise there would be lot of effort to collect the schedule.	
AT-03	M2	office	505	6	3	· A lot detailed inputs needed, so information which are essential or default minimum model would be nice.	
AT-03	M3	office	505	6	4	User behavior and setpoints is difficult to gather. Detailed information about the building is needed. Weather data costs money. Geometry was no problem. Consumption data ok to gather.	Please use SI units. Often values have to be added twice. Switching in two programs open studio and sketchup was annoying.
AT-03	Trad EPC	office	505	2	1	no difficult data	

4.4. Assessment Template Input Parameters

Case Nr3	Method4	Typology5	Conditioned floor area [m²]6	Time for calculation process	Grade of qualification testing person	Grade of qualification at least needed	Design of Input interface	User friendliness	Comments to the design and user friendliness
BE-01	M1	residential	137	0,001	7	4	5	3	Very good. Potential improvement; make clear distinction between input needed for M1 and input needed for M2 (and both); language settings (sometimes Spanish is retained persistently when English is requested). Potential improvements: Allow user defined input in Tab 8 - subtab Energy Needs; Default Schedules; DHW boiler; District heating; Upload file composition.
BE-01	M2	residential	137	0,001	7	4	5	3	Potential improvement: · add possibility of direct input of U-values of envelope components · Interior partition vertical: add possibility to insert window
BE-01	M3	residential	137	2	7	5	3	3	Templates could be provided
BE-01	Trad EPC	residential	137						
BE-02-3C	M1	residential	147	0,001	7	4	5	3	Very good. Potential improvement; make clear distinction between input needed for M1 and input needed for M2 (and both); language settings (sometimes Spanish is retained persistently when English is requested). Potential improvements: Allow user defined input in Tab 8 - subtab Energy Needs; Default Schedules; DHW boiler; District heating; Upload file

									composition.
BE-02-3C	M2	residential	147	0,001	7	4	5	3	Potential improvement: · add possibility of direct input of U-values of envelope components · Interior partition vertical: add possibility to insert window
BE-02-3C	M3	residential	147	2	7	5	3	3	Templates could be provided
BE-02-3C	Trad EPC	residential	147						
BE-03	M1	residential	147	11 seconds	7	4	3	5	Good and clear. -Spanish appears here an there but does not make any problem. some inputs can be givven multple times and you don't at the end which is impacting the results (e.g. ventilation)
BE-03	M2	residential	147	5 seconds	7	4	3	5	I don't see any input related to M2
BE-03	M3	residential	147	2	7	5	3	3	Templates could be provided
BE-03	Trad EPC	residential	147						

FI-01	M1	office	35213	3	7	6	3	3	· A lot of fields to be filled, some marks which are mandatory and which not would be nice · District heating option missing · It is not very handy that for cooling you have to make another model
FI-01	M2	office	35213	3	7	6	3	3	· District heating option missing)
FI-01	M3	office	35213	a lot (still learning)	7	7	3	2	· District heating option missing · Many steps and input forms, jumping between openstudio and sepap tool is confusing
FI-01	Trad EPC	office	35213	Some hours to change the model profiles to standard profiles in the regulation. 3h	7	7	5	5	*

FI-02	M1	school	2490	3	7	6	3	3	The basic idea of drop downs in clear. However the menus can make filling data complicated as all data is not visible in one “screen” at one glance. The use of Second Button is not indicated where in use? Visually a dashboard with tables could guide the filling procedure or even some files (templates) with dedicated API for data transfer in the future?
FI-02	M2	school	2490	3	7	6	3	3	
FI-02	M3	school	2490	a lot (still learning)	7	7	3	2	

FI-02	Trad EPC	school	2490	2	7	7	5	5	
FI-03	M1	school	7123	3	7	6	3	3	· How should heating with district heating and cooling be defined? District heating option missing from the Facility-> HVAC selection · Modifications should be saved or at least warning given when changing from sheet to another (the save button is not always visible without scrolling, so easily forgotten to press after changes made) · Adding energy bill data is a bit slow to add one by one even in case of monthly data · Several schedules that have cumulative effect on the results, are a bit hard to debug

FI-03	M2	school	7123	3	7	6	3	3	· Copying project: energy bills don't copy to new project, but duplicate to the old one (this occurred on the first copying attempt, not later any more) · some sheets have save button, that must be pressed, but SRI-sheets don't. Probably would be better if all have same saving mechanism. · Add Window-button could be as visible as add wall, now it took a while to find · no district heating option
FI-03	M3	school	7123	a lot (still learning)	7	7	3	2	· "Planta centralizada para radiadores Loop"? · no district heating option
FI-03	Trad EPC	school	7123	1	7	7	5	5	sometimes simplified too much
GR-01	M1	residential	75	2	4	4	3	3	The HVAC system selected for the specific project should be more clear/user friendly
GR-01	M2	residential	75	2+1	4	4	3	3	The HVAC system selected for the specific project should be more clear
GR-01	M3	residential	75	20	6	6	5	3	It is not clear which tabs from the RUN should be filled in.
GR-01	Trad EPC	residential	75	4	6	6	3	3	-

GR-02	M1	office	527	10	4	4	3	3	The HVAC system selected for the specific project should be more clear/user friendly
GR-02	M2	office	527	10+1	4	4	3	3	The HVAC system selected for the specific project should be more clear/user friendly
GR-02	M3	office	527	40	6	6	5	3	It is not clear which tabs from the RUN should be filled in.
GR-02	Trad EPC	office	527	15	6	6	3	3	-
GR-03	M1	office	2599	4	4	4	3	3	The HVAC system selected for the specific project should be more clear/user friendly
GR-03	M2	office	2599	4+1	4	4	3	3	The HVAC system selected for the specific project should be more clear/user friendly
GR-03	M3	office	2599	15	6	6	5	3	It is not clear which tabs from the RUN should be filled in.
GR-03	Trad EPC	office	2599	24	6	6	3	3	-

SP-01	M1	office	5500	0	7	5	1	1	Although photovoltaic production data is entered, it does not appear in the results.
SP-01	M2	office	5500	0	7	5	3	3	Equipment consumption is not linked to the thermal energy calculation of the building.
SP-01	M3	office	5500	0	7	5	4	5	As it is a more detailed method than 1 and 2, for a correct introduction of the inputs it is necessary to have knowledge of building energy modelling.
SP-01	Trad EPC	office	5500	0	7	6	4	5	
SP-02	M1	residential	355	0	7	5	1	1	Although photovoltaic production data is entered, it does not appear in the results.

SP-02	M2	residential	355	0	7	5	3	3	Equipment consumption is not linked to the thermal energy calculation of the building.
SP-02	M3	residential	355	0	7	5	4	5	As it is a more detailed method than 1 and 2, for a correct introduction of the inputs it is necessary to have knowledge of building energy modelling.
SP-02	Trad EPC	residential	355	0	7	6	4	5	
SP-03	M1	residential	90	0	7	5	1	1	Although photovoltaic production data is entered, it does not appear in the results.
SP-03	M2	residential	90	0	7	5	3	3	Equipment consumption is not linked to the thermal energy calculation of the building.
SP-03	M3	residential	90	0	7	5	4	5	As it is a more detailed method than 1 and 2, for a correct introduction of the inputs it is necessary to have knowledge of building energy modelling.
SP-03	Trad EPC	residential	90	0	7	6	4	5	
AT-01	M1	residential	880	3	7	6	2	2	The basic idea of drop downs in clear. However the menus can make filling data complicated as all data is not visible in one “screen” at one glance. The use of Second Button is not indicated where in use? Visually a dashboard with tables could guide the filling procedure or even some files (templates) with dedicated API for data transfer in the future?

AT-01	M2	residential	880	3	7	6	2	2	Geometry was no problem and similar to EPC calculation. Schedule challenging and interface not always intuitive to use. District heating missing.
AT-01	M3	residential	880	3	7	7	2	1	Biomass and district heating is not working. Floor heating is complicated and often not working. Confusing input in many steps. Switching open studio and SEPAP tool is not intuitive.
AT-01	Trad EPC	residential	880		7	5	5	5	
AT-02	M1	office	564	3	7	6	2	2	The basic idea of drop downs in clear. However the menus can make filling data complicated as all data is not visible in one “screen” at one glance. The use of Second Button is not indicated where in use? Visually a dashboard with tables could guide the filling procedure or even some files (templates) with dedicated API for data transfer in the future?
AT-02	M2	office	564	3	7	6	2	2	Geometry was no problem and similar to EPC calculation. Schedule challenging and interface not always intuitive to use. District heating missing.
AT-02	M3	office	564	3	7	7	2	1	Complex HVAC system requires a lot of knowledge and time in open studio. Floor heating is complicated and often not working. Confusing input in many steps. Switching open studio and SEPAP tool is not intuitive.
AT-02	Trad EPC	office	564		7	5	5	5	

AT-03	M1	office	505	3	7	6	2	2	The basic idea of drop downs in clear. However the menus can make filling data complicated as all data is not visible in one “screen” at one glance. The use of Second Button is not indicated where in use ? Visually a dashboard with tables could guide the filling procedure or even some files (templates) with dedicated API for data transfer in the future?
AT-03	M2	office	505	3	7	6	2	2	Geometry was no problem and similar to EPC calculation. Schedule challenging and interface not always intuitive to use. District heating missing.
AT-03	M3	office	505	3	7	7	2	1	Biomass and district heating is not working. Floor heating is complicated and often not working. Confusing input in many steps. Switching openstudio and sepap tool is not intuitive.
AT-03	Trad EPC	office	505		7	5	5	5	

4.5. Assessment Template Output Parameters

Case Nr4	Method5	Typology6	Conditioned floor area [m²]7	Error values occurred	Usability of output	Understandability of output	Design of output variables	Plausibility of output data	Effort compared to use	Comments to the output parameters
BE-01	M1	residential	137	1	5	5	3	4	1	Should be clarified that it concerns kWh and whether it concerns final or primary energy. Also output should be further processed into the EPC template as developed in ePANACEA.
BE-01	M2	residential	137	1	5	5	3	4	3	Link to EPBD board is highly appreciated, but could use more effort in translation to English.
BE-01	M3	residential	137	5	5	5	2	3	5	Multiple errors appeared and were solved by communications. Units are sometimes missing in parallel coordinate graph, thermal comfort can be added as an output
BE-01	Trad EPC	residential	137							
BE-02-3C	M1	residential	147	1	5	5	3	4	1	Should be clarified that it concerns kWh and whether it concerns final or primary energy. Also output should be further processed into the EPC template as developed in ePANACEA.

BE-02-3C	M2	residential	147	1	5	5	3	4	3	Link to EPBD board is highly appreciated, but could use more effort in translation to English.
BE-02-3C	M3	residential	147		5	5	2	4	5	Units are sometimes missing in parallel coordinate graph, thermal comfort can be added as an output
BE-02-3C	Trad EPC	residential	147							
BE-03	M1	residential	147	1	5	5	2	5	1	The outcomes can be shown regarding their importance.
BE-03	M2	residential	147	1	5	5	3	2	1	Some explanation can be added to be read on demand.
BE-03	M3	residential	147	10	5	5	2	3	5	Multiple errors appeared and were solved by communications. Units are sometimes missing in parallel coordinate graph, thermal comfort can be added as an output
BE-03	Trad EPC	residential	147							
FI-01	M1	office	35213		3	3	3	3	3	· What is the intended use of results if not made an EPC? · The acronyms used in the tool could be explained, e.g. EU is European Union not energy usage? · output lacks units · Maybe chart of the results could be nice also in the results sheet or ability to export/copy the results to excel or csv file

FI-01	M2	office	35213		3	3	3	3	3	· What is the intended use of results if not made an EPC? · I don't understand why the energy consumption has some extra fuel consumption and don't match with method 1 · yes, some values still remain after removing them from the model
FI-01	M3	office	35213		4	3	3	3	5	· Sketchup crashes quite lot · debugging is difficult · Very high indoor temperature values, a lot help needed to get these on decent level
FI-01	Trad EPC	office	35213		5	5	5	5	2(low effort)	EPC is considered as output here, not necessarily comparable with output of the other tools

FI-02	M1	school	2490		3	3	3	3	3	What is the final intended use ? Looks OK - but the fitting to original energy certificate was done by trials in schedules. The reality is not checked ? Output can be copied to excel. However- the visualization could be directly in M1 ? Units and short names need to be explained. Crashes with a) Spanish text b) data error messages (syntax etc) for coding persons In copied project all windows have disappeared
FI-02	M2	school	2490		3	3	3	3	3	What is the final intended use ? Looks OK - but the fitting to original energy certificate was done by trials in schedules. The reality is not checked ? Output can be copied to excel. However- the visualization could be directly in M1 ? Units and short names need to be explained.
FI-02	M3	school	2490		4	3	3	2	5	Very high indoor temperatures

FI-02	Trad EPC	school	2490	-	5	5	5	5 Reliable. (The work is not done to comply with the requirements only, but also to create an energy efficient building.)	2(low effort)	-
FI-03	M1	school	7123		3	3	3	3	3	· Acronyms not intuitive

FI-03	M2	school	7123		3	3	3	3	3	
FI-03	M3	school	7123		4	3	3	3	5	Units could be MWh or kWh rather than GJ, but this is probably due to open studio
FI-03	Trad EPC	school	7123		3	5	5		2(low effort)	EPC is the only output of method used here. 4 Reliable in most cases, method used here makes a lot assumptions
GR-01	M1	residential	75	2	2	2	3	3	4	- No heating and cooling outputs in the same project/model. - Heating values for the whole year. - Cooling values for the whole year (apart from Jan, Febr). M1 and M2 results correlation? Which values could be compare?
GR-01	M2	residential	75	2	2	2	3	1	3	- EPBD board outcomes: translation - Results tab/energy need: Cooling values for the whole year (GR-02) - Results tab/energy need/Temperature: internal or external? M1 and M2 results correlation? Which values could be compare?
GR-01	M3	residential	75	10	1	1	1	3	5	many errors
GR-01	Trad EPC	residential	75	0	2	2	3	2	3	The output is an xml file and it is confidential/auditor's ownership

GR-02	M1	office	527	7	2	2	3	3	5	- The TiTe file for winter measurements doesn't work - No heating outputs / no fuel availability for heating => no ventilation - Heating values for the whole year. - Cooling values for the whole year (apart from Jan, Febr).
GR-02	M2	office	527	7	2	2	3	1	3	- EPBD board outcomes: translation - Results tab/energy need: Cooling values for the whole year (GR-02) - Results tab/energy need/Temperature: internal or external?
GR-02	M3	office	527	10	1	1	1	3	5	many errors
GR-02	Trad EPC	office	527	0	2	2	3	2	3	The output is an xml file and it is confidential/auditor's ownership
GR-03	M1	office	2599	-	2	2	3	3	5	- Heating values for the whole year. - Cooling values for the whole year (apart from Jan, Febr).
GR-03	M2	office	2599	-	2	2	3	1	3	- EPBD board outcomes: translation - Results tab/energy need: Cooling values for the whole year (GR-02) - Results tab/energy need/Temperature: internal or external?
GR-03	M3	office	2599	10	1	1	1	3	5	(no outputs yet)
GR-03	Trad EPC	office	2599	0	2	2	3	2	3	The output is an xml file and it is confidential/auditor's ownership

SP-01	M1	office	5500	10	1	5		2	3	Cooling results are excessively high The results only point to the value for a standardized certificate. 1/ The analysis period did not correspond to the date of the measured data. 2/ The period of the bills entered did not correspond to the period of the measured data. If data are entered for invoices that start before or end after the analysis date, the measured fuel only sums the data from dates that fall within the range of the analysis period
SP-01	M2	office	5500		1	5		2	3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user
SP-01	M3	office	5500		5	5		5	1	Very useful for making decisions on energy efficient building retrofitting. 1/ Once the occupants behaviors have been introduced, adjusting calendars and loads
SP-01	Trad EPC	office	5500						3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user

SP-02	M1	residential	355	10	1	5		2	3	Cooling results are excessively high The results only point to the value for a standardized certificate. 1/ The analysis period did not correspond to the date of the measured data. 2/ The period of the bills entered did not correspond to the period of the measured data. If data are entered for invoices that start before or end after the analysis date, the measured fuel only sums the data from dates that fall within the range of the analysis period
SP-02	M2	residential	355		1	5		2	3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user
SP-02	M3	residential	355		5	5		5	1	Very useful for making decisions on energy efficient building retrofitting. 1/ Once the occupants' behaviors have been introduced, adjusting calendars and loads
SP-02	Trad EPC	residential	355						3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user
SP-03	M1	residential	90	10	1	5		2	3	Cooling results are excessively high The results only point to the value for a standardized certificate. 1/ The analysis period did not correspond to the date of the measured data. 2/ The period of the bills entered did not correspond to the period of the measured data. If data are entered for invoices that start before or end after the analysis date, the measured fuel only sums the data from dates that fall within the range of the analysis

										period
SP-03	M2	residential	90		1	5		2	3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user
SP-03	M3	residential	90		5	5		5	1	Very useful for making decisions on energy efficient building retrofitting. 1/ Once the occupants' behaviors have been introduced, adjusting calendars and loads
SP-03	Trad EPC	residential	90						3	The results only point to the value for a standardized certificate. In this way calibration is not useful for building end-user
AT-01	M1	residential	880	3	3	4	3	4	4	
AT-01	M2	residential	880	10	3	4	3	4	3	
AT-01	M3	residential	880	20	2	2	2	2	5	It is not clear what the output is. The output from the open studio process is clear but when coming to parametric analysis the output depends very strong on the schedules used. The schedules are often estimations and that is why the trust in a calibration is very poor

AT-01	Trad EPC	residential	880		5	5	5	5	2	standardized EPC is the output. No comments. HVAC could be more detailed
AT-02	M1	office	564	4	3	4	3	4	4	
AT-02	M2	office	564	15	3	4	3	4	3	
AT-02	M3	office	564	30	2	2	2	2	5	It is not clear what the output is. The output from the open studio process is clear but when coming to parametric analysis the output depends very strong on the schedules used. The schedules are often estimations and that is why the trust in a calibration is very poor
AT-02	Trad EPC	office	564		5	5	5	5	2	standardized EPC is the output. No comments HVAC could be more detailed
AT-03	M1	office	505	6	3	4	3	4	4	

AT-03	M2	office	505	11	3	4	3	4	3	
AT-03	M3	office	505	20	2	2	2	2	5	Due to an unexpected consumption peak in winter was not easy to calibrate adequately. User behavior is hard to gather retrospective
AT-03	Trad EPC	office	505		5	5	5	5	2	standardized EPC is the output. No comments HVAC could be more detailed

5. REFERENCES

5.1. Table of figures

5.2. Table of figures