UNIVERSITY OF MINHO
SCHOOL OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT

IEA ECBCS
Annex 56
Cost-effective energy and carbon emission optimization in building renovation

ECBCS Annex 56
Cost-Effective Energy and Carbon Emission Optimisation in Building Renovation

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Supported by ADENE
Portuguese Energy Agency

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

IEA ECBCS Annex 56 Background

Today's standards are mainly targeted to new buildings**, providing less guidance on the renovation of existing buildings**

Today's standards do not respond effectively **to the numerous technical, functional and economic** constraints **of this kind of buildings**

Today's standards are mainly targeted to energy efficiency measures **that very often result in** expensive processes and complex procedures**, seldom accepted by users, owners or promoters.**

IEA ECBCS Annex 56 Background

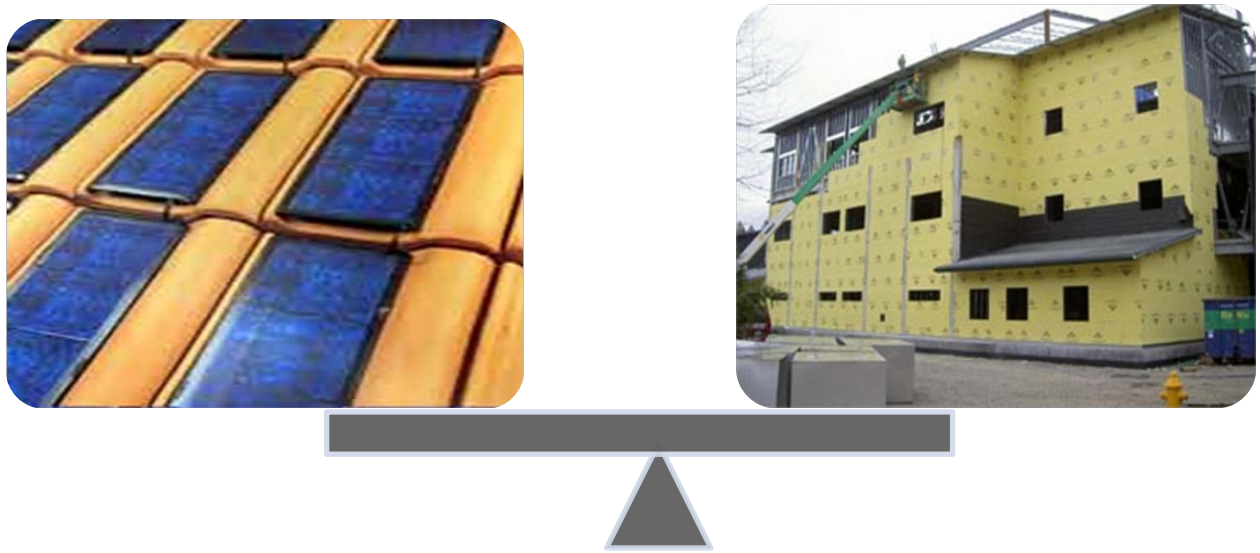
Within the EU, each Member State must prepare renovation plans for existing buildings, with the nearly-zero energy goal

which means:

- **Goals must be set for energy consumption and carbon emissions for the existing building stock**
- **Cost effective renovation packages must be found**

In existing buildings, the most cost-effective renovation solution **is often a** combination of energy efficiency measures and carbon emissions reduction measures**.**

So, it is relevant to investigate where is the balance point **between these two types of measures in a cost/benefit perspective.**

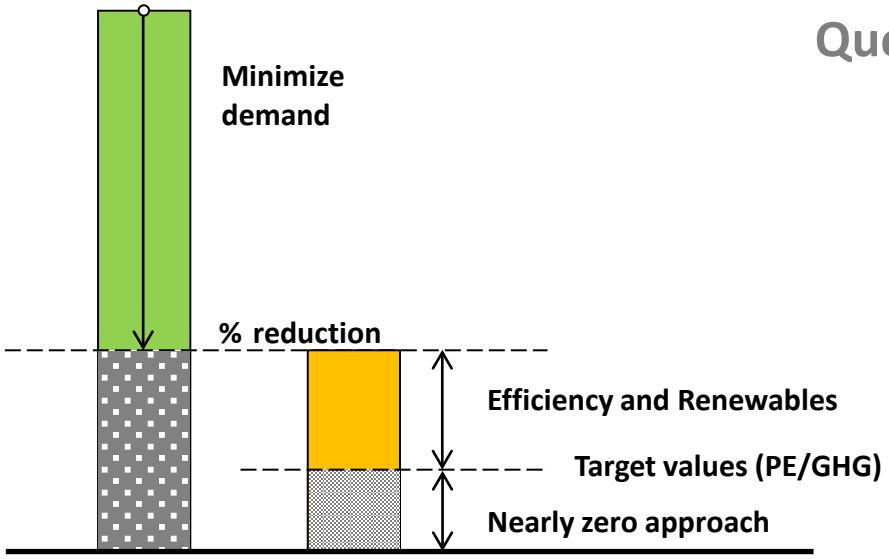


Question?

How to achieve the best performance with minimal effort?

Annex 56 Objectives

- **Develop a new methodology for a cost optimal building renovation towards both the nearly zero energy and nearly zero emissions objective**
- **Identify the optimal balance between the "minimization of demand" and "generation of renewable energy" measures in a cost/benefit perspective**



Questions ?

How far **is it possible to go with energy conservation and efficiency measures (initially often less expensive measures) ?**

From which point **the** carbon emissions reduction measures **become** more economical ?

Annex 56 Main Objectives

- **Define a** methodology for the establishment of cost optimized targets for energy and carbon emissions **in building renovation**
- Clarify the relationship between the emission and the energy targets **and their eventual hierarchy**
- **Determine** cost effective combinations **of** energy efficiency measures **and** carbon emissions reduction measures

However, in this project we intend to have a broader approach**,** going beyond **the cost effective reduction of carbon emissions and energy consumption and** take into account**, as much as possible, the** overall added value achieved in a renovation process

Annex 56 Main Objectives

Overall Added Value means identifying:

- **Global quality improvement**
- **Economic impact of the intervention**
- **Operating costs reduction**
- **Resulting co-benefits (as much as possible)**

It is also an objective, although in a voluntary basis, to take into account embodied energy and related emissions for building renovation materials and equipments since the better the performance of buildings the more relevant embodied energy use becomes.

Annex 56 Scope

- **Residential buildings**

  Single-family houses and multiple-family buildings

- **Non-Residential buildings without complex HVAC systems**
  - if relevant and useful information can be extracted from them
  - used to prove the applicability of the developed methodology and tools to other buildings' categories besides residential buildings)

Bairro Rainha D. Leonor, Porto, PT

Primary school – Svážná 9, Brno, CZ

Annex 56 Target Groups

Decision makers (owners, investors, promoters)

To make better decisions and choose the best options that apply to their needs

Multipliers (architects, planners, consultants and professionals of construction and building renovation industry)

Technical guidance

Policy makers

To define the most appropriate policies, measures and incentives to put into practice for an effective renovation strategy

Methodology:

- **Will allow taking into account** country specific situations **(like climate, electricity mix, conversion factors, national energy targets, etc.)**
- **Will allow** prioritizing either nearly-zero emissions renovation (NZEmB) or nearly-zero energy renovation **(NZEB) , each with an additional energy or emission goal that has to be achieved at the same time**
- **In any situation there is a strong requirement** to make sure that substantial energy reductions must be achieved whatever the priority chosen

The challenge will be to explore the tradeoffs between emissions reduction and energy reduction **at the nearly zero border** taking into account costs, energy use, emissions **and, as far as possible,** co-benefits

Co-Benefits

- **Integrate co-benefits in the methodology is one of the aims and one of the major challenges of this project**

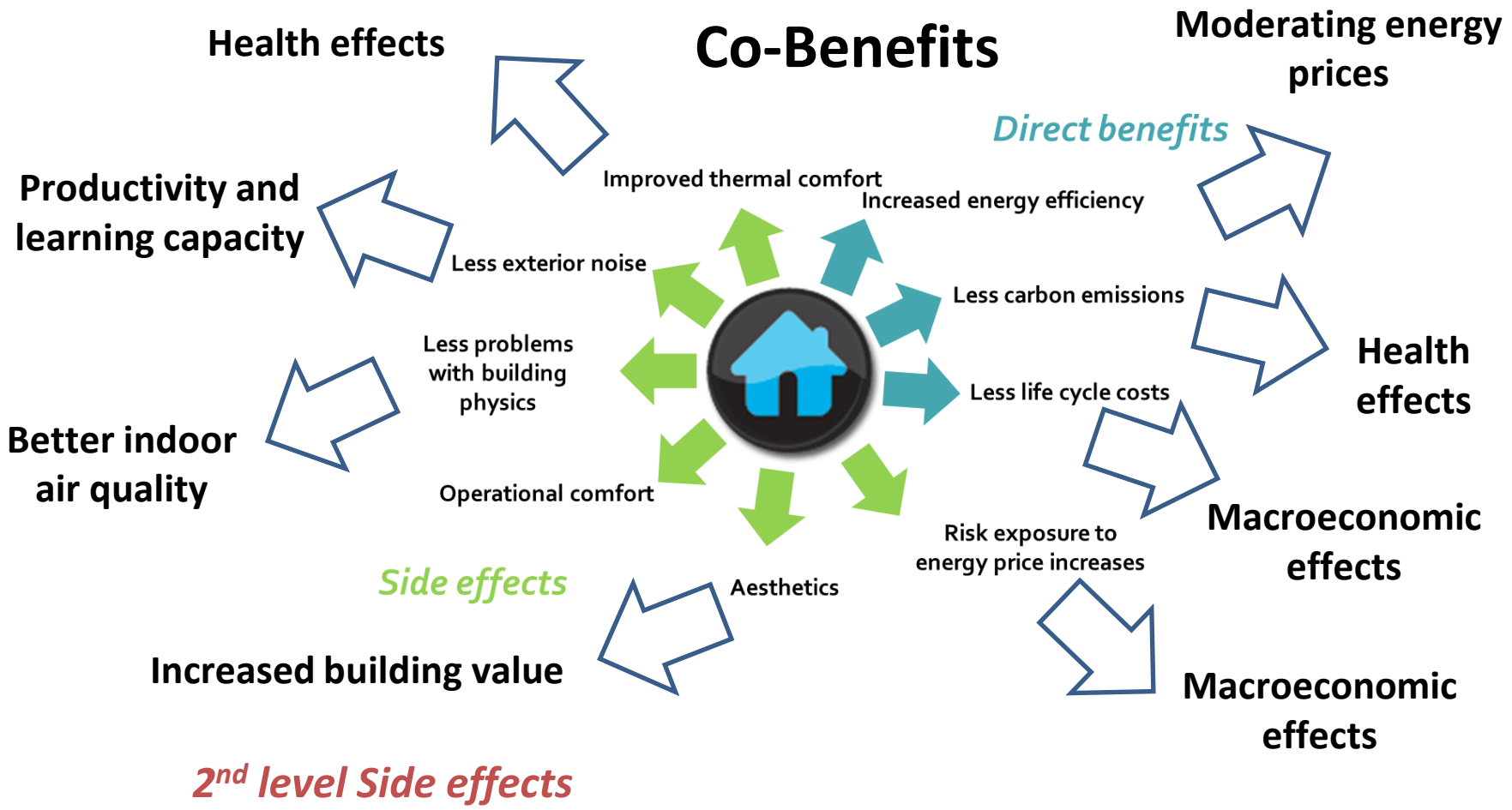
- **Co-benefits – All benefits besides energy and energy cost savings and carbon emission reductions like comfort improvement (thermal, natural lighting, indoor air quality, acoustics, etc.), fewer problems related to building physics, fewer negative external effects of the building (air pollution) and increased value of the building**

- **Co-benefits can be as important as energy cost savings and, in certain circumstances can be the drivers for the renovation**

Question:

How to find feasible methods to monetize, or at least partly quantify, co-benefits in order to take them into account in cost-benefit analysis?

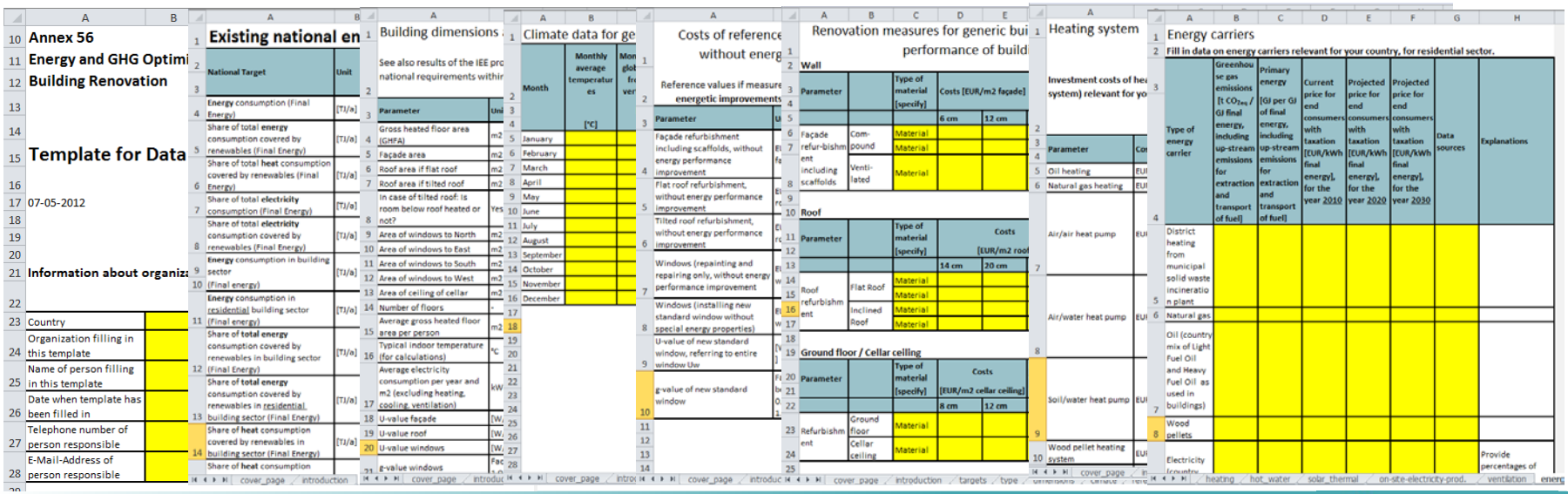
Co-Benefits


Health effects
Moderating energy prices
Direct benefits
Productivity and learning capacity
Improved thermal comfort
Increased energy efficiency
Less exterior noise
Less carbon emissions
Less problems with building physics
Health effects
Better indoor air quality
Less life cycle costs
Operational comfort
Macroeconomic effects
Risk exposure to energy price increases
Side effects
Aesthetics
Increased building value
Macroeconomic effects
2nd level Side effects

Methodology:

To develop and support the methodology:

- **Generic buildings in each country are being selected – prevailing typologies and constructive solutions must be found**
- **Parametric studies are being performed on them**



Two Approaches

Market Approach

Cost based, cost effective measures: **range for measures between cost optimal and cost neutral, ranking/trade-off between energy or emissions reduction measures** to be determined

Private cost perspective

Initial renovation cost
- Initial investment cost
- Replacement costs

Utilization costs
- Energy costs
- Maintenance costs
- Operational costs

Co-benefits

Relevant for owners, investors, users

Social cost perspective

- Initial investment cost
- Replacement costs
- Energy costs
- Maintenance costs
- Operational costs
- **External costs or benefits**

Relevant for policy makers

Normative Approach

Normatively (politically or environmentally) preset targets **(primary energy or carbon emissions reduction),** least cost measures to meet the targets

Preset energy targets

Preset with respect to
- Resource or environ-mental target
- Politically preset (depending on costs from market approach)

Preset emission targets

Preset with respect to
- Resource or environ-mental targets
- Politically preset (depending on costs from market approach)

Two Approaches

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Utilization costs building
- Energy costs
- Maintenance costs
- Operational costs

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Social cost perspective

- Initial investment cost
- Replacement costs
- Energy costs
- Maintenance costs
- Operational costs
- External costs or benefits

Relevant for policy makers

Preset energy targets

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Preset emission targets

Preset with respect to
- Resource or environ-mental targets
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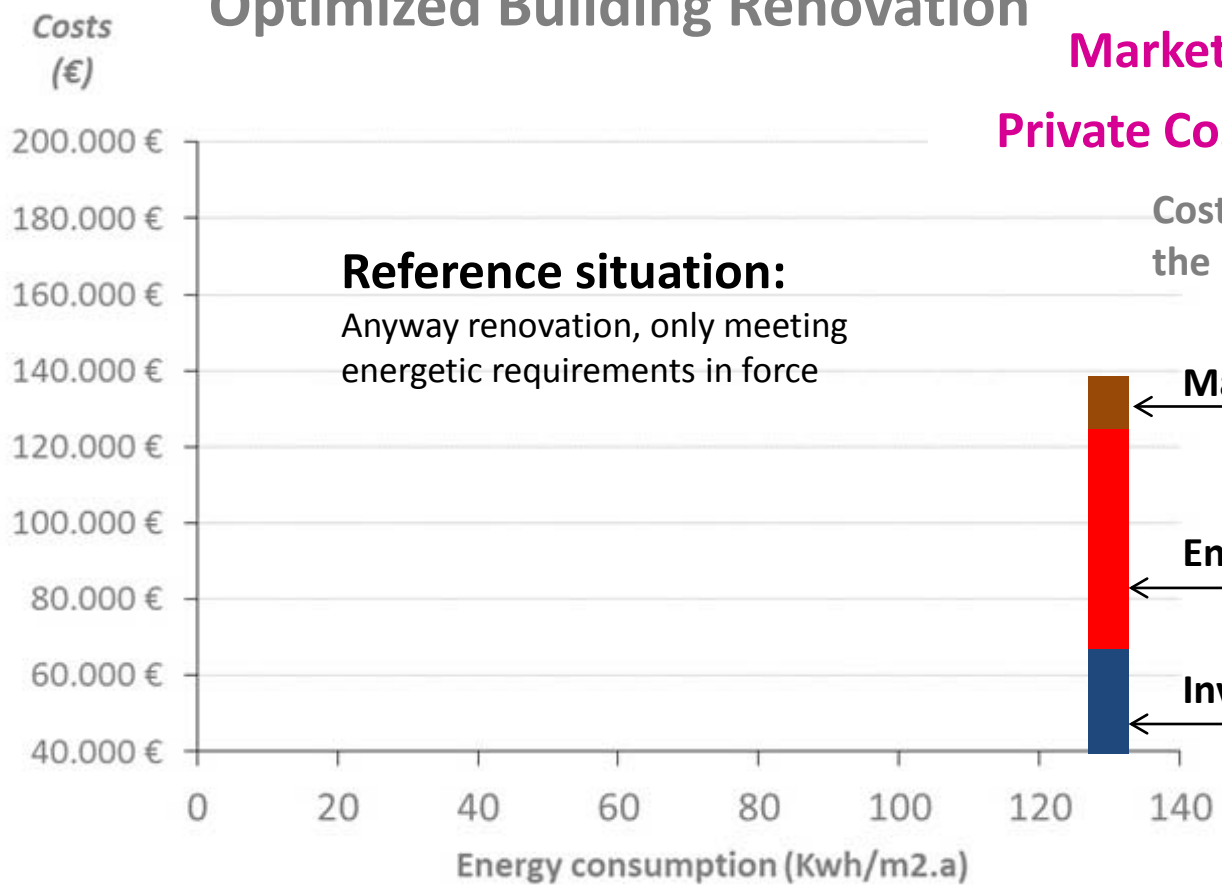
Methodology for Cost Effective Energy and Carbon Emissions Optimized Building Renovation

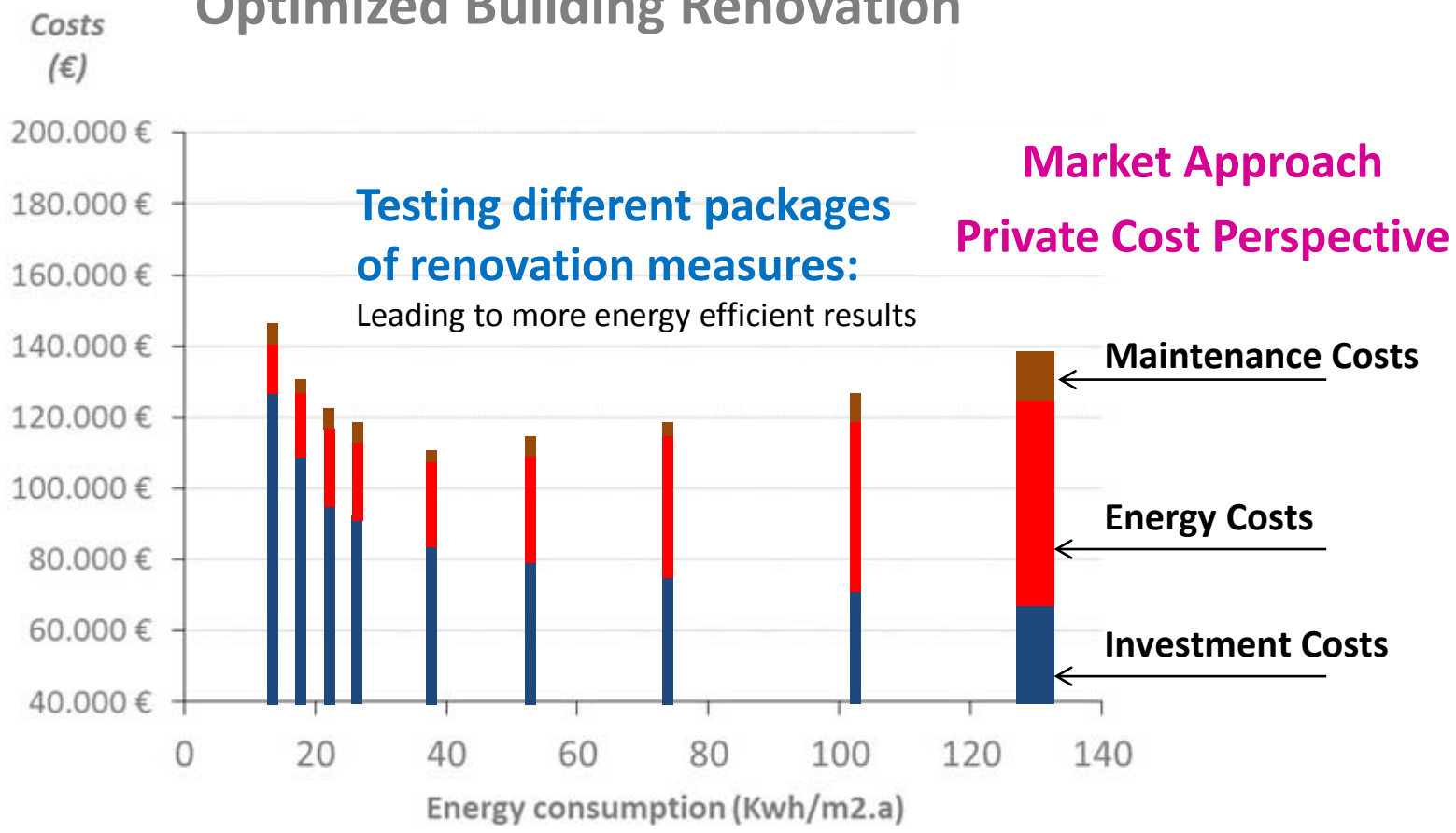
Market Approach

Private Cost Perspective

Costs assessed for the building life cicle



Methodology for Cost Effective Energy and Carbon Emissions Optimized Building Renovation



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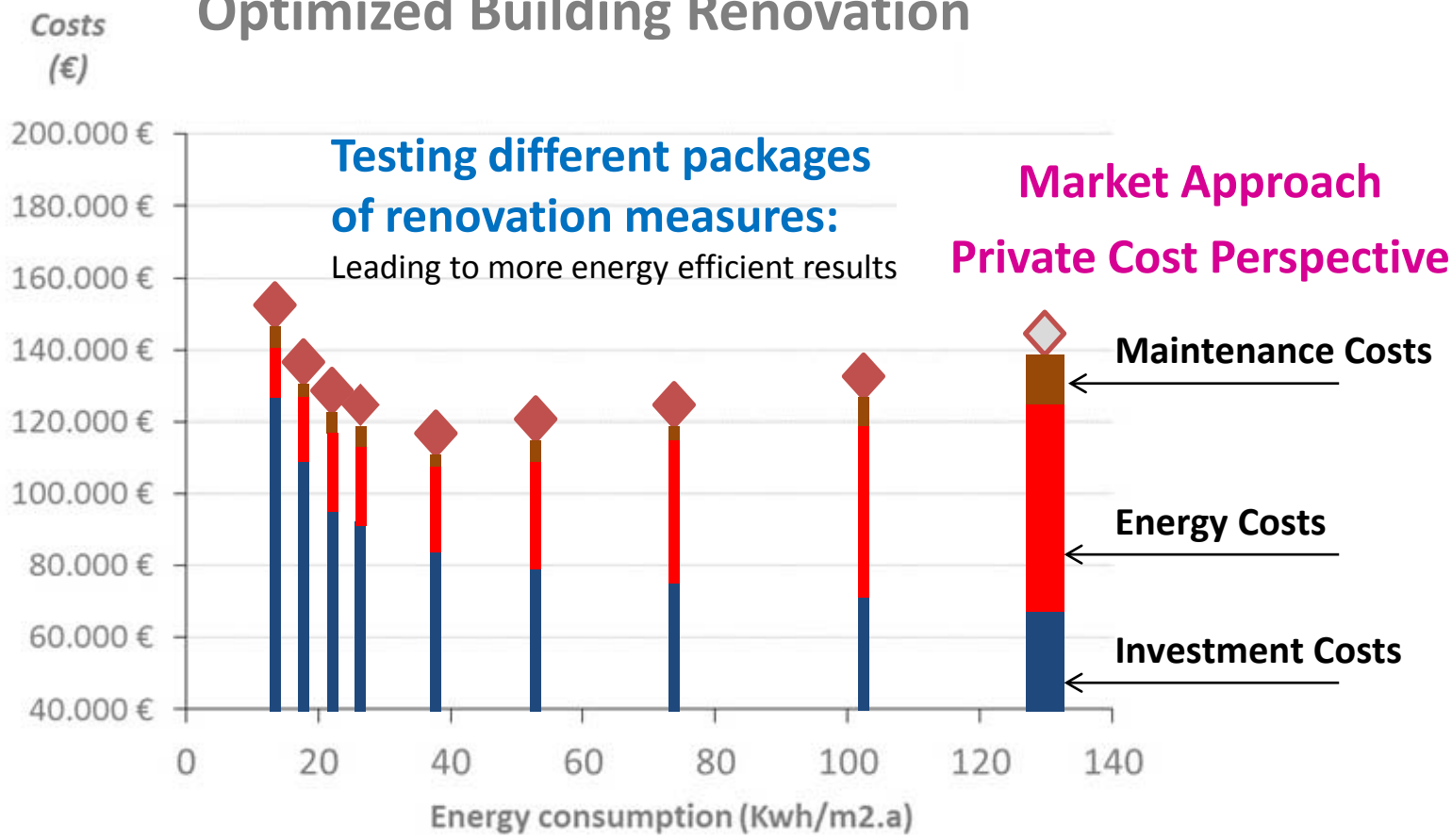

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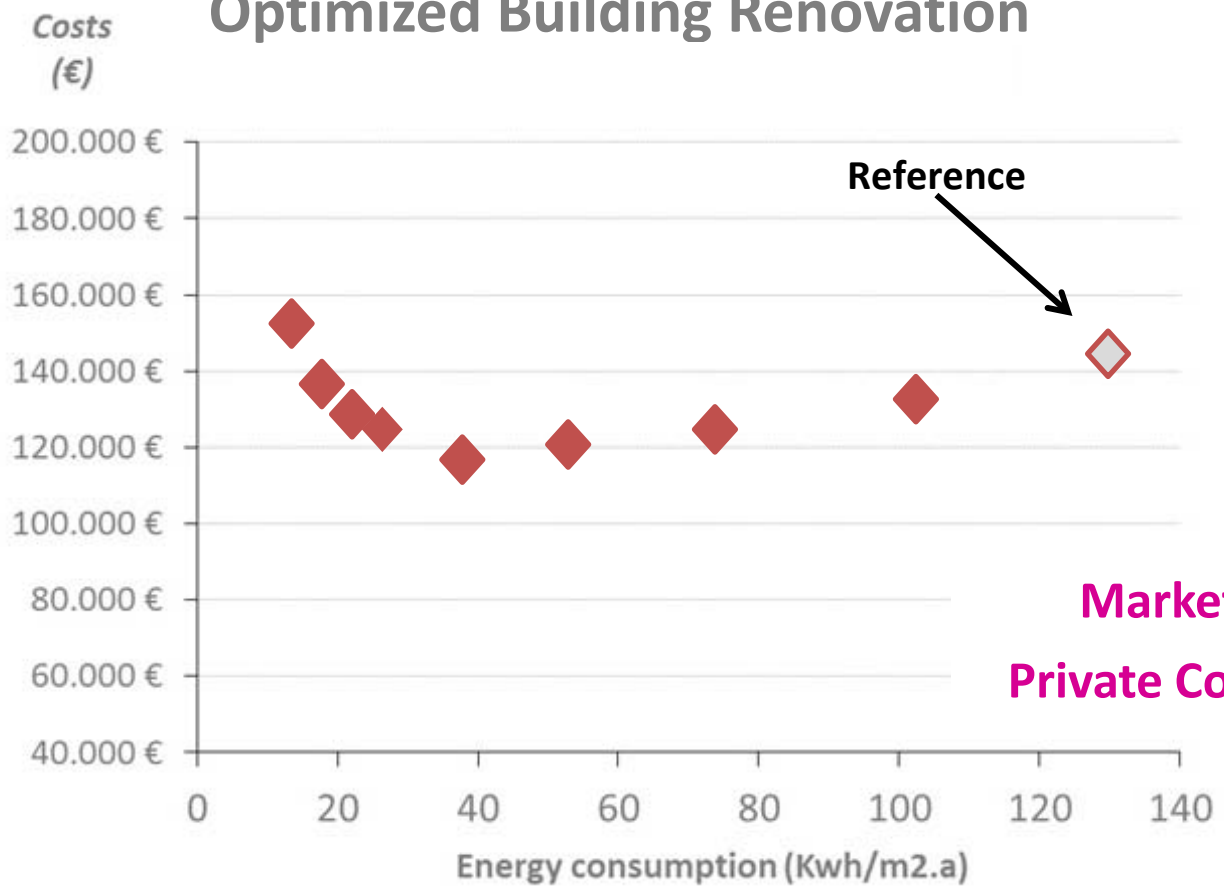
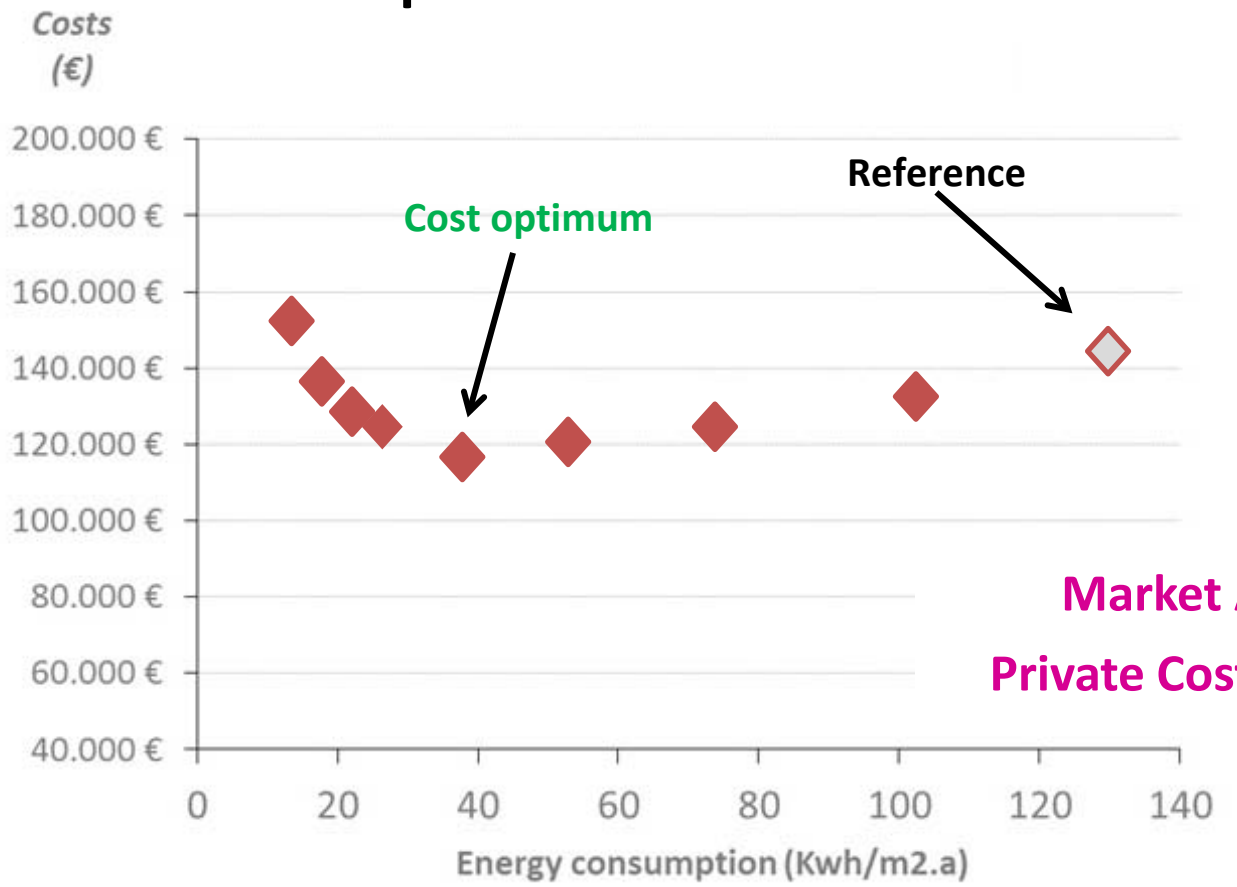


Market Approach

Private Cost Perspective

Cost optimum and Cost-effectiveness

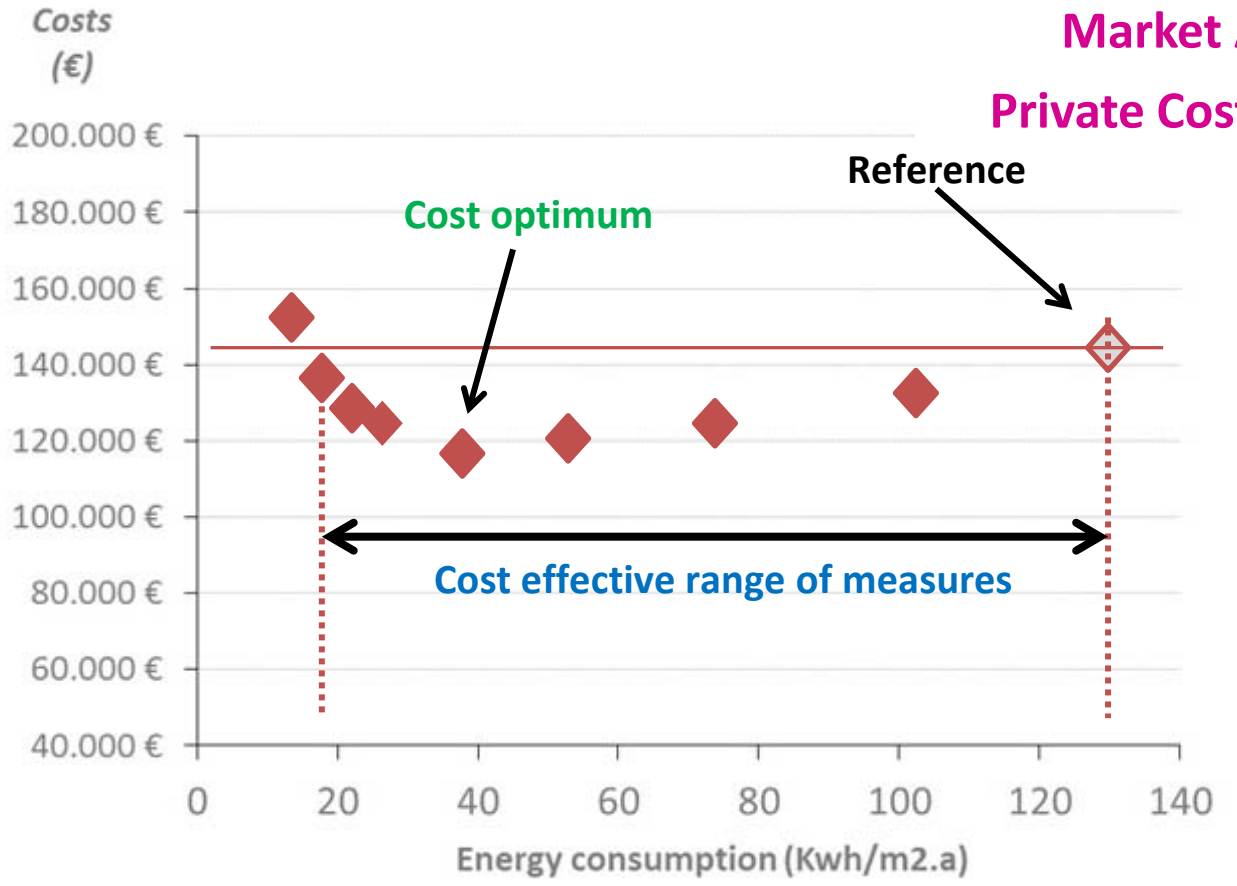


Market Approach

Private Cost Perspective

Global cost curve, starting from reference renovation solution towards less primary energy consumption or less carbon emissions

Cost optimum and Cost-effectiveness



Market Approach

Private Cost Perspective

First Results

Single-family building in Switzerland

The building has an oil heating system and a bad energy performance

Assumptions made for the parametric calculations:

Real interest rate: 3% p.a.

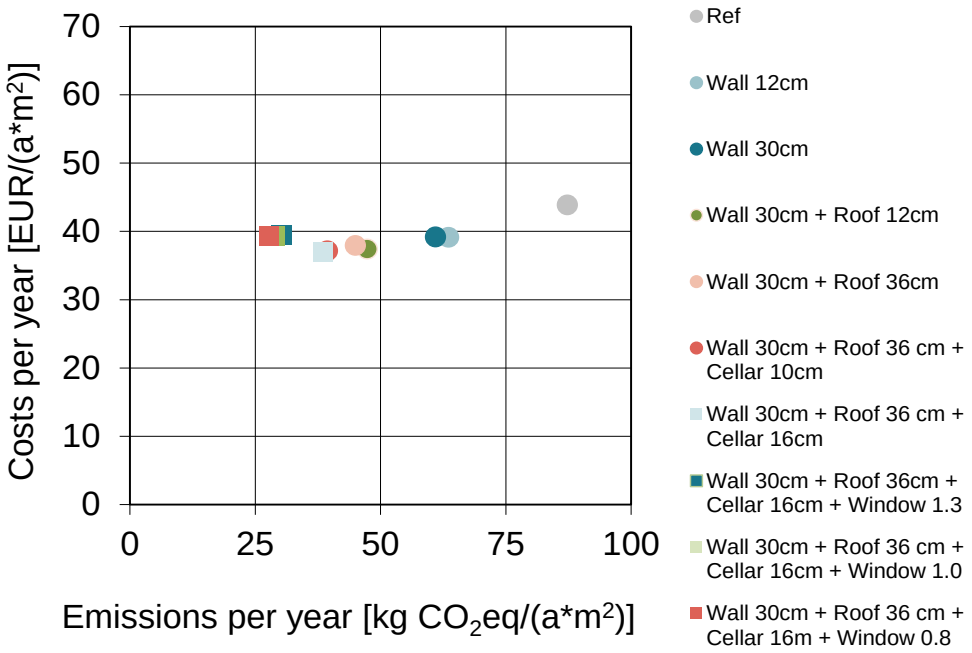
energy prices:

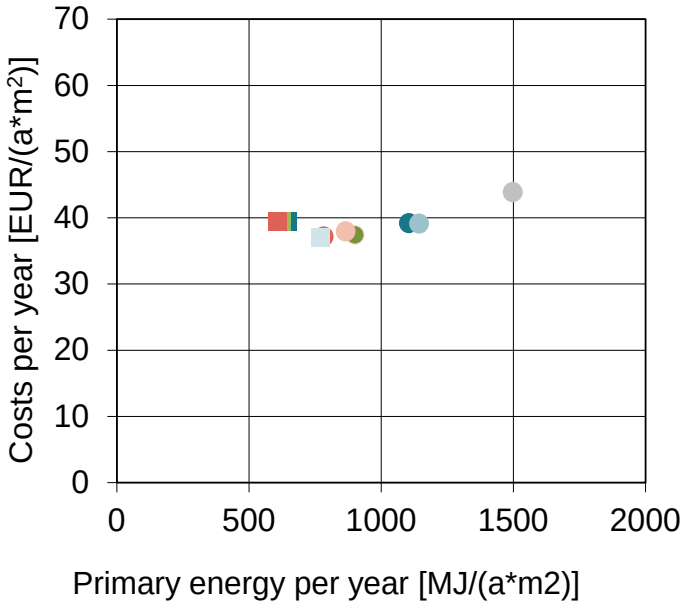
heating oil - 0.10 EUR /kWh,

wood pellets – 0.08 EUR/kWh,

electricity - 0.20 EUR/kWh

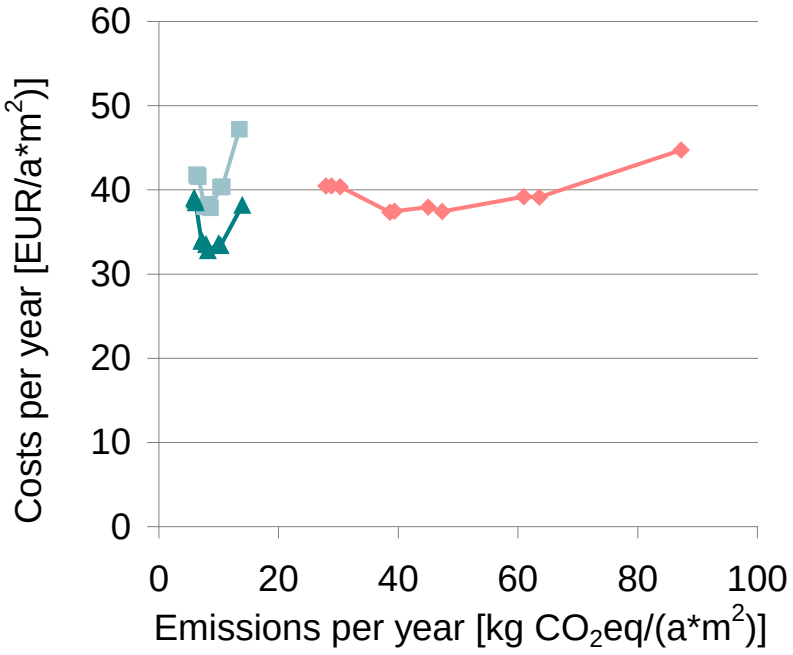
First Results
Energy Efficiency Measures on the Envelope

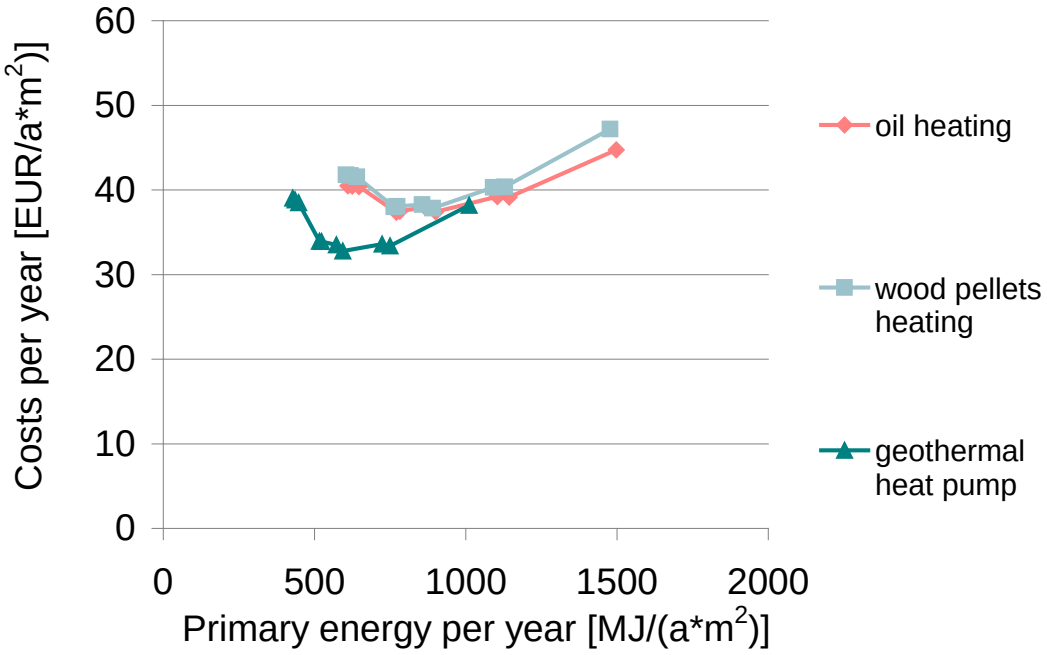




It is important to act on as many envelope elements as possible

Effects of changing the heating system on cost optimality





The switch to a renewable energy heating system has much more impact than changes in the building envelope

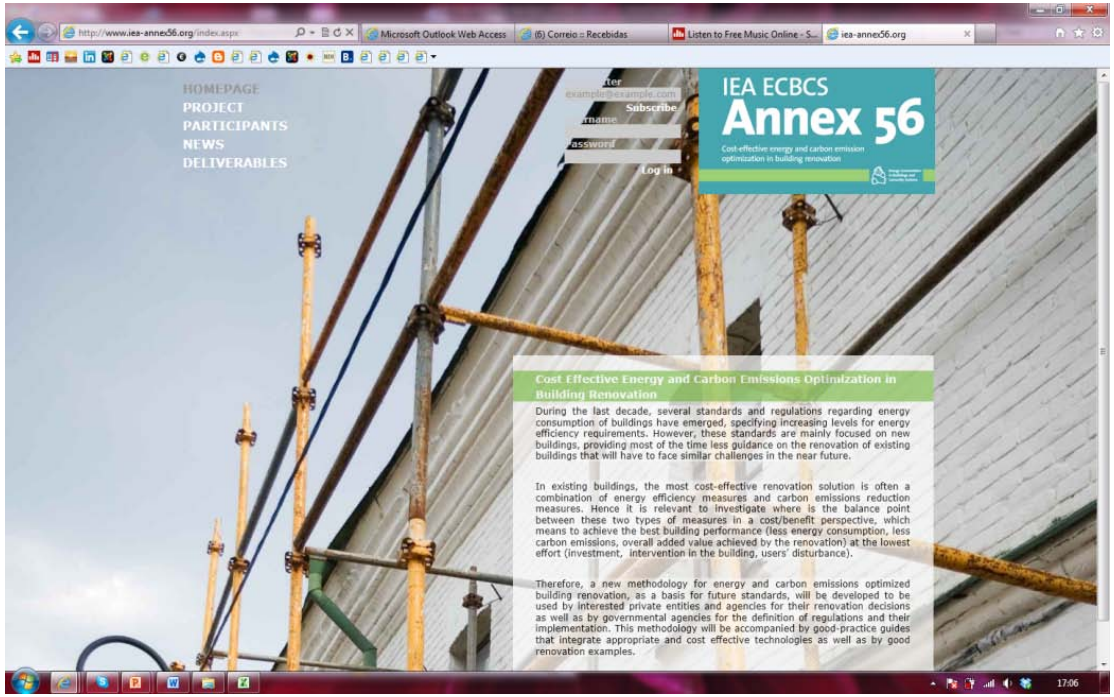
Some first conclusions

- **It is important to act on as many envelop elements as possible . How many building elements are renovated is more important than how many cm of insulation are used if only in few elements**
- **A switch to RES (geothermal heat pump or wood pellets) reduces emissions more significantly than only energy efficiency measures on the building envelope**
- **If net zero emissions is the target, it is cost effective to combine renewable energy sources with energy efficiency measures**

Further assessment for different buildings and different countries have to be performed to extend trade-off analyses

Annex 56 Information

Website is online www.iea-annex56.org



Annex 56 Information

Newsletters can be downloaded from the website


1st Newsletter

IEA ECBCS Annex 56

Cost-effective energy and carbon emission optimization in building renovation

"Working together to ensure reliable, affordable and clean energy"

The International Energy Agency (IEA) has established an Implementing Agreement on Energy Conservation in Buildings and Community Systems (ECBCS), with the aim of undertaking research and providing an international focus on building energy efficiency. Tasks are undertaken through a series of annexes that are directed at energy saving technologies and activities that support their application in practice.

The project "Cost Effective Energy and Carbon Emissions Optimization in Building Renovation" is in this context known as Annex 56, and it aims at developing a new methodology, as basis for future standards, to enable cost effective renovation of existing buildings while optimizing energy consumption and carbon emissions reduction.

Participating countries

The following countries are participating in Annex 56:

Portugal, Switzerland, Austria, Norway, Denmark, Italy, The Netherlands, China, Finland, Sweden, Spain and Czech Republic.

The overall responsibility for the management of the Annex belongs to the operating agent — Manuela Almeida, from University of Minho, Portugal, that is supported by the Portuguese National Energy Agency—ADENE.

Contacts and further information about the project are available at www.iea-annex56.org

BACKGROUND

IEA has identified the building sector as one of the most cost effective sectors for reducing energy consumption and consequently reduce carbon emissions. Existing building stock is crucial since buildings have long lifetimes and old buildings are the most inefficient ones.

"Built environment is responsible for 40% of primary energy use and 24% of carbon emissions."

In building renovation, current standards, mainly targeted to energy efficiency measures, often result in expensive processes and complex procedures, seldom accepted by users, owners and promoters. These procedures can be simplified if onsite production of renewable energy is taken into consideration in the renovation process, potentially reducing the volume and depth of work.

"In search for the most cost effective balance between energy efficiency measures and the use of energy from renewable sources in building renovation."

www.iea-annex56.org


IEA ECBCS Annex 56

Cost-effective energy and carbon emission optimization in building renovation

PROJECT OVERVIEW

Within the overall objective of slowing down climate change by reducing carbon emissions, existing buildings renovation must consider energy conservation and efficiency measures, as well as measures and technologies that foster the use of energy from renewable sources, produced onsite or nearby.

This project is developing a new methodology for cost effective renovation of existing buildings, using the right balance between the energy conservation and efficiency measures for one side and the measures and technologies that promote the use of renewable energy on the other. This methodology is to be used by private entities helping them in their renovation decisions as well as by governmental agencies that can use it for the definition of regulations and their implementation.

Annex 56 Methodology will allow:

- Establishing cost optimized targets for energy consumption and carbon emissions in building renovation;
- Clarifying the relationship between emission and energy targets and their eventual hierarchy;
- Determining cost effective combinations of energy efficiency measures and measures to promote the use of energy from renewable sources.

THE OPTIMIZATION PRINCIPLE

Project is investigating how to achieve the best results in:

Reduction of energy consumption | Reduction of carbon emissions | Comfort improvement | Overall added value

With the least effort in terms of:

Financial investment | Depth and duration of intervention | Disturbance of users

GLOBAL BENEFITS OF RENOVATION

Renovation process and cost optimization calculations must consider benefits beyond energy related parameters, which means identifying and as far as possible quantifying:

Global quality improvement | Economic Impact | Operating cost reductions | Comfort improvement | Increased value of the building

TOOLS AND CASE STUDIES

New tools or add-ons to existing ones will be developed to support the different target groups economic evaluation of building renovation options as well as deal with added value related issues.

Several case-studies are being used to provide significant feedback from practice on a scientific basis and support the process of decision-making.

Rainha D. Leonor neighborhood (Before renovation)

Rainha D. Leonor neighborhood (After renovation)

www.iea-annex56.org

Thank you

COST EFFECTIVE ENERGY AND CARBON EMISSIONS OPTIMIZATION IN BUILDING RENOVATION

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