EERAdata

DATA-DRIVEN DECISION-SUPPORT TO INCREASE ENERGY EFFICIENCY THROUGH RENOVATION IN EUROPEAN BUILDING STOCK

D 3.2 – Report on the type and format of the data required to model the building stock in the EERAdata methodology results

[WP3– Development of the EERAdata methodology]

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About the project

The EERAdata project is developing a decision-support tool to help local administrations in the collection and processing of their building and demographic data towards an assessment and prioritisation of Energy Efficiency (EE) measures in planning, renovating and constructing buildings.

While EU policy assigns a primary role to EE, the lack of a holistic understanding of the impact of EE investments has hindered its integration in the policy-making process. Coordination between demand and supply side of energy policy is not targeted, and there is need to gather the evidence on the benefits of EE in ecological and socio-economic terms as well as on its interactions with the broader policy context and energy market.

Project's goals

The overall goal of EERAdata is to show that EE measures are to be prioritized in building renovation and to analyse and evaluate these measured from an energy, ecological and socio-economical perspective. Therefore, a decision support tool (DST) will be developed within the framework of the project which will enable planners to evaluate energy efficiency measures on a life-cycle based approach. This approach should be applicable on individual buildings and city districts and the results should present their specific benefits out of the already mentioned perspectives. This will not only provide incentives for the implementation of these measures but also for the acquisition, collection, compilation and aggregation of data needed for these evaluations.

This results in several sub-objectives or goals that have emerged in the course of the project work and through the close cooperation with the regional and municipal partners. These will be further developed in the course of the project work. The further development of the DST and its application leads to new insights and expectations regarding the evaluations, calculations and analyses. In the following a few of these sub-goals are listed in brief:

- The analyses performed in EERAdata can be used as a basis for the development of regional and municipal guidelines and roadmaps for the promotion of effective EE measures. Based on this, specific efficiency measures in the building sector are identified and can be derived for several other building types and/or typologies.

- The holistic assessment extends the perspective on the building beyond the utilization phase. The results are used to show future benefits, e.g. from selectively high investments in a renovation. For example, the impact of the investment in building insulation on productivity in schools over a period of 10

years. In addition, interactions between the observation horizons, or calculation and analysis modules, are shown and thus the effect of different measures within several perspectives is illustrated.

- The project develops joint thematic studies and analytical reports on territorial needs and decarbonization pathways to assess and evaluate country-specific needs and requirements in the context of the EU-wide strategy.

- EERAdata is developing a beta version of a DST that will help local administrations to collect and process their building and demographic data in order to assess and prioritize energy efficiency measures in the planning, renovation and construction of buildings.

Table of contents

ABSTRACT 6

THE DIFFERENT CALCULATION MODULES AND THE IMPORTANCE OF DATA IN EERADATA 6

DATA PREPARATION IN THE EERADATA DST 7

TYPE AND FORMAT OF THE DATA FOR BUILDING STOCK MODELLING 8

LISTS OF ALL RELEVANT DATASETS IN THE EERADATA PROJECT 9
ALLOCATION OF DATA SETS TO CALCULATION AND ANALYSIS MODULES 23
UNCERTAINTY WITHIN EERADATA 31

UPCOMING DATA COLLECTION 31

Abstract

The goal of this task is to identify the type and format of data needed to model and analyse the building stock at the regional/municipal level through the EERAdata methodology. This will be done considering the availability of 'generic' data sources (e.g. the TABULA project) as well as of specific data from project frontrunner municipalities and across EU countries, and the necessary steps that will be required to access and format this data. The found information and categories will be comprised into a catalogue.

The different calculation modules and the importance of data in EERAdata

Since the methods developed and applied within EERAdata are mainly of a quantitative nature, the necessary data basis is one of the most important points within the project. Not only building-related data but also user and energy system specific as well as socio-economic data are needed. These data are related to different levels: People, building, neighbourhood, city, municipality, county, state, country, government, environment, etc.

In addition to the sheer volume of data, data availability is also an issue that can vary greatly between the partner municipalities and regions. Some data is not available at all, only limited, against payment, within the municipality or publicly available.

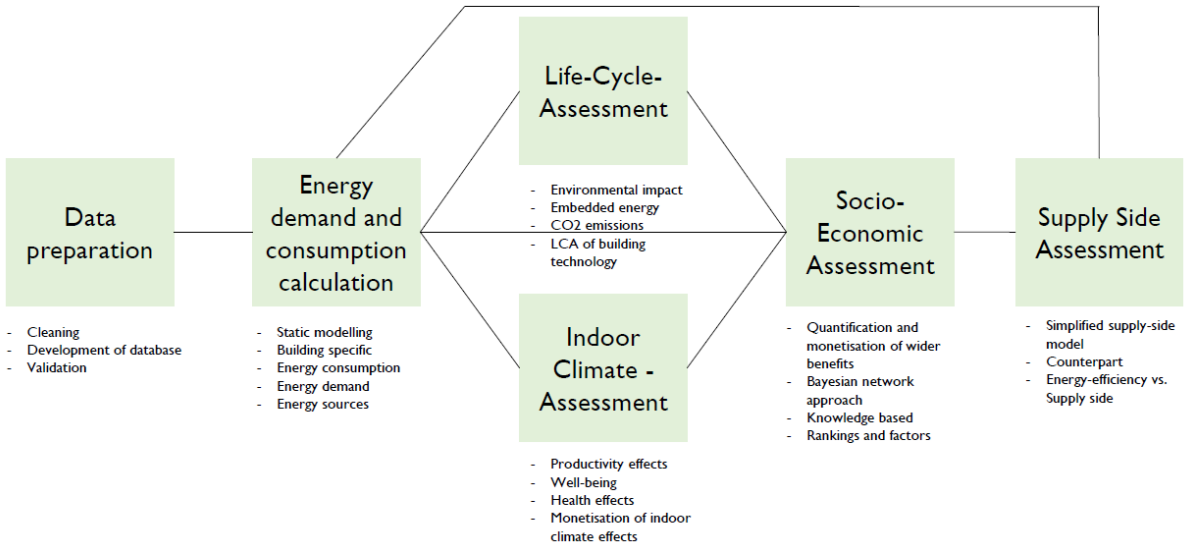

Figure 1: Decision Support Process

Another major challenge is that the different methods require the same input parameters or, if necessary, build on each other's results.

Basically, a distinction is made between the following calculation and analysis modules:

1. building energy demand and consumption calculation

2. life cycle assessment
3. indoor climate assessment
4. socio-economic assessment
5. supply side assessment.

The connection of the individual modules is shown in Figure 1, coming from Deliverable 5.1. This shows that the different modules partly build on each other or use results from previous modules. The large number of data sets, values, input-data has to be stored logically in a database to be available for all modules for calculations and simulations. In the context of this deliverable the types and formats of the data needed for the calculations and analyses in the different modules are listed and described. The overview serves as an important source for structuring the data and data formats within the project work.

The DST developed within EERAdata is designed to provide results for any data situation. In addition to the specific data to be verified by the municipalities, generic average data sets are generated and implemented as “default values” in the DST. We are aware of the fact that these default data do not provide an accurate result in any case, but we want to mark this and evaluate calculations and results with a corresponding "Level of Accuracy". On the one hand, this should enable local authorities to use the tool and familiarize themselves with it even if they do not have all the data necessary for the analyses in detail. On the other hand, they learn about the data structures and input data they need for a detailed analysis. When municipalities see the possibilities for analysis and evaluation that the DST offers, this can serve as motivation and incentive for data collection and future use.

Data preparation in the EERAdata DST

Since EERAdata follows the approach that calculations and analyses can be carried out on any data basis, of course with indication of the respective uncertainty in the calculation, it requires defined average data which can substitute data not available from the municipal side for first calculations.

From a technical point of view, the first calculations and results could thus be generated very quickly, although they would not be very project-specific – we talk about a “rough assessment”. The DST users have the possibility to replace this default data with specific data to get more accurate building-related results. The following data preparation is performed for the specific data introduced. The data must first be cleaned up in a subsequent step, which means that the data formats, value ranges and units are corrected and adjusted. In the course of this a validation of the values is performed by comparing the values with the already existing default data. The cleaned and validated data sets can be imported into the already defined database in a further step to be available for further calculations.

If data gaps still exist, they will be filled with default data. If all specific data, which are needed for the respective calculations and analyses, are provided, then no default data flow into the calculation and we can speak of a "detailed analysis".

The next chapter lists and defines all needed data for the calculation and analysis. The definition of the data includes the naming of the respective data set, including a short description, the naming of the type and format and the resolution of the data (building, city quarter, city level, etc.).

The exact range of values, or the numerical values behind the definitions can vary from country to country and from municipality to municipality. This deliverable is not about listing single specific numeric values but about the definition of data types and formats. The following list that adapts dynamically over the project and is maintained in the form of a digital database that is constantly updated. The process of data acquisition and processing is a constantly expanding process during the EERAdata project. In addition, the continuous development of the calculation and analysis modules requires a constant adjustment of the input values. The data list is to be seen as a kind of momentary recording that can change and adapt dynamically over the course of the project.

The "rough assessment" is carried out, for example, if no specific data is available for the calculation, or values that are required for further calculations and analyses are not available and have to be calculated. Here a specific case decision is made in each calculation step of each module. Will all data be provided by the municipality then this data doesn't have to be calculated and can directly be used for analysis or as input for calculation models. We then talk about a "detailed analysis".

If, for example, no energy consumption data are known for a building and/or can be provided by the municipality, then the energy demand must be calculated on the basis of data to be defined. The point is that the energy data are not only used in the Life Cycle Assessment module for analysis, but also as an input for the model "Supply Side Assessment".

To illustrate these links and double uses of input parameters, the next but one chapter "Allocation of data sets to calculation and analysis modules" shows which data sets and values in which calculation and analysis models are either required as input parameters or are available as output values resulting from a module.

Type and format of the data for building stock modelling

As already mentioned before, the definition of the data includes the naming of the respective data set, including a short description, the naming of the format and the resolution of the data. Additionally, for each data set it is defined in which calculation and analysis module it is needed as input data set. It is also defined whether a data set is an output of a model or not. If not, these data must be introduced from outside into the calculation and analysis model of default values are to be used.

First of all, all detailed lists of all parameters are presented. These lists are divided into categories. The categories are sorted beginning with general datasets to the ecosystem and getting more and more specific until the building specific datasets are defined.

- **Environmental data**

- **Geographical data**
- **Demographic data**
- **Policies and norms**
- **Energy supply**
- **Water consumption**
- **Life Cycle Assessment**
- **Socio-economic assessment**
- **Cost and budget data**
- **Building specific data**
- **Building specific consumption/ sources**
- **Building materials**
- **Technical Building services/ technology**
- **Building occupants**
- **Socio-economy of Indoor Environment Upgrades in Schools**

In a second step, each dataset of each category is allocated to a calculation and analysis module. Thereby it is marked if the dataset is needed as an input for calculations or if it's an output dataset of the calculation in the module itself. For each listed dataset which is marked as input data there will be a default-dataset defined which substitutes missing or non-available data for calculations and analysis.

Lists of all relevant datasets in the EERAdata project

The environmental data reflect the status of environmental pollution in terms of air quality and emissions caused by the consumption of material and energy resources in the building.

Environmental data			
Dataset/Parameter	**Description**	**Format/Unit**	**Resolution**
Air pollutant emission data	Emission values of the usual outdoor pollutants: Nox, PM2,5, PM10, CO, SO2, etc.)	µg/m³	Quarter, municipality, region
Building based environmental pollution (air, etc)	Environmental pollution other than air pollution, that is related to building operation (waste water, chemicals, etc.)	tbd	building sharp
Resource consumption in the building sector	Resources that are consumed by the construction, maintenance and renovation of buildings in the municipality	tbd	building sharp/ municipality sharp
Greenhouse gas emissions	The amount of GHG by the building sector	T CO2eq./year* building	Building sharp Municipality sharp

The Geographic Data reflect location-based data in the form of coordinates and coordinate based weather data.

Geographical data			
Dataset/Parameter	**Description**	**Format/Unit**	**Resolution**
Coordinates	Coordinates or address that show the exact location of the building	longitude/ latitude	Building sharp or even building section sharp
Orientation	Shows the orientation of the building for roof and heat gain through windows	compass direction	angle: (0° to 360°)
Climate data	Average climate data for location (lowest/highest/average Temp. per Year)	Temperatures, humidity, etc.	monthly/yearly

The demographic data includes average social data ranging from age to income structure.

Demographic data			
Dataset/Parameter	**Description**	**Format/Unit**	**Desired Resolution**
Nr of inhabitants	Number of inhabitants to estimate impact and exposure of building renovation measures	Nr	Municipality/ Region
Growth of population	Growth or decrease of population to estimate the potential of socio-economic impacts of building renovation	%/year, Nr/year	Municipality/ Region
Migration rates	Immigration or emigration of population to estimate the potential of socio-economic impacts of building renovation	%/year, Nr/year	Municipality/ Region
Age structure of inhabitants	Age structure of inhabitants to estimate the potential of socio-economic impacts of building renovation and to create defaults for age of structure of building occupants	%/ age-group, Nr/ age-group	Municipality/ Region
Inhabitant education	Education (primary, secondary, tertiary to estimate the potential of socio-economic impacts of building renovation on the workforce	%/Educational level, Nr/Educational level	Municipality/ Region
Poverty	Share of poverty and fuel poverty amongst the inhabitants in social housing to estimate the potential of socio-economic impacts of building renovation on the inhabitants of social housing	%/poverty level, Nr/ Poverty level	Municipality/ Region

The policies and standards-related data summarize the building-related parameters important for the calculations and analyses.

Policies and norms			
Dataset/Parameter	**Description**	**Format/Unit**	**Resolution**
Building codes	Binding building codes that have to be incorporated in any activity regarding building renovation	text	-
Minimum requirements for buildings	Minimum requirements for future buildings in the municipality and the related categories and target values	text	-
Regulations for public building renovation	Public regulations for building renovation	text	-
Energy efficiency standards for building renovation	EE standards for buildings, minimum energy efficiency requirements for building renovation	text	-
Energy performance certificates for public buildings	Energy performance certificates or passports for public buildings in the municipality	Certificate/ table	-
Reference buildings (desired U-values, etc.)	Reference buildings for certain renovation goals	Table	Building sharp

The energy supply datasets provide information on the structure of regional and urban energy supply, focusing primarily on grid losses and efficiency.

Energy supply			
Dataset/Parameter	**Description**	**Format/Unit**	**Resolution**
District cooling	Share of district cooling in the municipality/ region as share or absolute MWh/a	%, MWh/a	Yearly, municipality/ region sharp, building sharp, quarter sharp
District heating	Share of district heating in the municipality/ region as share or absolute MWh/a	%, MWh/a	Yearly, municipality/ region sharp, building sharp, quarter sharp
Gas distribution grid	Share of the gas distribution grids in the municipality/ region as share or absolute MWh/a	%, MWh/a	Yearly, municipality/ region sharp, building sharp, quarter sharp
On-site heat energy production	Share of on-site heat energy production on the building in the municipality/ region as share or absolute MWh/a	%, MWh/a	Yearly, municipality/ region sharp, building sharp, quarter sharp
Electricity distribution grid	Share of electricity distributed in which grid in the municipality/	%, MWh/a	Yearly, municipality/

	region as share or absolute MWh/a		region sharp, building sharp, quarter sharp
On-site electricity production	Share of on-site electricity production on the building in the municipality/ region as share or absolute MWh/a	%, MWh/a	Yearly, municipality/ region sharp, building sharp, quarter sharp
Type of on-site electricity production/ use	Production: PV, VAWT, HAWT, CHP, etc. Conversion: Electric boiler, heat-pump, lighting (incandescent, fluorescent (MB), CFLs, LEDs), ventilation, recuperations, etc.	Type and related specifications	building sharp, technology sharp
Type of on-site heating energy production/ use	Production: pellet furnace, woodchip furnace, firewood furnace, solar collectors, etc. Conversion: Heating substation, gas boiler, CHP, etc.	Type and related specifications	building sharp, technology sharp
Age of on-site energy production facilities	The age of PV plants, Solar thermal plants etc.	Year of installation	building sharp, technology sharp
Total primary energy use [MWh]	Total primary energy use of building, quarter, city, region to determine the energy supply requirements	Mwh	Yearly, municipality/ region sharp, building sharp, quarter sharp
Energy losses	Energy losses	kWh	Building sharp, grid sharp
EROI (Energy Returned on Energy Invested)	Efficiency: Energy returned on energy invested ratio	n.	building sharp, technology sharp, quarter sharp, municipal, region sharp
GHG emission factor	The Factor calculates the tons CO2 equivalent that are emitted for several gases, fossil fuels, etc.	t CO2 eq/MWh	municipal, regional, national
OPEX (operational expenditures)	Operational expenditure by type of energy production	€/kWh	technology sharp, municipal/region sharp
Energy independence ratio	* INSEE defines the rate of independence as follows: "[...] the ratio between the national production of primary energies (coal, oil, natural gas, nuclear power, hydropower, renewable energies) and the consumption of primary energy	%	national, regional, municipal sharp, Technology sharp

The data sets on water consumption are primarily aimed at collecting building-related and regional consumption data. Water treatment and water costs also play an important role here, along with other topics.

Water consumption			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Total water consumption in municipality	The total water consumption in the municipality/region or quarter	m3/year, liters/year	Quarter, municipality, region
Water demand per sector (urban - commercial/domestic, industry, agriculture…)	Water demand per sector in the municipality/region	m³/year,l/year, %	Quarter, municipality, region
Water demand per capita (with and without losses)	Water demand per capita throughout in total for the whole municipality region. One value, including losses, one value without losses	m³/(cap.day), liters/(cap.day) and per year	Building sharp
Share of water sources	Share of water sources, where is the water coming from: surface, groundwater, water reuse, grey water, etc)	%	Building sharp
Risk of water shortage	Indicates the risk of water shortage	Varying documentation	municipal, region-sharp
Water treatment costs total value	The average cost of water treatment for the whole municipality/region over the year	€/m³	municipal, region-sharp
Water treatment costs discretised value (separated by material costs, energy costs, etc)	The average cost of water treatment for the whole municipality/region separated for material, energy, infrastructure, etc)	€/m³	municipal, region-sharp
Wastewater treatment costs total value	The average cost of waste water treatment for the whole municipality/region over the year	€/m³	municipal, region-sharp
Wastewater treatment costs discretised value (separated by material costs, energy costs, etc)	The average cost of waste water treatment for the whole municipality/region separated for material, energy, infrastructure, etc)	€/m³	municipal, region-sharp
Water cost at building	Cost of water which is used in the assessed building	€/m³, €/l	building sharp
Wastewater cost at building	Cost of water which is used in the assessed building	€/m³, €/l	building sharp
Investment in water conservation	Investment in water conservation in the municipality/region	€/year, €m³, €/l	municipal, region-sharp
Total water demand per building	Water demand in the assessed building	m3/year, liters/year	Building sharp
Water use by room type (bath, kitchen, process, etc)	Share of water demand per water use in relation to the total water demand or volume per use (bathroom, kitchen, irrigation)	m3/year, litres/year, %	Building sharp

Water use by installation type	Share of water demand per water installation in relation to the total water demand or volume per installation (faucets, showers, urinals, toilets,…)	m3/year, litres/year, %	Building sharp
Nr of installations per building	Type of installation, water demand per installation, number of installations in the building, total water demand of all installation types (showerheads, water closets, faucets, urinals)	Nr/type	Building sharp
Use of hot water	Share or use of hot water in the assessed building	%, l/year, m^3/year	Building sharp

Life Cycle Assessment data is used to balance the energy and ecological balance of buildings over their entire life cycle. This aims at the technical building equipment as well as the structural elements.

Life Cycle Assessment			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Reference service life of building materials and technical building service components	The average lifetime of technological components and building components in the municipality/ region	Years/component	Building components sharp
Share of renewable/non-renewable Energy in primary energy source	e.g. what is the share of renewable/non-renewable energies in electricity grid mix? Or, how much non-renewable energies have to used to harvest wood, or to produce pellets? For these energy sources: Wood, Pellets, District Heating, Electricity, Gas, Oil	%	Municipality/region/country
Primary Energy Factors for primary energy sources	Wood, Pellets, District Heating, Electricity, Gas, Oil	-	Municipality/region/country
Embedded Energy of used building materials and technical building service components	Embedded energy in the used materials of the existing building as well as for added materials due to renovation for their Manufacturing / Use / End Of Life (recycling, incineration, reuse, landfill)	KWh/kg, MJ/kg, kWh/m^3 (building material), MJ/m^3(building material), kWh/kW (heat generator), etc.	Material sharp
CO_2 emissions of used building materials and technical building service components	CO_2 emissions of the used materials of the existing building as well as for added materials due to renovation for their Manufacturing / Use / End Of Life (recycling, incineration, reuse, landfill)	CO_2/kg, CO_2/m^3 (building material), CO2/kW	Material sharp

		(heat generator)	
Water use of used building materials and technical building service components	Water use of the used materials of the existing building as well as for added materials due to renovation for their Manufacturing / Use / End Of Life (recycling, incineration, reuse, landfill)	m^3/kg, l/kg, m^3/m^3, l/m^3, l/kW	Material sharp
Environmental impact of used building materials and technical building service components	Environmental impact of the used materials of the existing building as well as for added materials due to renovation for their Manufacturing / Use / End Of Life (recycling, incineration, reuse, landfill)	CO_2-eq/kg, CO_2-eq/m^3, CO_2-eq/kW	Material sharp

The socio-economic data is used to calculate the wider benefits of renovation and energy efficiency measures. It should be noted that the "Nr of workforce in the construction sector" dataset in particular will continue to grow as the project progresses and the "Socio-Economic Assessment" module is developed.

Socio-economic assessment			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Hourly rates in municipality	average hourly rate across population in municipality/ region	€/hour	Municipality/Region sharp
Working hours per day	average number of working hours per day in municipality/ region	hours/day	Municipality/Region sharp
Working days per year	average number of working days per year in municipality/ region	Days/year	Municipality/Region sharp
Rise in real wages	rise in real wages in municipality/ region	%/year	Municipality/Region sharp
Interest rate	interest rate in municipality/ region	€/year	Municipality/Region sharp
Energy cost	Cost per kWh paid by the building operator	€/kWh*year	building sharp, monthly
Public Health expenditure	Expenditure for public health in municipality, region per person	€/year*capita	Municipality/Region sharp
Average Sick days per employer	Average sick days per employer in the municipality/ region or building sharp	days/year	Municipality/Region sharp, building sharp
GDP	Monthly GDP data	EUR/month	Municipality/Region sharp
Unemployment rates	Number of unemployed inhabitants per month or year	%/year	Municipality/Region sharp
Nr of workforce in the construction sector	Number of inhabitants working for the construction sector, including unemployed workers in the construction sector	Nr/ %	Municipality/Region sharp

The cost values also play a role in the socio-economic evaluation and serve as a basis for amortization calculations.

Cost and budget data			
Dataset/Parameter	**Description**	**Format/Unit**	**Resolution**
Cost of renovation measures	Cost of specific renovation measures in the municipality or averages of them	Cost/ measure	Measure sharp, list or average
Cost of building maintenance	Cost of the maintenance of the assessed building	EUR/ building, measure	Building sharp
Cost of building operation in categories	Cost of building operation (water, energy, electricity, process energy, etc)	EUR/ category*year	Building sharp
Cost of labour in the construction sector	Cost of labour in the construction sector by position and level of the worker	EUR/ year*Capita	Municipality/ Regionsharp
Municipal Budget for building renovation	Budget per year per building renovation of the municipality/ region	EUR/ year	Municipality/ Regionsharp
Direct tax return rate from building renovation related businesses in the municipality	Tax returns that are directly going back to the municipal/regional budget from building renovation related businesses in the municipality in EUR or % of yearly turnover	EUR/ EUR turnover*year	Municipality/ Regionsharp
Tax return rates from wages	Tax returns that are directly going back to the municipal/regional budget from payed wages of the local construction, building renovation related work	EUR/ EURwages* capita*year	Municipality/ Regionsharp
Tax income table of the municipality/ region	The different sources, numbers and shares of the budget/ tax returns from the municipality/ region	EUR, share, category, per year	Municipality/ Regionsharp

The building-specific data characterize the buildings to be considered based on geometric parameters.

Building Specific Data			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Name, ID or title of building	Name or title of building (e.g. hospital padre pio, or jack johnson high school)	Text/Number	Builing sharp
Building age	construction year of the building or construction year of the biggest part of the building (when reconstruction, etc)	Year	Year or decade
Floor area	Used area of the building	m^2	Gross floor area Net floor area Construction area

Building footprint	The building floor area is the area over which the building is in contact with the soil	m²	m²
Building volume	The gross building volume is the total volume of all interior spaces in a building over the gross floor area.	m³	Defined by outer boundary surfaces of the foundation, the exterior walls and the roof
Room height	Height of rooms, roof and basement	m	room height for roof, normal storeys and basement
Storeys	Number of storeys of the building	Nr	Building or building section sharp
Building height	Height of the building	m	m, cm
Facade area	building width and height, or direct value of m² of envelope	m²	m², cm²
Roof area	Surface area of all roof areas	m²	m², cm²
Basement	Does the building have a basement	Yes/No	Binary
Window area	Could also be window height, window width, number of windows	m², Nr.	Window type sharp
Window ratio	Window-to-floor ratio, window to wall ratio, window-to-facade? For indoor climate, facade porosity is needed (window-to-facade).	% (of facade m²)	Building or building section sharp
Roof type			
Building use	Which is the use for the building? Educational?, Office, Laboratory, School, Health, etc.	typology	Building sharp
Surface area for primary use	Which used area of the building is reserved for the primary use of the building	m²/use, %	Building sharp
Amount of public buildings	Number of public buildings	Nr	Municipal, region sharp
3D Building Model	3D Building Model/ City Model (in case a larger building stock needs to be assessed)	CityGML-format	from building to regional level
Building type	A representative building (whether a real or invented building) is a typical example of a building group (row building, single building, corner building, etc.). It presents all characteristic features of these groups.	typology	-

The resource consumption values cover the consumption of energy resources.

Building specific consumption/ sources			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Total energy consumption	Total energy consumption of the assessed building incl. electricity, heating, cooling, hot water energy	kWh/year	hourly/daily/ monthly/yearly building or building section sharp
Heating energy consumption	Consumption of heating energy of the assessed building	kWh/year	hourly/daily/monthly/yearly building or building section sharp
Cooling energy consumption	Consumption of cooling energy of the assessed building	kWh/year	hourly/daily/monthly/yearly building or building section sharp
Hot water consumption	Consumption of hot water energy of the assessed building	kWh/year, l/year	hourly/daily/monthly/yearly building or building section sharp
Electrical energy consumption	Consumption of electricity in the assessed building	kWh/year	hourly/daily/monthly/yearly building or building section sharp
Energy source total	Types and share of energy sources for the total energy consumption of the assessed building	%	building and technology sharp
Energy source heating	Type and share of heating energy sources for the assessed building	%	building and technology sharp
Energy source cooling	Type and share of cooling energy sources for the assessed building	%	building and technology sharp
Energy source electricity	Type and share of electricity energy sources for the assessed building	%	building and technology sharp
Energy source hot water generation	Type and share of hot water energy sources for the assessed building	%	building and technology sharp
Primary energy factors	Primary energy factors for all types of energy sources	Nr	municipality, region
Total primary energy use	Primary energy consumption of the assessed building	kWh/a	building sharp
Final energy use for the lighting	Electricity consumption, or share for lighting in the building	kWh/a, %	building sharp
Energy rating	Energy rating from building performance certificate, check levels for each country	Class	Building sharp

The information on building materials summarizes the consumption of material resources.

Building materials			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Exterior walls	Type of material used for the existing walls	Type/ Material mass, volume, thickness (kg/m³/cm)	Building component sharp
Roof	Type of material used for the existing roof	Type/ Material mass, volume, thickness (kg/m³/cm)	Building component sharp
Interior Walls	Type of material used for the existing interior walls	Type/ Material mass, volume, thickness (kg/m³/cm)	Building component sharp
Bearing structure	Type of material used for the existing bearing structure	Type/ Material mass, volume, thickness (kg/m³/cm)	Building component sharp
Base Plate	Type of material used for the base plate	Type/ Material mass, volume, thickness (kg/m³/cm)	Building component sharp
U-Values for building parts	U-Values of external walls, roof, base plate	W/m2*K	Building component sharp, for each building age class (according to year of construction of building)

The information on technical building services also summarizes their consumption of material resources.

Technical Building Services			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Loss and efficiency factors_1	Building leakage factor (air tightness)	m³/h*m²	hourly
Loss and efficiency factors_2	Shielding and terrain factors at building location		
Ventilation system	Ventilation system data, if existing	Type, details, energy consumption, installation	Building sharp
Heating System	Heating system data	Type, details, energy consumption, installation	Building sharp

Cooling System	Cooling system data, if existing	Type, details, energy consumption, installation	Building sharp
Water heating system	Water heating system and type d	Type, details, energy consumption, installation	Building sharp
Age of systems	Age of technical components of building	Age	Building service sharp
Efficiency of systems	Efficiency of technical components of building	Input/output ratio for defined services	Building service sharp
On-site pumping systems: type of systems	On-Site pumping systems, type of system, efficiency, energy consumption	Efficiency, kWh/l, kWh/m³, age, etc	Building service sharp
Using time of building services	Time of use per building technology, e.g. 24 hours use of heating	hr/day	Building service sharp
Cooled surface area	Area of the building which is cooled by air conditioning		Building sharp
Heated surface area	Area of the building which is heated	m², %	Building sharp
Ventilated surface area	Area of the building which is ventilated and how	m², %	Building sharp
Building services control information	Information on the control and regulation of building technology like heating or cooling	text	Building service sharp
Building illumination information	Information on the schedules, control, automation etc of building illumination	hr/day, %, Text	Building service sharp
Use of wood fired heating	Share wood fired heating used in the municipal public buildings	%	Municipality

The required user-specific information is requested in the following table.

Building occupants			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Occupant Nr	Number of Occupants working, living or studying in the assessed building	Nr	Building or building section sharp
Occupant Nr by Occupant type	Number of occupants per type, like staff, visitor, pupil, patient	Nr/ Type	Building or building section sharp
Occupant time	Occupant schedules, working times or timetables	h/day/week/ month/year	h/day
Occupant age distribution	Age distribution of the occupants in the assessed building	%/ agegroup, Nr/ agegroup	Building sharp
Occupant sick days	Sick days of occupants, employees in the assessed building per year, average per capita per building	days/Year* occupant, days/year* building	building sharp

Occupant health data	Data of all kind regarding the health of occupants in the assessed building	text, statistics	-
Nr of employees in the public building	Nr of occupants that are employed by the municipality/ region	Nr	Building sharp
Nr of non-employees in the public buildings	Nr of occupants which are not employed by the municipality/ region	Nr	Building sharp
Ownership of property (Owned , rented, etc by the municipality)	The owner situation of the building, rented, owned or lent by the municipality/region?	text, statistics	Building sharp

The information required to calculate socioeconomy of indoor environment upgrades in schools is listed in the following table.

Socioeconomy of Indoor Environment Upgrades in Schools			
Dataset/Parameter	**Description**	**Format**	**Resolution**
Years in school	Average number of years a pupil spends in school. Default value: 9 years	Years	Municipal, region, country sharp
Years before starting work	Number of years after the pupil has left primary school until he/she starts working. Default value: 5 years	Years	Municipal, region, country sharp
Equipment lifetime	Lifetime in years of technical installations included in an indoor environment upgrade. Default value: 30 years	Years	Municipal, region, country sharp
Schooldays per year	Number of school days per year. Default value: 200 days	Days	Municipal, region, country sharp
Share of learning outside school	Percentage of learning outside school, e.g. by homework done at home. Default value 10%	%	Municipal, region, country sharp
Weekly hours in class	Percentage of weekly working hours teachers are present in classrooms with an upgraded indoor climate. Default value: 50%	Hours	Municipal, region, country sharp
Time spent in upgraded classrooms	Percentage of time in school spent in rooms that have been refurbished. Default value: 80%	%	Municipal, region, country sharp
Adult caring of ill child	Percentage of sick days when the pupil needs to be cared for by an adult (average for the whole school). Determined as grades 0-6 out of all 0-9 grades. Default value: 66%	%	Municipal, region, country sharp
Percentage parents outside labour market	Percentage of unemployed and other citizens outside the labor market among the 25-49-year-olds (parent age). Default value: 48%	%	Municipal, region, country sharp
Share of child's sick days not	Percentage of sick days when the pupil is cared for by persons outside the labour market (e.g.	%	Municipal, region, country sharp

affecting the labour market	grandparents), by parents with flexible working hours, or where parents work while caring for a sick child and at least one parent is in the labor market. Default value: 10% (needs national adaptation).		
Average hourly salary	Average hourly salary default value: 35 Euro	Euro	Municipal, region, country sharp
Working hours per day	Number of working hours per day. Default value: 7,4 hours	Hours	Municipal, region, country sharp
Average hourly salary teachers	Average hourly teacher salary, Default value: 36,5 Euro	Euro	Municipal, region, country sharp
Teachers' number of working hours per day	Number of teaching hours per day, hours. Default value: 7,4 years	Hours	Municipal, region, country sharp
Discount rate 0-35 years	Discount rate for the first 35 years. Default value: 4%	%	Municipal, region, country sharp
Discount rate 35-70 years	Discount rate between year 35 and 70. Default value: 3%	%	Municipal, region, country sharp
Growth in real wages	Growth in real wages, Default value: 1%	%	Municipal, region, country sharp
Salary increase	Salary increment per extra year of learning in school, Default value: 1%	%	Municipal, region, country sharp
Performance improvement	Percentage of performance improvement that can be translated into increased number of hours with learning, Default value: 100%	%	Municipal, region, country sharp
State income tax	State income tax. Default value: 12,13%	%	Municipal, region, country sharp
Municipal tax	Average municipal tax. Default value: 24,93%	%	Municipal, region, country sharp

Allocation of data sets to calculation and analysis modules

- Building energy demand and consumption calculation: Number 1
- Life Cycle Assessment: Number 2
- Indoor climate assessment: Number 3
- Socio-economic assessment: Number 4
- Supply side assessment: Number 5

Environmental data		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Air pollutant emission data	4	4
Building based environmental pollution (air, etc)	4	
Resource consumption in the building sector	4	2 (In terms of energy resources such as oil, gas, etc.)

Geographical data		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Coordinates	4	
Orientation	3	
Climate data	1, 2, 3, 4	

Demographic data		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Nr of inhabitants	4	
Growth of population	4	
Migration rates	4	
Age structure of inhabitants	4	
Inhabitant education	4	
Poverty	4	

Policies and norms		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Building codes	1, 2	

Minimum requirements for buildings	2	
Regulations for public building renovation	2	
Energy efficiency standards for building renovation	1, 2	
Energy performance certificates for public buildings	1, 2	
Reference buildings (desired U-values, etc.)	1, 2, (3)	

Energy supply		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
District cooling	1, 4, 5	
District heating	1, 4, 5	
Gas distribution grid	5	
On-site heat energy production	1, 2, 5	
Electricity distribution grid	1, 5	
On-site electricity production	1, 4	
Type of on-site electricity production/ use	1, 2, 4, 5	
Type of on-site heating energy production/ use	1, 2, 4, 5	
Age of on-site energy production facilities	1, 2	
Total primary energy use	1, 2, 4, 5	
Energy losses	1, 5	
Average overall efficiency	1, 5	
EROI (Energy Returned on Energy Invested)	4, 5	
GHG emission factor	1, 2, 4, 5	

OPEX (operational expenditures)	4, 5	
Energy independence ratio	4, 5	

Water consumption		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Total water consumption in municipality	4	
Water demand per sector (urban - commercial/domestic, industry, agriculture…)	4	
Water demand per capita (with and without losses)	4	
Share of water sources	4	
Risk of water shortage	4	
Water treatment costs total value	4	
Water treatment costs discretised value (separated by material costs, energy costs, etc)	4	
Wastewater treatment costs total value	4	
Wastewater treatment costs discretised value (separated by material costs, energy costs, etc)	4	
Water cost at building	4	
Wastewater cost at building	4	
Investment in water conservation	4	
Total water demand per building	4	
Water use by room type (bath, kitchen, process, etc)	4	

Water use by installation type	4	
Nr of installations per building	4	
Use of hot water	4	

Life Cycle Assessment		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Reference service life of building materials and technical building service components	2, 3	
Share of renewable/non-renewable Energy in primary energy source	1, 2	
Primary Energy Factors for primary energy sources	1, 2, 5	
Embedded Energy of used building materials and technical building service components	2 (Related to a reference unit, or reference flow, such as 1 m^3 of concrete or 1 kW of biomass boiler)	2 (Related to the absolute value resulting from the multiplication of the reference value with the dimensioning of the component/building material)
CO_2 emissions of used building materials and technical building service components	2 (Related to a reference unit, or reference flow, such as 1 m^3 of concrete or 1 kW of biomass boiler)	2 (Related to the absolute value resulting from the multiplication of the reference value with the dimensioning of the component/building material)
Water use of used building materials and technical building service components	4	
Environmental impact of used building materials and technical building service components	4, 2 (Related to a reference unit, or reference flow, such as 1 m^3 of concrete or 1 kW of biomass boiler)	2 (Related to the absolute value resulting from the multiplication of the reference value with the dimensioning of the component/building material)

Socio economic assessment		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Hourly rates in municipality	4, 3	
Working hours per day	4, 3	
Working days per year	4, 3	
Rise in real wages	4, 3	
Interest rate	4, 3	

Energy cost	4	
Public Health expenditure	4	3
Average Sick days per employer	4	3
GDP	4	
Unemployment rates	4, 3	
Nr of workforce in the construction sector	4	

Cost and budget data		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Cost of renovation measures	4	
Cost of building maintenance	4	
Cost of building operation in categories	4	
Cost of labour in the construction sector	4	
Municipal Budget for building renovation	4	
Direct tax return rate from building renovation related businesses in the municipality	4	
Tax return rates from wages	4	
Tax income table of the municipality/ region	4, 3	

Building Specific Data		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Name, ID or title of building	2, 3	
Building age	2, 4	
Floor area	2, 4, 3	2
Building footprint	2, 3	2
Building volume	2, 3	2
Room height	2, 3	2
Storeys	2, 3	2

Building height	2, 3	2
Facade area	2	2
Roof area	2	2
Basement	2	2
Window area	2, 3	2
Window ratio	2, 3	2
Roof type	2, 3	
Building use	2, 4	
Surface area for primary use	2, 4	
Amount of public buildings	2, 4	
3D Building Model	2	
Building type	2, 4, 3	

Building specific consumption/ sources		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Total energy consumption	1, 2, 4, 5	1, 5
Heating energy consumption	1, 2, 4, 5 (if information is available then it's used as input)	1, 2, (3), 5 (if information is not available on building level, then its calculated)
Cooling energy consumption	1, 2, 4, 5	(3) (if information is not available on building level, then its calculated)
Hot water consumption	1, 2, 4	2 (if information is not available on building level, then its calculated)
Electrical energy consumption	1, 2, 4, 5	1, (3) (if information is not available on building level, then its calculated)
Energy source total	1, 2, 4, 5	1, 5 (if information is not available on building level, then its calculated)
Energy source heating	1, 2, 4, 5	1, 5 (if information is not available on building level, then its calculated)
Energy source cooling	1, 2, 4, 5	1 ,5 (if information is not available on building level, then its calculated)
Energy source electricity	1, 2, 4, 5	5
Energy source hot water generation	1, 2, 4, 5	

Total primary energy use	1, 2, 4, 5	1, 2, 5
Final energy use for the lighting	1, 2, 4, 5	5
Energy rating	1, 5	5

Building materials		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Exterior walls	1, 2	2 (if information is not available on building level, then its calculated)
Roof	1, 2	2 (if information is not available on building level, then its calculated)
Interior Walls	1, 2	2 (if information is not available on building level, then its calculated)
Bearing structure	1, 2	2 (if information is not available on building level, then its calculated)
Base Plate	1, 2	2 (if information is not available on building level, then its calculated)
U-Values for building parts	1, 2, 3	

Technical Building Services		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Loss and efficiency factors_1	1, 2	
Loss and efficiency factors_2	1, 2	
Ventilation system	1, 2, 4	
Heating System	1, 2, 4, 3	
Cooling System	1, 2, 4, 3	
Water heating system	1, 2, 4	
Age of systems	2	
Efficiency of systems	1, 2, 4	
On-site pumping systems: type of systems	1, 2, 4	
Using time of building services	2	
Cooled surface area	1, 2	
Heated surface area	1, 2	

Ventilated surface area	1, 2	
Building services control information	1	
Building illumination information	1	
Use of wood fired heating	4	

Building occupants		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Occupant Nr	4	
Occupant Nr by Occupant type	4	
Occupant time/ schedules	4	
Occupant age distribution	4, 3	
Occupant sick days	4	3
Occupant health data	4	
Nr of employees in the public building	4	
Nr of non-employees in the public buildings	4	
Ownership of property (Owned , rented, etc by the municipality)	4	

Socioeconomy of Indoor Environment Upgrades in Schools		
Dataset/Parameter	**Input for Model:**	**Output of Model:**
Years in school	3, 4	
Years before starting work	3, 4	
Equipment lifetime	2, 3, 4	
Schooldays per year	3, 4	
Share of learning outside school	3, 4	
Weekly hours in class	3, 4	
Time spent in upgraded classrooms	3, 4	
Adult caring of ill child	3, 4	
Percentage parents outside labour market	3, 4	
Share of child's sick days not affecting the labour market	3, 4	
Average hourly salary	3, 4	
Working hours per day	3, 4	

Average hourly salary teachers	3, 4	
Teachers' number of working hours per day	3, 4	
Discount rate 0-35 years	3, 4	
Discount rate 35-70 years	3, 4	
Growth in real wages		3, 4
Salary increase		3, 4
Performance improvement		3
State income tax	3, 4	
Municipal tax	3, 4	

Uncertainty within EERAdata

As part of the DST, the user is provided with default data for each input parameter that is required for the calculations and analyses at the beginning of the calculations. If the users were to perform the calculations on the basis of this default data, they would get a result with the maximum level of uncertainty.
The more specific data users enter via the DST and make it available for calculations and analyses, thereby replacing default data, the lower the uncertainty level of the calculations get. By showing the above-mentioned "Level of Accuracy", users can get an overview of the accuracy of their calculations and analyses at any time. In addition, the DST marks all information that is still included as default data in the calculations and analyses and which information is included as specific values in the report.

Upcoming data collection

The acquisition, collection, refinement, storage, evaluation, etc. of any kind of data required for the evaluations is a process that is continuous throughout the entire project.

As described in Deliverable 5.1, data management consists of the following steps:

1. Data collection
2. Data storage
3. Data processing
4. Data reporting

The initial data collection takes place externally, i.e. outside the Decision Support Tool (DST) within the communities or municipalities. For this purpose, a clear list of required data and their data structure is provided in the form of an Excel sheet. The data collection is followed by the data storage. In between, as already described, a validation of the inserted data sets takes place. The data storage takes place in a digital database, which is modular and dynamic. The data processing takes place in the context of the use of the data in the different calculation modules. This results in the data that is reported and made available and prepared for different user groups.