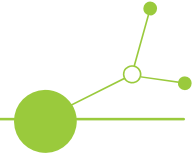




D 1.1.2 Analysis of current systems for management of buildings



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A. Report summary

This report seeks to provide an assessment of current systems for building management that are available in MESTRI partner countries. To that end this report uses data from Italy, Germany, Poland, Croatia, and Austria to compare systems and to recognise regional differences and specificities, thereby laying the groundwork to evaluate a variety of tools against the needs and the requirements that form the basis of the Smart Data Hub.

To that end it is worth first considering what the key needs of the smart data hub are. This is outlined in section B *Guiding topics for selecting tools*. In particular, this deliverable outlines our concept of the three different needs that the Smart Data Hub must meet, referred to here as the three use cases. These will be explored in more depth later, however in summary, use case I considers the individual building level and seeks to suggest high level renovation packages that are appropriate for various building types. Meanwhile, use case II takes a more granular approach in the direction of a renovation concept, starting at the individual building level and focusing on the development of specific renovation concepts. Finally, use case III functions at the portfolio level to suggest a decision roadmap that also considers top-down budgeting. These three use cases form the backbone of the concept of the Smart Data Hub, thus the management systems that are currently available are evaluated in this report against their capacity to deliver in a way that aligns with these three central use cases.

Given the centrality of these use cases, key criteria were developed against which the software could be compared. This was to determine whether they provided sufficient information to allow for a reconciliation with the needs of these use cases. In particular the main criteria for assessment were: the capacity for the software tool to contribute to portfolio management, meaning its capability to assess a portfolio of buildings in lieu of merely individual buildings; the software's capability to produce renovation concepts, this considered the sensitivity of the tool and the ability to introduce very specific data; the capacity of the software to determine individual measures, based on inputting granular information; the ability of the user to enter data into the tool, in particular varying the level of its specificity based on regional and contextual availability; the software's ability to provide 3D models and thermal simulation, this is not always necessary for all use cases but provides a more detailed and comprehensive approach; and finally compatibility with the CRREM path, EU taxonomy, and other core requirements, as without meeting these specifications the tool will lose a lot of its value. These were the main tools against which the current systems were assessed.

Another key element is their sensitivity to regional variation, this is why this report is divided based on countries, as within each country there will be regional variation and complexities which need to be accounted for. Alongside this it is also important that any tool is able to adapt to different national needs and requirements where appropriate.

The report has gathered information analysing these systems against these criteria and has ultimately put together a shortlist of three different tools. These three tools are Optimuse, Scandens and Yessa. These tools alongside the others analysed by e7 and partners reflect that a plethora of tools already exist on the market which could contribute to the creation of the Smart Data Hub. This information has led consortium partners to suggest that a next rational step would be to explore the potential of working with pre-existing software tools to ensure that the Smart Data Hub meets of the complex needs required to facilitate good portfolio level decisions that respond to diverse central European geographies and needs.



B. Guiding topics for selecting tools

The Smart Data Hub developed in the MESTRI project should support the sustainable management of buildings and enable the identification of buildings for investments according to certain criteria and sustainability characteristics.

Based on this, existing tools will be researched to assess which functions can be provided by already established tools and where gaps exist. A major focus of the Smart Data Hub will be how to interlink considerations at individual project and portfolio level. Both perspectives are relevant for further development and impact investment decisions.

Three use cases were therefore identified by e7 that should be considered and covered in the subsequent development of the Smart Data Hub.

Use case 1: Use case I focuses on the individual building level. It seeks to select high level renovation packages appropriate for various building types and ideal typical starting conditions. To achieve use case I a generic tool will be developed that provides an initial assessment and classification of buildings, using this a high-level investment strategy can be developed.

Use case 2: Use case II operates at the individual building level and is focused on the development of renovation concepts. These renovation concepts will have a higher level of detail compared to use case I, including onsite visits, additional building data etc. requiring a comparable level of detail to an energy audit. In particular, use case II differs from use case I in these ways:

- By providing a more detailed analysis of the buildings.
- By providing additional data derived through on-site visits, for which a standardised checklist is provided to ensure that relevant and comparable data is collected.
- By providing a feasibility check for generically assigned packages of measures.
- Resulting in a suitable renovation concept for each individual building.

Use case 3: Use case III operates at the portfolio level to elaborate a decision roadmap, including top-down budgeting. In particular, the data collected on individual buildings is considered at the portfolio level, thus enabling assessments and plans to be designed for the entire building stock. Moreover, different objectives and priorities will result in portfolios renovating buildings in different sequences and to different standards.

The main criteria in the search for existing tools has focused on the following:

- **Portfolio management:** Are there already software solutions that deal with the management and planning of building renovation in relation to an entire portfolio? What feature can be used to classify these portfolio stocks to provide an overview in these programmes? According to which metrics can portfolio level decisions possibly be made using these classifications? Do these criteria relate to both sustainability and financing?
- **Renovation concepts:** To what extent are renovation concepts already taken into account at individual project level, and is it already possible to create renovation concepts within the software tool? Are individual measures for thermal building renovation and boiler replacement proposed by the programme? If so, what principles and criteria are used to select them and what catalogue of measures is in the background? Is it possible for the user to intervene here? Above all, it is also relevant which target values are aimed at for individual buildings and for an entire portfolio.
- **Renovation measures:** Both a holistic view of renovation concepts and a realistic provision of individual measures that can subsequently be combined to form a bundle of measures are important for an overall package. Therefore, the objective is not only to suggest a large selection of different



measures, but also the possibility to adapt them individually is crucial. The criteria on which the selection of the various measures are based is also relevant.

- **Data entry:** As a basis for all subsequent assessments and calculations, also as an important cornerstone for suitable renovation measures, the depth of detail and necessary accuracy of data is crucial. Therefore, attention was also paid to which data had to be entered for the evaluation of the buildings and what options were available should these not be completely available.
- **3D model and thermal simulation:** If a holistic view of buildings at all levels and with varying degrees of detail is to be carried out in a single tool, not only data availability but also data preparation is of crucial relevance. Especially for a detailed thermal analysis of the building programmes that can already offer a 3D model and, ideally also a thermal simulation were preferred.
- **Compatibility with CRREM path, EU taxonomy and similar requirements:** Especially for building owners with larger building stocks, a long-term view is highly relevant. Therefore, it was also researched whether the software tools already offer an assessment of the buildings according to the EU taxonomy or the CRREM path.

Even after the deliverable is completed, contact with the tools' developers will continue. Some of the tools will be looked at in more detail, so there may be further insights and possible collaborations.

C. Country overview of current systems for management of buildings

Italy

CERPLAN (Cost Effective Renovation Plan)

Most important use cases	It simulates redevelopment scenarios for a building stock determining the most suitable and cost-effective solutions.	
Deep renovation addressed by	The software developed by Eurac Research, makes it possible to organise more clearly all the data necessary for correct planning of interventions and, above all, identifies where and when to intervene with a rapid economic return. Interventions are selected with a medium- to long-term approach.	
Typical users	The Autonomous Province of Bozen, Public buildings, such as offices and schools.	
Data to be input	General information; Geometric data; Envelope data; Energy consumption data; HVAC information (Heating, cooling, ventilation); Lighting information; Renewable energies.	
	Is the following data requested? If yes, how will it be collected?	
	Building data	-
	Cubage	Yes



Energy performance indicators	No (they are calculated by the software itself)
Location	Yes
Others	Yes
Building portfolio data	-
Costs/budgets	Yes (in the first stage, they are calculated by the software itself according to the first hypothesis and, once the interventions have been selected, they are inserted by the user)
Measures (individual measures/bundles of measures)	No
Other	Yes
Grouping of buildings	No
Used default values	User and system profiles, such as climatic conditions, are taken from the applicable regulation. The results are generated by a computational approach that mixes default values and data entered by the user.
Proposed renovation measures	Insulation of opaque surfaces; Replacement of windows; Installation of: condensing boiler, biomass boiler or chiller; Replacement of artificial light; Installation of heat recovery on ventilation
If not proposed, how are they put together	-
What do they address	Reducing energy consumption and CO2 emissions
Unique features	Currently, EURAC Research is working to implement a new logic that will select interventions in order to achieve the targets and respect the timelines introduced by the new EPBD. In addition, a link with seismic requirements will be added.
Limitations	The software is not yet able to take into account all possible interventions related to energy improvements, e.g. the installation of heat pumps is not taken into account. As it has been developed by a research institute and is still being developed, the time needed to implement changes is long compared to a private company.

Germany

INM Management



Most important use cases	Software for the energy management and controlling of buildings in communalities. The software is cheap (unique payment of 40€ per building, less for over 20 buildings) and intuitive. The data can be given manually or automatized.
Deep renovation addressed by	This tool is designed to monitor all energy aspects of the building. This means that it provides a very solid foundation for renovation decisions and also for the assessment after a renovation. In a portfolio analysis, the tool analyses this and finds the buildings with the highest need for renovation measures.
Typical users	Cities and other public building owners, this software is especially useful for smaller communalities.
Data to be input	As this is a software for energy management, it mostly requires the surface area and the energy data that needs to be updated regularly (by hand or automatically). Taken renovation measures or concepts for future renovation can be included.
	Is the following data requested? If yes, how will it be collected?
Building data	Yes (year, surface etc.)
Cubage	No
Energy performance indicators	Yes, manually or automatically in a chosen interval
Location	Yes
Others	-
Building portfolio data	Yes
Costs/budgets	When a taken measure is included, it is possible to add the costs. Budgets for future investments cannot be included
Measures (individual measures/bundles of measures)	Can be included
Other	-
Grouping of buildings	Yes, the buildings are categorized by use case
Used default values	No data is intentionally used in default values. Those are only used if needed information is not available from a measurement / if data is incomplete.



Proposed renovation measures	In the course of the reporting, it is possible to get "hints to energy reduction potentials". As we don't yet use this part of the tool, we cannot tell how far those proposals go. The need for measures is calculated based on benchmark values.
If not proposed, how are they put together	-
What do they address	The measures would address the energy efficiency of the building.
Unique features	Compared to other software, this tool is very cheap which makes it a good choice for small communities and prevents the tool from being more expensive than the savings resulting from the energetic analysis. Moreover, it includes the portfolio analysis which is very sophisticated.
Limitations	Compared to the software by Ingsoft, this tool is less intuitive and user-friendly in the in- and output of information. This means that it is more time-consuming for the end-users. If this time is invested, there is no lack in output information. The difference explains the cost difference between the tools.

Ingsoft InterWatt

Most important use cases	This tool provides energy- climate- and sustainability management. Compared to the INM software, this tool is more expensive especially for smaller communalities which is why we only use it for larger cities.
Deep renovation addressed by	-
Typical users	This tool is typically used by larger cities and companies.
Data to be input	Floor space, energy consumption, meter readings
	Is the following data requested? If yes, how will it be collected?
Building data	-
Cubage	No
Energy performance indicators	Yes
Location	Yes
Others	-



	Building portfolio data	Year of construction, renovation
	Costs/budgets	No
	Measures (individual measures/bundles of measures)	No
	Other	-
Grouping of buildings	-	
Used default values	-	
Proposed renovation measures	-	
If not proposed, how are they put together	Based on the very detailed energy analysis, it is possible to see whether a building needs to be renovated or not. The specific measures can then be discussed apart from the software.	
What do they address	-	
Unique features	Use for larger clients because it is very easy to use and the quality of graphs and tables is very high.	
Limitations	This is a pure energy-related tool that does not include aspects of facility management. On one hand, this makes the energy-management very focused and easy to use. On the other hand, there needs to be another tool used for those tasks.	

VertiGIS FM by VertiGIS, former GEBman by KMS Computer GmbH

Most important use cases	<p>In contrary to the other presented softwares, VertiGIS FM is a facility management tool. As the Energy agency of Northern Bavaria only focuses on energy management and prefers focused software for this use case, we don't have personal experience with this software. It is very broad and divided in several sub-software packages:</p> <p>Buildings, Contracts, Energy, Greenspaces, Maintenance, Parcels and Street lights.</p> <p>Based on the goals of MESTRI-CE, we answer the following question with the publicly available information for VertiGIS FM Buildings, VertiGIS FM Energy and VertiGIS FM Maintenance.</p>
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<p>Deep renovation addressed by</p>	<p>The package "buildings" is meant to manage buildings, have an overview over all the assets and their data. In the package "Maintenance", inspections and measurements are managed. This mostly refers to devices instead of buildings, but those can also be for example heat supply systems. The package "Energy" creates a data base of operation values.</p> <p>As the inspections and measurements from all devices are closely monitored and organized through the software, this gives a very good base for analysis leading to renovation plans. This tool does not propose renovation measures by itself.</p>
<p>Typical users</p>	<p>Communalities, industry and building managers</p>
<p>Data to be input</p>	<p>Buildings: Categories, locations, materials, usage, surface areas, volumes</p> <p>Maintenance: Type, name, serial number, bar code, end of service, trade, service level, status, reason, work sheets, check lists, threshold tables, maintenance strategies, property categories, characteristic values, damage category, authorized person</p> <p>Energy: The specific requirements are not public, but the description shows that the most important information are the consumption parameters and that the tool can be adapted to personal demands when more information is given (for example setting an alarm when the consumption hits a certain benchmark).</p>
<p>Is the following data requested? If yes, how will it be collected?</p>	
<p>Building data</p>	
<p>Cubage</p>	<p>-</p>
<p>Energy performance indicators</p>	<p>-</p>
<p>Location</p>	<p>-</p>
<p>Others</p>	<p>-</p>
<p>Building portfolio data</p>	<p>-</p>
<p>Costs/budgets</p>	<p>-</p>
<p>Measures (individual measures/bundles of measures)</p>	<p>-</p>
<p>Other</p>	<p>-</p>



Grouping of buildings	-
Used default values	-
Proposed renovation measures	-
If not proposed, how are they put together	-
What do they address	-
Unique features	It is possible to define different access rights to different users.
Limitations	The tool is a large investment and includes many features that only apply if the users have a big portfolio of buildings or a company with many machines. In our experience, the energy management packages in facility management software have a lower performance than pure energy management software.

Poland

OnePlace Platform - 3D Energy Management System

Most important use cases	The tool presents the buildings of the selected cities/municipalities and its 3D models by using geospatial data and 3D building models for energy-related needs, improves energy efficiency planning and management, facilitates renewable energy usage and help in defining Sustainable Energy Action Plans (SEAP) at urban level.
Deep renovation addressed by	The tool provides the information of buildings essential to declare if the deep renovation for given building is needed, by comparison of the collected energy and building data. The tool shows which buildings in the area should be the prioritized to deep renovation and which measures can be implemented.
Typical users	Municipalities/Cities. The tool was developed during BOOSTEE-CE project and adjusted for new countries in TARGET-CE project. At the moment, the tool can be used by the any municipality/region by collecting GIS models and energy data about the buildings in the region. The tool can be used by every segment which is open to collect and transfer data for tool operator.
Data to be input	Tool requires collection of building footprints from cartography or LiDAR data to produce 3D buildings models. Tool (to be useful) needs additional Information which can be collected (if its available): name of building, year of construction, building type, number of floors, energy source (heat), energy consumption (heat), electricity consumption, CO2 emissions, technology used to harvest a renewable energy, estimated photovoltaic potential of building roofs, energy efficiency measures already implemented in the building, recommended energy



	efficiency measures for the building, smart meters, energy audit (if it's developed for building)
	Is the following data requested? If yes, how will it be collected?
Building data	-
Cubage	No
Energy performance indicators	Yes - information from energy certificate or energy audits
Location	Yes - collection of building footprints from cartography or LiDAR data to produce 3D buildings models
Others	No
Building portfolio data	Yes - collection of energy efficiency measures implemented in the building to see what can be done to increase energy efficiency from building
Costs/budgets	No
Measures (individual measures/bundles of measures)	Yes - as stated in building portfolio data
Other	Yes - by using the technical documentation/energy certificates/energy audits of buildings
Grouping of buildings	No
Used default values	The tool does not calculate the values - it's only shows in 3D models building with data to compare and analyse.
Proposed renovation measures	The tool does not propose (calculate) any renovation measures - the measures can be described as element of the building data, but not calculated by the tool. These measures can be: the insulation of external envelope, replacement of windows and doors, replacement of heating and/or domestic hot water system, replacement of lightning, ventilation, cooling and renewable energy sources integration
If not proposed, how are they put together	The renovation measures are collected from available documentation, depending on it details. Renovation measures can be described in general e.g., insulation of roof; or can be shown as well-detailed measures e.g. insulation of unheated attic with 15 centimetres of granulated wool (when data comes from energy audit or is calculated on the basis of the existing and required heat transfer coefficient of the external envelope)



What do they address	These measures address the needs and requirements of the applicable technical conditions for the building, especially regarding the maximum value of the Primary Energy Index (EP) and the maximum heat transfer coefficients for the building's external envelopes (for new or thermally modernized buildings).
Unique features	The tool is clearer in the view and presents the data with the one mouse click. It's open to use for any European country located in Central and Eastern Europe
Limitations	The main limitation is the lack of the measurement's calculations. Therefore, user/owner of building must propose and calculate it themselves. The main problem is to demonstrate the energy performance of the building - when the owner does not have any energy meters, the calculation of energy is troublesome without execution of energy certificate or energy audit

Living EPC Tool

Most important use cases	The Living EPC tool provides to the user information what to perform during deep renovation to adjust building energy status to "nearly zero energy building" standard. Therefore, the tool performs calculations that show us options for thermal modernization of a given building based on the entered data from the energy performance certificate regarding energy consumption in the building, the heating system, and external envelopes. Based on the indicated data, it calculates possible thermal modernization variants along with their costs and SPBT.
Deep renovation addressed by	The tool is well-suited to provide the deep renovation options for its users. The tool is focused on the deep renovation, because of its designation - Living EPC Tool is about to find out if there is possibility to achieve NZEB standard. Deep renovation is necessary to achieve it. The use of the tool also corresponds with the financial possibilities of the user, thanks to the cost calculations. The user can automatically see if the deep renovation is financially feasible.
Typical users	The tool was developed during eCentral project and adjusted to Polish standards during TARGET-CE project. During the second project, the tool was used and tested by the regional authority, therefore only public buildings sector is active within this tool.
Data to be input	The tool requires the general information about the building (name, year of construction, address) and specific energy data about energy consumption and external envelopes (energy consumption, heating system information, lighting, cooling, ventilation, external envelopes surface and its heat transfer coefficient). The tool additionally to calculate financial data, needs e.g. the unit cost of energy or costs of envelope renovation.



Is the following data requested? If yes, how will it be collected?	
Building data	-
Cubage	Yes - data collected from energy certificate
Energy performance indicators	Yes - data collected from energy certificate
Location	Yes
Others	Yes
Building portfolio data	Yes
Costs/budgets	Yes - costs are collected on the basis of the availability market prices of services and energy resources
Measures (individual measures/bundles of measures)	No - measures calculate itself and are shown in different variants
Other	-
Grouping of buildings	No, software sees buildings as the units, but it is possible to benchmark them and generate the report for the particular group.
Used default values	The energy performance data (Primary Energy Index, reduction of primary energy and CO2 emission) and financial data (cost of renovation, SPBT) is calculated with use of the default values and with use of the inputted by the user data. The default values are taken from national legislation (in Polish legislation it is mostly maximum Primary Energy Index) and the climate data.
Proposed renovation measures	the insulation of external envelope, replacement of windows and doors, replacement of heating and/or domestic hot water system, modernization of heating and/or domestic hot water system, replacement of lightning with LED, ventilation system modernization, cooling system modernization and renewable energy sources integration
If not proposed, how are they put together	-
What do they address	Measures address the reduction of the primary energy usage to the NZEB standard and reduction of CO2 emission.
Unique features	The tool has additional features which is:



	<p>1. Benchmarking of the buildings in the area which is coordinated by user - user can analyse which building's deep renovation is the most expensive, which is most cost-effective, and which has the best energy performance after deep renovation.</p> <p>2. Report generation - the calculation can be downloaded in form of xls. file and forwarded to the expert, which do not have the credentials to the Living EPC Tool.</p>
Limitations	<p>Tool is only developed for few countries which include Poland, Croatia, Hungary, Germany, Slovenia and Italy. There is possibility to access it in English language. Other limitation is only registered users, who are accepted by moderator can have access to the tool.</p>

Croatia

Energy Management Information System - EMIS

Most important use cases	<p>Energy Management Information System - EMIS is a web application for monitoring and analysing energy and water consumption in public sector buildings. EMIS provides a transparent oversight and control of energy consumption, making itself an inevitable tool for systematic energy management.</p>
Deep renovation addressed by	<p>The tool addresses the issue of deep renovation indirectly, as it contains data and features essential for the analysis of existing energy and water consumption and the basic energy properties of the building.</p>
Typical users	<p>Using the tool and entering data on energy and water consumption is mandatory for all owners and users of public buildings in the Republic of Croatia. Usually, data is entered by people who manage buildings, technicians or employees of institutions or companies who do this for owners and users. For example, REGEA enters the necessary data for the buildings of its founders (counties) and uses the tool.</p>
Data to be input	<p>Data on energy and water consumption is entered on a monthly basis, either manually or via remote entry. There is a set of basic data about the building (basic information, size, data from the energy certificate - building envelope and technical systems). There is also a module for data in case of energy renovation (time, scope, savings, etc.)</p>
<p>Is the following data requested? If yes, how will it be collected?</p>	
Building data	Yes, manually
Cubage	Yes, manually
Energy performance indicators	Yes, manually



	Location	Yes, manually
	Others	Yes, data on energy and water consumption, manually/remote entry
	Building portfolio data	Yes - manually
	Costs/budgets	No
	Measures (individual measures/bundles of measures)	No
	Other	Yes, data on energy renovation (if applicable)
Grouping of buildings	Yes, aligned with Technical regulation on energy economy and heat retention in buildings and Ordinance on energy audits of buildings and energy certification - family houses, multi-apartment buildings, hospitals, hotels and restaurants, educational, sport halls, commercial buildings, office buildings, other non-residential. The tool also groups buildings by ownership.	
Used default values	The software primarily functions as a database for energy and water consumption data. It is possible to compare and analyse the mentioned data within - and get a useful and efficient overview of consumption and possible anomalies.	
Proposed renovation measures	No	
If not proposed, how are they put together	-	
What do they address	-	
Unique features	EMIS greatly facilitates the process of systematic energy management in public buildings, as it provides easy access to energy consumption and cost data, easy graphical and tabular display and data printing and analysis results with simpler preparation of data needed to build local energy efficiency improvement plans and related reports. Using EMIS provides and enables transparent display and control of energy consumption and energy-related costs in all public sector buildings.	
Limitations	The tool lacks a module for the analysis of proposed energy renovation measures and elaboration of possible scenarios in order for the user/owner to receive information about possible renovation measures, costs and savings.	



Slovenia

DEMAS	
Most important use cases	It simulates redevelopment scenarios for a building stock determining the most suitable and track energy performance.
Deep renovation addressed by	The software developed by a private company, makes it possible to organise more clearly all the data necessary for correct planning of interventions and, above all, identifies where and when to intervene with a rapid economic return.
Typical users	Municipalities
Data to be input	General information; Geometric data; Envelope data; Energy consumption data; HVAC information (Heating, cooling, ventilation); Lighting information; Renewable energies.
	Is the following data requested? If yes, how will it be collected?
Building data	-
Cubage	No
Energy performance indicators	Yes
Location	Yes
Others	Yes
Building portfolio data	No
Costs/budgets	Yes
Measures (individual measures/bundles of measures)	No
Other	Yes
Grouping of buildings	No
Used default values	User and system profiles, such as climatic conditions, are taken from the applicable regulation. The results are generated by a computational approach that mixes default values and data entered by the user.



Proposed renovation measures	Insulation of opaque surfaces; Replacement of windows; Installation of RES systems; Replacement of artificial light; Installation of heat recovery on ventilation
If not proposed, how are they put together	-
What do they address	Reducing energy consumption and CO2 emissions
Unique features	No unique features, it's pretty straightforward.
Limitations	The software is not yet able to take into account all possible interventions related to energy improvements, e.g. the installation of heat pumps is not taken into account. As it has been developed by a research institute and is still being developed, the time needed to implement changes is long compared to a private company.

Austria

Self-developed Excel-tool for evaluation decarbonisation measures on residential and non-residential buildings

Most important use cases	<ul style="list-style-type: none"> • evaluation of renovation measures of the building envelope • evaluation of replacement of existing fossil fuel driven heating system with a renewable heating source • assessment of the retrofit options on costs, CO2-Emissions, final and primary energy demand
Deep renovation addressed by	The tool compares different depths of renovation, of which one is always deep renovation with focus on the principal "energy efficiency first"
Typical users	The tool only used by employees of e7. The focus of the tool is on residential buildings, but with small adaptations it is also suitable for non-residential buildings.
Data to be input	The tool requires data of the EPC of the existing building and EPC of the different renovation options. Good knowledge about the building and building site is required to use the tool adequate. Usually, an on-site visit is done before the tool is applied.
	Is the following data requested? If yes, how will it be collected?
Building data	-
Cubage	EPC
Energy performance indicators	EPC



	Location	Address
	Others	Hating power and envelope areas via EPC
	Building portfolio data	No
	Costs/budgets	Cost estimations are done with costs from a construction cost database (Baukostenindex)
	Measures (individual measures/bundles of measures)	Expert knowledge is necessary for specifying the individual measures
	Other	-
Grouping of buildings	No, the tool is only used for single property projects.	
Used default values	Energy performance indicators	
Proposed renovation measures	-	
If not proposed, how are they put together	The renovation measures are proposed by the one who uses the tool. The measures are based on deep evaluation of the individual building.	
What do they address	Heating demand reduction, energy performance, decarbonisation of the heating system, PV	
Unique features	The tool is excellent for comparing different renovation measures or packages. It does a easy and quick cost estimation and calculation of the running costs. You can develop detailed renovation strategies for one building, with reasonable effort.	
Limitations	At the moment the tool is not addressing ventilation and cooling systems. Building portfolio management can't be done with this tool either.	

Ecotech EPC Software

Most important use cases	Issuing energy performance certificates for the currently valid OIB guidelines in Austria. Comparison of different variants of building components and equipment of buildings regarding energy consumption and environmental aspects.
Deep renovation addressed by	It reviews the normative requirements for major renovations of buildings. It can compare different variants in terms of energy consumption and climate impact.



Typical users	Architects and planners of buildings, building physics offices, master builders, energy consultants as well as all other authorised bodies that are allowed to issue energy certificates according to WKO (Wirtschaftskammer Österreich)
Data to be input	<ul style="list-style-type: none"> • Data on the geometry of the building • Data on the building services of the building • Data on the component structures of all components that define the thermal envelope of the building • Location
Is the following data requested? If yes, how will it be collected?	
Building data	-
Cubage	Yes
Energy performance indicators	-
Location	Yes
Others	Building Service
Building portfolio data	-
Costs/budgets	-
Measures (individual measures/bundles of measures)	Measures must be entered by the applicant
Other	-
Grouping of buildings	No, only a single building can be evaluated
Used default values	Domestic hot water, ventilation rate, domestic power consumption, lighting consumption
Proposed renovation measures	No, measures must be entered by the applicant.
If not proposed, how are they put together	Entered by the applicant.



What do they address	Measures are entered by the calculator itself. It makes sense to first propose measures for the building envelope and then measures for the building services.
Unique features	Simulation includes easy variation of u-values of building components including windows
Limitations	Automatized renovation measures, costs for measures

D. Comparison and further research

Tool	Pros	Cons	Useful for	Notes
Optimuse	Intuitive handling, covers many use cases, thermal simulation	Start up with not so much experience yet	Use case I, Use case III	proposed by e7 for further consideration
Scandens	Intuitive handling, covers many use cases, thermal simulation	Currently only adapted to Swiss data	Use case I, Use case III	proposed by e7 for further consideration
yessa	Large database of measures	No focus on buildings (but on the operation)	Use case II	proposed by e7 for further consideration
Aibatros	Very advanced, has already many users	No thermal simulation, assessment of the condition of the building elements is not very detailed	Use case I, Use case III	
Ecocities	Easy handling but very simple	No updates, no thermal simulation	Use case I, Use case III	
DREEM	Working with a portfolio approach	Only tested in 3 regions so far	Use case I, Use case III	was not researched further
Plan 4	Accurate recording of the buildings	No possibility to plan measures at portfolio level	Use case I	was not researched further
EVEBI	Very advanced	Manual composition of measures for individual buildings	Use case II	was not researched further
CAALA	Covers many use cases, works in different levels of detail	No thermal simulation, not intuitive handling	Use case I, Use case III	



EERAdata	Easy handling	Not an advanced software tool	Use case I, Use case III	was not researched further
Predium	Covers many use cases	No thermal simulation, primarily considers economic valuations	Use case I, Use case III	
OPTIML	Covers many use cases, thermal simulation, based on an extensively developed method.	Software tool is currently not yet ready	Use case I, Use case III	

Tools that are currently used by the project partners

OnePlace Platform - 3D Energy Management System	Provides information of many buildings	No measurement's calculations and without energy meters, the calculation of energy is troublesome without execution of energy certificate or energy audit	To provide energy input	
Living EPC Tool	Easy handling	Only developed for few countries, input data is necessary	Use case II, Use case III	
Cerplan	Easy handling, already used by the Province of Bolzano	No thermal simulation, no advanced portfolio planning	Use case III	
INM Management	Good and cheap energy management tool for small communities	No renovation measures	To provide energy input	
Ingsoft	Good energy management tool for large communities/companies	No renovation measures	To provide energy input	
VertiGIS FM	Useful for portfolio analysis	Time-consuming	Good and cheap energy management tool for small communities and portfolio management	
Energy Management Information System - EMIS		No analysis of proposed energy renovation measures	Easy access to energy consumption, cost data and analysis results	



MESTRI-CE

			with simpler preparation of data to build local energy efficiency improvement plans	
DEMAs	Organises more clearly all the data necessary for correct planning of interventions and, above all, identifies where and when to intervene with a rapid economic return.	Still under development, not all measures are taken into consideration e.g. heat pumps	Use case III (simulates redevelopment scenarios for a building stock)	
Self-developed Excel-tool (e7)	Gathers information about energy performance through renovation measures and costs	No proposed renovation measures, no portfolio view	Use case II (detailed list of measures and their costs)	
Ecotech EPC Software	Easy variation of building components	No automatized renovation measures and costs	Preparation of building data	

E. Shortlisted tools

Optimuse

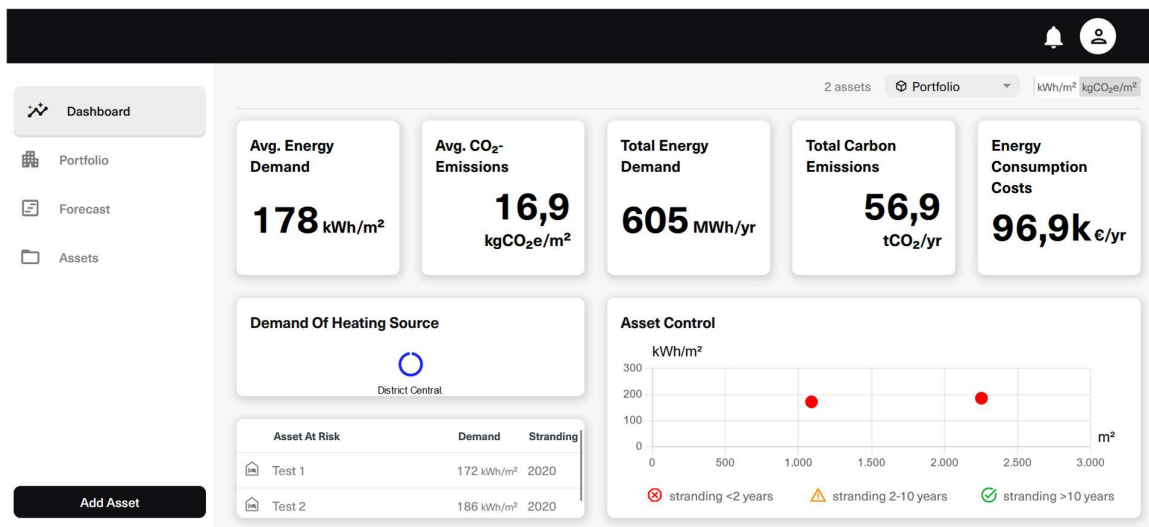


Figure 1 Screenshot of the software tool "Optimuse"



Optimuse is a start-up based in Vienna. They are currently working on a software tool that will provide a portfolio analysis of building portfolios. The software tool is structured very intuitively, working with various widgets and clear templates.

Data on specific buildings is entered. Relevant information includes the building function, the address, the year of construction, the heating source and its year of installation. Further data on the building, the heating system and the building envelope can also be entered if available, making the subsequent result more accurate. Following this data on consumption, floor plans of the building and further details can be uploaded.

AI creates a 3D model using the GIS data provided based on the exact address and the other building-relevant data and statistical values. Based on this model, a thermal simulation (energyplus) is performed, which forms the basis for further calculations and renovation concepts. Measures are then proposed by the programme and describe their influence on the building, i.e., how the greenhouse gas emissions or the energy demand of the building change. The investment costs for all measures are also included. This means that the investment costs can be planned for the entire portfolio and that these measures can be arranged individually over time.

An overview of the entire portfolio is possible in relation to several indicators such as total energy demand, total carbon emissions and energy consumption costs.

For use cases 1 and 3, some functions are already included. However, especially with regards to use case 2, adjustments would still be necessary.

Scandens

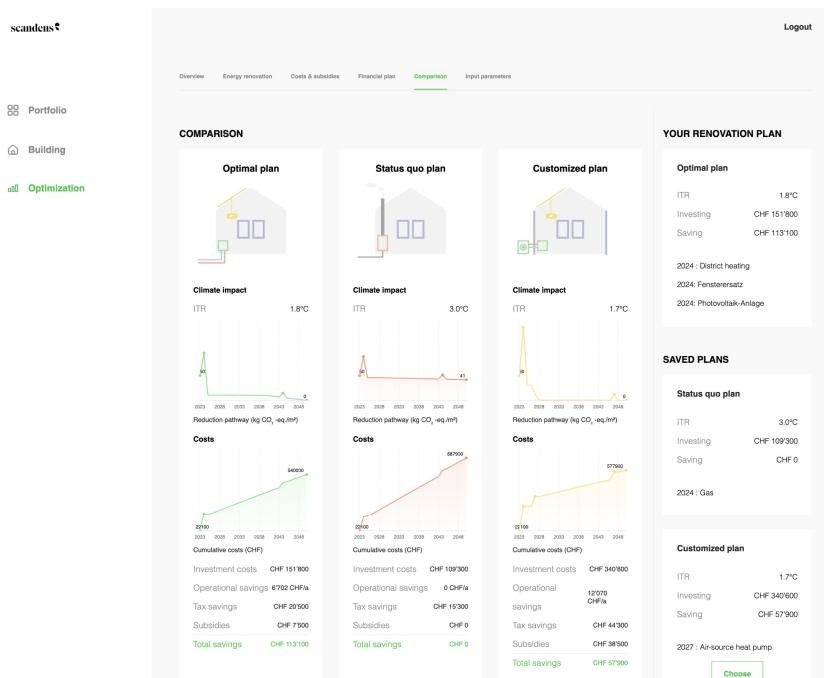


Figure 2 Screenshot of the software tool "scandens"

Scandens is a software tool that is being developed by a Swiss company and is already in use in some companies. First and foremost, the tool works with as little data input as possible. Therefore, it is necessary to know at least the address of the building. All public data will then be incorporated in order to be able to create a building model. Especially in Switzerland, there is a good database that can be accessed. If available, further data on the building can also be entered, for example information on the building



envelope or the heating system. Here, too, the level of detail can vary. For example, the year of the last renovation can be entered, and if information on individual U-values is available, these can also be entered.

Based on the existing data, a 3D model is also created with which an hourly dynamic simulation is carried out. Based on the results for each building, renovation measures are proposed. An initial assessment of their feasibility is also done. For example, it is indicated whether there is sufficient space on the property for deep drilling to be able to instal a geothermal heat pump.

Based on the measures, the potential savings in terms of energy and CO2 emissions and the investment costs for implementing the measures as well as their running costs are calculated. Subsequently, both the renovation variants and their impact can be compared with other variants.

As a complete overview, one can look at the buildings in their current and planned condition in comparison to the other buildings in the portfolio.

Yessa

The screenshot shows the Yessa software interface. The main title is "Energiesparmaßnahme - Optimierung Wärmeverteilung". The left sidebar contains navigation options: Hauptmenü, Unternehmen, Basisinfo, Standorte, Gebäudegruppen, Gebäude, Energieverbrauch, Anlagen, Verkehrsmittel, Maßnahmen (highlighted), Berichte, and Analyse. The main content area is divided into several sections:

- Übersicht:** Title: Optimierung Wärmeverteilung; Verbrauchsbereich: Gebäude Wärme; In Auswertungen berücksichtigen: Ja; Position: 0; Priorität: 2 - Mittel; Ausgangssituation: Das Wärmenetz ist jetzt ganzjährig in Betrieb. Folgende Maßnahmen werden empfohlen: Die Betriebszeiten des Heizkreises werden an den tatsächlichen Bedarf angepasst, Normal- und Absenkbetrieb werden hinterlegt; Eine Anpassung der Systemtemperaturen und Absenkung der Heizkurve an den tatsächlichen Bedarf wird schrittweise durchgeführt; Einzelne Werte der GLT Visualisierung sollen geprüft werden, hier liegen teilweise unplausible Werte vor (siehe Fotodokumentation GLT Bilder); Hinterlegen einer Heizregabe (Grenztemperatur ab der geheizt werden darf) für die einzelnen Stränge zur Reduktion von Laufzeiten der Pumpen und somit Reduktion von Verteilverlusten; Pumpentausch, Umrüstung auf hocheffiziente Umwälzpumpen soll erfolgen.
- Energieeinsparungen:** Verbrauch vor Maßnahme [kWh/a]: 46.169.000,00; Eingabemodus Energieeinsparungen: Absolut; Einsparungen Absolut: 500.000,00; Einsparungen Brutto [kWh/a]: 500.000,00; Rebound-Faktor: 1,00; Spill-Over-Faktor: 1,00; Sicherheitszu-/abschlags-Faktor: 1,00; Einsparungen Netto [kWh/a]: 500.000,00; Verbrauch nach Maßnahme [kWh/a]: 45.669.000,00; Einsparungspotential: Sehr hoch; Umsetzungsaufwands: Gering.
- Übersicht Reduktion Kosten und CO2:** Reduktion Energiekosten [€/a]: 35.000,00 €; Reduktion Betriebskosten [€/a]: 0,00 €; Reduktion Gesamtkosten [€/a]: 35.000,00 €; Reduktion CO2-Emissionen [kg]: 40.000,00; Beilage Berechnungen: k.A.
- Amortisationsrechnung:** Investitionskosten [€]: 0,00 €; Reduktion Gesamtkosten [€/a]: 35.000,00 €; Amortisation Statisch [a]: 0,00; Geplante Nutzungsdauer [a]: 0.

Figure 3 Screenshot of the software tool "yessa"

Yessa was primarily created as a software tool for energy audits. Among other things, it helps with the complete collection of all necessary data during on-site visits and with the subsequent evaluation. A comprehensive library of measures was created in the tool itself, which can be used for both the operation of companies and buildings. Subsequently, report forms are issued according to the respective country-specific specifications.



Optiml

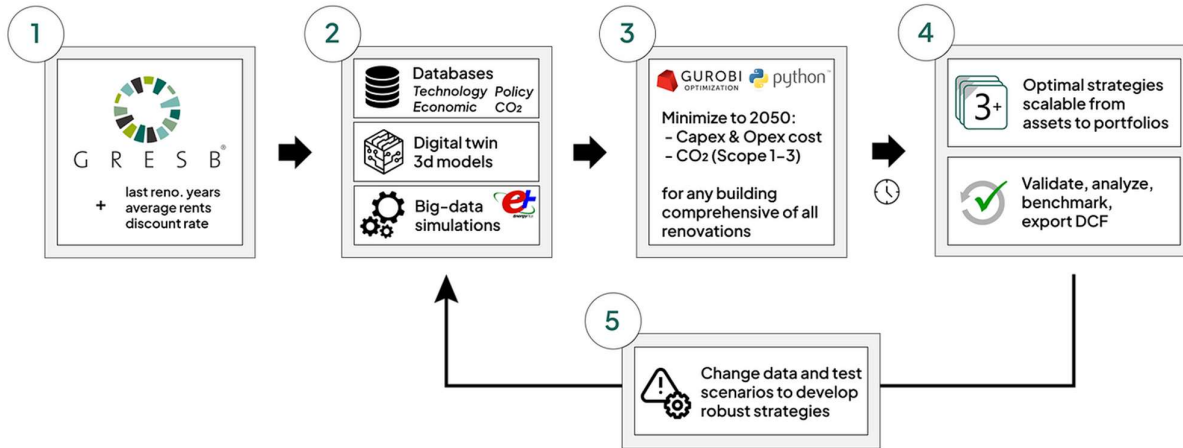


Figure 4 Process of "Optiml"-Tool

The method behind the Optiml software tool was developed over many years and ultimately resulted in a software tool that can be used for both individual properties and entire portfolios. The core functions lie in investment management, portfolio and asset management and in ESG and sustainability.

Only a limited number of data points need to be entered in order to create a 3D model based on real data that is entered by the building owners or public data such as GIS (Geografisches Informationssystem). Based on real data but also on public databases, a model is created that should correspond as closely as possible to reality. The more real live data can be added, the more the model will be. Then a thermal simulation of the building using energyplus can be carried out which is used for the selection of certain measures and their impact.

Several scenarios can be defined as a goal, which require different measures. These strategies are always set in relation to a basic strategy. Optiml itself will propose at least three different strategies for the whole building portfolio.

Individual measures per building are then proposed automatically but can be adjusted manually. Certain feasibility checks can already be carried out in this step. The goal is to develop a detailed renovation plan. At the time this deliverable was written there were no further information on how detailed the measures are and how they are selected.

A major focus of this tool is a comprehensive calculation of OPEX and CAPEX and the overall economic view and classification.

A roll-out of a first version of the tool in Switzerland is currently planned. Adaptations and verifications for other countries are currently being prepared.

F. Conclusion

During the research of programmes and considering all the programmes already used in the partner countries, some already developed programmes were discovered that already have some important qualities. There are therefore programmes on the market, which could partly help in programming a tool that meets the MESTRI requirements. Quality characteristics were therefore identified that would be useful for possible further development. These include:



- **Portfolio management:** In order to lay the foundations for Use Case III, it is considered useful to use a further development of a software tool in which a portfolio view of buildings is already possible to a certain extent.
- **Renovation concepts:** The compilation of suitable renovation concepts is a challenge for some buildings. Therefore, Use Case I was developed for the development of a Smart Data Hub, with which a high-level renovation concept for as many buildings as possible is to be created by assigning high-level building typologies and bundles of measures based on them. If software tools already offer the possibility to create such concepts automatically, a faster and simpler allocation of measures would be possible.
- **Renovation measures:** The basis for the targeted allocation of measures to buildings or building typologies is the level of detail of individual measures and the possibility to deal with all cases that can occur in buildings. The development of a comprehensive library of measures is therefore essential in order to be able to plan as accurately as possible.
- **Data entry:** The basis for portfolio management as well as renovation measures and renovation concepts is data entry. The principle of "as little as necessary, as much as possible" applies. With regard to larger building portfolios, it must be assumed that there is very extensive data on some buildings and only very sporadic information on others. It is therefore necessary to develop a tool that on the one hand offers the possibility to achieve results with only a few data entry points, but on the other hand also offers the option to enter further, more detailed data in order to increase the accuracy.
- **3D model and thermal simulation:** Software tools that are already at a very up-to-date level also offer the creation of 3D models and thermal simulations. This allows further steps to be taken in a much more targeted and precise manner. This standard is therefore also being strived for in the MESTRI project.
- **Compatibility with CRREM path, EU taxonomy and similar requirements:** Especially for building owners who have a large portfolio, compatibility with EU regulations such as the EU taxonomy or the CRREM path is also of great importance. So, if a programme is developed that already covers many life cycle steps of a building, it is timely to carry out this check as well.

In consideration of the points described above, the following software tools have been selected that already fulfil some of the requirements. It is therefore intended to enter into cooperation with those tool developers with whose support the greatest possible output can be achieved in MESTRI.

	Portfolio management	Renovation concepts	Renovation measures	Data entry	3D model and thermal simulation	Compatibility with CRREM path, EU taxonomy and similar requirements
Optimuse	x	x		x	x	x
Scandens	x	x		x	x	x
yessa			x	x		
Optiml	X	X		X	X	x