

Enhancing Energy Performance Certification:

Guidelines for creating Renovation Passports from data repositories

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TIMEPAC aims to modernize building certification practices according to the latest Energy Performance of Buildings Directive (EPBD) review. The guidelines series provides recommendations for stakeholders involved in building certification to improve their working procedures to meet the objectives of the Directive.

The guideline aims to provide building owners, property managers, and stakeholders with a clear framework for enhancing energy efficiency in buildings over time. It aligns individual renovation efforts with national and EU targets, such as achieving nearly Zero-Energy Building (nZEB) and Zero-Energy Building (ZEB) standards.

It helps stakeholders understand the necessary processes, data requirements, tools, and responsibilities, while offering access to crucial legal, financial, and technical resources for effective renovation implementation. Ultimately, the guideline ensures that each renovation phase is well-documented, financially viable, and compliant with evolving regulations. It is designed as a standalone document that can be easily translated into national languages for stakeholder discussions and used in designing Renovation Passport schemes.



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TIMEPAC "Guidelines for creating Renovation Passports from data repositories"

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1. Introduction to the guidelines

The **Renovation Passport** is an evolving tool aimed at guiding building owners through stepwise or comprehensive renovations to meet energy efficiency goals, particularly those aligning with **nZEB (nearly Zero Energy Buildings)** and **ZEB (Zero Energy Buildings)** standards. Rooted in insights from partner countries of TIMEPAC, the Renovation Passport addresses varied national practices in energy performance and renovation planning, drawing from Energy Performance Certificates (EPCs), energy audits, and Building Information Modeling (BIM). The passport should ideally connect with existing energy audits and databases to streamline renovations effectively and affordably. Table 1 shows the key aspects of the Renovation Passports gained out of the TIMEPAC project.

Aspect	Description
1. Workflow Overview	<p>Starting Points: Varied approaches across countries. Some EPCs offer general text, while others provide detailed, stepwise measures tied to audits.</p> <p>EPC and Audits: In some regions, energy audits are included in EPCs, providing strong support for roadmap development.</p>
2. Data and Tools	<p>Data Sources and BIM Integration: Combines EPC databases and emerging building logbooks (limited in most areas). BIM/BEM tools improve renovation accuracy by detailing materials, surfaces, and systems, though compatibility issues persist.</p>
3. Tracking Renovation Evolution	<p>Versioned EPC Databases: EPC databases could track renovation changes through versioning to document updates, ideally linking to specific measures.</p> <p>Energy Management: Energy management systems (EMS) and regular audits are useful for monitoring progress and updating goals.</p>
4. Target Group Communication	<p>Information Access: Building owners and managers need easy, secure access to EPCs, audits, and updates. Roadmap alignment with property management helps plan renovations efficiently, ensuring resources are optimized.</p>
5. Challenges and Considerations	<p>Data Integration and Ownership: Balances accessible data with ownership and liability; full-functioning logbooks would support this.</p> <p>Cost and Applicability: BIM/BEM standards are costly for small buildings;</p>

	<p>cost-effective solutions are needed.</p> <p>Long-Term Relevance: Must adapt to evolving standards, tech, and district goals. Provides guidance for both immediate needs (e.g., system replacement) and long-term ZEB goals.</p>
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Table 1 Key aspects of the Renovation Passport

The thematic summary of country contributions of the TIMEPAC partners showed in Table 1 was used as the basis for developing the guidance presented. Therefore, the TIMEPAC proposal for creating Renovation Passports from data sets and tracking the development of building renovation is well-founded and practically relevant. Thus, it is not only a working tool for TIMEPAC partners, but also a useful input into the discussions on the topic outside the TIMEPAC consortium. All figures in this chapter were developed by the lead partner SERA within the scope of this task.

1.1 Purpose

The purpose of the guideline is to provide building owners, property managers, and relevant stakeholders with a structured, step-by-step roadmap to improve building energy efficiency over time. This helps align individual renovation efforts with national and EU goals, like reaching nearly Zero-Energy Building (nZEB) or Zero-Energy Building (ZEB) standards. The guideline supports stakeholders in understanding the processes, data requirements, tools, and responsibilities involved, and in accessing the necessary information, including legal, financial, and technical resources, to execute renovation measures effectively.

In summary, it aims to ensure that each renovation phase is well-documented, economically feasible, compliant with evolving regulations, and aligned with long-term sustainability goals. The guideline is designed to be useful as a stand-alone document, as well. It can easily be translated into national languages for discussion with stakeholders and further use in designing and applying Renovation Passport schemes.

1.2 Features of the TIMEPAC Renovation Passport

In a nutshell, the Renovation Passport should complement the energy performance certificate and provide a solution to the challenge of increasing the building renovation rate, and to achieve a Zero-Emission building stock in the long run. It is based on a Renovation Roadmap displaying building specific renovation measures to be implemented in a given sequence and timeframe.

Approaches to the Renovation Passport have been developed and implemented as part of subsidy schemes in several EU member states. In 2018, the concept was introduced into the legal framework of the Energy Performance of Buildings Directive 2010/31/EU (EPBD) with the amending directive (EU) 2018/844. It has been further strengthened in the Commission proposal for the recast EPBD, expected to be fully negotiated by the end of the year 2023 or at the beginning of 2024.

Differences between EPC and Renovation Passport

Table 2 shows the main differences between the Energy Performance Certificate and the Renovation Passport.

	Characteristics of the mandatory Energy Performance Certificate	Characteristics of the voluntary Renovation Passport
Building specific	Yes – but not mandatory; for existing buildings: can be based on default values	Yes – because it is important for the economic assessment of improvement measures
User specific	No – based on standard user behaviour/standard user profile	Yes – because it is important for the economic assessment of improvement measures
Real energy consumption	No – based on a given calculation method to determine energy demand	Yes – based on operational data, because it is important for the economic assessment of improvement measures
On-site visit	Not mandatory, depends on the regulatory framework and the purpose of the EPC	Yes – because reliable information about the actual condition must be available
Format of recommendations	Can be general; data fields often not sufficiently specified	Format is specified by the operator of the voluntary scheme Stepwise implementation of specific renovation measures in a given sequence
Tracking the implementation of recommendations	Not mandatory; often not possible	Not mandatory; possible if planned by the operator of the scheme
Method of tracking the implementation of renovation measures	Possible through the EPC database if it allows for versioning of EPCs of a building, and distinct recommendations are represented by individual and defined data fields	Several possibilities, for example through the EPC database

Table 2 Comparison of Energy Performance Certificate and Renovation Passport

The TIMEPAC Renovation Passport, with its claim to track the implementation of renovation measures, links the EPC to the architectural and engineering work of actual renovation planning and implementation, as shown in Figure 1.

Process of creating a Renovation Passport

The process is as follows:

1. The analysis of existing building data from data repositories, including the existing EPC if available, reduces the effort for data collection, and serves to prepare the on-site visit.
2. The on-site visit is needed to determine the actual status of the building and to collect missing information.
3. This information basis is used to develop the Renovation Roadmap with the sequence of renovation measures to be implemented. Achievement of Nearly-Zero Energy (nZEB) and Zero Emission Building (ZEB) targets is verified by EPC calculations.
4. Measures to be implemented in the first step are selected and financing is secured.
5. Detailed planning is done, and renovation works are performed.
6. The EPC for the renovated building is issued and the Renovation Roadmap is updated.

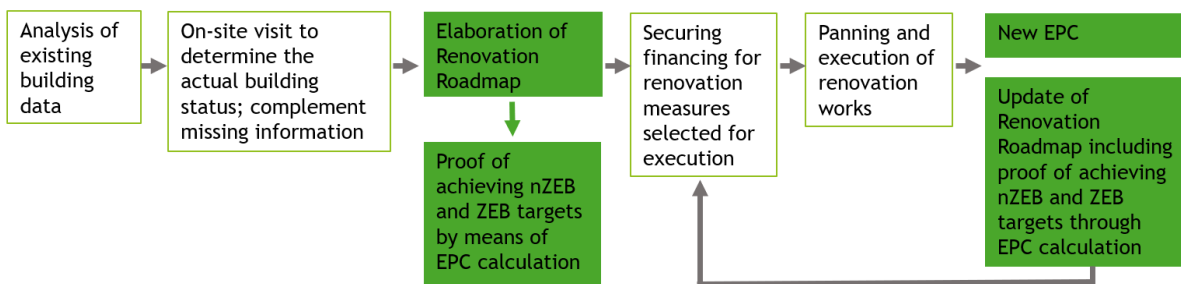


Figure 1 Overview of workflow of TIMEPAC Renovation Passport (SERA 2023)

Currently, the EPC can only be issued to verify the achievement of nZEB targets, as zero emission targets still need to be defined in detail by the recast EPBD expected by end of 2023.

The link between EPC and Renovation Passport is displayed in more detail in the Figures 2 and 3.

The indicators listed are exemplary and not exhaustive.

Figure 2 shows in a schematic presentation that the EPC (created conventionally or using BIM) serves as a starting point in terms of building data and energy performance. Renovation Roadmaps are drawn up taking into account additional data such as from on-site visits and energy bills.

The individual renovation steps, which follow one another, each end with an EPC and thus the determination of the energy performance achieved.

Figure 3 shows that when the measures of a renovation stage are implemented, an update of the EPC is made. This gives the previous EPC the status "outdated", and the current EPC provides the input into the updated Renovation Roadmap.

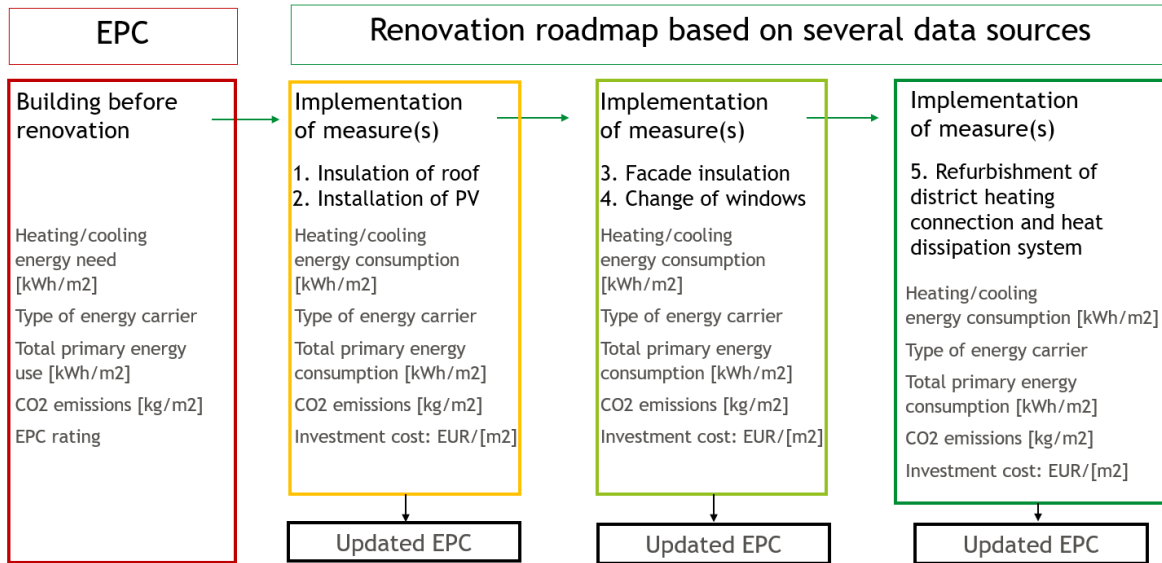


Figure 2. Overview of relation between EPC and Renovation Roadmap (a) (SERA 2023)

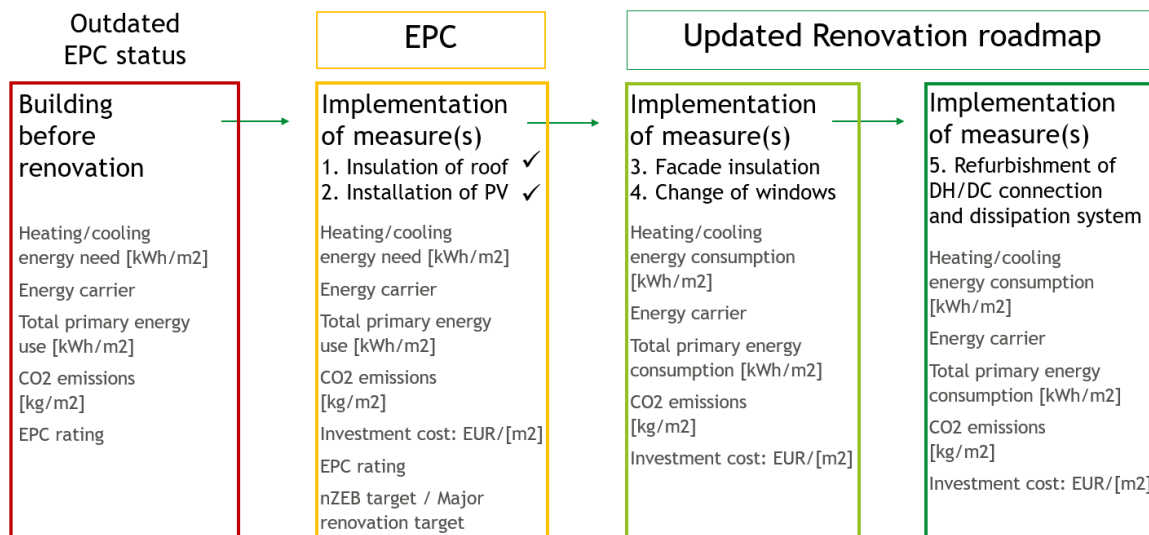


Figure 3. Overview of relation between EPC and Renovation Roadmap (b) (SERA 2023)

Validity of the Renovation Passport

The validity of the Renovation Passport must be limited in the sense that the first package of renovation measures or the first selected renovation measure must be implemented within a given time, for example five years.

This is important as legal changes occur over time, and the Renovation Passport needs to be synchronized with changes for example in nZEB¹ and/or ZEB² definitions, calculation methodology, or integration rules for renewable energy sources.

Secondly, such a limitation of validity is also a way how to synchronize the Renovation Passport with technological changes and integration of new products and solutions.

Thus, the process outlined in the figures above, based on updating the Renovation Roadmap after each step has been implemented, ensures that technological and regulatory changes are properly addressed. If there is no update of EPC and Renovation Roadmap within the given deadline, an alert could be activated in the database and the status of the Renovation Roadmap could be changed to "invalid", meaning that the entire process starting from data analysis and on-site visit would start from scratch.

1.3 Creating Renovation Passports from data repositories

1.3.1 Overview of the workflow

The Renovation Passport is closely tied to the EPC and it can draw valuable insights from it during its development. Furthermore, upon implementing a measure from the Renovation Roadmap, a new EPC must be issued as proof of compliance with nZEB and ZEB targets. Therefore, a link with the EPC calculation software package can be useful to save time and effort for entering data into different tools. However, this depends on which kind of EPC software tools are actually used in a country or region.

There are basically two ways to establish this link between EPC and Renovation Passport, depending on the situation in each country:

- The EPC calculation software, which includes energy modelling and is already linked to material databases, is to be further developed to meet the requirements of the Renovation Passport.
- The EPC calculation software remains a simple tool for proving compliance with legal requirements, but indicators for real energy consumption, health, comfort, life cycle cost, and climate change adaptation are calculated with other tools.

Figure 4 shows the elements of the Renovation Passport in terms of processes and data repositories or data sources that can provide input into developing a Renovation Passport or are even necessary to perform this task well.

As shown in the process described in Figure 4, the wealth of information that can be generated about a building but is scattered in different places. The concept of a building logbook represents an approach to store all information about a building in one place, and the use of a standardized building

¹ nZEB nearly Zero Energy Building, definition according to EPBD

² ZEB Zero Emission Building, definition according to Commission proposal for recast EPBD

logbook would be a major step forward in terms of increasing the efficiency of data provision for developing the Renovation Roadmap.

In addition to building data that could be stored in the building logbook, information is needed about urban plans, spatial energy plans and other information which is important for achieving zero-emission targets through increasing renewable energy use. This information can be stored in one place called Municipal information system. However, often, this is not available, or not yet easily accessible, and thus needs special attention when elaborating the Renovation Passport schemes.

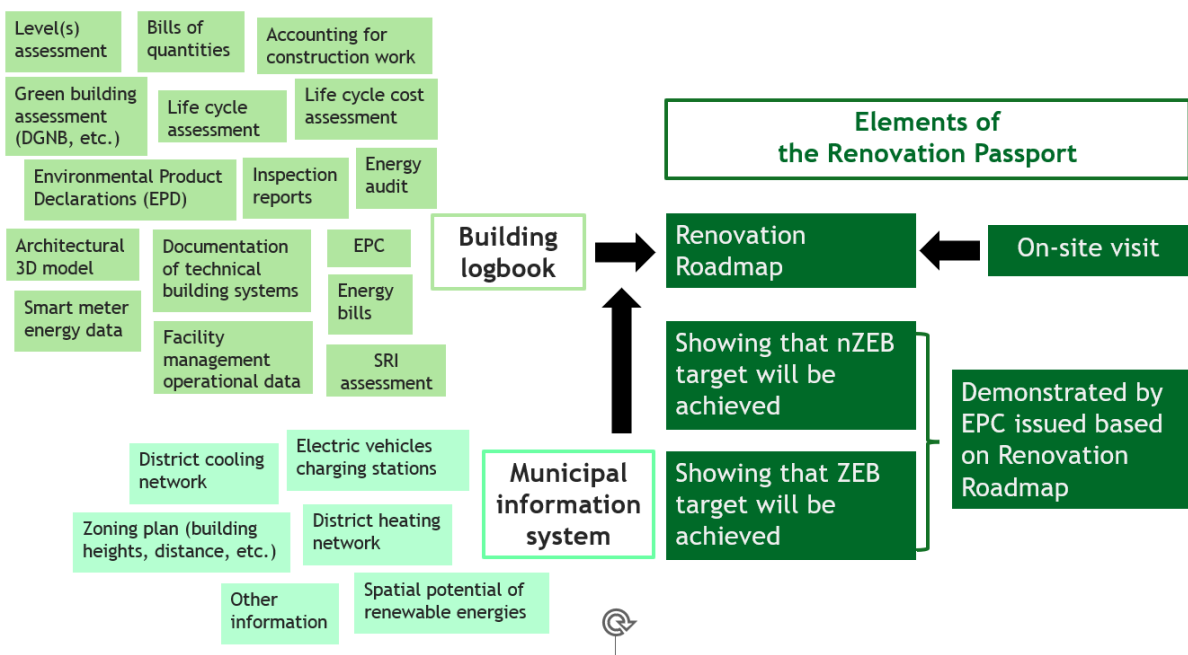


Figure 4. Overview of data and processes for the Renovation Passport (SERA 2023)

1.3.2 Specific aspects of data repositories including BIM

Building data that is already available can be used for analysis, provides a source of input data into developing the Renovation Passport. It can be used to prepare the site visit and the collection of remaining information. As shown in the process described in Figure 12, the wealth of information that can be generated about a building but is scattered in different places. The concept of a building logbook represents an approach to store all information about a building in one place.

The concept of a building logbook can be put into practice through the following exemplary approaches:

- The EPC database environment: all EPCs, Renovation Passports and subsidy applications for a building are stored in the related specific account. In addition, the building owner can upload additional information, and give access to this information to third parties (example Province of Salzburg, Austria).
- A BIM offering software: Level 3 BIM provides a possibility to store data at the same place and with the option of ensuring up-to-date information. Especially regarding renovations, there is an added value, namely the fact that the architectural model allows to show changes of area and volume that can occur as part of a renovation project (example CYPE BIMserver.center).

Creating an architectural model necessitates an initial investment of effort. Later, the use of the architectural model offers several advantages:

- It can bring significant improvements in terms of quality assurance and prevention of errors and fraud as it can be employed to accurately determine surface types, sizes, and materials used to calculate various indicators including those used for proving compliance with regulatory requirements.
- It avoids multiple data collections which are a source of error and a potential vulnerability to manipulation of assessment results.
- It can provide a solution when it comes to produce an EPC for the entire building and EPCs for the individual building units at the same time.

In addition, a building energy model (BEM) is necessary which contains information about the location of energy systems within the building.

Table 3 shows a comparison of the two logbook approaches.

Table 3. Comparison of logbook approaches

	EPC database environment	BIM offering software
Data exchange and sharing	Data exchange in defined formats in the form of retrieving and providing files.	Data sharing and re-use of data in several software tools at the same time.
Ownership and re-use of data	Arrangements for re-use of designs, calculations, etc. are necessary (e.g. inclusion in tenders and contracts).	Is regulated by the terms of use.
Ensuring up-to-date information	Is checked by the expert in case of an occasion.	The entire building information model, including energy systems, is always maintained. The sovereignty over the data must be clearly assigned to a person.
Liability	Processes are repeated: EPC holds the status of an expert opinion, the issuer cannot rely on the work done by another expert due to liability reasons, unless it is issued by another expert of the same company. Also, experts use different tools.	Repetition of processes is avoided, for example: the entire building information model is subject to a thorough quality check and certification process.

	EPC database environment	BIM offering software
Connection with other databases	Each building (and building unit) must have a unique identity that allows to retrieve building specific information from other databases. Legal challenges need to be solved.	Information is incorporated during creation and maintenance of building models.

Considering that several EPC calculation tools are available on the market in some countries and that thinking about the implementation of a building logbook is still at an early stage, a product-independent approach using data repositories for the creation of Renovation Passports would encompass the following considerations:

- The first step is to export and save EPC data using an open format that does not require specific calculation software.
- One option is to use the IFC format, which allows the file to be accessed without relying on specialized software. However, IFC does not support the transfer of all energy related information calculated using energy calculation tools. Therefore, additional files are necessary to incorporate such data, and saving them in an .ifc.zip file format can help maintain an open process.
- To complete the process of saving EPC information for the future, a new type of repository or digital platform is needed. This platform would enable experts and public administrators to upload, search, and access information and models related to energy data and building refurbishment scenarios. The goal is to create an environment where these resources can be utilized and constantly updated.
- A crucial aspect of the platform is its integration with existing databases that contain building-related information, such as the building cadastre and the EPC database. This integration would allow for a comprehensive evaluation of building assessments that is continuously updated over time.

1.3.3 Procedures of tracing the evolution of building refurbishment

In the recitals of the proposed EPBD recast (Commission proposal 15/12/2021), reference is made to the EPC databases Member States have to set up which shall also allow to gather data related to building Renovation Passports and smart readiness indicators. In addition, it is planned to extend the current independent control system (according to article 18 EPBD) for EPCs to include Renovation Passports and smart readiness indicators. Reference is also made to monitoring and enforcement of a buildings policy which is key to ensure that it makes real progress on the ground, in particular with regard to the improvement of the existing building stock.

This advocates for a mechanism to trace the implementation of renovation measures with a procedure which is tied to the EPC database. An example is shown in Figure 5, as implemented by the province of Salzburg. Essentially, the recommendations in the EPC are replaced by the specific Renovation Passport. The implementation of a measure is linked to the updating of the EPC and to the updating of

the Renovation Passport. Thus, by means of comparisons, the measures and the indicators can be tracked.

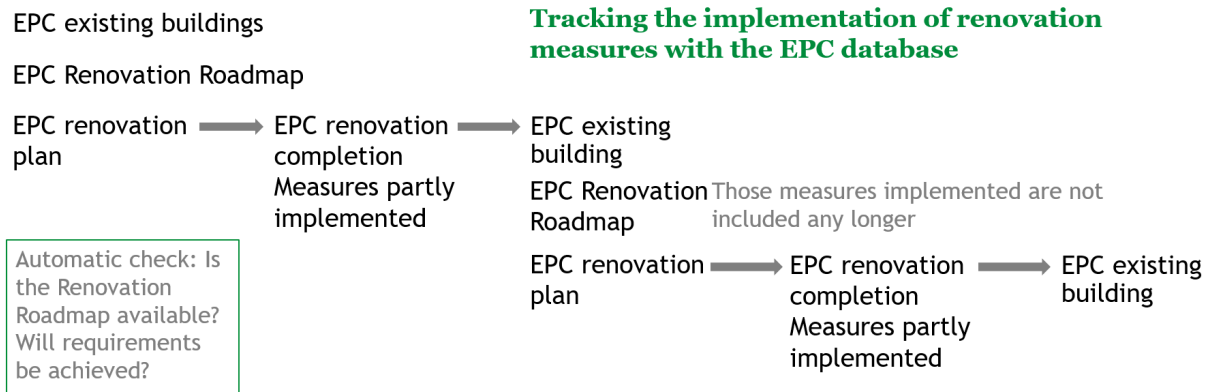


Figure 5. Integrating Renovation Passports into the EPC database and the independent control system (SERA 2023)

This process can be enhanced by integrating a BIM-based workflow, enabling the implementation of changes to the building model in alignment with the Renovation Roadmap and the generation of a new EPC seamlessly (Figure 6).

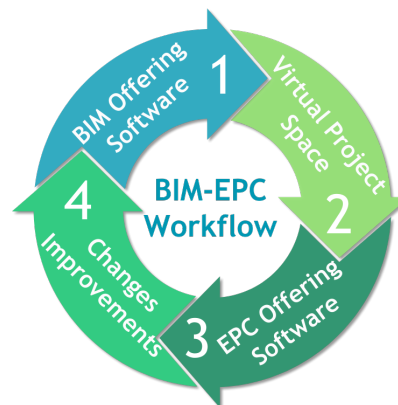


Figure 6. A BIM based workflow to generate the Renovation Passport in connection with the EPC (SERA 2023)

Nonetheless, a prerequisite for this is the inclusion of EPC certification software within the corresponding software package. Additionally, it's worth noting that the BIM-based workflow can serve as an independent method for logging changes to the building, irrespective of the EPC database.

Another possibility of tracing the evolution of building refurbishment is connected to energy audits and energy management systems. Energy audit reports contain recommendations how to improve the building's energy performance which can be further developed to form a Renovation Roadmap. If an energy management system is in place, it can be used for tracking building refurbishment and verifying achievements.

1.4 The perspective of policy makers and administration

1.4.1 Key issues for implementing the Renovation Passport

The following aspects need to be considered to ensure an effective Renovation Passport:

- **Keep cost of the Renovation Passport low:** This can be achieved through making use of data repositories. Professionals will use the data to be prepared for the on-site-visit. In this way, the site-visit will be most effective.
- **Easy access to energy consumption data (operational data) for professionals:** Advantage should be taken from the smart meter roll-out, and professionals should be granted access to smart meter data based on their license.
- **Ensure latest information on the building status:** This information is based on tracking the implementation of renovation measures and is needed by ESCOs, real estate valuers, and for the national renovation plans.
- **Enable the spatial reference of the information:** A link to regional/municipal plans with information about spatial renewable energy potentials and details of the urban plans is especially important with a view to achieving the zero-emission target.
- **Include financial information and a reference to the Taxonomy Regulation:** Financial information should include a life cycle cost analysis and a statement how the renovation project would be rated against the criteria of sustainable investment according to Taxonomy Regulation.
- **Extend the independent control system according to Article 18 EPBD from the EPC to the Renovation Passport:** Indicators refer to square meter and cubic meter which means that the determination of floor area and volume is a source of errors regarding the reliability of indicators. Quality checked Level 3 BIM architectural models could be used by the independent control system to check the reference area and the reference volume used for calculating the indicators.
- **Make the Renovation Passport accessible for further renovation planning:** It needs to be clear that the Renovation Passport does not substitute technical and construction planning, but offers the building owner and/or the facility manager an orientation to start such a process.

1.4.2 Detailed information on key issues

The following tables provide further information on the key aspects briefly described in the previous section. The information is structured as follows:

- **TIMEPAC scenario:** the envisaged situation, as a result of the analysis carried out in the TIMEPAC project.
- **Challenges that need to be addressed:** difficulties encountered during the analysis carried out in the TIMEPAC project.
- **Possible solutions:** approaches analysed and tested in the TIMEPAC project.

More information about each aspect is provided in the Tables 4 to 12 below.

Table 4. Keep cost of Renovation Passport low through making use of data repositories

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Keep cost of Renovation Passport low through making use of data repositories	<p>Data are generated by experts; due to liability reasons, experts usually do not build on the work of other experts, even if data is accessible, which is often not the case.</p> <p>Building related data can be generated in different legal contexts, for example: energy audits under the EED and the respective national body which can be different from the body responsible for the building law and the transposition of the EPBD; inspection of heating and cooling systems under the clean air act and not under the building law, and the respective databases with the reports are managed by different departments of the administration; etc.</p> <p>If data is accessible, it is not available in the required form. Lack of data hinders renovations at neighbourhood level that would allow to reduce costs due to economies of scale.</p>	<p>Level 3 BIM: Promote the use of architectural and TBS models of the building. The models would contain information about materials and the respective LCA data.</p> <p>BIM models contain information that is otherwise split between different sources: 2D plans, structural engineering description, technical building services description, building physics parameters of materials, results of material life cycle assessments.</p>
		<p>Data format: Develop a common data format for recording and storing operational data.</p>
		<p>Data accessibility: Provide a platform where building specific data can be stored and shared by the building owner (building logbook). Ideally, these data should have undergone a quality check. Ideally, the building owner does not need to upload the data but can retrieve them automatically from other databases.</p>

Table 5. Easy access to energy consumption data (operational data) for professionals

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Easy access to energy consumption data (operational data) for professionals	For residential buildings access to energy consumption data can be difficult, especially in multi-unit residential	Smart meter data: Advantage should be taken from the smart meter roll-out. Each building/building unit is equipped (or will be equipped soon) with a smart electricity meter and a smart meter for

TIMEPAC scenario	Challenges to be addressed	Possible solutions
	<p>buildings and for more than one billing period.</p> <p>Monthly payments to energy providers do not reflect the true energy consumption which is disclosed in the annual balance.</p>	<p>grid-bound energy sources such as gas, district heating and district cooling.</p> <p>There is the possibility to opt out from the smart meter scheme, but this is the exemption. The business-as-usual procedure should be based on the use of smart meter data. Professionals should be granted access to smart meter data based on their professional license.</p> <p>Energy bills: In addition, energy bills provide useful information, and they are the only source of information for non-grid-bound energy sources such as solid biomass. A copy of the energy bill should be transferred automatically to the building logbook.</p>

Table 6. Ensure latest information on the building status

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Ensure latest information on the building status	<p>The actual building status is unknown. The EPC has a validity of 5 to 10 years, and during this period, changes may have occurred. This leads to challenges in various areas:</p> <p>In the building renovation plan that will substitute the long-term renovation strategy according to proposed EPBD recast, the</p>	<p>A process of tracking the implementation of measures presented in the Renovation Passport ensures that the latest information about the building status is available.</p> <p>It is also important to make some selected information publicly accessible for further use.</p> <p>Possible options for tracking the implementation of renovation measures are:</p> <ul style="list-style-type: none"> • through the extended EPC database including Renovation Passports

	<p>renovation rate must be reported.</p> <p>Real estate valuers need up-to-date information about the building for their assessment and thus will appreciate such information.</p> <p>ESCOs are also interested in the actual status of buildings in a certain area, to decide if further investigation could be worthwhile.</p>	<ul style="list-style-type: none"> • through energy audits and energy management systems (the building specific; result would need to be transferred to the building logbook) • through logging changes to the building in building information models (building specific and available in the building logbook)
		<p>To make selected information from the database publicly accessible: A data processing step is needed to connect buildings to a Geographical Information System and display selected data on a map.</p>

Table 7. Enable the spatial reference of the information

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Enable the spatial reference of the information	As far as the integration of renewable energy systems into the Renovation Roadmap is concerned, information about potentials and possible obstacles is difficult to access and sometimes not even available.	<p>Municipal/regional spatial information repository: A link should be established with regional/municipal plans to provide information about spatial renewable energy potentials and details of the urban plans which could hinder the exploitation of renewable energy.</p> <p>This is especially important with a view to achieving the zero-emission target.</p>

Table 8. Include financial information and a reference to the Taxonomy Regulation

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Include financial information and a	Economic profitability calculations are not suitable to consider the investor user dilemma regarding energy	Life cycle cost analysis: For the Renovation Passport, the parameters for the life cycle analysis must be specified so that the results are comparable.

reference to the Taxonomy Regulation	<p>efficiency and renewable energy measures.</p> <p>Life cycle cost analysis can provide a solution to this challenge. However, per definition, life cycle cost analysis can refer to different physical and temporal system boundaries, and thus, results from different calculations are hardly comparable.</p> <p>Financing organisations need easily understandable information on the extent to which a project is compliant with the Taxonomy Regulation or not.</p>	<p>But even then, this cost estimate only offers a rough orientation due to the long period under consideration and the rapidly changing economic environment. It must be clear that no liability can arise in this respect for the experts involved.</p>
		<p>Compliance with the criteria of the Taxonomy Regulation: Regarding financing, it is suggested to include a statement in the Renovation Passport on how the renovation project would be rated against the criteria of sustainable investment according to Taxonomy Regulation.</p>

Table 9. Extend the independent control system according to Article 18 EPBD from the EPC to the Renovation Passport

TIMEPAC scenario	Challenges to be addressed	Possible solutions
Extend the independent control system according to Article 18 EPBD from the EPC to the Renovation Passport	In the course of a building renovation, the volume and the net floor area of a building can change, for example because an additional floor is added. Indicators refer to square meter and cubic meter which means that the determination of floor area and volume is a source of errors regarding the reliability of indicators.	Check of renovation measures, timeline, energy savings, area and volume: Often, the independent control system is a stepwise system which is based on an automatic plausibility check implemented during or after upload of the EPC into the database. Checks need to include the renovation measures suggested in the Renovation Passport and could focus on estimated savings and the implementation timeline. Quality checked Level 3 BIM architectural models could be used by the independent control system to check the reference area and the reference volume used for calculating the indicators.

Table 10. Make the Renovation Passport accessible for further renovation planning

TIMEPAC scenario	Challenges to be addressed	Possible solutions
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<p>Make the Renovation Passport accessible for further renovation planning</p>	<p>It is not always clear that the Renovation Passport does not substitute technical and construction planning, but provides orientation to the building owner and/or the facility manager to start such a process.</p> <p>It is important that the Renovation Passport includes information about crucial energy-related aspects which need to be considered when starting detailed technical and construction planning.</p>	<p>Start of renovation planning based on the Renovation Passport: It must be ensured that the building owner and the facility manager take note of the Renovation Passport. If general measures are planned for the buildings, it must be clear that the Renovation Passport will be consulted so that the corresponding energy upgrading will also take place.</p> <p>The first step is to upload the Renovation Passport into the building logbook which the owner and the facility manager have access to. Ideally, however, a link can be established between the Renovation Passport and the facility management software used for property management.</p>
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The Tables 56 and 57 refer to the requirements for the Renovation Passport as outlined in Article 10 of the proposals for EPBD recast and provide suggestions on how authorities could address these requirements, and/or which aspects are important to consider.

Table 11. Requirements which most likely will apply (based on the Commission proposal for the recast EPBD)

Requirements the Renovation Passport shall comply with (according to Article 10 Commission proposal for EPBD recast)	Recommendations on how these requirements can be addressed by the authority
<p>It shall be issued by a qualified and certified expert, following an on-site visit</p>	<p>Specialised professionals such as energy auditors, EPC assessors, and energy advisors should be entitled to develop Renovation Passports after having passed an additional training.</p>
<p>It shall comprise a Renovation Roadmap indicating a sequence of renovation steps building upon each other, with the objective to transform the building into a zero-emission building by 2050 at the latest</p>	<p>The Renovation Roadmap must be building specific and provides orientation for the building owner what needs to be done to upgrade the building according to the standard.</p> <p>The Renovation Roadmap is the basis for a detailed technical renovation and construction planning. Renovation measures must be planned applying the principle of energy efficiency first, whenever possible.</p>

Requirements the Renovation Passport shall comply with (according to Article 10 Commission proposal for EPBD recast)	Recommendations on how these requirements can be addressed by the authority
	<p>The Renovation Roadmap is the basis for access to affordable finance which includes the cost for detailed technical renovation and construction planning.</p> <p>A municipal information system is established (zoning plan, spatial energy information, etc.) to ensure transformation into zero-emission buildings.</p>
It shall indicate the expected benefits in terms of energy savings, savings on energy bills and operational greenhouse emission reductions as well as wider benefits related to health and comfort and the improved adaptive capacity of the building to climate change	<p>The information to be included on wider benefits might require the use of additional tools.</p> <p>The information to be included on the improved adaptive capacity of the building to climate change might require an assessment that includes information from the municipal plan (e.g. heat islands, green spaces, urban ventilation corridors, share of soil capable of rainwater infiltration).</p>
It shall contain information about potential financial and technical support	<p>The measures outlined in the Renovation Roadmap should be eligible for funding if the packages of measures and the sequence are adhered to.</p> <p>Funding covers both, detailed design and implementation of renovation measures, i.e., costs for planners/engineers, materials, and labour are eligible.</p>

Table 12. Additional possible requirements (based on the Parliament proposal for the recast EPBD)

Additional possible requirements for the Renovation Passport (according to the Parliament proposal)	Comments and recommendations for the authority
Issued in a digital form suitable for printing	Upload via XML from the software to the Database is recommended. In this way, an important step is made to extend the Independent Control System to the Renovation Passport as required by the Commission proposal for recast.

Additional possible requirements for the Renovation Passport (according to the Parliament proposal)	Comments and recommendations for the authority
Renovation steps building upon each other in line with the Energy Efficiency First principle	This is an essential principle, but not easy to control and enforce. It needs to be addressed in trainings and funding schemes.
Outlining measures to reduce whole life-cycle greenhouse gas emissions in the renovation process	<p>The scope needs to be defined: is it only related to materials and building operation, or is construction site logistics (transport of materials, machines, and workers for renovation) also included?</p> <p>The databases of the embedded energy (and emissions) of the materials should be consistent and common in the European Union, in order to be able to compare the results of life-cycle greenhouse gas emissions of different buildings.</p>
Expected benefits in terms of whole life-cycle greenhouse gas emissions reductions	Whole life-cycle greenhouse gas emissions reductions can gain importance in connection with national carbon tax schemes and the extension of emission trading to non-ETS sectors such as the building sector.
Information about a potential connection to an efficient district heating network, the share of individual or collective generation and self-consumption of renewable energy	Access to spatial information regarding district networks, renewable energy potentials, and municipal urban plans is required. Regarding solar technologies, it is essential to have information regarding possible urban changes in terms of new buildings to be constructed in the neighbourhood, and the possibility of adding storeys to buildings in the neighbourhood.
Information on a range of estimated costs for each recommended renovation step, as well as the estimated costs of a one-step deep renovation as a reference scenario	The reference scenario of a one-step deep renovation scenario should not be mandatory. In many cases, when a staged renovation is envisaged, a one-step renovation is simply not an option for practical reasons such as building components technical and/or economic lifetime, and financing.
Information on bill of materials, information on construction products circularity as well as wider benefits related to health, comfort, indoor environmental quality, safety such as fire, electrical, and seismic safety	Material and product databases contain results of life cycle assessments. Environmental Product Declarations (EPD) can be used to extract the relevant information. Attention needs to be paid to the fact that EPDs can be generic or product specific.

Additional possible requirements for the Renovation Passport (according to the Parliament proposal)	Comments and recommendations for the authority
	It is recommended to check the planned renovation measures regarding implications on fire safety (insulation, installation of PV systems) and other aspects. However, this requires detailed technical and construction planning that is beyond the scope of a Renovation Passport. It must be clear that the Renovation Passport does not substitute technical and construction planning.
Information on any major renovations made to the building, and any retrofitting or replacement of a building element that forms part of the building envelope with significant impact on the energy performance.	The development of a Renovation Passport must be based on an on-site visit. It is necessary to assess the status quo, as the energy performance certificate and energy audit reports, if available, may be outdated, as well as the architectural drawings and the documentation of the technical building systems, because changes have been made to the building.
The Renovation Passport may contain additional information, taking into consideration the composition of the household and any planned renovations, including those not relating to energy, in accordance with national law and practice.	This is an essential aspect, because renovation measures such as changes to the building envelope or the heating system are not always carried out exclusively to improve energy efficiency.
Member States shall facilitate the integration of Renovation Passports in the digital building logbook, gathering technical and legal information with essential data for property owners to plan and execute deep and staged deep renovations.	Attention needs to be paid to Copyright law/act and Intellectual Property Rights of designs, reports and data collections. Guidance is needed who owns which data and who can re-use data under which conditions; e.g. contractual agreements that data, designs, reports are uploaded to the building logbook and can also be shared with others by the building owner.

1.4.3 The role of municipalities

Apart from overriding federal and/or state building regulations, municipalities enact ordinances based on local, topographical, and demographic conditions. Here, the holistic approach to interfaces between energy performance certificates and 3D models of a building for renovation can be embedded very well. TIMEPAC supports the municipalities in filling the gaps.

- In the municipalities, original plans of the building stock are usually available, but rarely digitised. They also contain all the information about the various grid owners (natural gas, district heating, district cooling, and electricity). These must be collected by a specialist planner before renovation and the actual condition of the building, which is provided with a notice from the responsible municipality, must be determined.
- These original plans have to be reconciled with the current condition of the building and the owner's ideas under building law. For the authorities, an official submission plan, previously 2D, is explicitly important, as it shows, for example, the taxable area. Thus, the holistic approach of TIMEPAC therefore also helps here in the municipalities, as it breaks down these areas quickly and reliably.

A forward-looking example that has already been implemented in Vienna is the EU-funded "BRISE Vienna" project, in which a BAM - a building application model - is submitted digitally to the authority, which makes a statement in advance on the 3D model. The Artificial Intelligence in the background quickly examines the legal specifications, and residents can use virtual reality to check out the future building. The advantages are a 50% reduction in processing time for the authority and the citizens. More information is available at <https://digitales.wien.gv.at/projekt/brisevienna/>

1.5 The perspective of building professionals

1.5.1 Key points concerning workflow and corresponding tools

The following key points concerning the workflow and the corresponding tools are important in the process of generating a TIMEPAC Renovation Passport and consequently more renovations.

The TIMEPAC Renovation Passport, with its claim to track the implementation of renovation measures, links the EPC to the architectural and engineering work of actual renovation planning and implementation.

In this context, it is noted that each architectural or planning office works with different software providers, drawing software with their updates and various operating systems. Each of them also offers the possibility of a 3D model to work with different components involved in the project.

The following important points need to be considered when establishing the ideal workflow:

- In terms of developing the **TIMEPAC Renovation Passport** including the long-term Renovation Roadmap and the possibility of tracking the implementation of renovation measures, a specific model with a BIM offering software must be created in which all the data relevant to the project participants, such as the attributes of the materials, are listed. The compatibility of the files plays a major role here which can be ensured by compatible software products.
- In terms of **actual planning and implementation of renovation measures**, in many cases, an official submission plan for the renovation project is required by the authority which has to comply with certain requirements.
- In terms of **issuing the EPC**, the official software approved in a country must be applied.
- Ideally, the **BIM offering software and the included software packages** can perform the three functionalities as described above.

- In any case, a coordinator who manages the data and recreates it in case of changes due to the implementation of renovation measures is of great importance. This is a new role, the one of the **TIMEPAC manager**.

Larger offices have one or more BIM experts. SMEs still save the costs, as it does not (yet) seem economically viable to use BIM except for large-volume construction projects, which tend to be industrial and commercial buildings. The same applies to the creation of the Energy Performance Certificate, either it is created in the office or outsourced.

The implementation of the TIMEPAC Renovation Passport can be the starting point to combine several small offices into a network, using the same BIM offering software and the corresponding software packages.

In summary, the possibility of all data being collected in one place should be more widely used by professional designers. This would be to their advantage to be able to perform the life cycle assessment of a building, which is required not only for the improved TIMEPAC EPC and Renovation Passport, but also for green building rating systems and determination of compliance with the Taxonomy Regulation.

1.5.2 Software providers, plug-ins, and EPC software

It is important to note that using different software providers results in loss of information each time data is transferred. Although the .ifc exchange format enables product-independent cooperation, information losses cannot be avoided at present and are particularly problematic for material properties, which play a decisive role for the extended TIMEPAC EPC and the Renovation Passport.

Figure 7 shows a brief overview of the market of software providers concerning 3D software, BIM, energy modelling and LCA assessment software, as well as EPC providers, using the example of Austria. It is evident that collaboration between different companies on the Renovation Passport will be challenging due to the different software that is used.

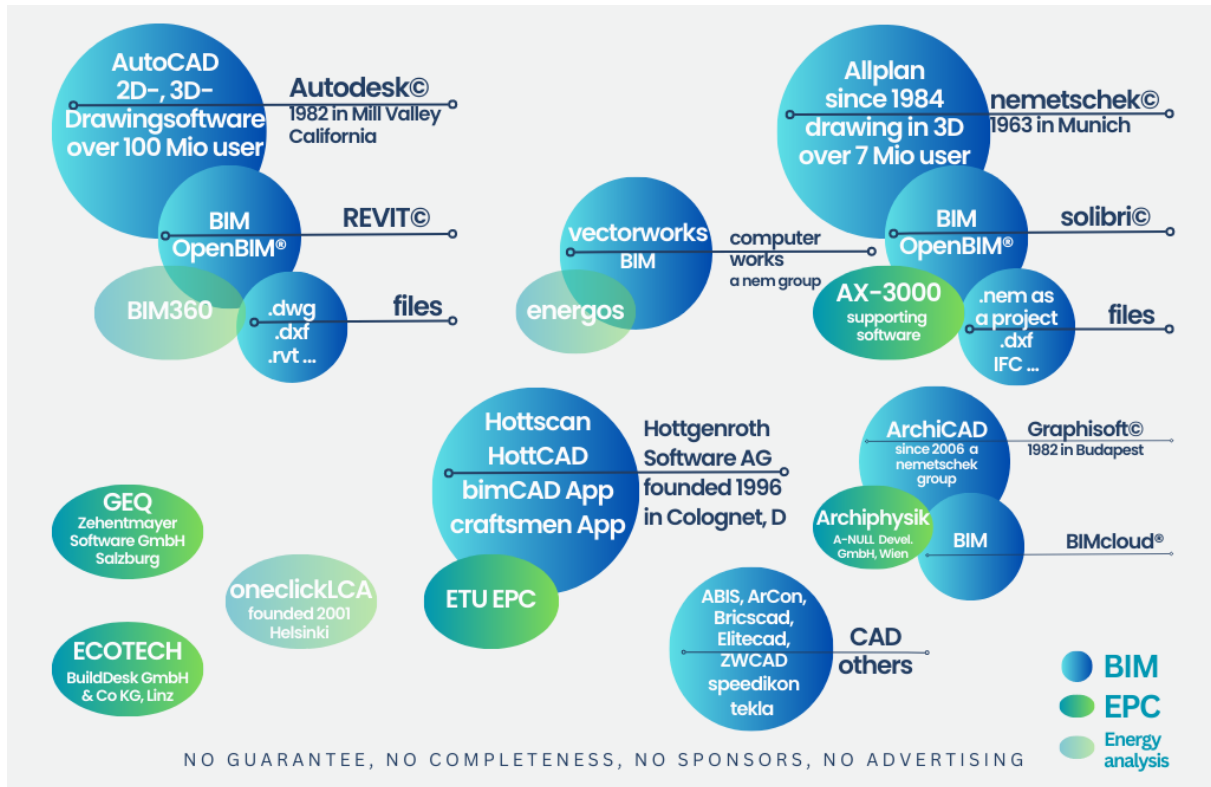


Figure 7. A brief overview of software providers with focus on Austria (SERA 2023)

1.5.3 Workflow with the software tools of CYPE

CYPE Ingenieros offers software solutions for engineering and construction with its headquarters in Alicante (Spain). With 171 applications, they cover the entire range of design, analysis, regulation, reports, and graphical results (plans and 3D models). The individual applications have small amounts of data, only 12 MB each.

Furthermore, they created a collaborative tool, the so-called BIMserver.center. This virtual platform connects these modules via OpenBIM® in the cloud as a holistic solution. In accordance with EN ISO 19650, it manages all information and stores all data throughout the life cycle of a construction project. It is a place where experts can work on the project in a team, make it public in the sense of OpenBIM® or not (Figure 8).

The specialist planner is able to upload a building, feed it into the various modules offered and also work on it there. BIM experts have the possibility, if there is a change, to change it directly here.

- CYPE facilitates many things: implement all changes without importing all new models. The workflow with CYPE connects the individual models, adds supplements in parallel and uses only the tools needed for this purpose.
- Three options are available to start a project:
 1. You prefer 2D drawings for the project, so you use the IFC Builder.
 2. The planner applies the tool CYPE Architecture or optionally another one.
 3. The Open BIM Construction Systems, if you want to define the construction elements before the energy model.

- Then the tool Open BIM Analytical Model follows. If you work with an IFC-file then the IFC Uploader will be beneficial. To create an analytical model, the OpenBIM Analytical Model is used and easily guides to the CYPETHERM EPlus.
- CYPETHERM EPlus is the energy modelling tool and generates the EPC.
- If you want to compare some models or make changes within them, e.g. through renovation measures, the tool CYPETHERM Improvements Plus is available.

It is important to know that the tools for official Energy Performance Certificates according to legal provisions are only available for the countries Spain, Portugal, Italy, and France. In these countries, the EPC can be generated from CYPETHERM EPlus. Thus, these countries benefit from the seamless and complete data transfer between tools without loss of information. Changes to the architectural model due to renovation measures will be reflected automatically in the EPC.

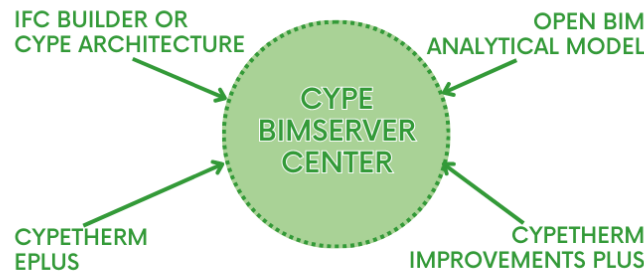


Figure 8. Overview of the relevant software tools of CYPE (SERA 2023)

1.6 The perspective of building owners and property managers

1.6.1 Single-family houses

Building owners have to face a multitude of possibilities to adapt their living space to the respective demands. Depending on the stage of life of the owner or on the year of construction of the living space, there are different reasons arise why renovations are relevant.

- The space requirements no longer cover family needs
- Material fatigue appears on an object and causes creeping damages to the building structure
- Roof renovation
- Outdated drainage and heating pipes
- High energy consumption

The simple installation of a photovoltaic system and the replacement of the heating system at great expense do not make a building energy efficient. The life cycle assessment of the building comes into focus.

It is not easy for the owners to figure out the extent of renovation in terms of time or technical possibilities. The holistic approach of the BIM based TIMEPAC Renovation Passport helps to generate a virtual 3D model to which everyone has access with all data sovereignty, which is stored with the

Energy Performance Certificate or with specific data on the building structure and can be modified depending on the renovation status.

These processes capture temporal developments on buildings along with the complicated renovation route. With a virtual twin, created from a BIM-offering software and its plug-ins, an enhanced energy certificate is created that potentiates the number of renovations in existing buildings.

Challenges in this area are the high financial costs of redevelopment. These costs are not only justified by the fact that building-relevant data is stored for future generations, who have faster access to the structure of the building. In addition, the real estate industry is taking up the term 'stranded asset'. This means that existing properties are devalued due to high CO2 emissions to such an extent that they are difficult or even impossible to sell on the real estate market - they become stranded. It also means that energy-inefficient buildings lose significant value. Building refurbishments to zero-emission standard not only bring comfort for the occupants - but they are also worthwhile in the long run.

1.6.2 Apartment buildings

In the case of apartment buildings, renovation is either to be carried out on condominiums, rental flats or the building complex itself. These are managed by building managers, whose focus is the maintenance and upkeep of the same. The holistic approach of the BIM-based TIMEPAC Renovation Passport provides a fast, cost-effective and supportive method to assist property managers. This results in the following:

- Combine several building complexes in ONE refurbishment campaign to reduce costs.
- First advantage: Contractors such as façade builders, heating engineers, plumbers, receive large orders for an entire area. If you only refer to a single building with a single order, it is uneconomical. Many things are not renovated for this reason due to the high expenditure of time and the low return.
- Second advantage: The one-stop-shop of the TIMEPAC Renovation Passport provides a project-controlling unit that coordinates all participants, property managers, architects, executing companies, based on the intelligent 3D model. During the renovation process, everyone involved has access to the 3D model, which, with rapidly advancing digitalisation, can also be read with data glasses and modified on-site in the near future. Even if something unforeseen happens on the construction site, the collaborative BIM image of the building is analysed and reflects the changes to the building or building services in real time. It saves costs and is stored for subsequent planners and generations, and later changes.

Good examples for such group building renovations exist, for example in Hepokulla, a suburb of Turku in Finland. This is a joint project of seven housing companies carrying out extensive renovation work on 26 apartment buildings. These include façade and pipe renovations, implementing geothermal energy, recovery from exhaust air and provisions for solar power. Both the pipes and the facades were nearing the end of their useful life, and the mortgage lending value of the flats would not have been sufficient to cover the square metre cost of the refurbishment of around € 1,200. With the help of an external valuer, it was possible to show that the value of the flats would increase to a sufficient level if

the whole area were uniformly refurbished.³ So, the term "stranded asset" also plays a significant role here.

1.6.3 Non-residential buildings

For non-residential buildings, the same applies as for those already mentioned, but there are differences in data protection rules. In general, non-residential buildings benefit from the holistic approach of the BIM based TIMEPAC approach. The interlink of the improved Energy Performance Certificate with the ever-evolving 3D models in the appropriate application framework and usage space helps to unfold the great renovation potential on the one hand and to facilitate the documentation of changes within it on the other hand.

- The virtual model of a building object contains all data regarding energy consumption and life cycle information. These are managed in designated data repositories.
- Changes to the building resulting from refurbishment are updated as required.

The ownership structure of non-residential buildings must be considered. In the case of administrative and state institution buildings there are seldom - if any - requirements for data protection with respect to the collected and deposited data of the object. In the private sector, dealing with it is essential.

³ Kaisa Salminen, Renovation project Hepokulla, Rakennuslehti – in "Construction Industry Magazine", 28.02.2022



Figure 9. How to turn your building in a zero-emission building with the TIMEPAC Renovation Passport (SERA 2023)

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Annex A – Definitions of nearly Zero-Energy Building and Zero-Emission Building

Article 2 – Definitions

EPBD recast - Commission proposal

'zero-emission building' means a building with a very high energy performance, as determined in accordance with Annex I, where the very low amount of energy still required is fully covered by energy from renewable sources generated on-site, from a renewable energy community within the meaning of Directive (EU) 2018/2001 [amended RED] or from a district heating and cooling system, in accordance with the requirements set out in Annex III;

'nearly zero-energy building' means a building with a very high energy performance, as determined in accordance with Annex I, which cannot be lower than the 2023 cost-optimal level reported by Member States in accordance with Article 6(2) and where the nearly zero or very low amount of energy required is covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;

EPBD recast - Council proposal

'zero-emission building' means a building with a very high energy performance, as determined in accordance with Annex I, requiring zero or a very low amount of energy, producing zero on-site carbon emissions from fossil fuels and producing zero or a very low amount of operational greenhouse gas emissions, in accordance with the requirements set out in Article 9b.

'nearly zero-energy building' means a building with a very high energy performance, as determined in accordance with Annex I, which cannot be lower than the 2023 cost-optimal level reported by Member States in accordance with Article 6(2) and where the nearly zero or very low amount of energy required is covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;

EPBD recast - Parliament proposal

'zero-emission building' means a building with a very high energy performance, as determined in accordance with Annexes I and III, which contributes to the optimization of the energy system through demand-side flexibility, where any very low residual amount of energy still required is fully covered by energy from:

- (a) renewable sources generated or stored on-site;
- (b) renewable sources generated nearby off-site and delivered through the grid in accordance with Directive (EU) 2018/2001 [amended RED];
- (c) a renewable energy community within the meaning of Directive (EU) 2018/2001 [amended RED]; or

(d) renewable energy and waste heat from an efficient district heating and cooling system within the meaning of Directive (EU) .../... [recast EED], in accordance with the requirements set out in Annex III; 'nearly zero-energy building' means a building with a very high energy performance, as determined in accordance with Annex I, which cannot be lower than the 2023 cost-optimal level reported by Member States in accordance with Article 6(2) and where the nearly zero or very low amount of energy required is covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;