



iBRoad2EPC

TRAINING MODULE FOR PUBLIC AUTHORITIES

UNDERSTANDING iBRoad2EPC



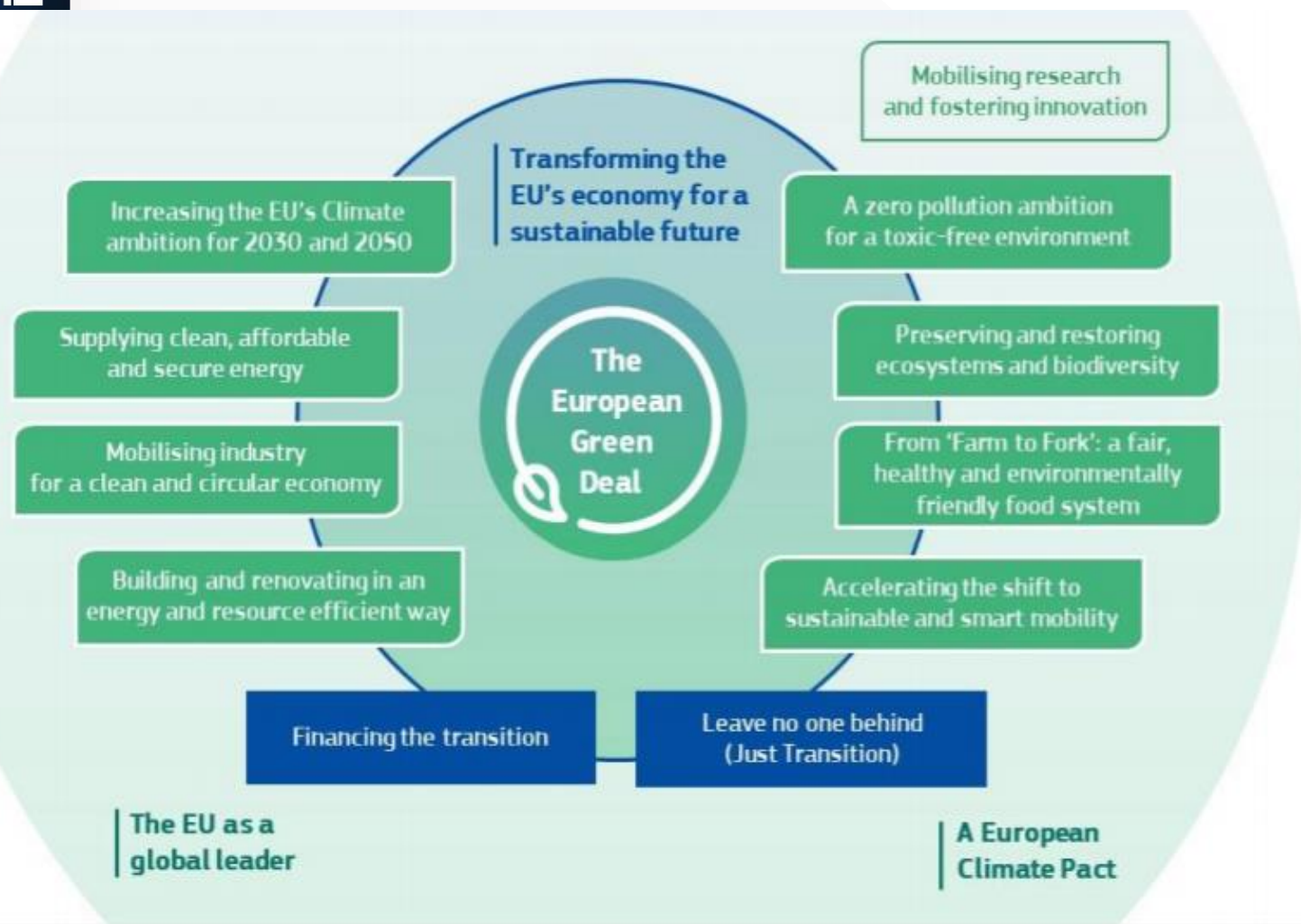
This project has received funding from the European Union's HORIZON 2020 research and innovation programme
under grant agreement No 101033781

EU AND NATIONAL POLICY

Directives, plans, obligations, regulatory
framework

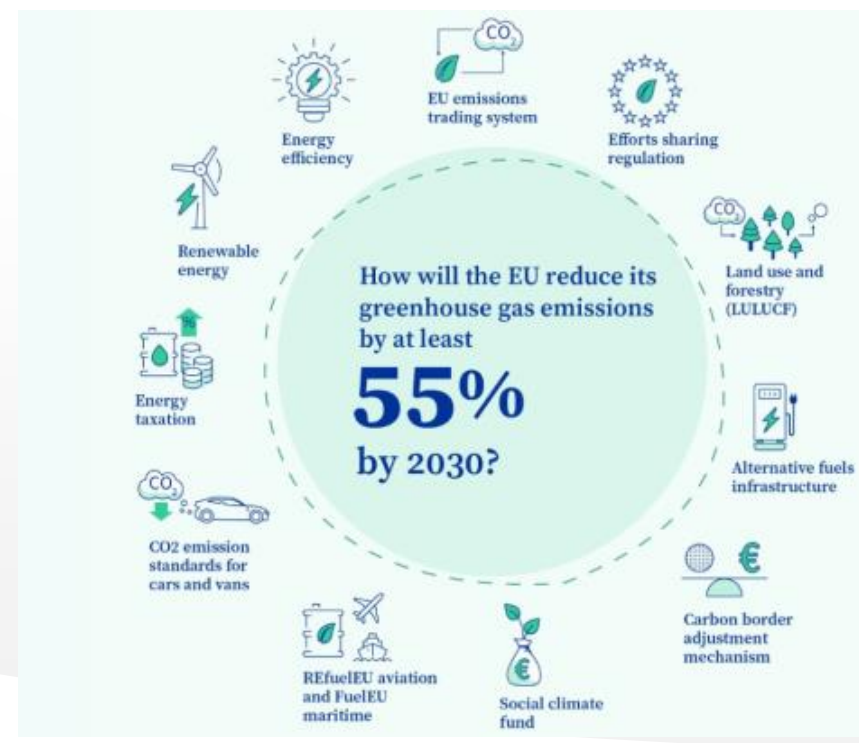
European Green Deal

- [Communication](#) by the European Commission in 2019
- Defines commitment to tackling climate and environmental-related challenges.



& Fit for 55 package to deliver on the European Green Deal

- [Communication](#) by the European Commission in 2021
- Systemically overhaul of EU legislation.
- Following legally binding targets set in the European Climate Law: **net reduction of at least 55% GHG by 2030** compared to 1990 levels.



The role of buildings to achieve the European Green Deal

Buildings are the single largest energy consumer in Europe.



In 2050, 9 out of 10 existing buildings will still be in use.

40% of EU energy consumption

1/3 of the energy-related greenhouse gas emissions

Heating, cooling and domestic hot water account for 80% of the energy that we, citizens, consume.

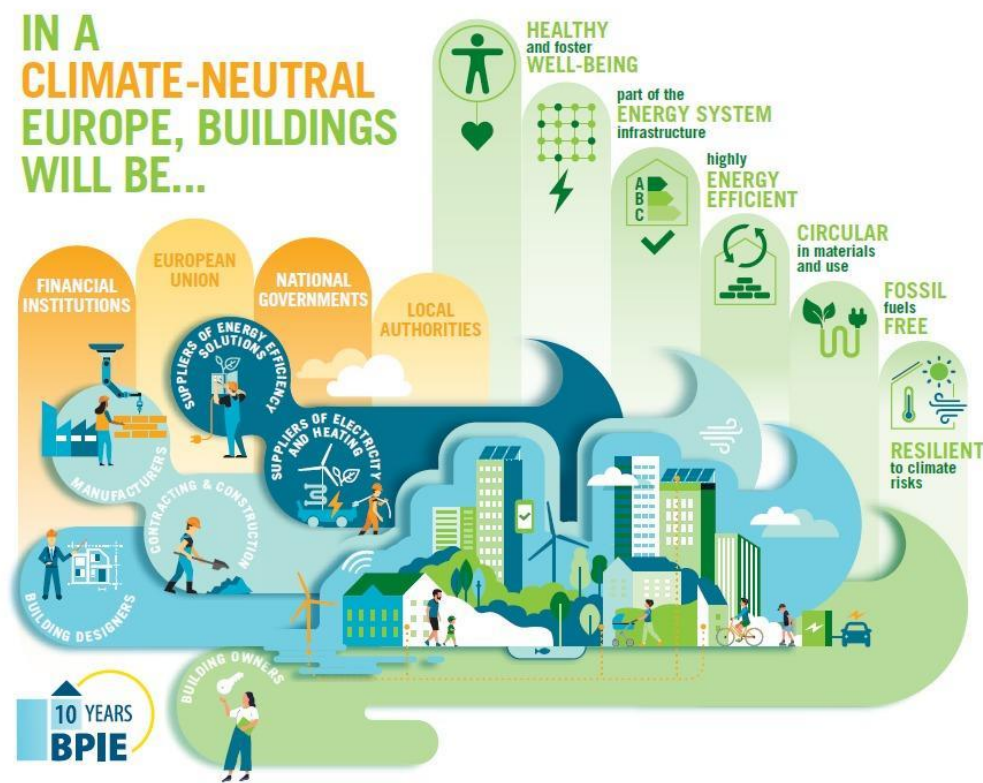
About 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient.

Up to 97% have a significant potential for further improvement but only about 1% of the building stock is renovated each year.

Renovation Wave 2020 - A European Strategy for Building Renovation Policy

- [Communication](#) by the European Commission in 2020 to “greening our buildings, creating jobs, improving lives”
- Three key focus areas:
 - Decarbonising the **heating and cooling systems** in buildings
 - Tackling **energy poverty and worst-performing buildings**, focusing on renovations that improve living conditions, reduce energy bills for vulnerable groups.
 - **Renovation of public buildings** like schools, hospitals, and administrative buildings, to lead by example.
- Targets:
 - at least **double renovation rates until 2030** and make sure renovations lead to higher energy and resource efficiency.
 - **35 million buildings units renovated by 2030.**
- Intention to consider the introduction of a ‘**deep renovation**’ standard as part of the EPBD revision.

AN ACTION PLAN FOR THE RENOVATION WAVE: COLLECTIVELY ACHIEVING SUSTAINABLE BUILDINGS IN EUROPE



Source: [BPIE - The Buildings Performance Institute Europe](#)

The 2024 EPBD recast for Deep Renovation

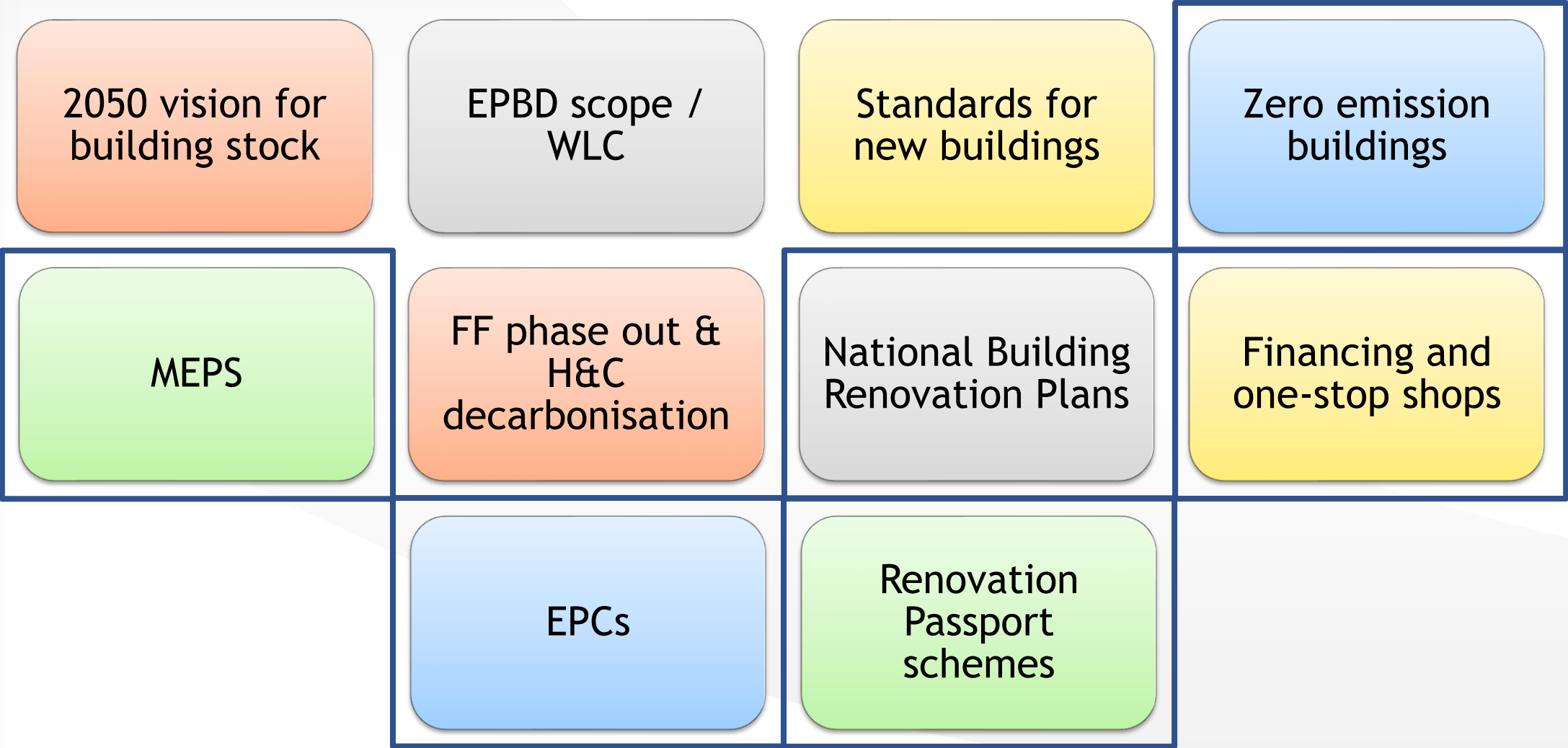
‘Deep renovation’ means a renovation which is in line with the ‘energy efficiency first’ principle, which focuses on essential building elements and which transforms a building or building unit:
(a) before 1 January 2030, into a nearly zero-energy building;
(b) from 1 January 2030, into a zero-emission building.
(Article 2 (20))

Good to know:

- Renovation passports provide a clear roadmap for staged deep renovations, helping owners and investors plan the best timing and scope for interventions.
- Member States shall incentivise deep renovation and staged deep renovation with higher financial, fiscal, administrative and technical support.
- Policies for the promotion of deep renovation of buildings, including staged deep renovation must be mentioned in the NBRPs

2024 EPBD recast – EU’s buildings directive

What sections of the 2024 EPBD recast are most important for iBRoad2EPC?



Zero-emission buildings (ZEBs)

A zero-emission building (ZEB) means a building with a very high energy performance, requiring zero or a very low amount of energy, producing zero on-site carbon emissions from fossil fuels and zero or a very low amount of operational greenhouse gas emission. (Article 2(2))

Good to know:

- They replace previous nearly-zero emission standards
- The ZEB standard will entry into force starting with:
 - 1 January 2028 for new buildings owned by public bodies.
 - 1 January 2030 for all new buildings.
- Member States shall ensure that the **total annual primary energy use** of a new or renovated ZEB is covered by:
 - energy from renewable sources generated on-site or nearby, or from a renewable energy community,
 - energy from an efficient district heating and cooling system, or from carbon free sources.

Energy Performance Certificates (EPCs) (Article 19)

‘energy performance certificate’ means a certificate, recognised by a Member State or by a legal person designated by it, which indicates the energy performance of a building or building unit, calculated in accordance with a methodology adopted pursuant to Article 4. (Article 2(30))

Good to know:

- Better defined design guidelines to improve readability. Member States also need to ensure a common visual identity.
- EPC will be done through an on-site visit, though this can happen by virtual means.
- New recommendations will include information on cost and benefits, and new EPCs have a link to advisory services (such as information of one-stop shops).
- Improved data scope that includes better energy performance coverage and GHG metrics.
- The EPC lifespan has not been shortened to 5 years.
- When Member States choose to integrate a renovation passport, it shall substitute the recommendations provided by the EPC.



Renovation Passports (Article 12)

‘Renovation passport’ means a tailored roadmap for the deep renovation of a specific building in a maximum number of steps that will significantly improve its energy performance. (Article 2 (19))

Good to know:

- The scheme will be of **voluntary use** by owners of buildings, unless Member States decide to make it mandatory.
- Member States may decide to allow for the renovation passport to be drawn up and issued jointly with the energy performance certificate.
- Member States need to ensure that the renovation passport can be uploaded to the national database for the energy performance of buildings and accessed via the digital building logbook.
- Annex VIII of EPBD with list of requirements for renovation passport
- Member States will need to provide a dedicated digital tool for preparing and potentially updating the renovation passport.

Minimum Energy Performance Standards (MEPS) (Article 9)

‘Minimum energy performance standards’ means rules that require existing buildings to meet an energy performance requirement as part of a wide renovation plan for a building stock or at a trigger point on the market such as sale, rent, donation or change of purpose within the cadastre or land registry, in a period of time or by a specific date, thereby triggering the renovation of existing buildings. (Article 2 (4))

- MEPS will ensure that non-residential buildings do not exceed the specified **maximum energy performance threshold** (expressed in kWh/m²/year).
- The MEPS will ensure that all non-residential buildings are below:
 - 16% threshold as of 2030.
 - 26% threshold as of 2033.
- The maximum energy performance threshold may be differentiated between different building types and categories.

National Building Renovation Plans (NBRPs) (Article 3)

Member States should establish national building renovation plans which replace the long-term renovation strategies [...] which are to become an even stronger, fully operational planning tool for Member States, in line with the ‘energy efficiency first’ principle, with a stronger focus on financing and ensuring that appropriately skilled workers are available for carrying out building renovations. (37)

Good to know:

- The NBRPs are based on a harmonised template to ensure comparability of plans (Annex II)
- Member States shall submit the first draft building renovation plan to the Commission by 31 December 2025 and the first building renovation plan by 31 December 2026. Updates need to be submitted every five years.
- The NBRPs will be submitted as part of the integrated national energy and climate plans and their updates (thus 2nd NBRP draft already needs to be submitted in 2028).
- NBRP will need to include roadmaps for phasing out fossil fuels in heating and cooling by 2040 at the latest.

iBRoad2EPC & the 2024 recast EPBD

(43)

*There are some **synergies between renovation passports and energy performance certificates**, in particular as regards the assessment of the current performance of the building and the recommendations for its improvement*

In order to make the most of those synergies and reduce costs for building owners, Member States should be able to allow the renovation passport and the energy performance certificate to be drawn up jointly by the same expert and issued together.

*In the case of such joint drawing up and issuing, the renovation passport should **substitute the recommendations in the energy performance certificate**. It should, however, remain possible to obtain an energy performance certificate without a renovation passport.*

National legislation in the field of Energy Efficiency

National Energy and Climate
Plan 2030 - Energy Efficiency
Chapter (relation to EED)

SCE -Building Energy
Certification System (transposing
EPBD and contributing to EED
article 7)

Detailed legislative package:

- Qualified Experts and Exam
- Indoor Air Quality
- Minimum Energy Performance Requirements
- Certificate contents
- Quality check
- Audits and systems maintenance
-

National legislation – Requirements for the energy performance of buildings - SCE

Covered by Decree-Law No. 101-D/2020



Subject to compliance with requirements

- New Buildings
- Buildings subject to renovation
- Buildings subject to major renovation
(Execeptions as per Article 9)

Decree n.º 138-I/2021



Ordinance n.º 6476-E/2021



Subject to mandatory Energy Certification

- New Buildings
- Buildings subject to major renovation
- Existing buildings under Article 18(1)
(Exceptions according to Article 18(2))

Decree-law n.º 101-D/2020 (Chapter III)

National legislation – Requirements for the energy performance of buildings - SCE



Decree-law 101-D/2020 - Requirements and standards are divided in these main types of buildings:

- Residential, Small Non-Residential Buildings (effective rated output < 30 kW), Small Non-Residential Buildings with climatization (effective rated output > 30 kW) and
- Large Non-Residential Buildings (the ones with over 1000 sqm).

New buildings, major renovations, Large Non-Residential Buildings, buildings on transaction (rental, sale, leasing, donation, etc.) and buildings under energy efficiency financing programmes and related tax benefits must have an EPC.

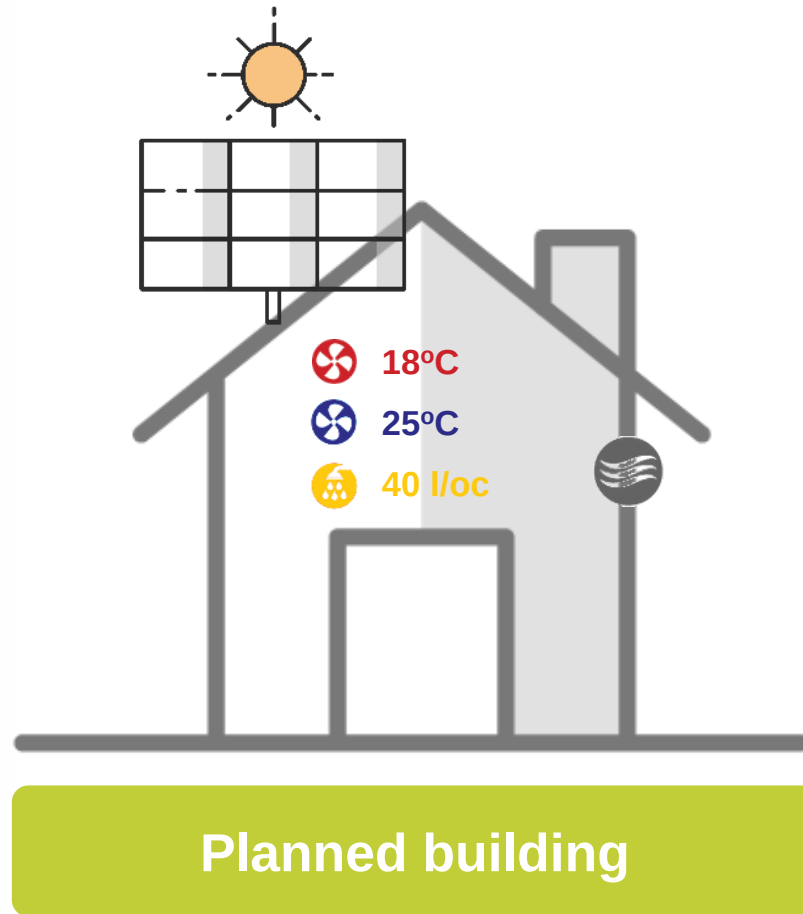
New buildings and major renovations also must comply with minimum energy performance requirements:

- **New residential buildings - Class A; Major renovation on residential buildings - Class C;**
- **New non-residential buildings - Class B; Major renovation on non-residential buildings - Class C.**

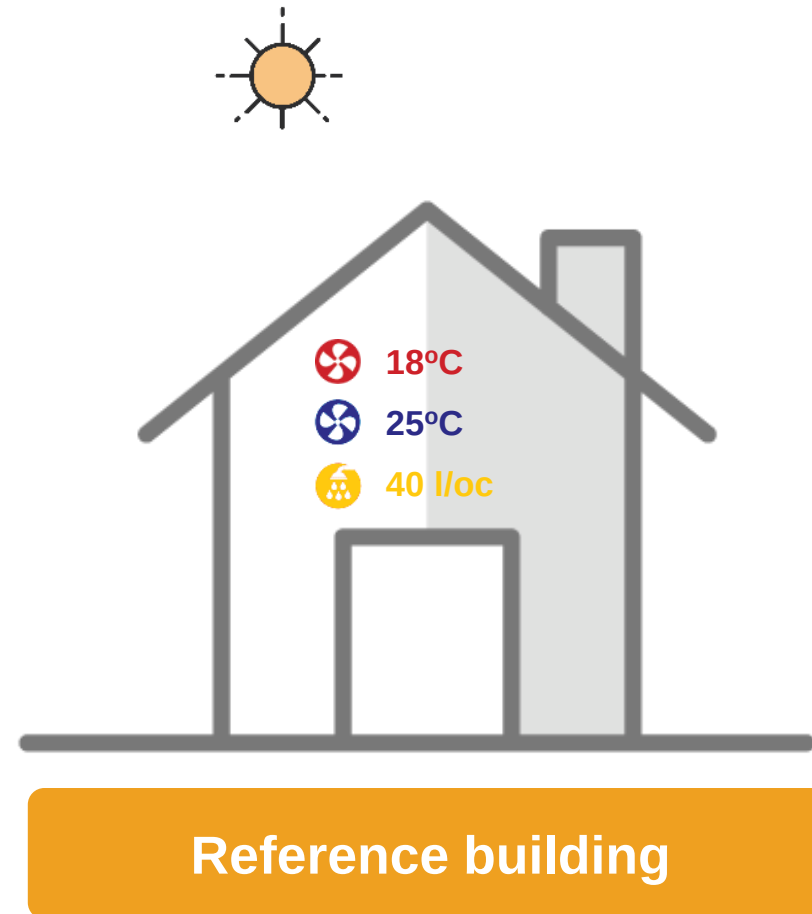
No major differentiation is made for public buildings in terms of requirements and standards but, public owned and occupied buildings that are frequently visited by the general public with an area >250m², are automatically obliged to have an energy performance certificate. These public buildings are also obliged to display the energy certificate in their premises. For private buildings this is mandatory only for Large Non-Residential Buildings.

All buildings must display the energy class when advertising any transaction.

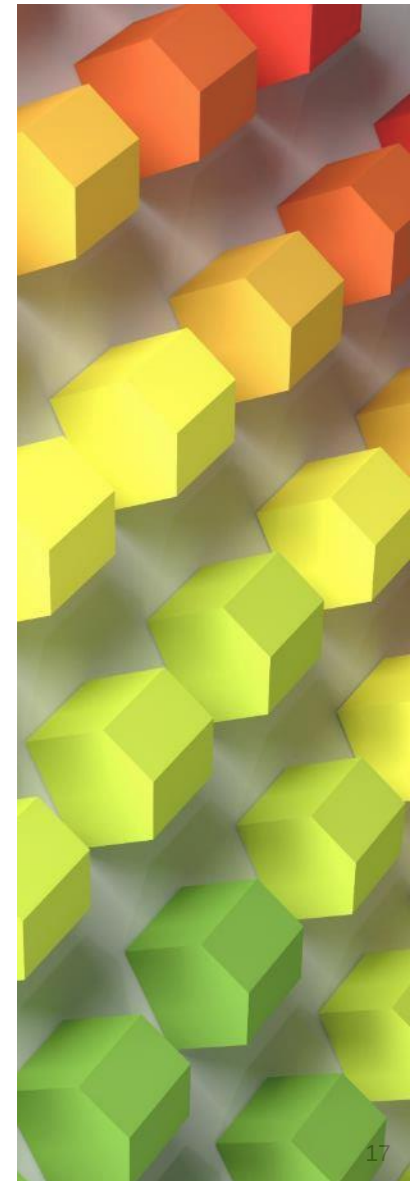
National legislation – Energy certificate and energy classes



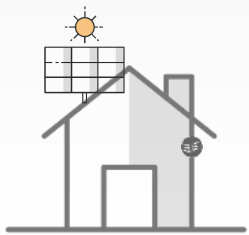
Simulation with the real characteristics of the building envelope and technical systems



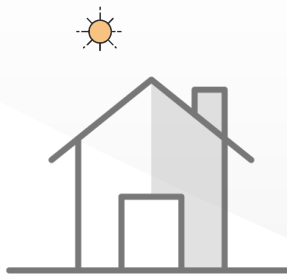
Simulation with reference characteristics of the building envelope and technical systems



National legislation – Energy certificate and energy classes



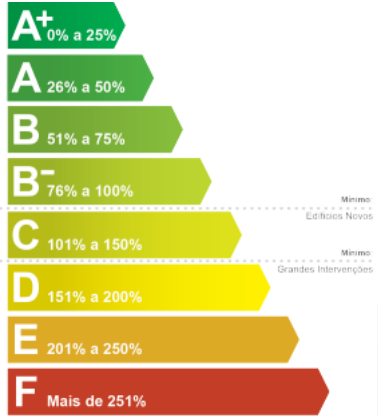
**Nominal Primary Energy
Needs – N_{tc}**



**Reference Nominal Primary
Energy Needs– N_t**

$$R_{Nt} = \frac{N_{tc}}{N_t}^*$$

Classe energética	R_{Nt}
A+	$R_{Nt} \leq 0,25$
A	$0,25 < R_{Nt} \leq 0,50$
B	$0,50 < R_{Nt} \leq 0,75$
B -	$0,75 < R_{Nt} \leq 1,00$
C	$1,00 < R_{Nt} \leq 1,50$
D	$1,50 < R_{Nt} \leq 2,00$
E	$2,00 < R_{Nt} \leq 2,50$
F	$R_{Nt} > 2,50$



Source: [SCE Manual](#)

* Example for residential



Deep renovation benefits

Why it's so important

Deep Energy Renovation – Why is it important?

before

290
kWh/
m²year



Energy savings
Bills reduction
Reduced maintenance costs
Extended building life

after

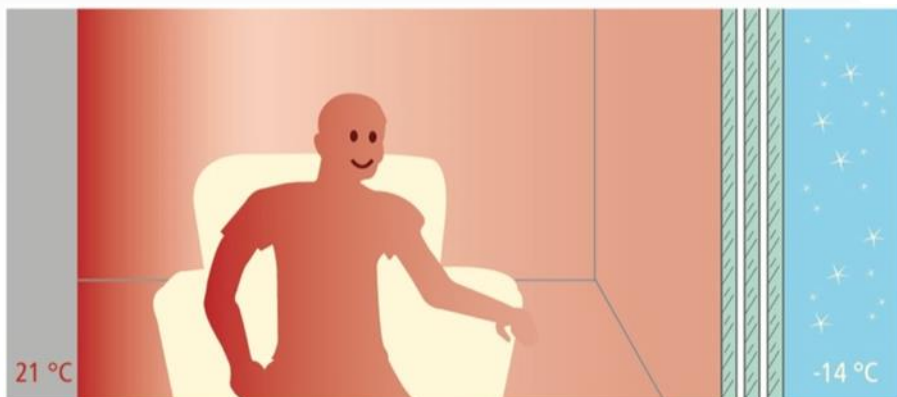
94%
savings

17
kWh/m²year



In deep renovation of existing buildings energy savings are >60%

Deep Energy Renovation – Why is it important?



Provides optimal thermal comfort

- ✓ Warm surrounding surfaces
- ✓ No cold pocket in the legs
- ✓ Better thermal insulation and air tightness provide better sound insulation of the building
- ✓ Optimal solar gains in winter and summer

Deep Energy Renovation – Why is it important?



Improves indoor
air quality in
buildings

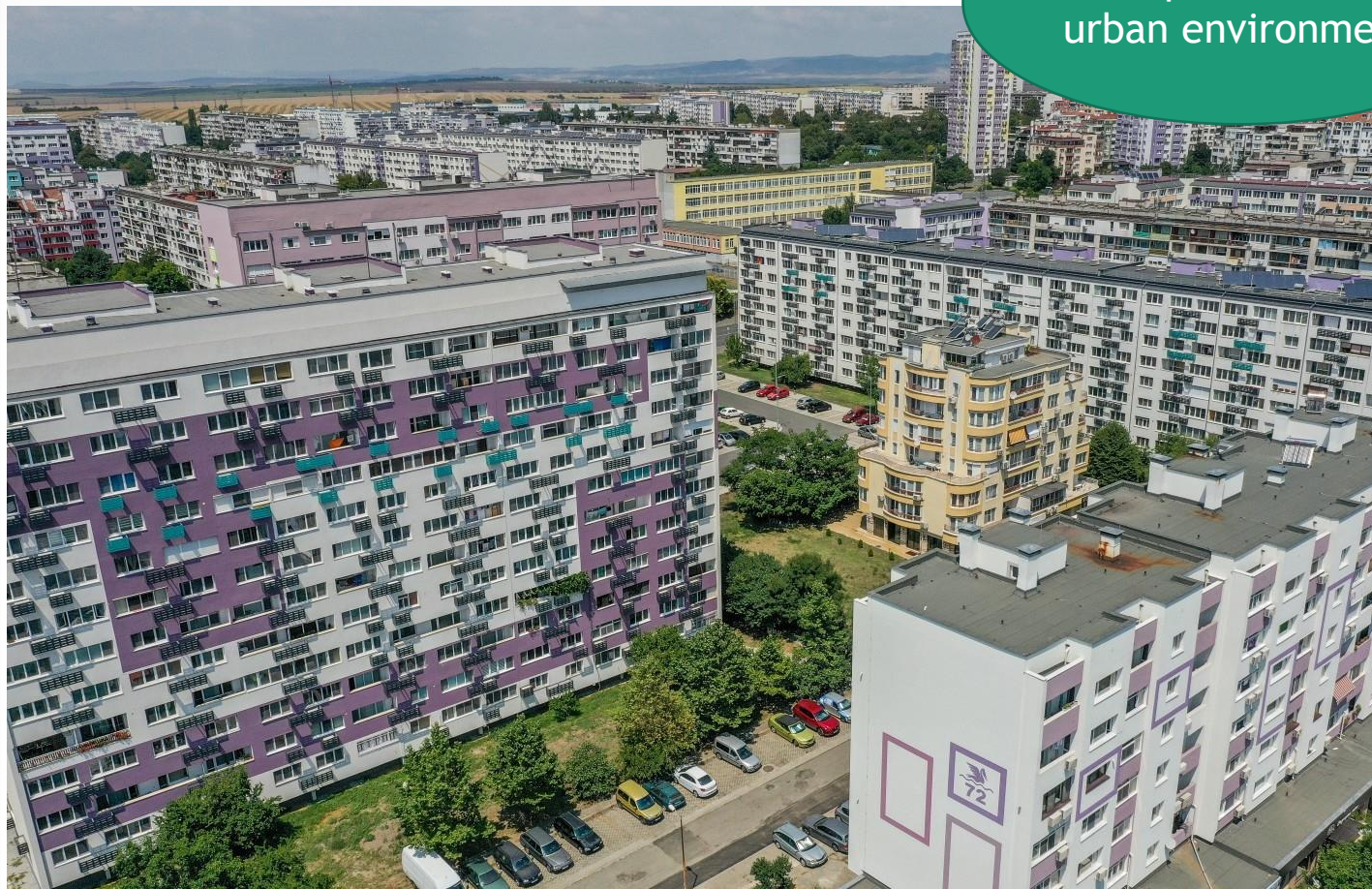
- ✓ Sufficient oxygen and healthy CO₂ levels
- ✓ No external contaminants
- ✓ Removing indoor pollutants at the source
- ✓ Regulated air humidity
- ✓ Prevents mold growth



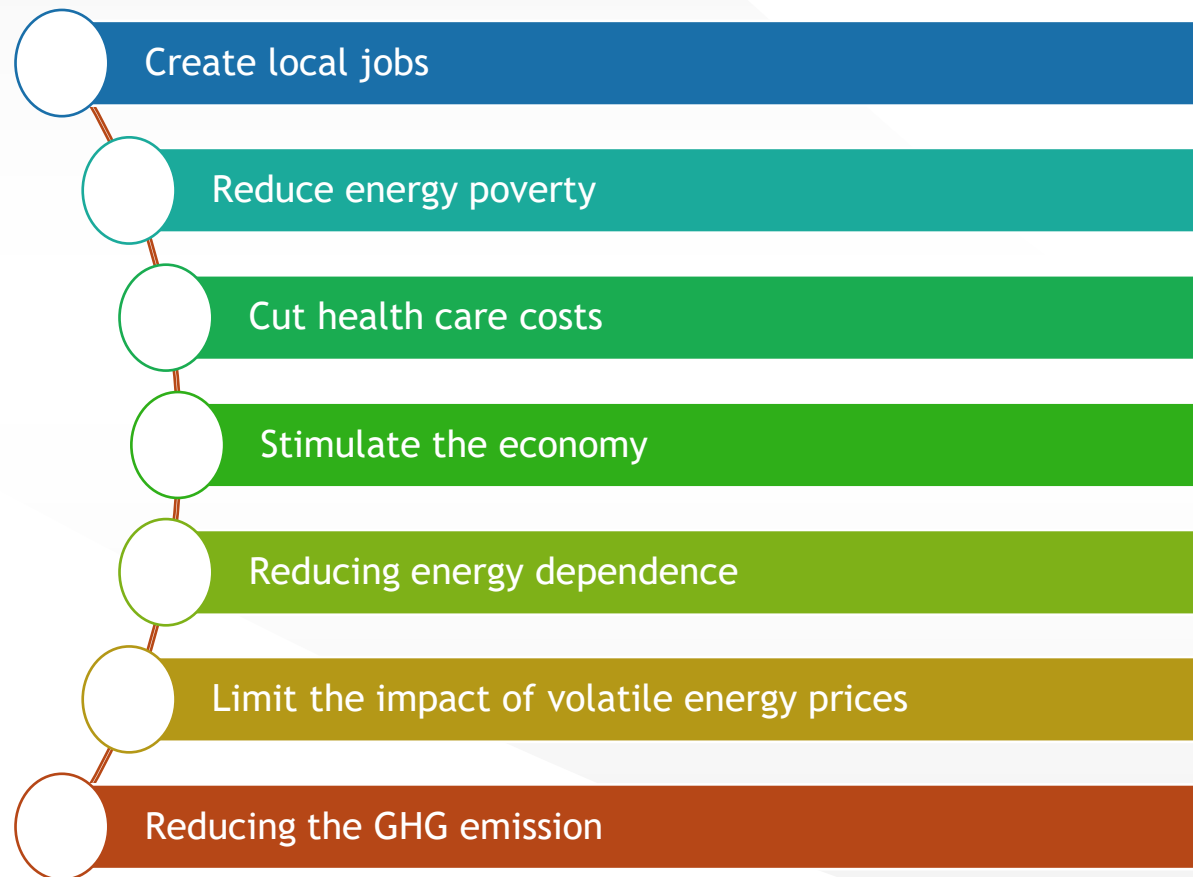
Reduction of respiratory diseases
Better concentration and better sleep

Deep Energy Renovation – Why is it important?

Improves the
urban environment



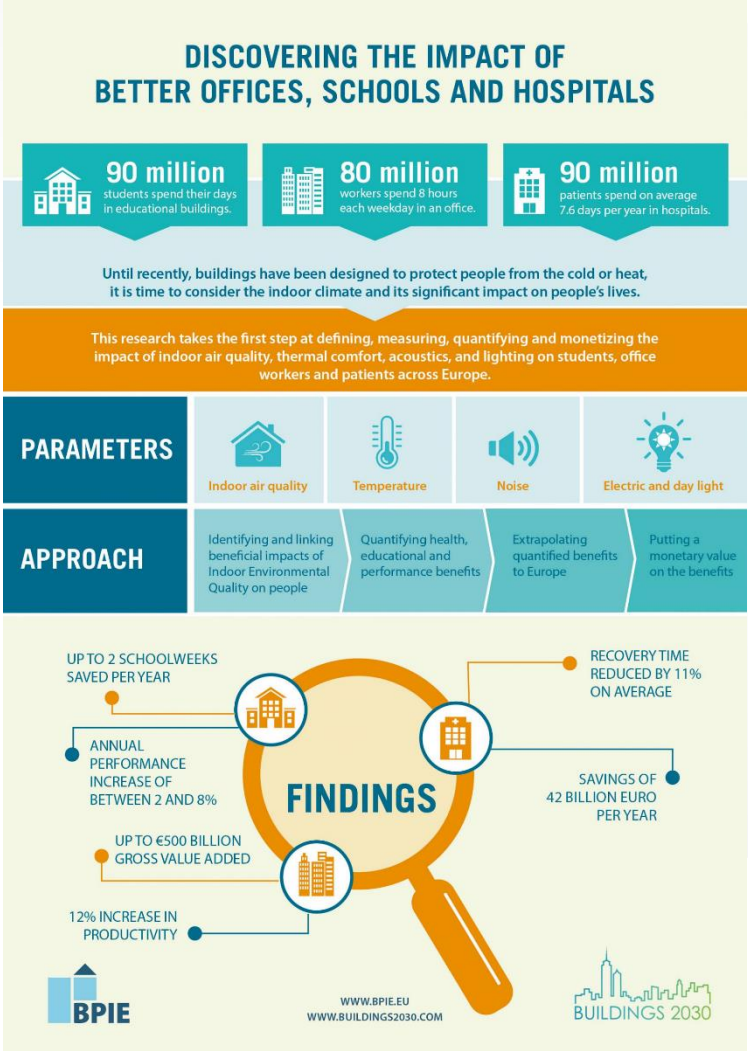
Deep Energy Renovation – Why is it important?



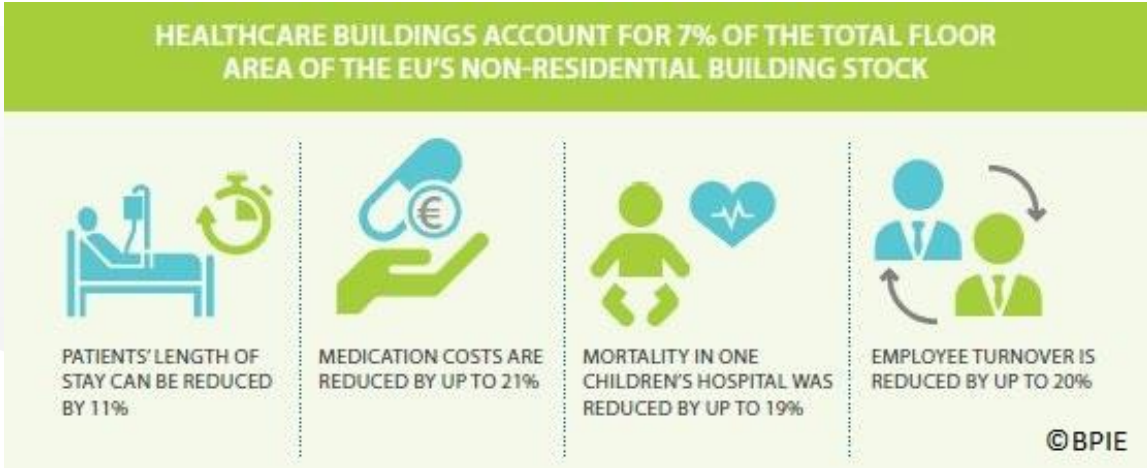
Every 1 MEUR invested in deep renovation of buildings creates an average of **18 jobs** in the EU (more than 40 in Bulgaria). These are local, long-term jobs that stimulate economic activity.

Reduce the average length stay in hospital by 11%
Medication cost could be reduced by up to 19%

Benefits of Deep energy renovation in numbers



©BPiE



©BPiE

Deep Energy Renovation – Why is it important?



Reducing the risk
of climate crises



Step-by-step approach

Principles of step-by-step renovation of buildings

Single step or Step-by-step

	Single step	Step by step
Definition	All possible measures at the time of decision-making	Renovation measures performed according to trigger points in a specific sequence and timeline
Time dimension	At once	Over the years (or decades)
Main risks	Insufficient funds to implement all measures properly Replacing equipment before it is needed Ahead of technology development	Lock-in effects and misinvestments if the individual steps do not build on one another in a specific sequence.
Barriers	Disruption and/or affordability	Carring out more than one reconstruction
Opportunities / Benefits	Savings starts earlier	Measures can be adapted to future obligations along the line
Cost	Very high costs for deep renovation at once	Investments for the next steps can be covered by the savings of the previous ones

Step By Step

Lock-in effect

When sufficient funds cannot be allocated to renovate buildings, compromises with quality are often resorted to. For example, instead of installing insulation 15 cm thick, 5 cm is installed, or additional activities are omitted, such as sealing joints around windows or other work. Thus, the building is now completely, or sometimes partially, renovated, but with measures that do not result in sufficiently low energy consumption. These measures, once done, cannot be redone with thicker insulation or better window frames installed at least for the next 30-50 years (lifecycle of the measures). It is this effect that is called the lock-in effect.

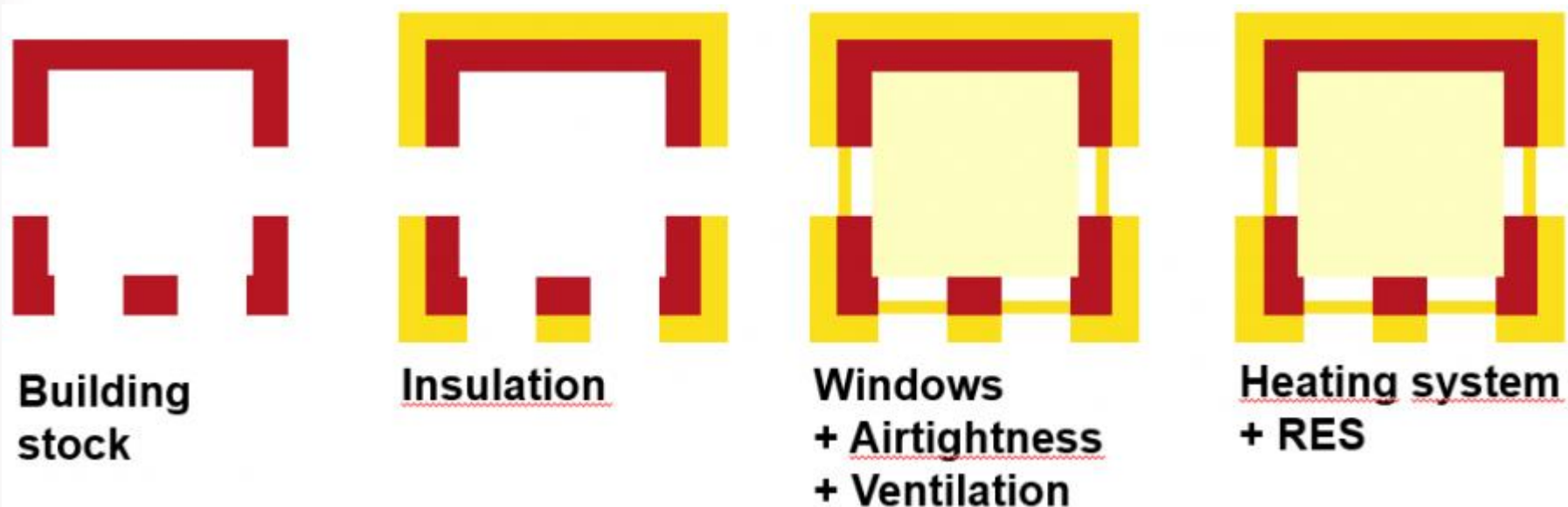


Step-by-step recommendations

In general, we can differentiate between two types of step-by-step renovation processes:

Sequential renovation of building components

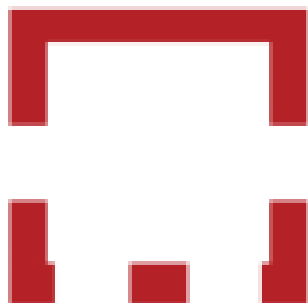
- Step 1 consists of the wall insulation;
- Step 2 – the windows will be replaced and a ventilation system is installed;
- Step 3 – the roof insulation, the heating system and other measures are implemented to finally reach NZEB Standard.



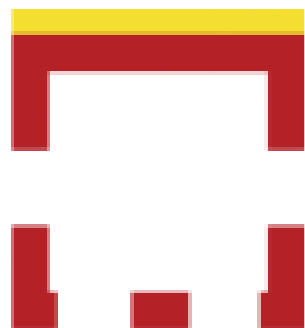
When performing a step-by-step renovation, it is very important that the activities are planned in such a way that it does not get the so-called "lock-in" effect.

Step-by-step recommendations

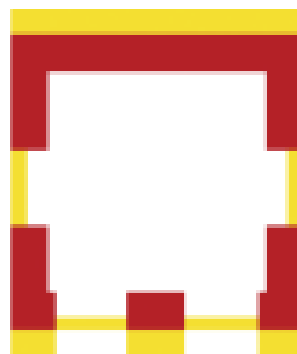
a step-by-step approach by facades



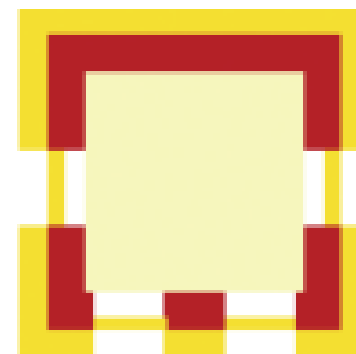
Current situation



Insulation of North Facade



South facade, windows and air tightness



East and West facades, mechanical systems and RES

When performing a step-by-step renovation, it is very important that the activities are planned in such a way that it does not get the so-called "lock-in" effect.

Principles of approach step-by-step

- Technical approach
 - What is applicable to the building?
 - How old are components and do they need a renovation / change?
 - In what sequence can the measures be most correctly stretched?
- Approach to the obligations of the owner
 - What obligations does the owner currently have?
 - What obligations expected to have in the future?
 - What additional regulations are required (e.g. fossil fuel bans)?
 - Carbon neutrality by 2050

Specific project designs and plans

- It is necessary that the step-by-step renovation plan is drawn up by a qualified specialist who could propose different combinations of measures that allow both optimal technical and economic benefits, as well as allowing to upgrade the effect with the next steps.
- It is necessary for the technical projects and drawings to be in accordance with the measures and their technological sequence, not allowing lock-in effects for further upgrading.
- The project should be designed to maximise the energy saving potential.



New indicators and evaluation hidden benefits

What the IEQ, SRI are MEPI means

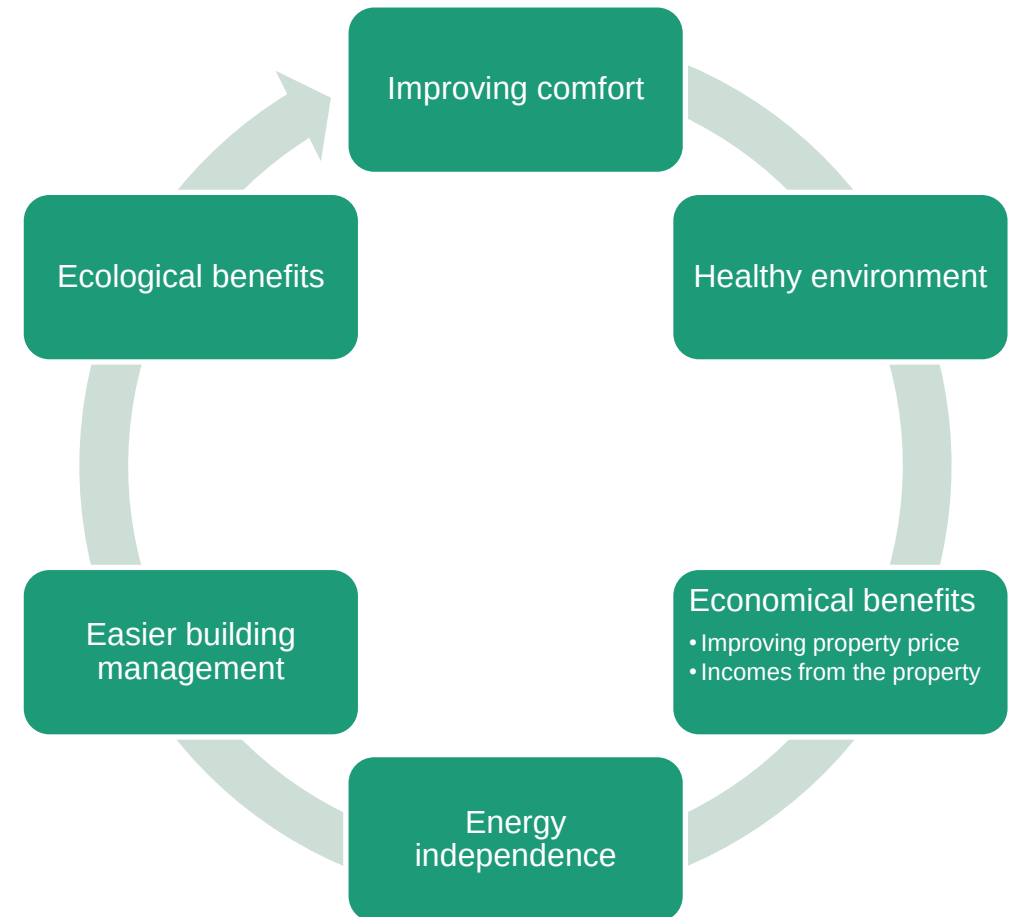
Energy measures benefits

When assessing the financial implications of energy efficiency renovations, it is imperative to look beyond mere payback considerations. While it is true that energy efficiency measures typically yield a return on investment and contribute to financial gains, adopting a comprehensive approach can yield greater benefits from renovation endeavors.

Incorporating a holistic perspective involves acknowledging the non-energy financial advantages associated with renovations. Notably, considering both energy and non-energy financial implications can optimize the outcomes of energy efficiency renovation initiatives.

Hidden benefits

From energy cost to improving indoor environment, outdoor air pollution, building management and energy independence these hidden benefits can also be measured or evaluated



Building renovation indicators

- Indoor Environmental Quality indicator (IEQ)
- Smart Readiness Indicator (SRI)
- Measured Energy Performance Indicator (MEPI)



Indoor Environmental Quality (IEQ)

- Indoor air quality
- Thermal comfort
- Lighting
- Acoustics



Smart Readiness Indicator (SRI)

- Optimise energy efficiency and overall in-use performance
- Adapt their operation to the needs of the occupant
- Adapt to signals from the grid (for example energy flexibility).



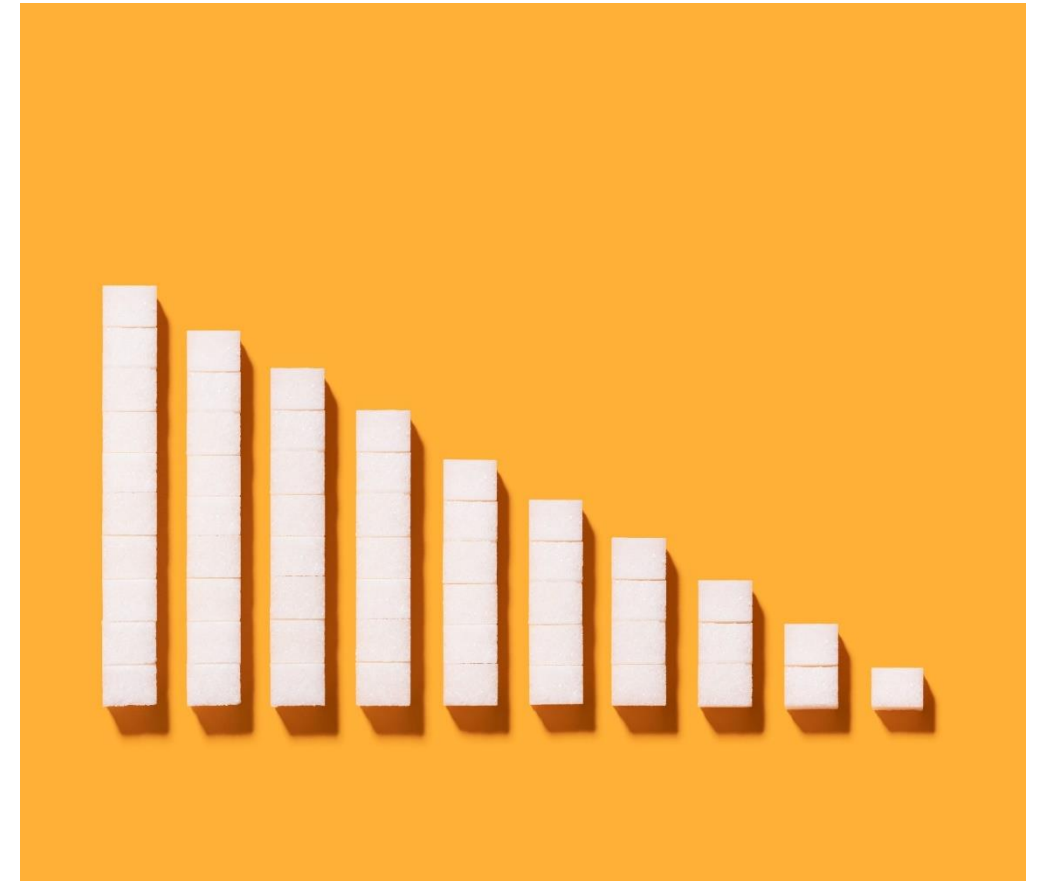
<https://ec.europa.eu/newsroom/ener/newsletter-archives/34153>

Measured Energy Performance Indicator (MEPI)

Not covered by most of the EPCs in the EU

MEPI includes:

- Energy bills
- Measurements on specific consumers
- Building energy balance based on the consumption



MEPI. Methods

- Building-level simple approach
 - Energy data
 - Normalization (adapting to normal climate conditions)
- Building-level detailed approach
- Stock-level model development

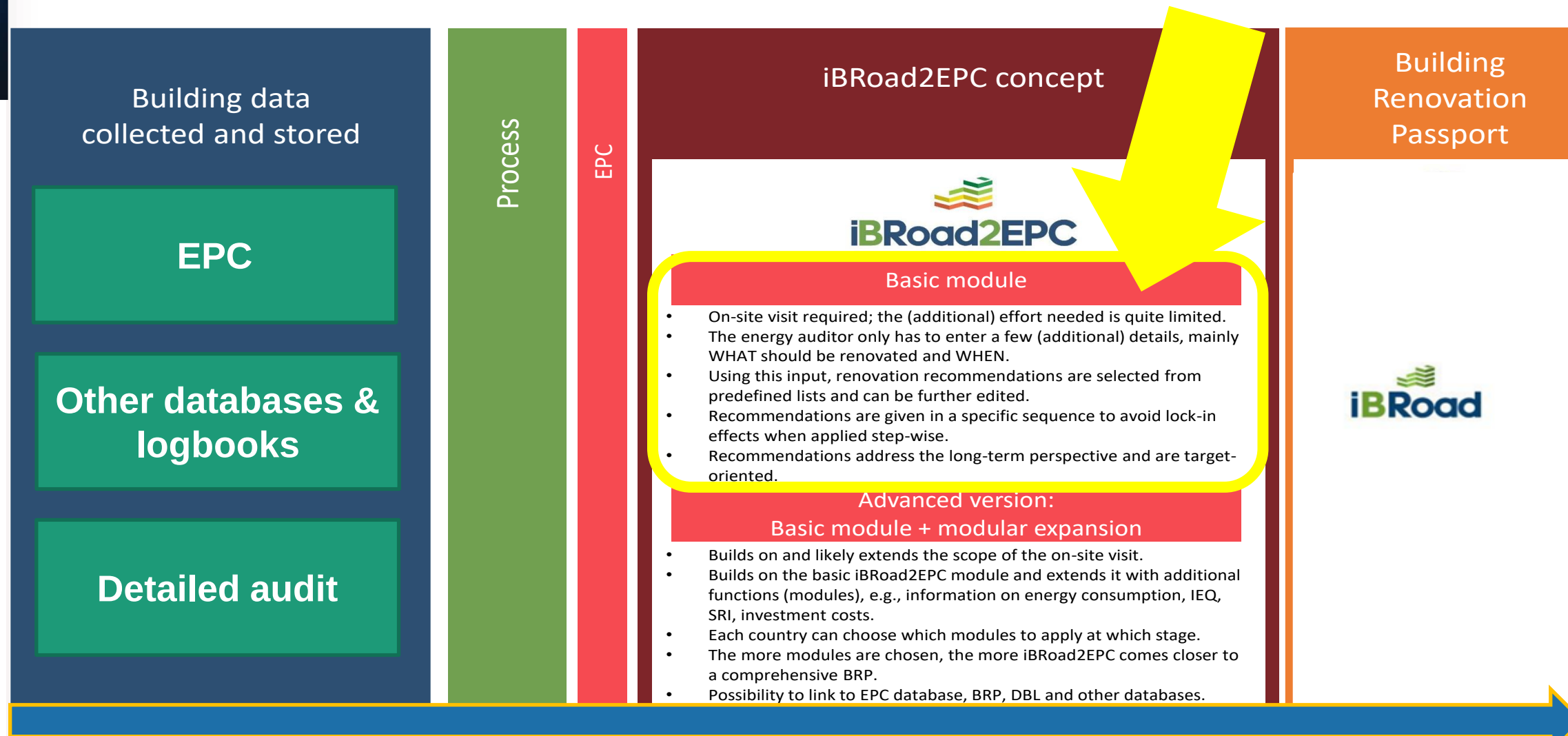




iBRoad2EPC approach

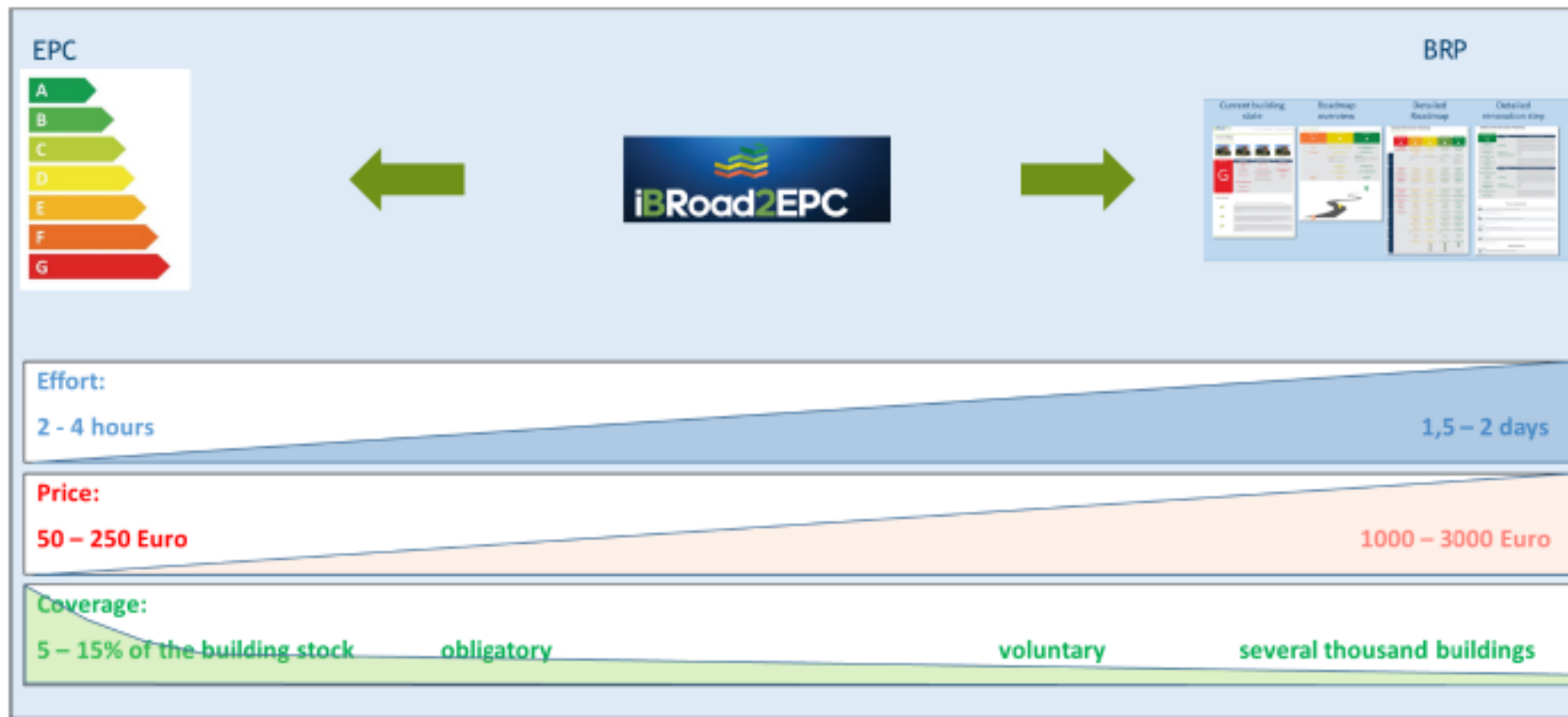
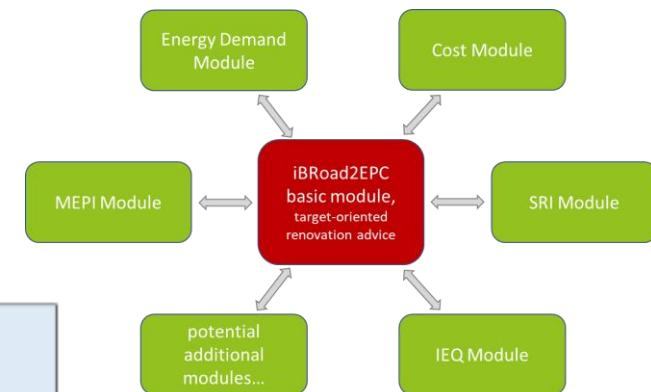
What do we propose

iBRoad2EPC concept

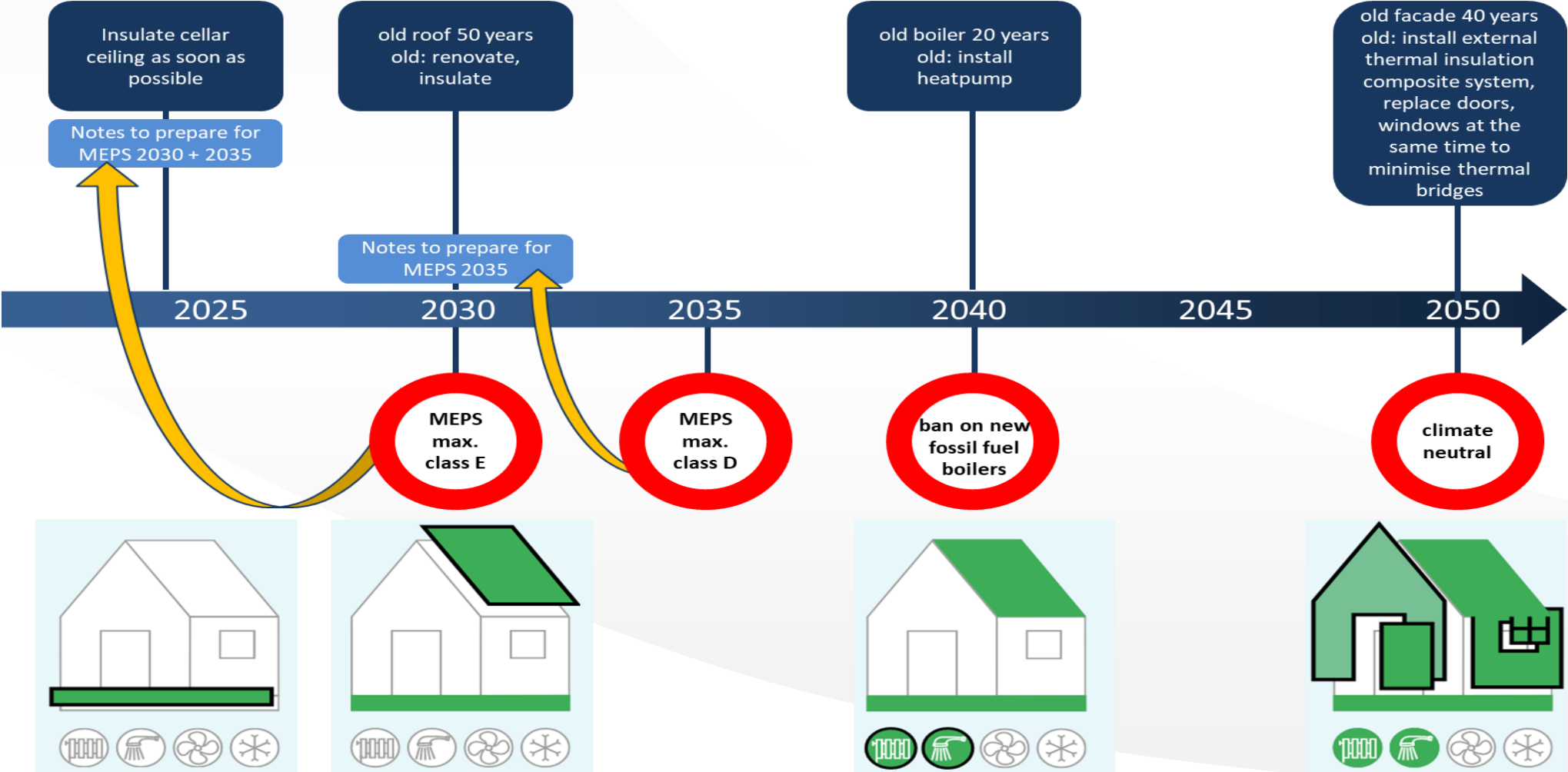


iBRoad2EPC market placement

Product flexibility can be adapted to market conditions in individual countries



iBRoad2EPC concept



Benefits of iBRoad2EPC approach

iBRoad2EPC

Improved recommendations to stimulate (staged) renovation of existing buildings

An individual long-term renovation strategy considering the avoidance of mistakes (lock-in effects)

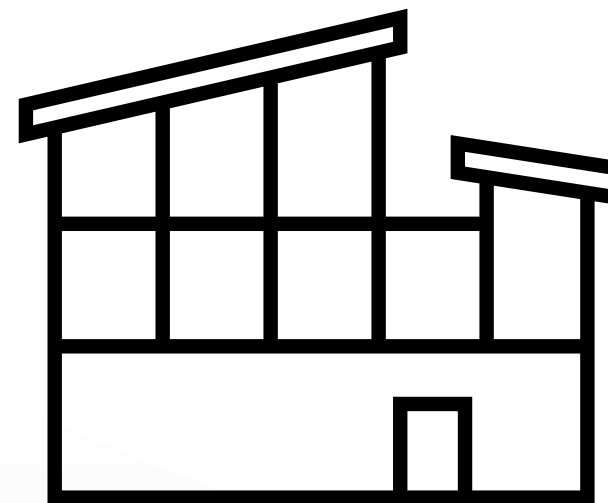
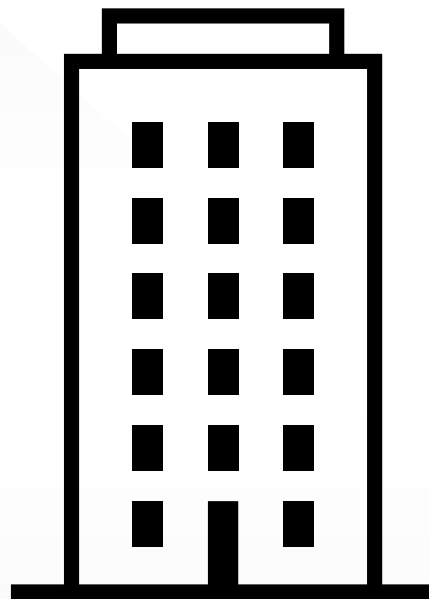
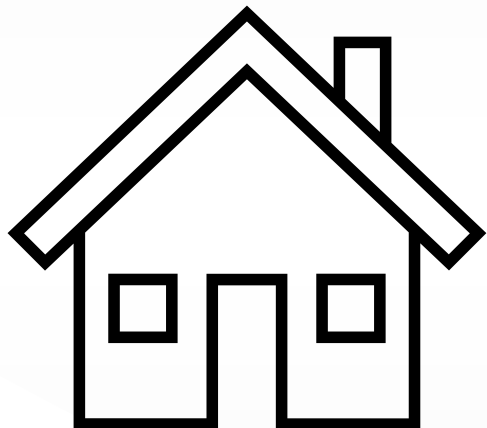
Recommendations that are aligned with the national climate targets as well as future requirements and obligations

Improve quality and user trust

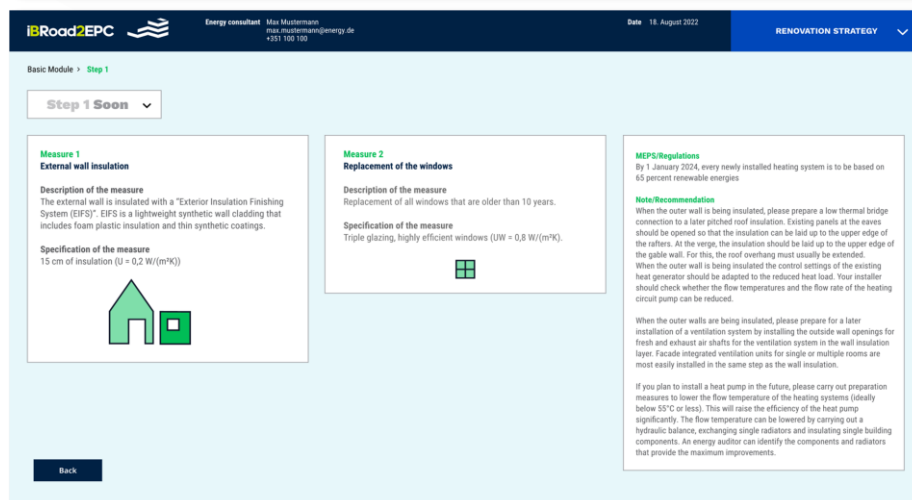
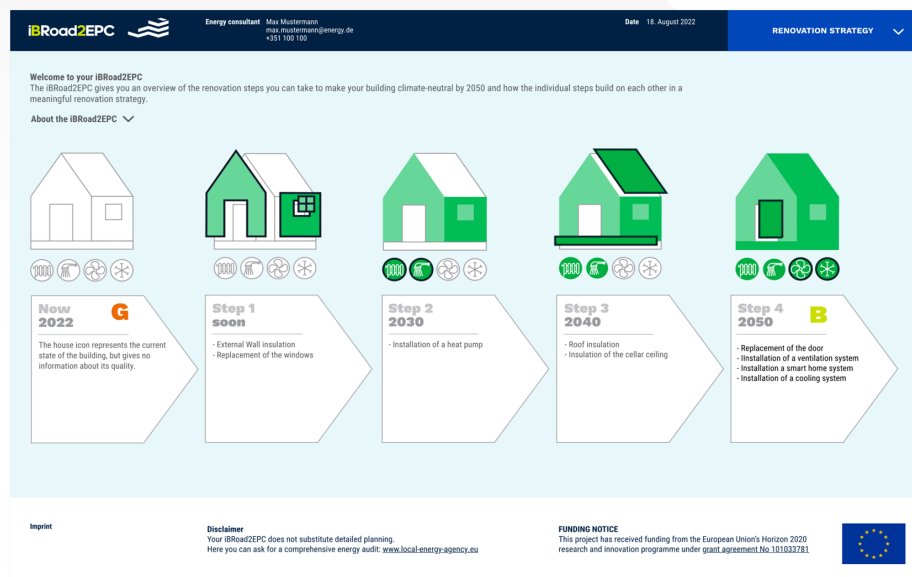
Additional indicators (e.g., IEQ, SRI, etc.)

A holistic and integrated approach to other national tools/schemes

Benefits of iBRoad2EPC approach



iBRoad2EPC approach



- iBRoad2EPC is an **energy consultation** for building owners, issued by building professionals.
- iBRoad2EPC outlines an initial **renovation strategy** on how a building can become climate neutral in the long term.
- The strategy can include a full renovation in **one step**, but also a renovation in **several steps**.
- The long-term perspective means that the individual renovation steps build on each other, building component connections can be prepared in good time and even future renovation obligations can be taken into account today.

iBRoad2EPC approach



Triggers

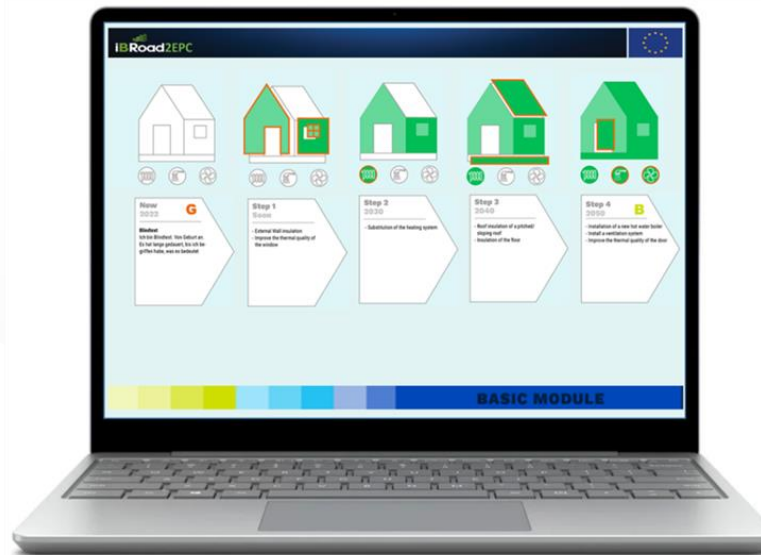
Any legal change can be considered as a trigger for a building change.

so, for example, if there are obligations for every building to be Class D by 2030 then the measures made to that particular building will have to meet that target in 2030

iBRoad2EPC approach

Design

On the main page of iBRoad2EPC it is easy to distinguish the measures, both visually on the images and in the description below each image.



iBRoad2EPC approach

Various preliminary texts are included in the tool to warn of various possible problems resulting from the connection of the measures to be implemented in different steps.

Renovations to be done by: ASAP

Costs	Maintenance costs : € 0	Energy related costs : € 0	Funding : € 0		
Energy	Energy sources :	1. Gas	Final energy demand : 167 kWh/m²a	GHG emissions : 40 kg/m²	Energy costs : 2800.0 €/a

1. Roof - Insulation of the top storey ceiling

Isolamento da cobertura do piso superior em sótão (desvão ventilado - espaço não útil). As placas de isolamento são colocadas sobre a esteira horizontal. No caso de tectos permeáveis ao vapor, pode ser necessário colocar uma barreira de vapor sob o isolamento para evitar a acumulação de humidade no material de isolamento. Pergunte ao seu projectista sobre isto. Se o sótão tiver de ser pisado, o material de isolamento deve ser coberto com tábuas estáveis.

⚠ Preparations for later renovations steps

2. External wall - External insulation (EIFS System)

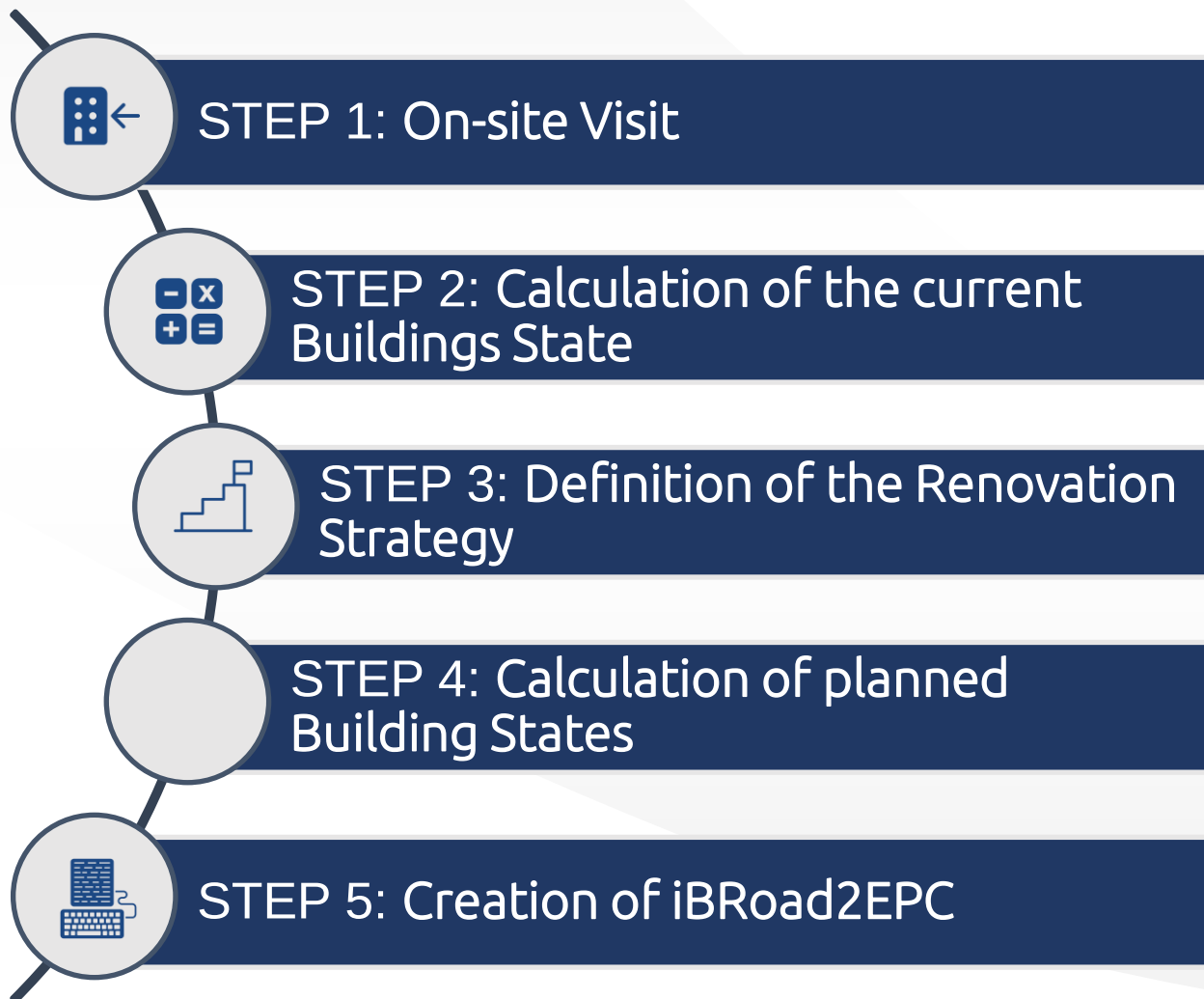
The external wall is insulated with an "Exterior Insulation Finishing System (EIFS)". EIFS is a lightweight synthetic wall cladding that includes foam plastic insulation and thin synthetic coatings.

⚠ Preparation for later renovation steps

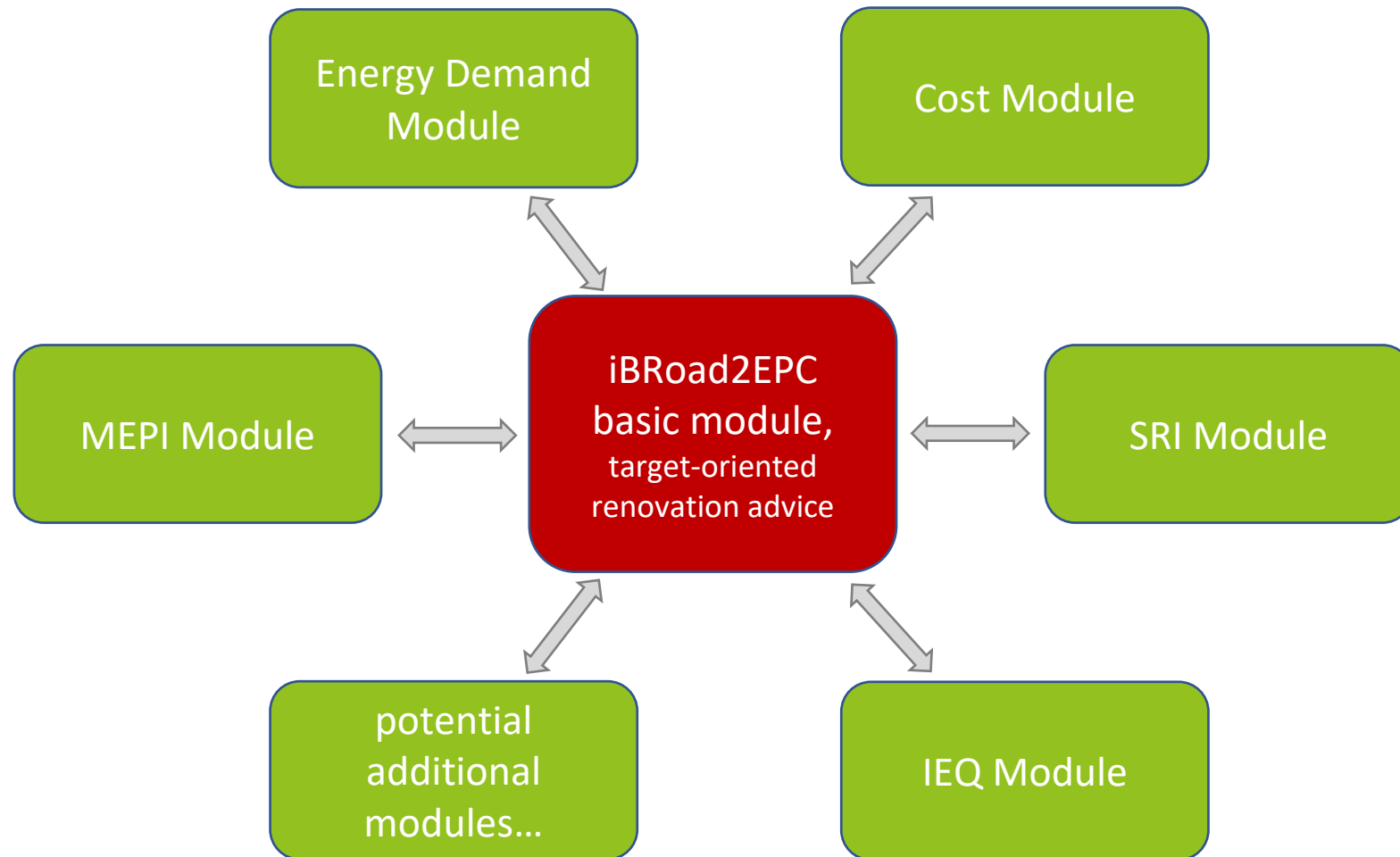
Preparation for a later insulation of a flat roof

When the outer walls are being insulated, please prepare for a later flat roof insulation. The upper edge of the parapet should be insulated. The sheeting should be wide enough so that the later flat roof insulation can be connected.

iBRoad2EPC main steps



iBRoad2EPC modules



The modular structure of iBRoad2EPC makes it flexible and expandable



iBRoad2EPC basic module

ibRoad2EPC



Energy consultant

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Date

18. August 2022

RENOVATION STRATEGY



Basic Module > Step 1

Step 1 Soon



Measure 1

External wall insulation

Description of the measure

The external wall is insulated with a "Exterior Insulation Finishing System (EIFS)". EIFS is a lightweight synthetic wall cladding that includes foam plastic insulation and thin synthetic coatings.

Specification of the measure

15 cm of insulation ($U = 0,2 \text{ W}/(\text{m}^2\text{K})$)



Measure 2

Replacement of the windows

Description of the measure

Replacement of all windows that are older than 10 years.

Specification of the measure

Triple glazing, highly efficient windows ($UW = 0,8 \text{ W}/(\text{m}^2\text{K})$.



MEPS/Regulations

By 1 January 2024, every newly installed heating system is to be based on 65 percent renewable energies

Note/Recommendation

When the outer wall is being insulated, please prepare a low thermal bridge connection to a later pitched roof insulation. Existing panels at the eaves should be opened so that the insulation can be laid up to the upper edge of the rafters. At the verge, the insulation should be laid up to the upper edge of the gable wall. For this, the roof overhang must usually be extended.

When the outer wall is being insulated the control settings of the existing heat generator should be adapted to the reduced heat load. Your installer should check whether the flow temperatures and the flow rate of the heating circuit pump can be reduced.

When the outer walls are being insulated, please prepare for a later installation of a ventilation system by installing the outside wall openings for fresh and exhaust air shafts for the ventilation system in the wall insulation layer. Facade integrated ventilation units for single or multiple rooms are most easily installed in the same step as the wall insulation.

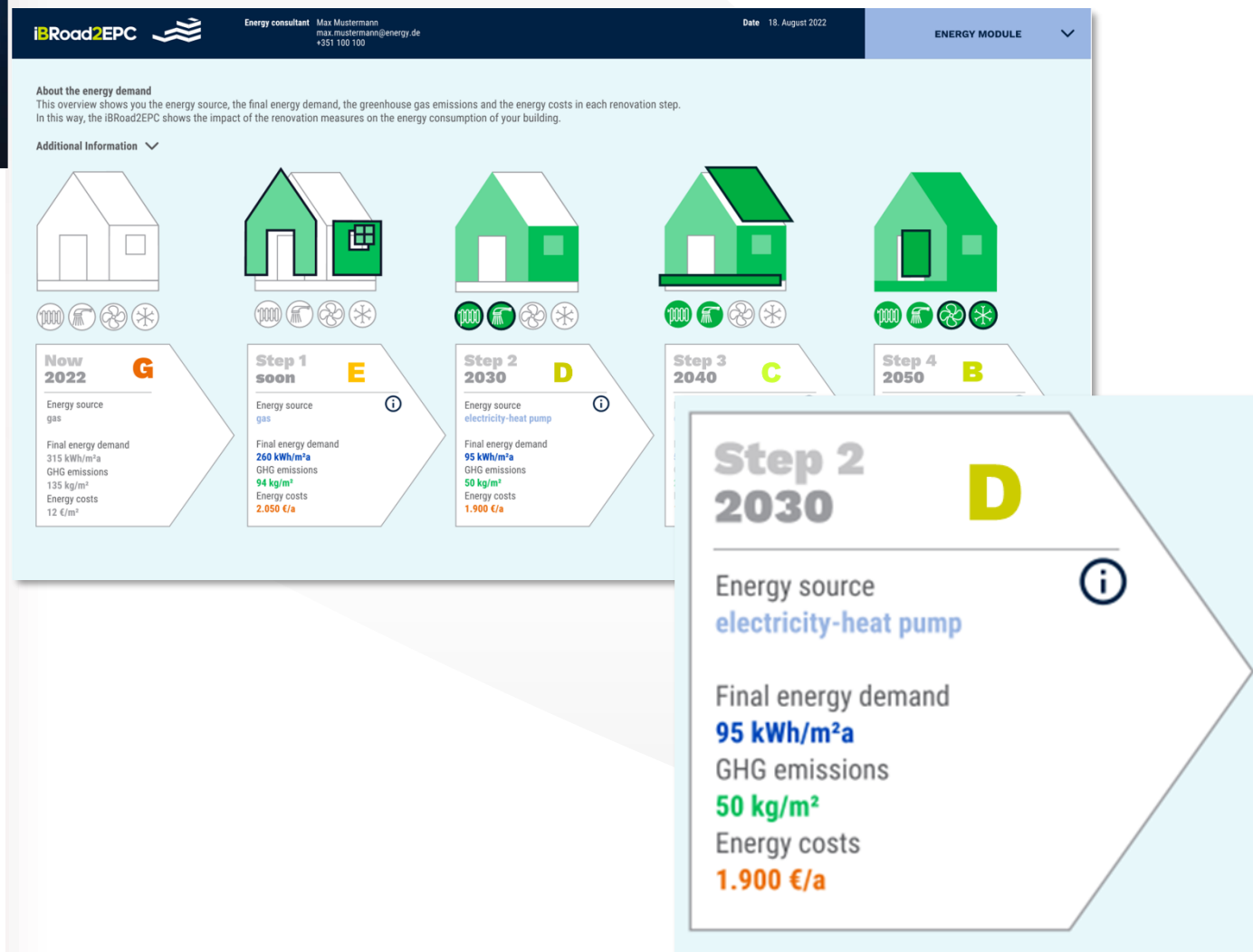
If you plan to install a heat pump in the future, please carry out preparation measures to lower the flow temperature of the heating systems (ideally below 55°C or less). This will raise the efficiency of the heat pump significantly. The flow temperature can be lowered by carrying out a hydraulic balance, exchanging single radiators and insulating single building components. An energy auditor can identify the components and radiators that provide the maximum improvements.

Back

Steps

The detailed description of steps and measures, included in those steps, is also an integral part of iBRoad2EPC and part of the basic module.

iBRoad2EPC additional modules

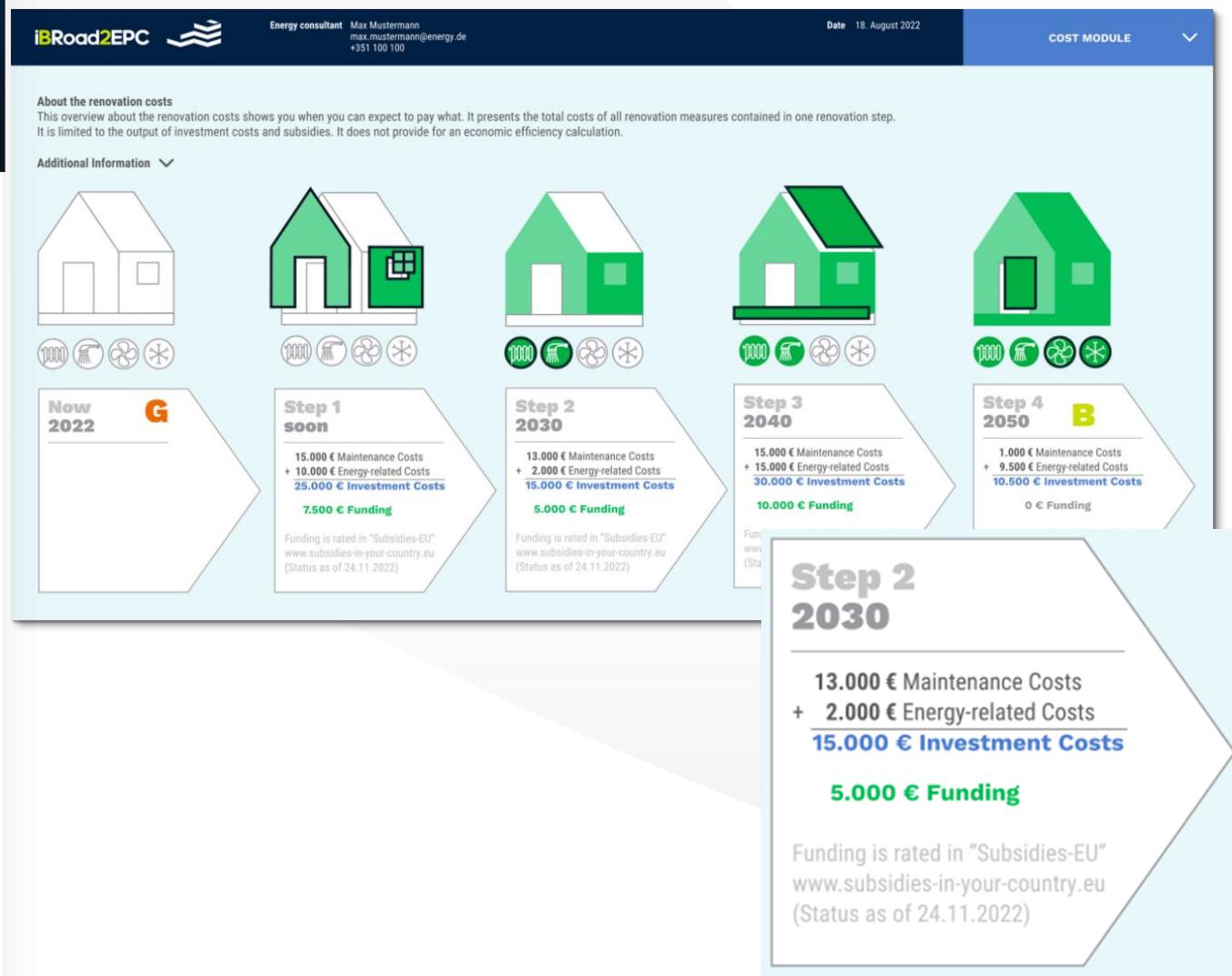


The Energy Demand Module

adds the following information for each renovation step to the iBRoad2EPC:

- final energy demand
- efficiency class
- greenhouse gas emissions
- energy costs

iBRoad2EPC additional modules

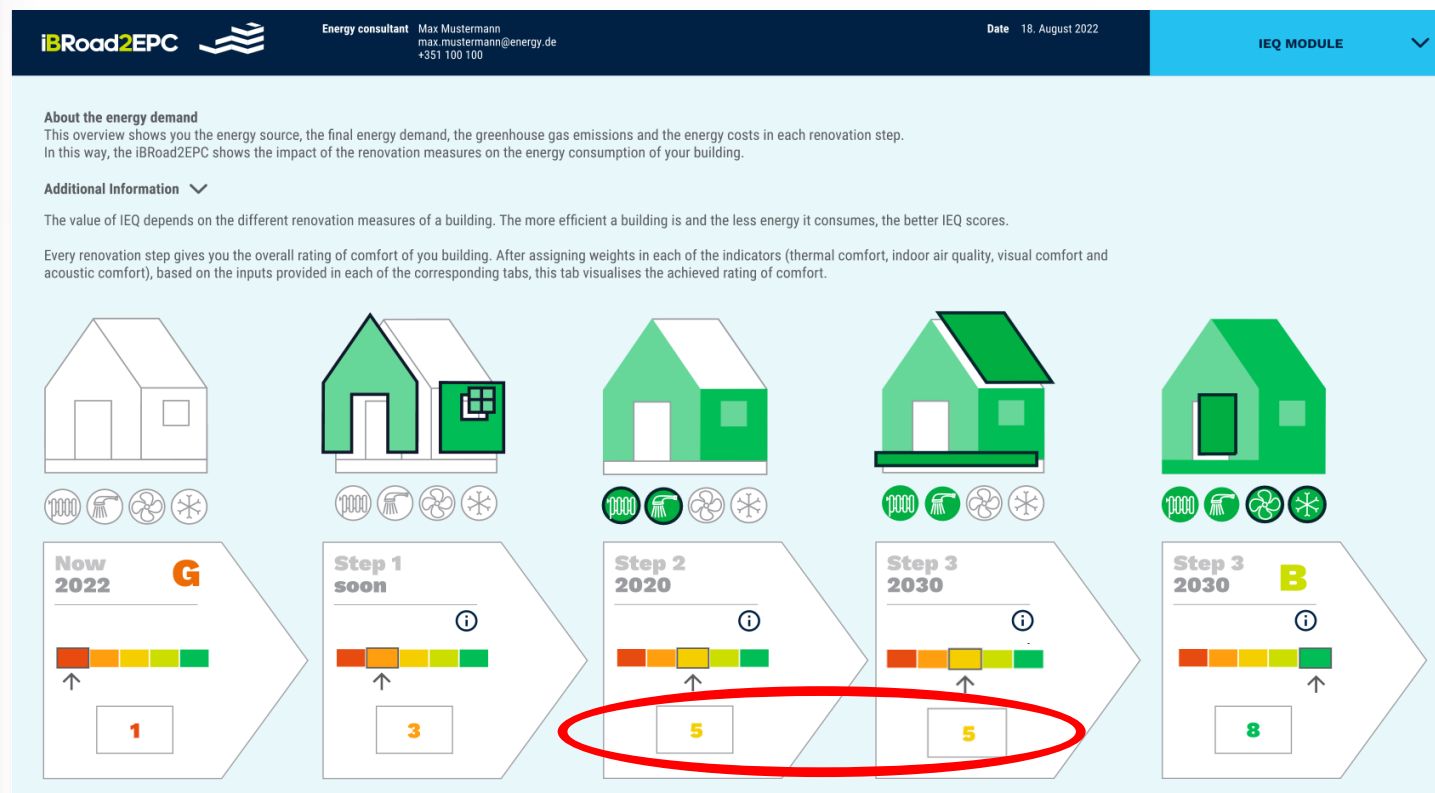


The Investment cost module

allows for the display of renovation costs in iBRoad2EPC. The following cost types can be presented:

- total investment costs
- maintenance costs
- energy-related additional costs
- funding

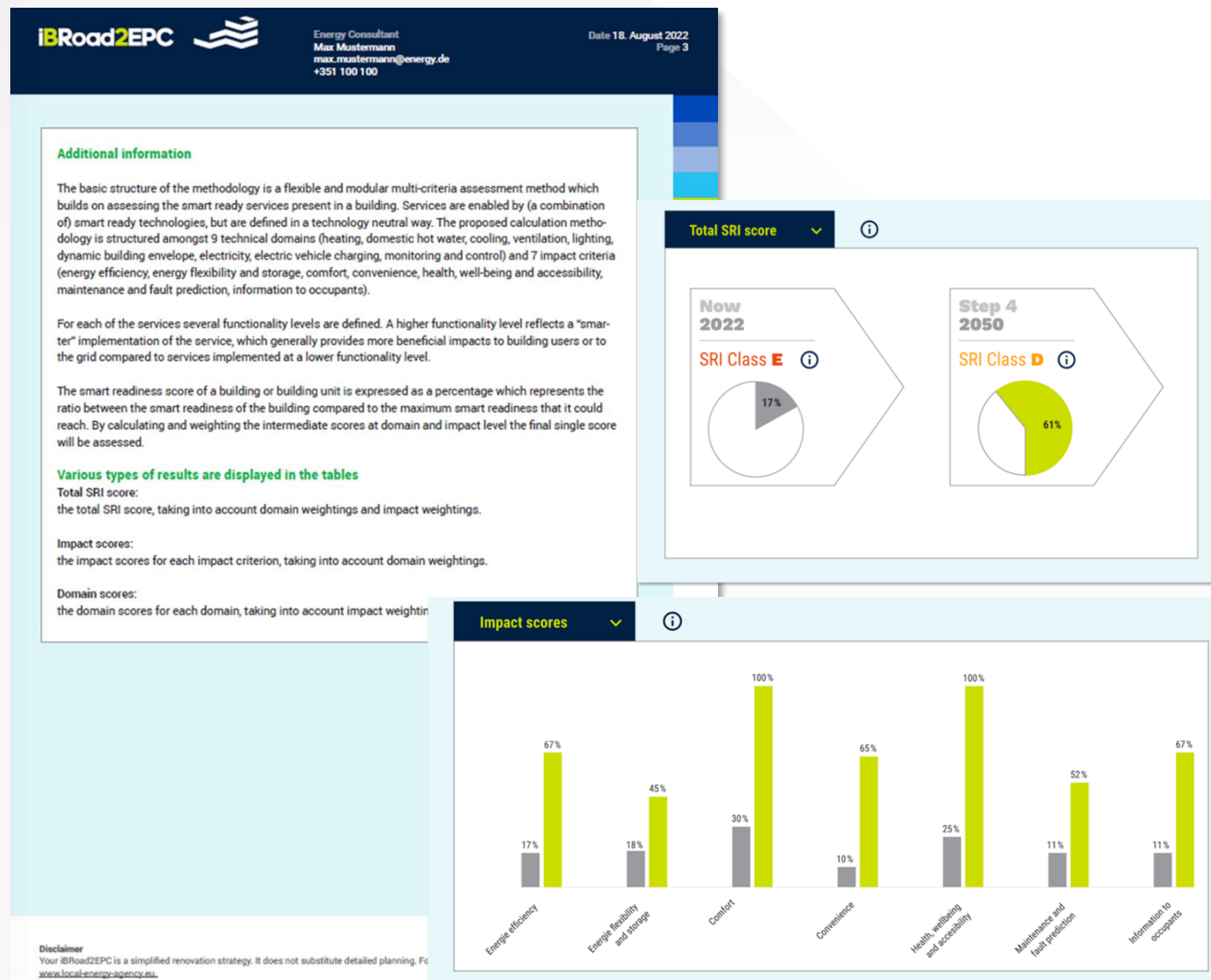
iBRoad2EPC additional modules



IEQ

Any measure that affects different aspects of comfort or air quality changes the overall IEQ score.

iBRoad2EPC additional modules

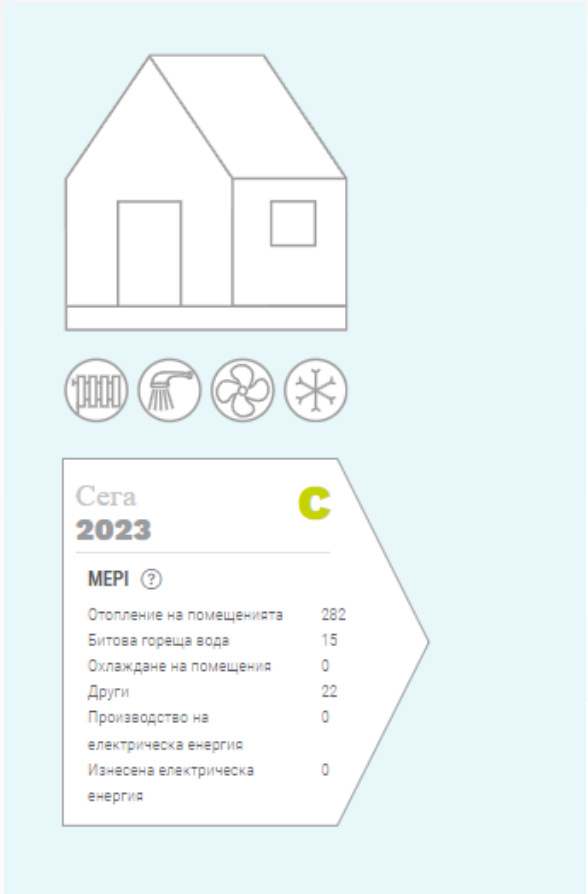


SRI

The SRI rates the readiness of buildings in performing three key functionalities:

- to optimise energy efficiency and overall in-use performance
- to adapt their operation to the needs of the occupant
- to adapt to signals from the grid (for example, energy flexibility)

iBRoad2EPC additional modules



Standard measured energy delivered and exported (standard year and use)

Q_std	[kWh/(m²·year)]										
Delivered for Space heating	27	3	5	5	6	2	0	1	1	1	2
Delivered for Domestic hot water	13	3	5	0	2	1	0	0	1	0	1
Delivered for Space cooling	0	0	0	0	0	0	0	0	0	0	0
Delivered for Other	2	0	0	0	0	0	0	1	0	0	0
Delivered for Electrical energy production	6			6							
Exported electrical energy	4							3	1		
Q_std_tot		6	11	11	9	3	0	5	4	2	4
[kWh/(m²·year)]											

Energy carrier												
Total	Solid	Liquid	Gaseous					Electrical energy produced by CHP	Electrical energy from on-site	Solar thermal	Environment	Total exported electrical energy
	Bio	Bio	Fossil									
			CHP									
	Delivered from distant											

MEPI

MEPI presents the main information on the real measured consumption of the object, with the information broken down by individual consumers of the relevant energy:

- heating
- cooling
- domestic Hot Water and others

as well as the energy produced and exported from the site

Interlinkage iBRoad2EPC

iBRoad2EPC Coupling with Energy Performance Certificates (EPC)

Coupling with the national EPC Software

Interaction of iBRoad2EPC and EPC Database

Interaction of iBRoad2EPC and spatially resolved
Data in a Building Database

Interactions with iBRoad Roadmap and Logbook

Basic knowledge of energy efficiency improvements

Thermophysical properties, efficiency ratios
and most important indicators

Energy consumption in buildings

Building Energy Consumption

- Refers to the total energy used by a building for heating, cooling, lighting, and powering appliances.
- Measured in units such as kilowatt-hours (kWh)
- Critical for understanding the environmental impact and operational costs of a building.

Energy Class

- Categorizes buildings based on their energy efficiency.
- Typically ranges from A (most efficient) to G (least efficient), similar to appliance energy labels.
- Higher energy classes indicate lower energy consumption and reduced environmental impact.



Energy consumption in buildings

Energy Performance

- Indicates how efficiently a building utilizes energy resources.
- Assessed through indicators like energy intensity (energy used per square meter of area)
- Important for benchmarking, setting targets, and implementing energy-saving measures.

GHG emissions (CO2)

- Significant greenhouse gas emitted from building-related activities.
- Contributes to the greenhouse effect and climate change.
- Understanding and reducing CO2 emissions in buildings are crucial for mitigating climate impacts and achieving sustainability goals.

Primary Energy

- Represents energy consumed directly from natural resources.
- Includes sources like coal, oil, gas, sunlight, wind, and water.
- Understanding primary energy consumption is crucial for assessing environmental impact and energy sustainability in buildings.



Energy efficiency improvements

Energy efficiency improvements in a building can be roughly divided into two categories - **building envelope** and **building technical systems**.

Where the building envelope encompasses all the elements that separate the internal living space from the changing external environment.

While building systems are those systems that take care of providing comfort inside by maintaining temperature and air in the rooms, providing hot water for domestic needs and taking care of the air quality in the living spaces.

Achieving optimal comfort inside buildings is only possible when the elements of both categories work well and are tailored both to each other and to the needs of the building.



Building envelope basic terminology

Thermal conductivity

λ value [W/(mK)]

The amount of heat that can pass through 1 meter of a given **material**, for example a mineral wool, at a temperature difference of 1 K

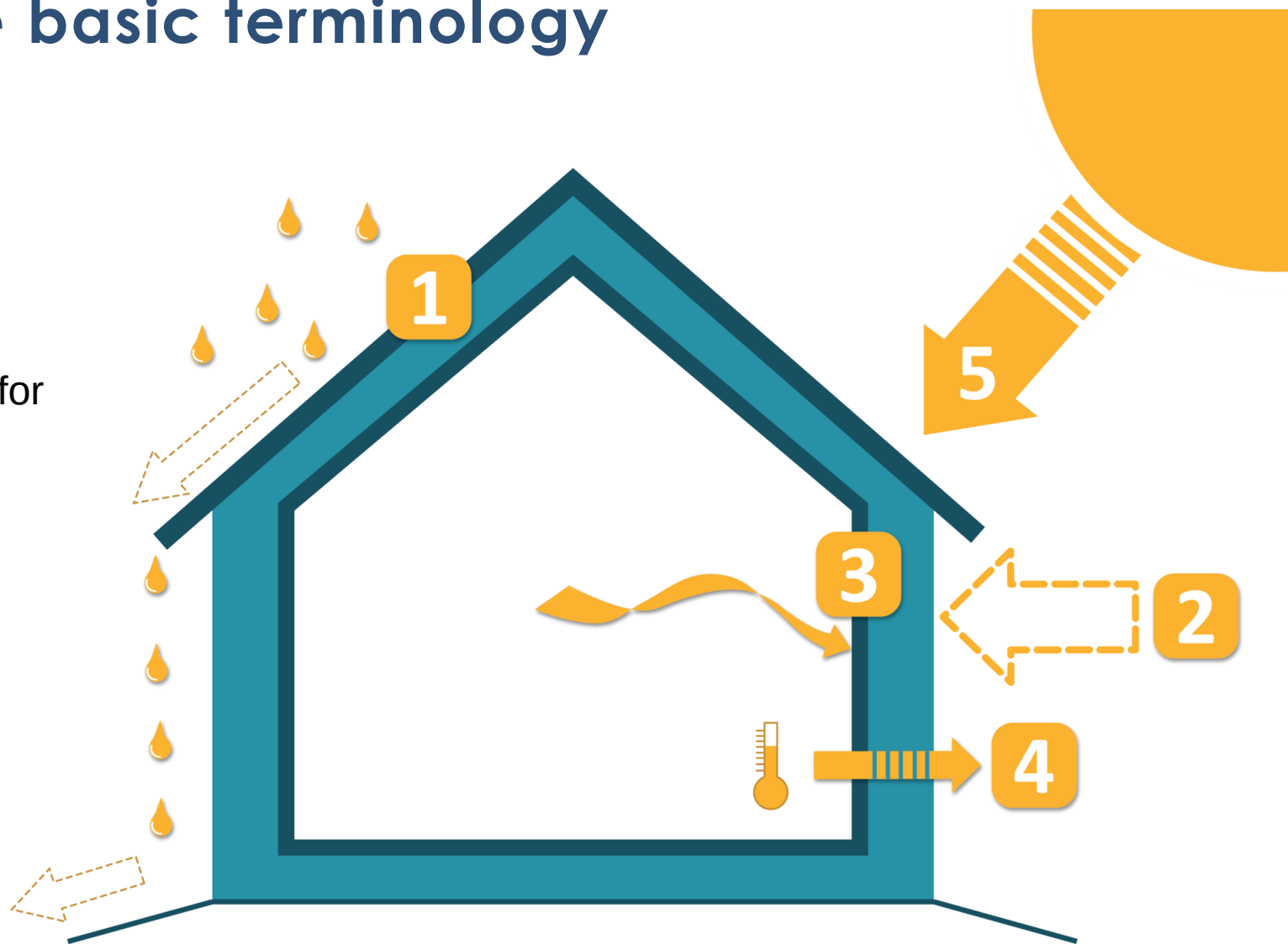
Property of the material

Heat transfer

U value [W/(m²K)]

The amount of heat that can pass through an element from **building envelope**, for example a wall, at a temperature difference of 1 K

Property of whole element from the building envelope



Building envelope basic terminology

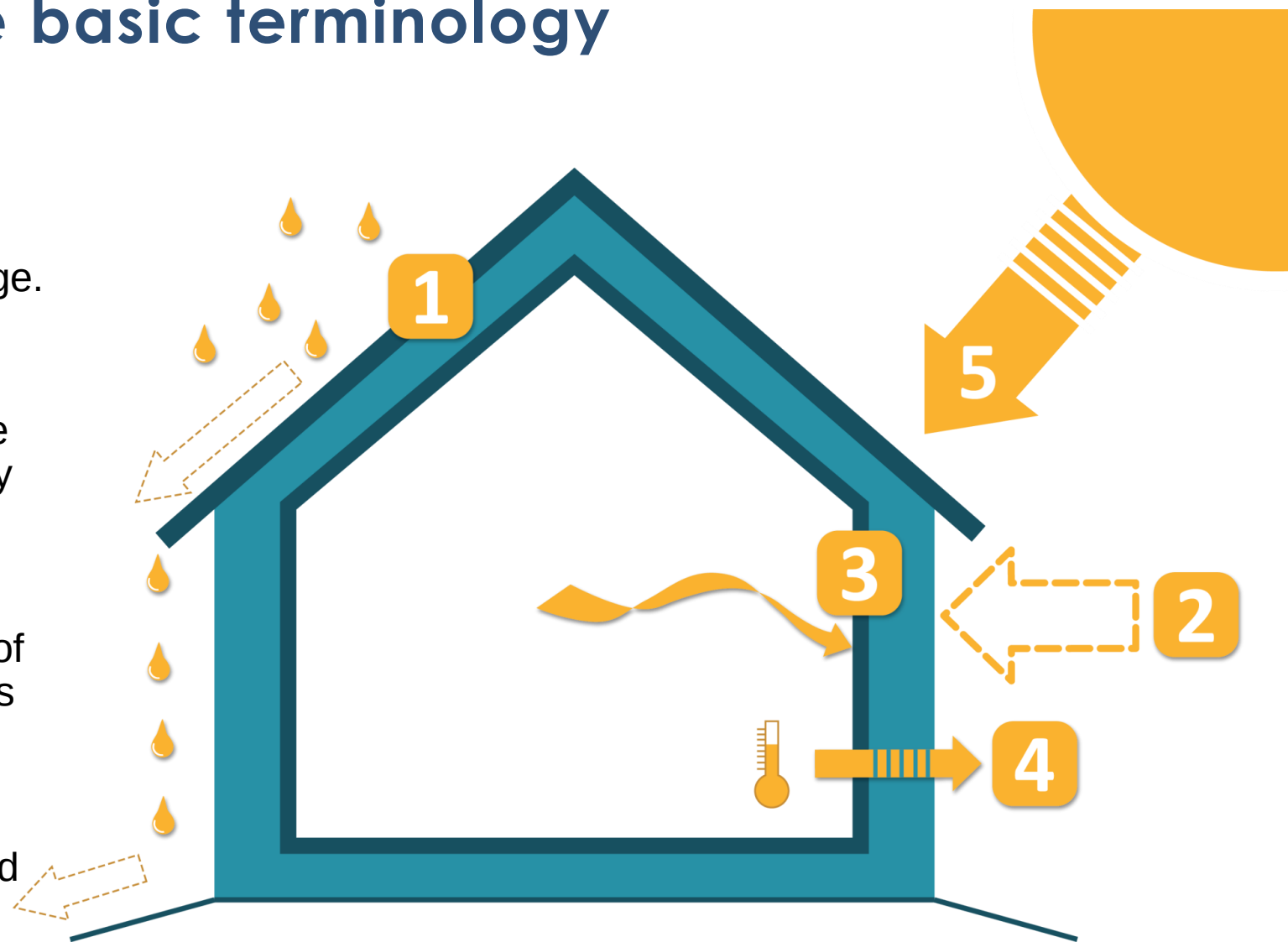
Airtightness refers to how tightly sealed a building is against air leakage.

This is a parameter of the building envelope. The airtightness can be measured with airtightness tests. The results of which are expressed mainly by n_{50} and q_{50} .

Moisture permeability is the ability of materials to allow water vapor to pass through them:

μ – moisture permutability

S_d – moisture permutability compared to 1 m of air



Example for typical recommendation in building envelope

Pitched roof insulation between rafters

Text:

Insulation for gable roofs, as with many other thermal insulations for pitched roofs, is possible both as above-rafter and as between-rafter and below-rafter insulation. Rafters are the beams in the pitched roof construction that extend from the eaves (lower limit of the roof) to the ridge (upper limit), whereby terms such as intermediate, above and below rafter insulation are self-explanatory. Mixed variants such as combined above-rafter and between-rafter insulation are also possible with a gable roof. If the attic space is not used, you can also consider insulating the top floor ceiling between the attic and the top floor with insulation boards or loose insulation material.

Specification:

Roof U-value after implementation minimum $0.24 \text{ W/m}^2\text{K}$

Note/recommendation (in case of stepwise renovation)

When the roof is being insulated, please prepare for a later insulation of the outside walls by designing a sufficient roof overhang to cover the wall insulation. New downpipe connections in the ground should already take into account the extent of the future wall insulation.



Photograph © Passive



<https://spsroofingltd.co.uk/blog/roof-insulation-cost/>

Technical building systems

Definition

Technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site electricity generation, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit and more



Example for typical recommendation in building envelope

Pellet boiler

Description of measure :

Substitution of the heating system by a pellet boiler. The boiler is placed in the place of the old boiler. Build a pellet store. It must allow a suitable transport route to the pellet boiler and good fillability from the outside. Pellet stores can be built either in a separate room, underground or outside. Make sure that the pellet store is large enough. It determines how often pellets have to be delivered. Pellets are delivered by tanker. This requires a good connection between the pellet store and the road..

Specification:

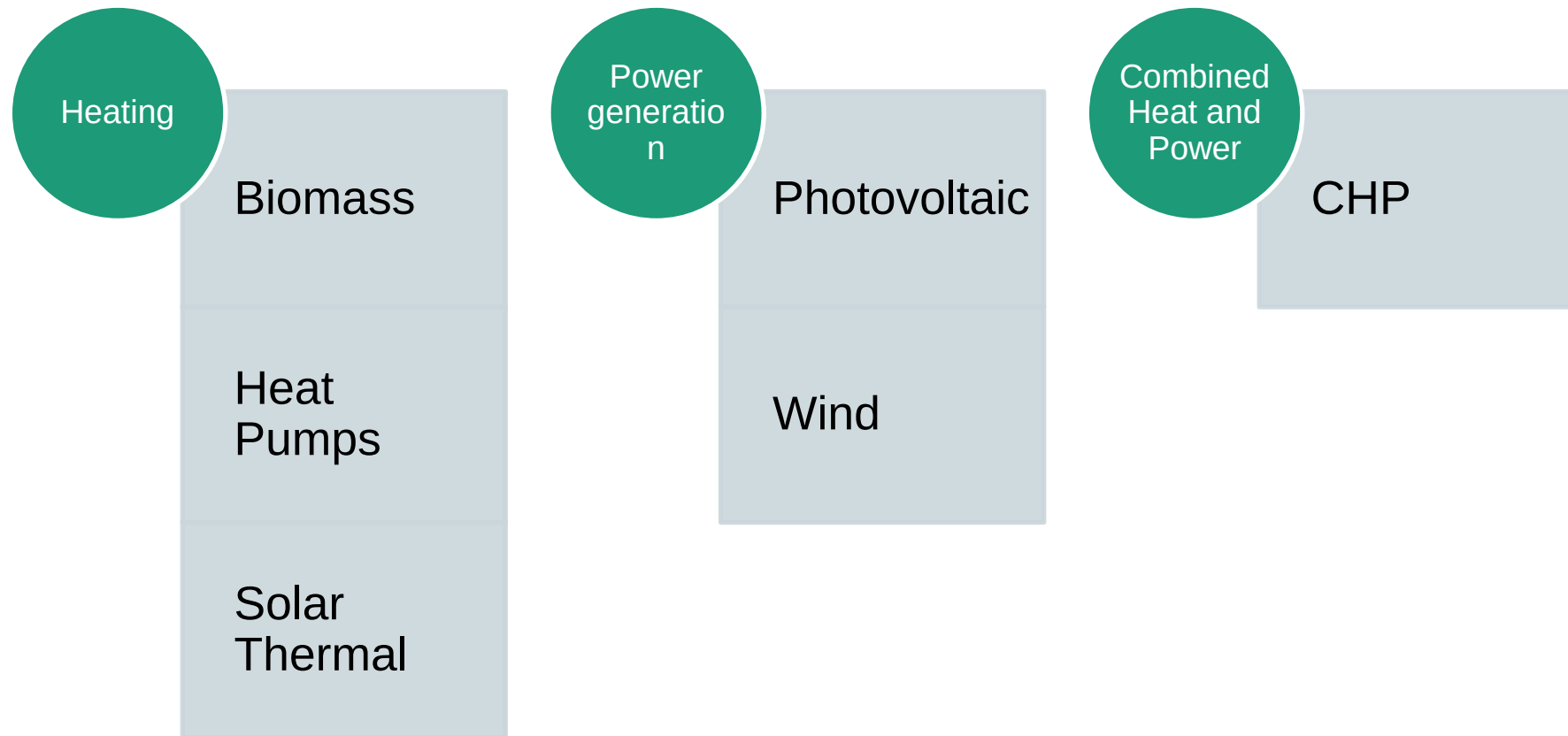
The heating capacity must be calculated for your building.



<https://www.jlphillips.co.uk/wood-chips-vs-wood-pellets-biomass/>

Renewable energy integration in building projects

Categorised according to the usage (building level) :



Efficiency of heat pump

COP (Coefficient of performance): the relation between the power (kW) drawn out of the heat pump (in heating mode), and the power (kW) that is supplied to the compressor

SCOP (Seasonable coefficient of performance): describes the average COP during the heating season, shows how effective the heat pump is in heating mode on annual basis

EER (Energy Efficiency Ratio): A ration of the cooling output relative to input power

SEER (Seasonal Energy Efficiency Ratio): the ratio between the total cooling output during the heating season and the total energy consumption during that time

ESEER (European Seasonal Energy Efficiency Ratio): Based on a formula used in the European region to measure the seasonal efficiency of air conditioners and chillers in cooling mode



Photo: Baukraft Engineering

Specific project designs and plans

Building material / Heating system technology	Lifetime
• Windows	30
• Cement external wall	100
• Gas and coal boiler	30
• Sloped roof	60
• XPS insulation material	30
• Heat pump	20
• Electric heater	25

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