Home Renovation Roadmaps to Address Energy Poverty in Vulnerable Rural Districts

Online webinar: "Quantifying the impact: Addressing energy poverty through efficiency"

Evaluation of energy efficiency measures addressing the needs of households experiencing energy poverty in rural areas

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General context: RENOVERTY project

- Causes of energy poverty at the local, regional, national, and European scales have recently become clearer, yet an absence of practical and theoretical understanding of how to address the issue in rural areas exists.

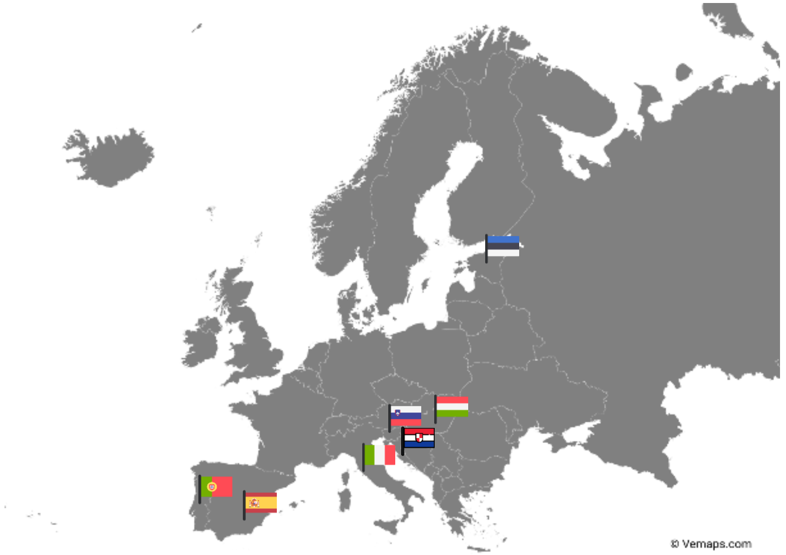
- Rural areas across Central Eastern (CEE), Southern Eastern (SEE), and Southern Europe (SE) are traditionally much poorer, and more vulnerable to energy poverty.

- Despite their need for support, they are left behind in the energy transition, and practices to reduce energy poverty are lacking.

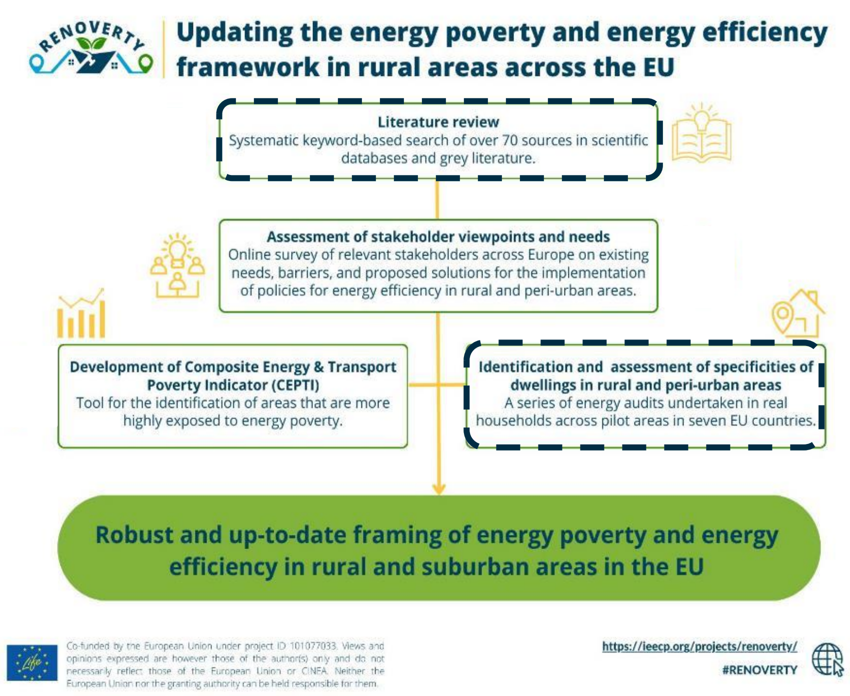
RENOVERTY main objective

Design a scalable series of renovation roadmaps with operating models for 7 vulnerable rural areas across CEE, SEE, and SE, while ensuring the replicability of the model in the European Union.

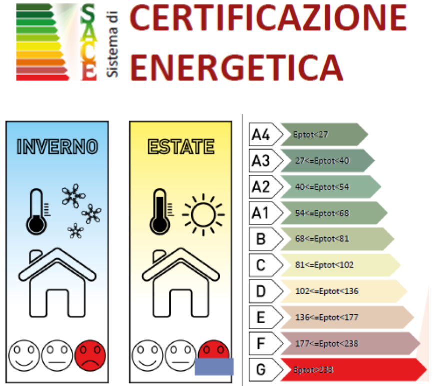
- ✓ Supporting 12 Local Action Groups (LAGs) for the creation and implementation of Rural Energy Efficiency Roadmaps (REERs).
- ✓ Empowering all (non) public actors in rural areas to become involved in the process of renovating vulnerable districts/buildings.
- ✓ Delivering a scalable operating model, to support the replicability of REERs and guide more public actors to renovate rural vulnerable districts after the project ends.



RENOVERTY approach



More than **85 audits were** conducted in the 7 **pilot countries**



Co-creation process:
Include **stakeholders** in the development of the **renovation roadmaps**

Appropriate **energy efficiency measures (EEMs)** to address the **specific needs** of **rural areas.**

Quantifying the impact of different **EEMs**

DREEM
Dynamic High-Resolution Demand-Side Management Model

RENOVERTY: Evaluation of EEMs

Evaluation of **EEMs** for households experiencing **energy poverty** in the pilot regions.

Evaluation criteria:

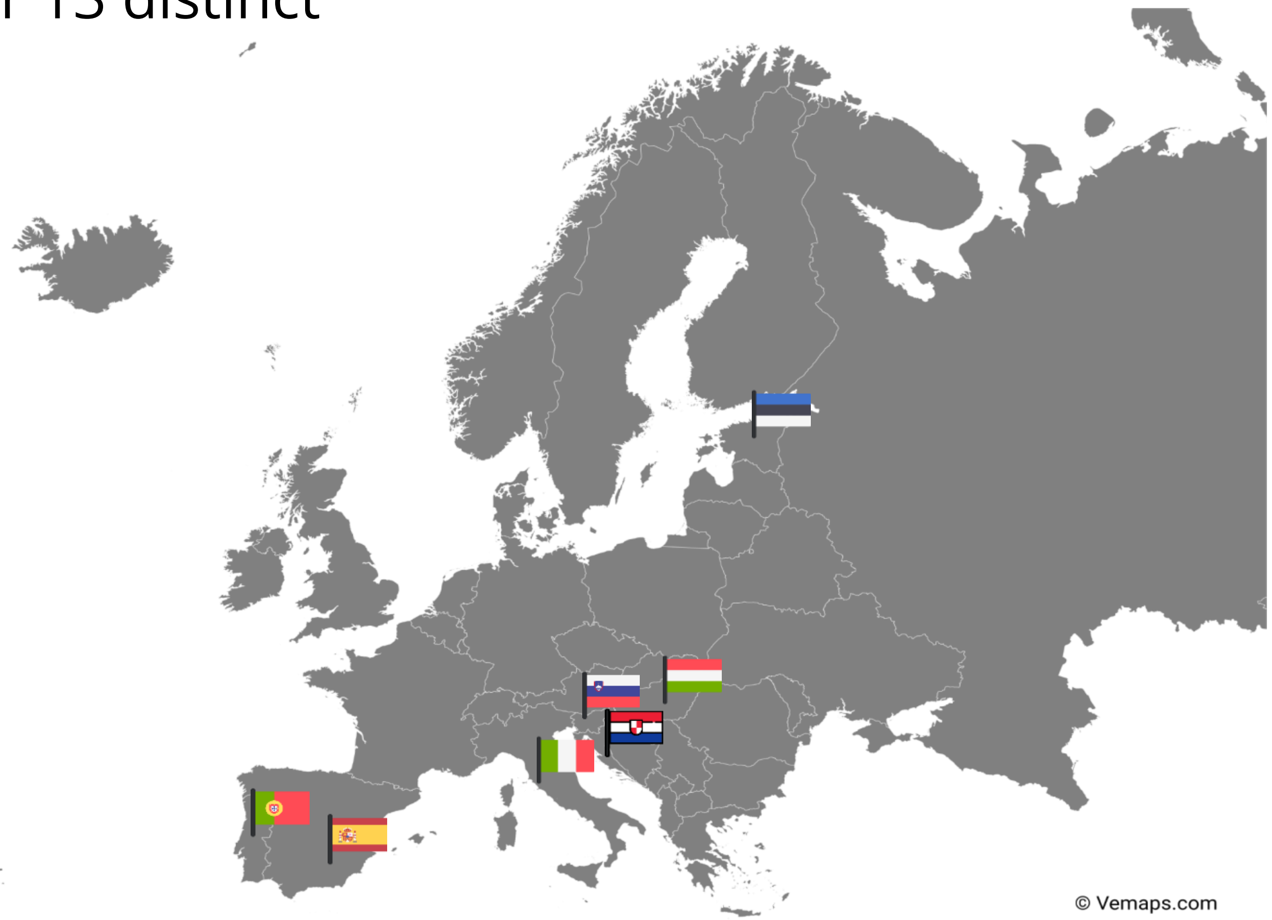
- The **energy-saving potential** of the EEMs
- The **cost-effectiveness** of the EEMs

Find the report [here]

RENOVERTY: Geographical Scope

EEMs were evaluated in seven pilots for 13 distinct **building typologies**:

- Sveta Nedelja (***Croatia***) *(2 typologies)*
- Tartu (***Estonia***) *(1 typologies)*
- Bükk-Mak & Somló-Marcalmente-Bakonyalja Leader (***Hungary***) *(2 typologies)*
- Zasavje (***Slovenia***) *(2 typologies)*
- Parma (***Italy***) *(2 typologies)*
- Coimbra (***Portugal***) *(2 typologies)*
- Osona (***Spain***) *(2 typologies)*



DREEM

Dynamic High-Resolution Demand-Side Management Model

ELSEVIER

Energy Conversion and Management

Volume 205, 1 February 2020, 112339

A modular high-resolution demand-side management model to quantify benefits of demand-flexibility in the residential sector

Vassilis Stavrakas, Alexandros Flamos

HORIZON 2020

Life

HORIZON EUROPE

Currently applied and further developed in multiple **EC-funded H2020**, **HE**, and **LIFE** projects

Building sector

Energy demand simulation model

Benefits & **limitations** of demand-flexibility primarily for **consumers** & other **power actors** involved

RENOVERTY

DigiBUILD

IAM COMPACT

ENSMOV PLUS

ENCLUDE
Energy Citizens for Inclusive Decarbonization

LOCATEE

OBSERVE
NATIONAL BUILDING STOCK OBSERVATORIES

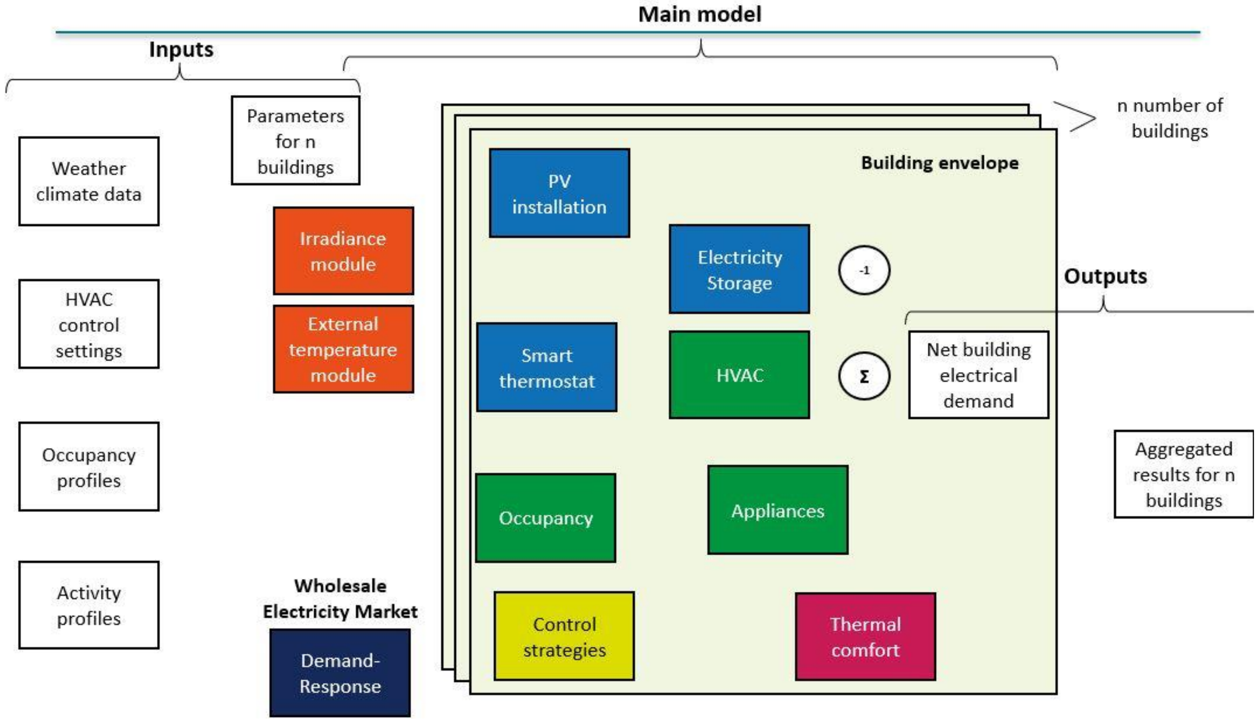
Inherit

RENOVERTY

Model Characteristics

Main **principles** of **component-** & **modular**-based system modelling approach

- **Interdependence** of decisions **within** modules
- **Independence** of decisions **between** modules
- **Hierarchical dependence** of modules on components embodying **standards** & **design rules**



Modular structure

How is the model parameterised in this application?

DREEM
Dynamic High-Resolution Demand-Side Management Model

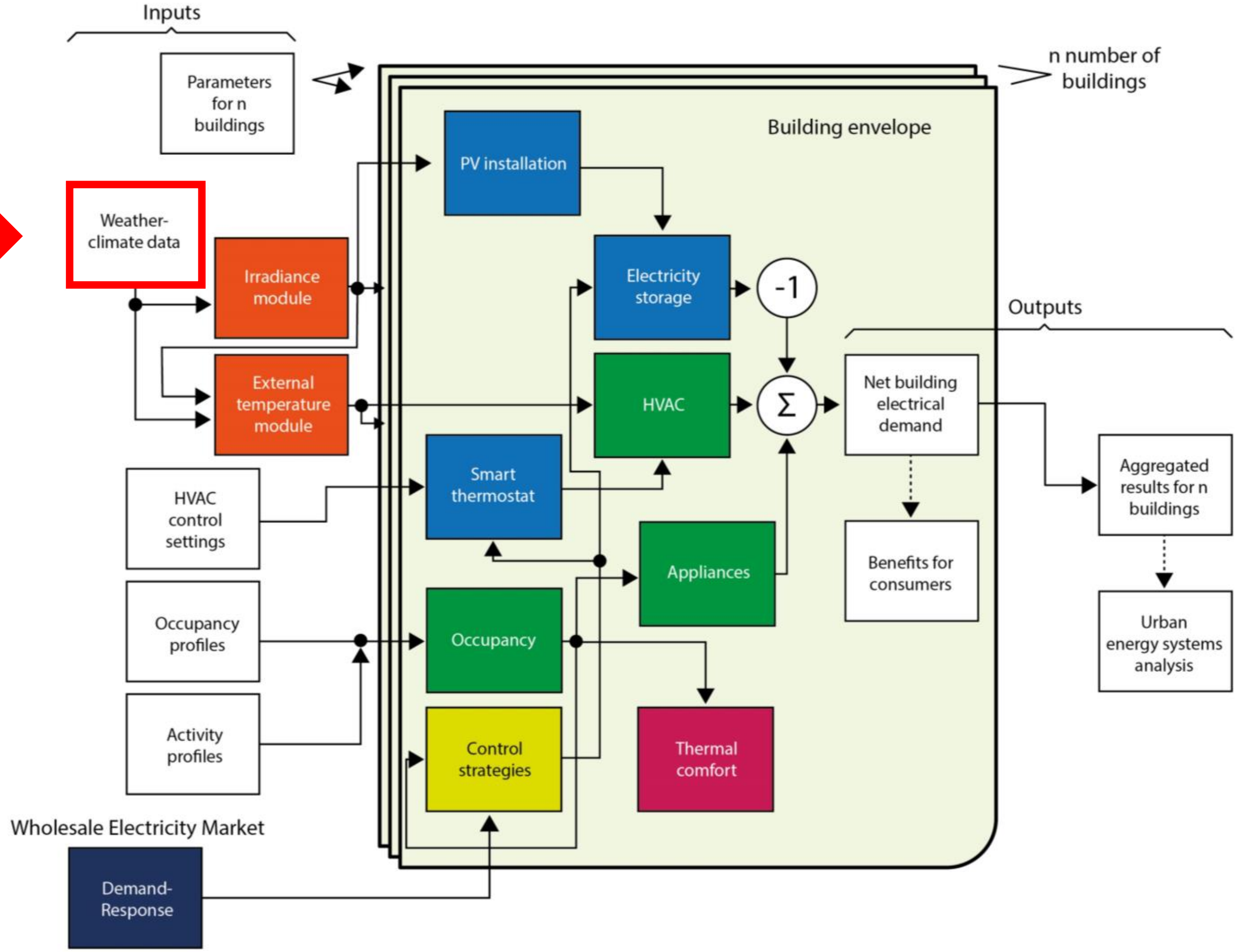
Existing Situation – Baseline Scenarios (1/3)

Weather-Climate data

Climate.OneBuilding.Org

Renewables.ninja

Typical Meteorological Years (TMY) for **several regions** in the pilot countries.

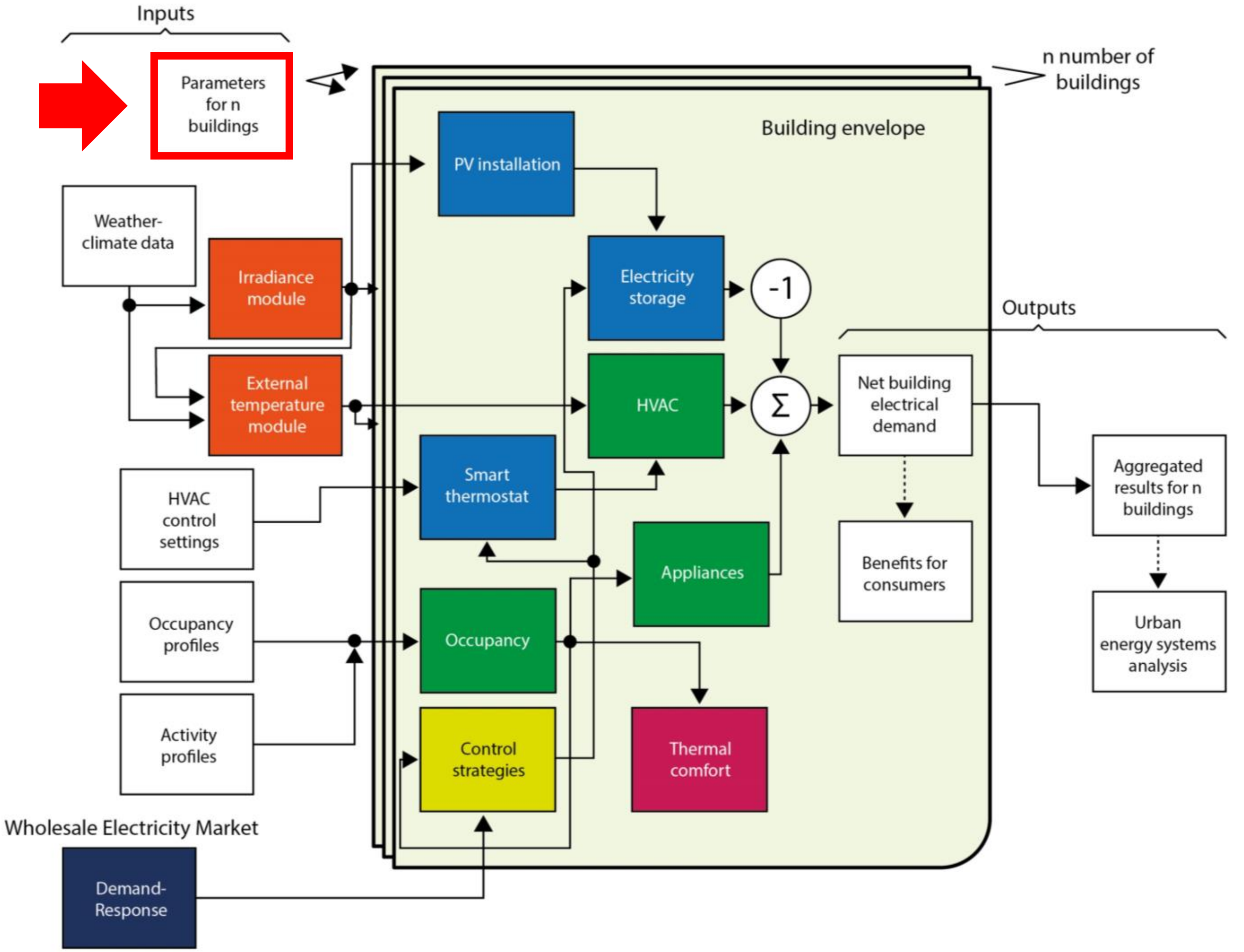


Existing Situation – Baseline Scenarios (2/3)

Energy Audits & Certificates

Building parameters

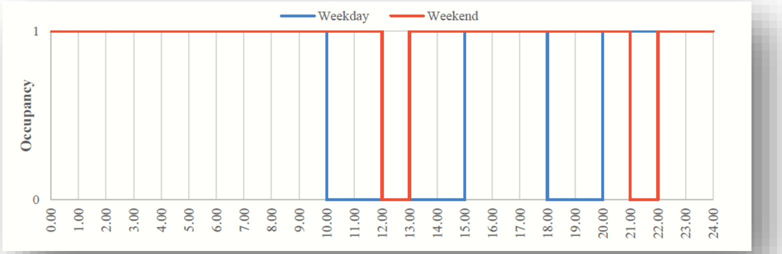
- ✓ Construction year
- ✓ Type of building
- ✓ No. of floors
- ✓ Total floor area, Height
- ✓ Total roof area
- ✓ Total wall area
- ✓ Total windows area
- ✓ U-values



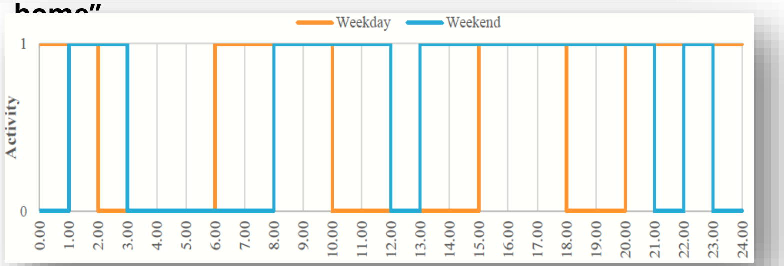
Existing Situation – Baseline Scenarios (3/3)

Occupancy & activity profiles

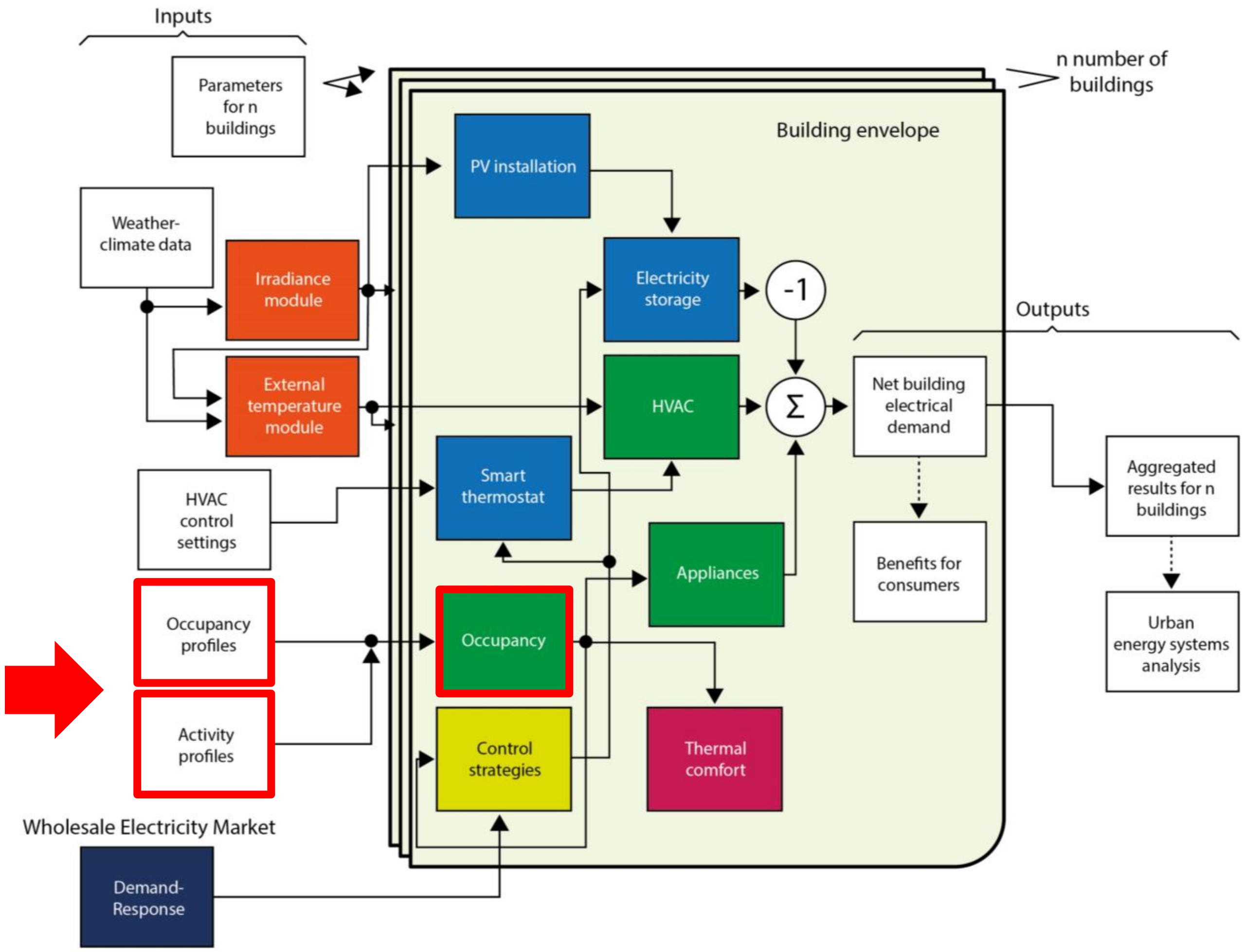
Building composition, **occupancy** & **activity** patterns from **energy audits**



1= “at home”, 0= “not at home”



1= “active”, 0= “not active”



Future situation – Energy efficiency scenarios

Evaluated the **performance** & **replicability** potential of **EEMs**

- ✓ Long-term energy savings
- ✓ Sustainability
- ✓ Risk
- ✓ Return of investment

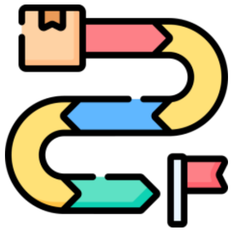
Cost-effectiveness

$$LCSE = \frac{(CRF * Cost_{investment}) + Cost_{O\&M}}{Energy\ Savings\ (kWh)}$$

Heating technology change:

Substitution of fossil fuel boilers with efficient **technologies** (e.g., **heat pumps**, etc.)

Assist the development of the renovation roadmaps



particularities of households experiencing energy poverty in rural pilot regions

providing **policymakers**, **consumers** & other potential **end-users** with useful insights

What about the simulation results?

Indicative results: Rural region of Osona, Spain

Country: Spain
Region: Osona

Type of building/usage: Single Family House

Year of Construction: 1960-1980

Total floor area: 140 m²

Osona, Spain (SFH)	
Building characteristics	
Year of construction	1960-1980
Total floor area of the building	140 m²
Total area of exterior walls of the buildings	72 m²
Total roof area of the building	58 m²
Total area of windows	11 m²
Building envelope/construction features	
U_{wall}	2.40 W/m²/K
U_{floor}	2.20 W/m²/K
U_{roof}	2.60 W/m²/K
U_{window}	3.60 W/m²/K
HVAC and lighting systems	
Heating system	Oil boiler
Nominal capacity	24 kW
COP	0.85

Indicative results: Baseline scenario

Total energy consumption:

- 31,194.6 kWh/year

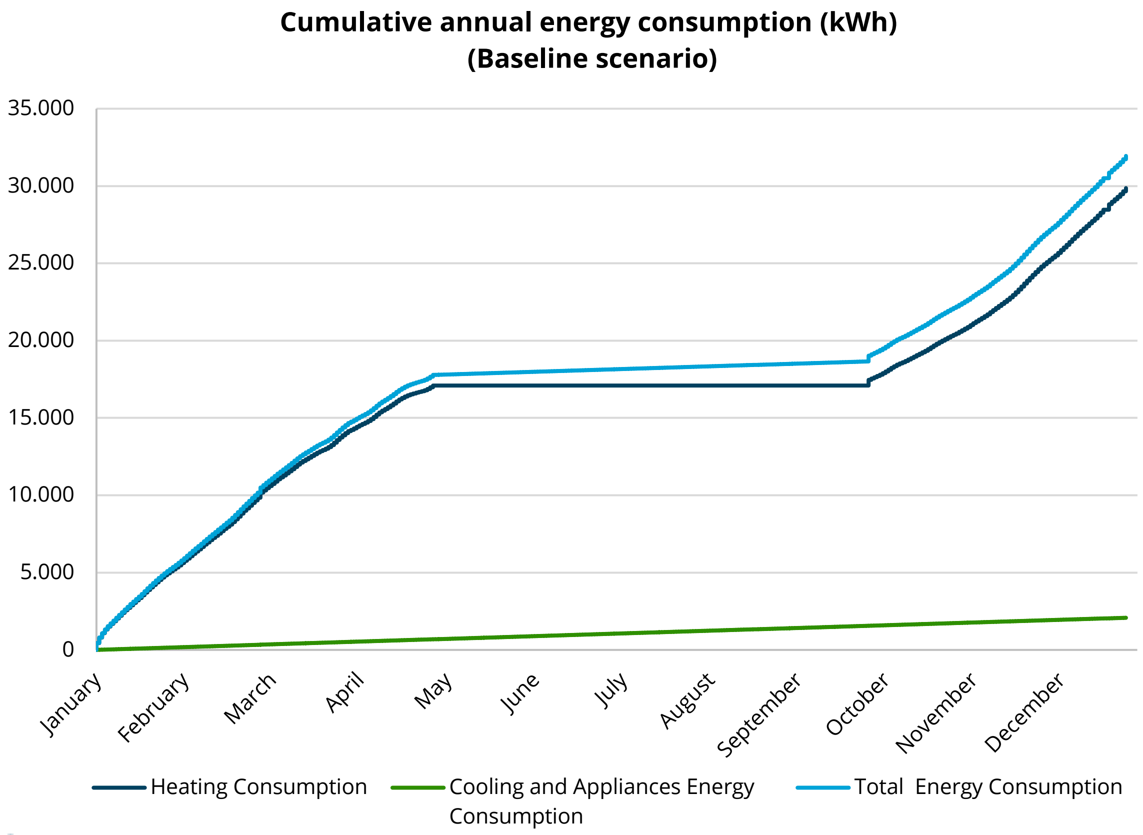
Heating energy consumption:

- 29,867.0 kWh/year

Energy for **cooling** and **appliances**:

- 2,079.6 kWh/year

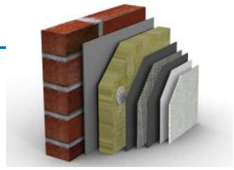
- 8,631.8 kg of CO_2 **emitted** per year



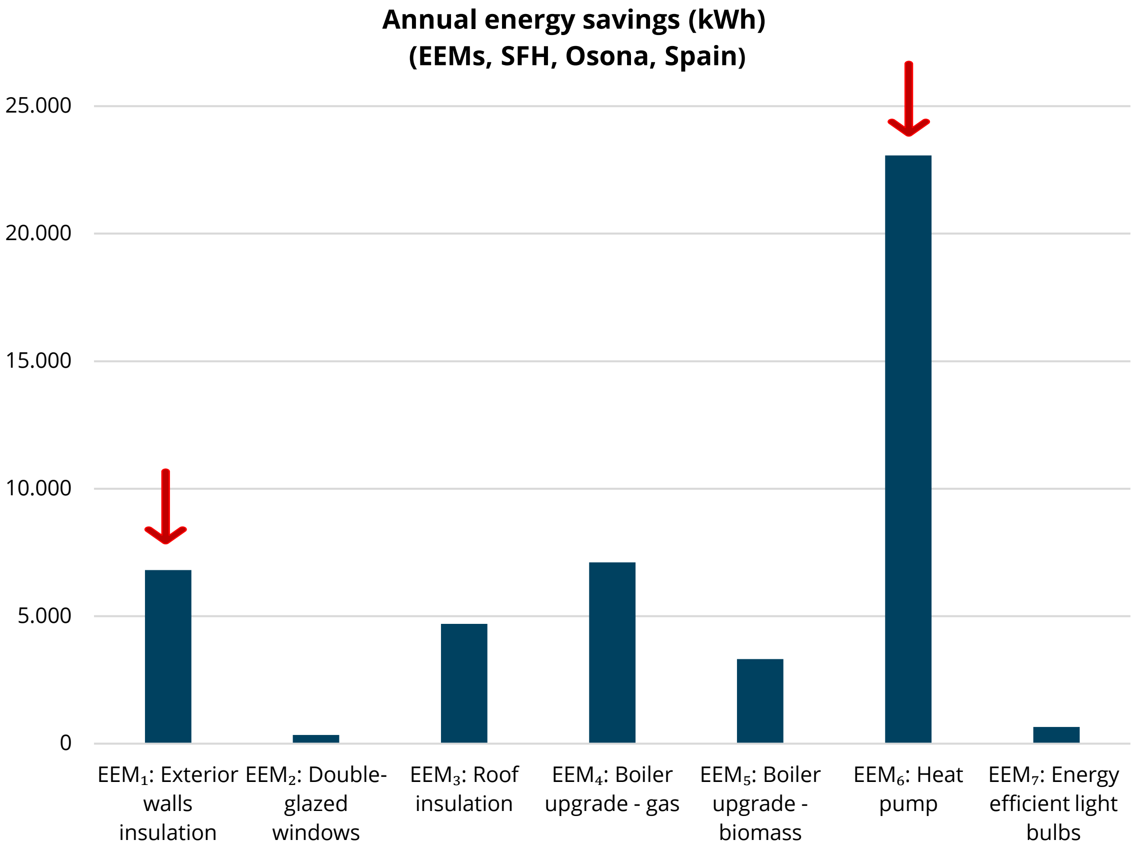
Heating Needs → >90% of total energy consumption

Indicative results: EEMs simulated

Energy efficiency measures (EEMs) simulated	
EEM_1	Envelope upgrade: Exterior walls insulation
EEM_2	Envelope upgrade: Double-glazed windows
EEM_3	Envelope upgrade: Roof insulation
EEM_4	Heating technology change: Boiler upgrade - gas
EEM_5	Heating technology change: Boiler upgrade - biomass
EEM_6	Heating technology change: Heat pump
EEM_7	Lighting system upgrade: Energy efficient light bulbs LED



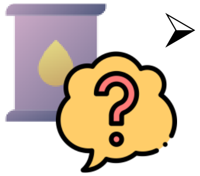
Indicative results: Energy performance



Annual energy savings (in kWh) for the different EEMs (SFH, Osona, Spain)

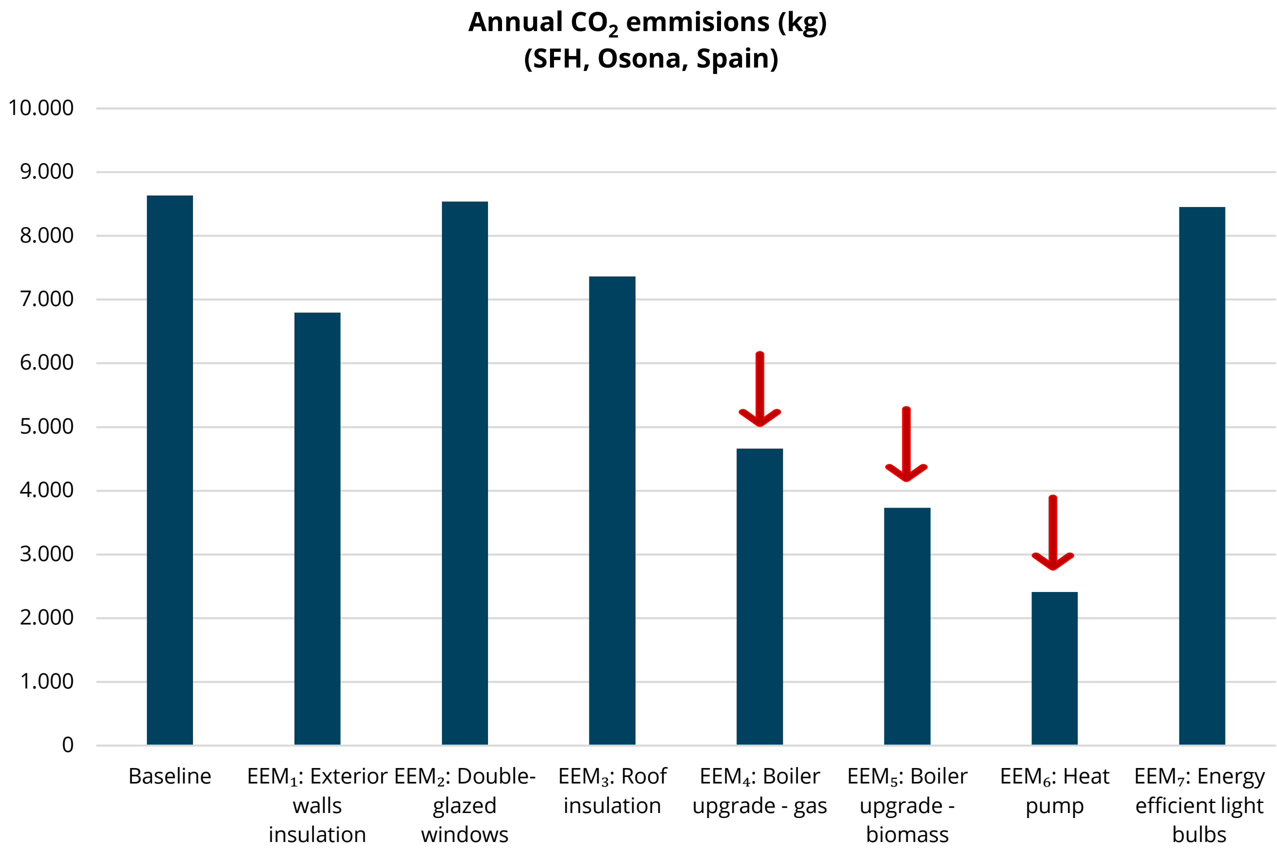
	Energy savings (kWh)	Reduction (%)
EEM_1: Exterior wall insulation	6,806.0	21.3
EEM_2: Double-glazed windows	340.8	1.1
EEM_3: Roof insulation	4,694.6	14.7
EEM_4: Boiler upgrade - gas	7,111.6	22.3
EEM_5: Boiler upgrade - biomass	3,318.6	10.4
EEM_6: Heat pump	23,072.2	72.2
EEM_7: Energy efficient light bulbs	658.2	2.1

- *Envelope upgrade*
  - *6,806.0 kWh/year / 21.3%*



- *Heating system change*
  - *23,072.2 kWh/year / 72.2%*

Indicative results: Emissions reduction



Annual energy savings (in kWh) for the different EEMs (SFH, Osona, Spain)

	Emissions avoided (kg CO_2)	Reduction (%)
EEM_1: Exterior wall insulation	1,837.6	21.3
EEM_2: Double-glazed windows	92.0	1.1
EEM_3: Roof insulation	1,267.5	14.7
EEM_4: Boiler upgrade - gas	3,968.1	46.0
EEM_5: Boiler upgrade - biomass	4,898.2	56.7
EEM_6: Heat pump	6,221.5	72.1
EEM_7: Energy efficient light bulbs	177.7	2.1

- *Heating system changes leads to superior performances*

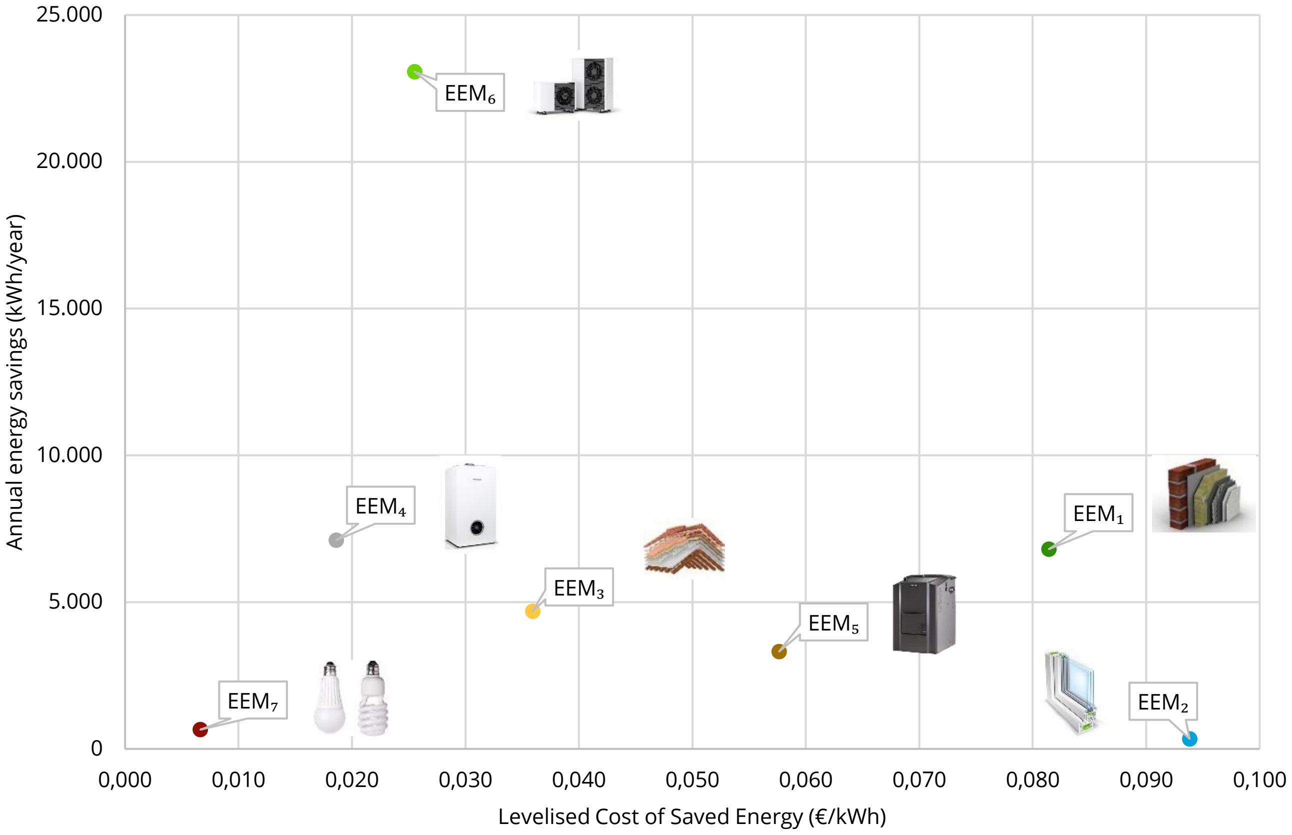
46%

Indicative results: Technoeconomic assesement

	Investment Costs (€)	Lifetime (years)	Discount Rate (%)	NPV (€)	PP (years)	LCSE (€/kWh)
EEM_1	9,583	30	4.00%	6,705.8	13.3	0.081
EEM_2	553	30	4.00%	262.7	16.1	0.094
EEM_3	2,917	30	4.00%	8,318.8	5.0	0.036
EEM_4	1,800	20	4.00%	24,997.8	0.9	0.019
EEM_5	2,600	20	4.00%	42,646.2	0.8	0.058
EEM_6	8,000	20	4.00%	28,600.1	3.2	0.026
EEM_7	65	23	4.00%	2,008.1	0.5	0.007

- *EEM_7 and EEM_4 have the **best levelised cost of saved energy** and the **shorter payback periods**.*
- *Heating system changes have higher **profitability (NPV)***

Indicative results: Cost effectiveness



- *Comparison of the annual energy savings with **LCSE**.*
- *Impact of EEMs in terms of **energy saving** coupled with **initial cost of the interventions**.*

***Significant** energy savings + **Low** LCSE*

***Mediocre** energy savings + **High** LCSE*

Indicative results: Rate of financial support

	Subsidy level	NPV (€)	PP (years)	LCSE (€/kWh)
EEM_1	25%	9,101.4	9.3	0.061
EEM_2		400.9	11.1	0.070
EEM_3		9,047.9	3.7	0.027
EEM_4		25,447.8	0.7	0.014
EEM_5		43,114.2	0.6	0.043
EEM_6		30,600.1	2.4	0.019
EEM_7		2,024.4	0.4	0.005

	Subsidy level	NPV (€)	PP (years)	LCSE (€/kWh)
EEM_1	50%	11,497.1	5.8	0.041
EEM_2		539.2	6.8	0.047
EEM_3		9,777.0	2.4	0.018
EEM_4		25,597.9	0.5	0.009
EEM_5		43,764.2	0.4	0.029
EEM_6		32,600.1	1.6	0.013
EEM_7		2,040.6	0.2	0.003

- *Profitability*

36%

- *Payback Period*

4 yrs

- *Profitability*

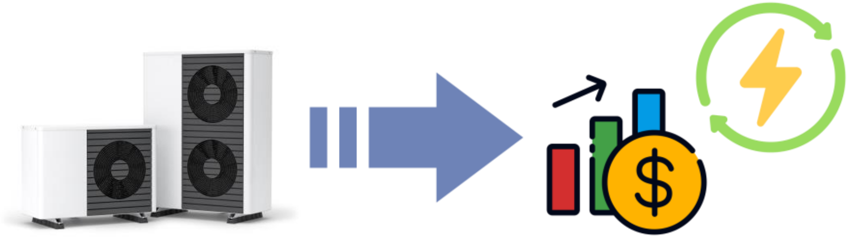
71%

- *Payback Period*

7.5 yrs

Concluding remarks: Cross country insights (1/2)

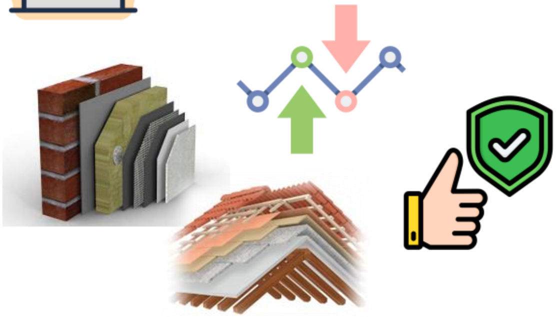
Across pilot cases, the installation of heat pumps **consistently** leads to **significant energy savings**, but **local energy prices** strongly impact its **economic** performance.



Energy efficiency measures focusing on **envelope upgrades** are strongly influenced by:

- **Building** characteristics
- Renovation **costs**
- **Baseline** heating technology

External wall insulation shows the greatest **variability** in terms of **energy-saving potential**, while **roof insulation** has the most **consistent** performance.



Concluding remarks: Cross country insights (2/2)

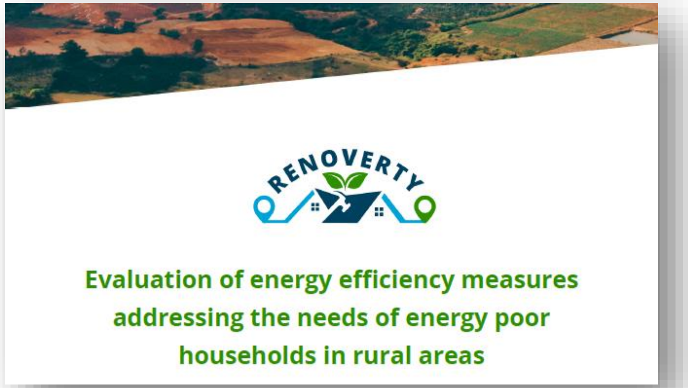
Importance of baseline conditions in determining the effectiveness of interventions aimed at reducing energy consumption and environmental footprint.

Prioritisation of areas with greater inefficiencies.

Need for financial support to achieve higher household profitability.

- *Cost effectiveness*
- *Household profitability*

- *Environmental impact*
- *Alleviation of energy poverty*



Q & A

- Discussion points
- Questions
- Comments

Thank you.

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