Efficiency matters.

ECEEE 2019 summer study

Investment cost-curves for heating and cooling demand reduction in residential buildings

www.heatroadmap.eu

Presqu'île de Giens, 06.06.2019

Ulrich Reiter
TEP Energy GmbH, Zurich

Authors: Ulrich Reiter, Andrea Palacios, Martin Jakob (TEP Energy)
Pia Manz, Tobias Fleiter (Fraunhofer ISI)

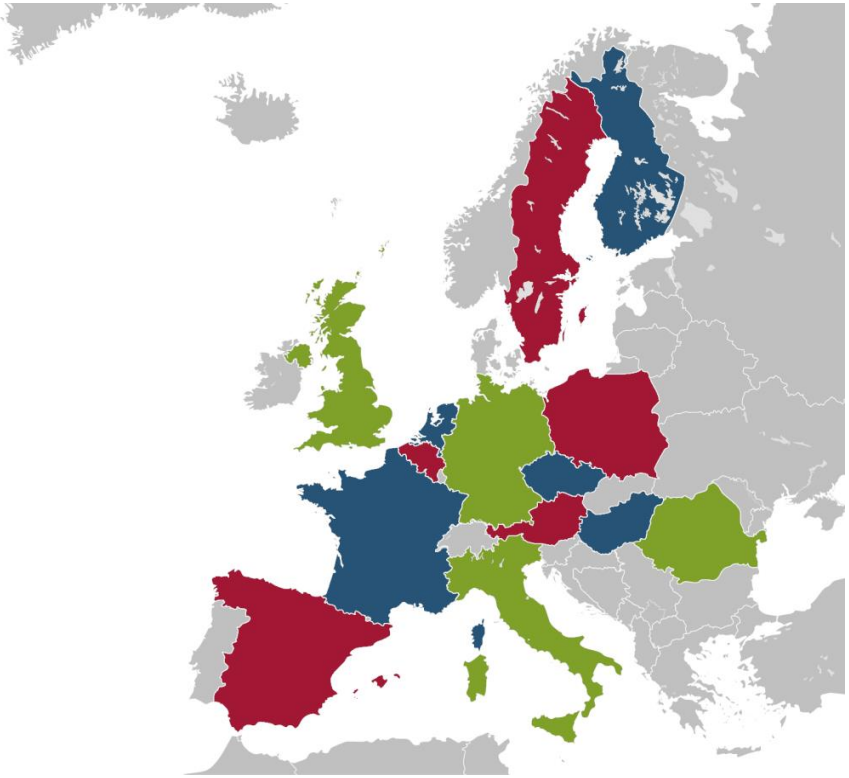
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

2050 Heat Roadmap Europe
A low-carbon heating and cooling strategy

Source: fotolia

Heat Roadmap Europe 4

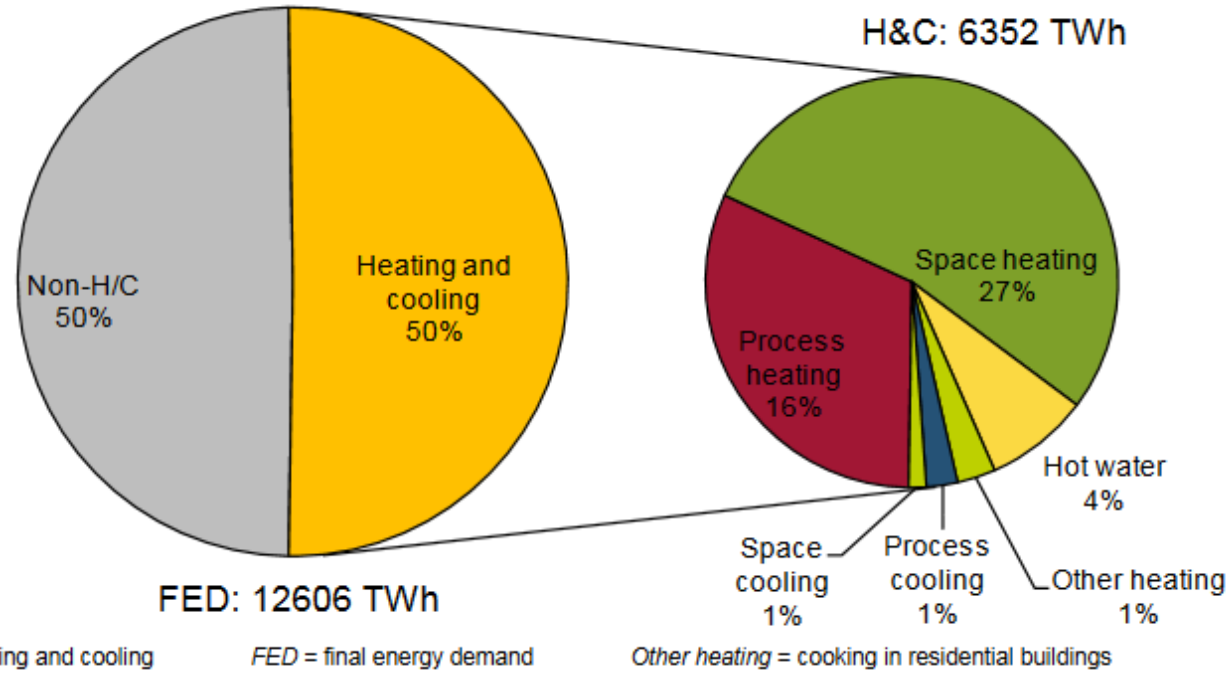
- 4th study (2016-2019): low-carbon and cost-effective heating and cooling strategies for 14 member states.
- HRE4 Countries: 14 Largest EU Countries by Heat Demand = 90% of EU Heat
- 2 approaches
  → Decarbonize the H/C supply
  → Reducing the H/C demand
    → H/C demand in Industry
    → H/C demand in buildings
      → Residential
      → Tertiary



The results of the two approaches are the inputs for an **optimization model** for the energy system of H/C in Europe

Context EU

- Clear long-term objective to decarbonise the energy system
- H/C has the highest share in the total **final energy demand** (Approx. 50%)

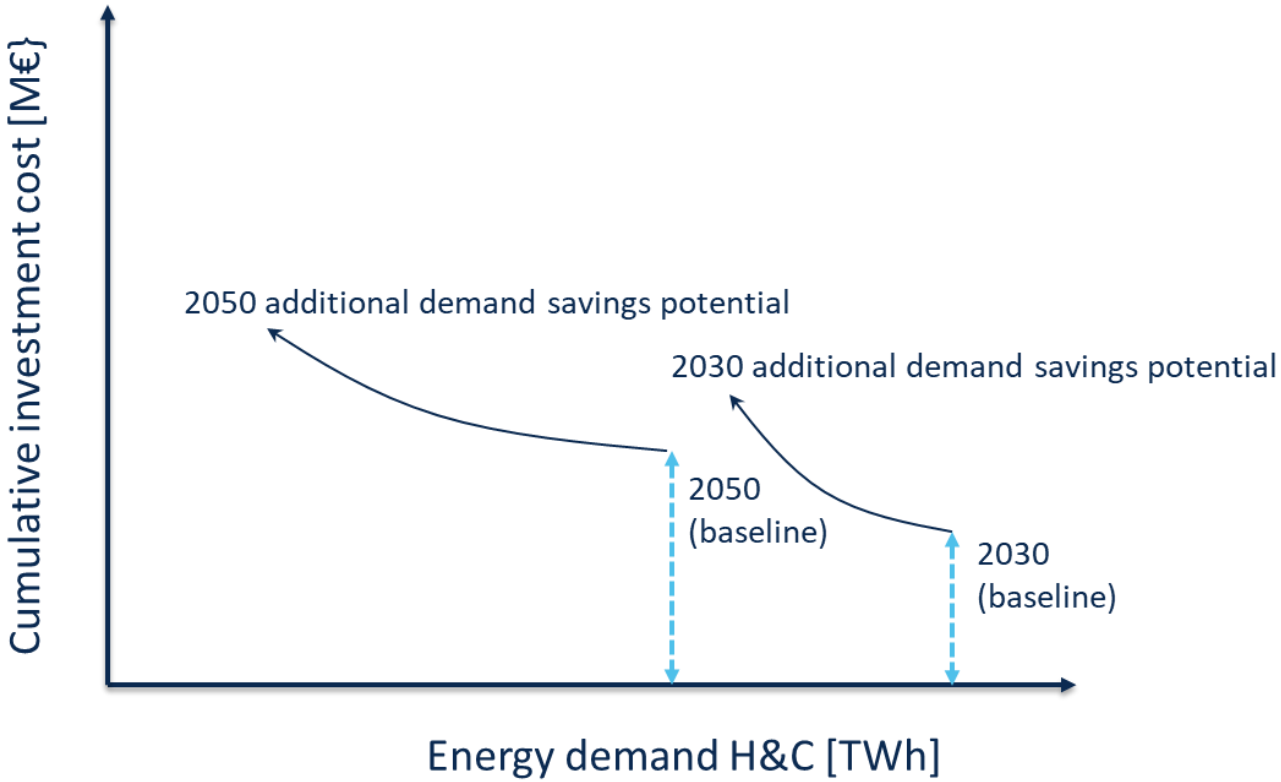


H/C = heating and cooling *FED* = final energy demand *Other heating* = cooking in residential buildings

- **How to decarbonise the H/C sector?**

H/C savings potential and costs

How much H/C savings (delivered energy) in the building sector – and at which cost?



- BASELINE scenario as starting point (reference)
- Further savings explored in comparison with the baseline

Methodology

H/C demand **BASELINE** scenario

Baseline considerations

- **Activity**: current trends and future changes (increase) in economic output and consumption (GDP, Energy prices, added value, etc.)
- **Energy efficiency**: Today's implemented policies (e.g. building codes). Not further tightened.

Building Stock & Framework Data

- Occupation
- Sector specific
- Building Age
- Typology
- Elements lifetime and U-values
- Technologies incl. labor costs
- Retrofit options
- Energy prices

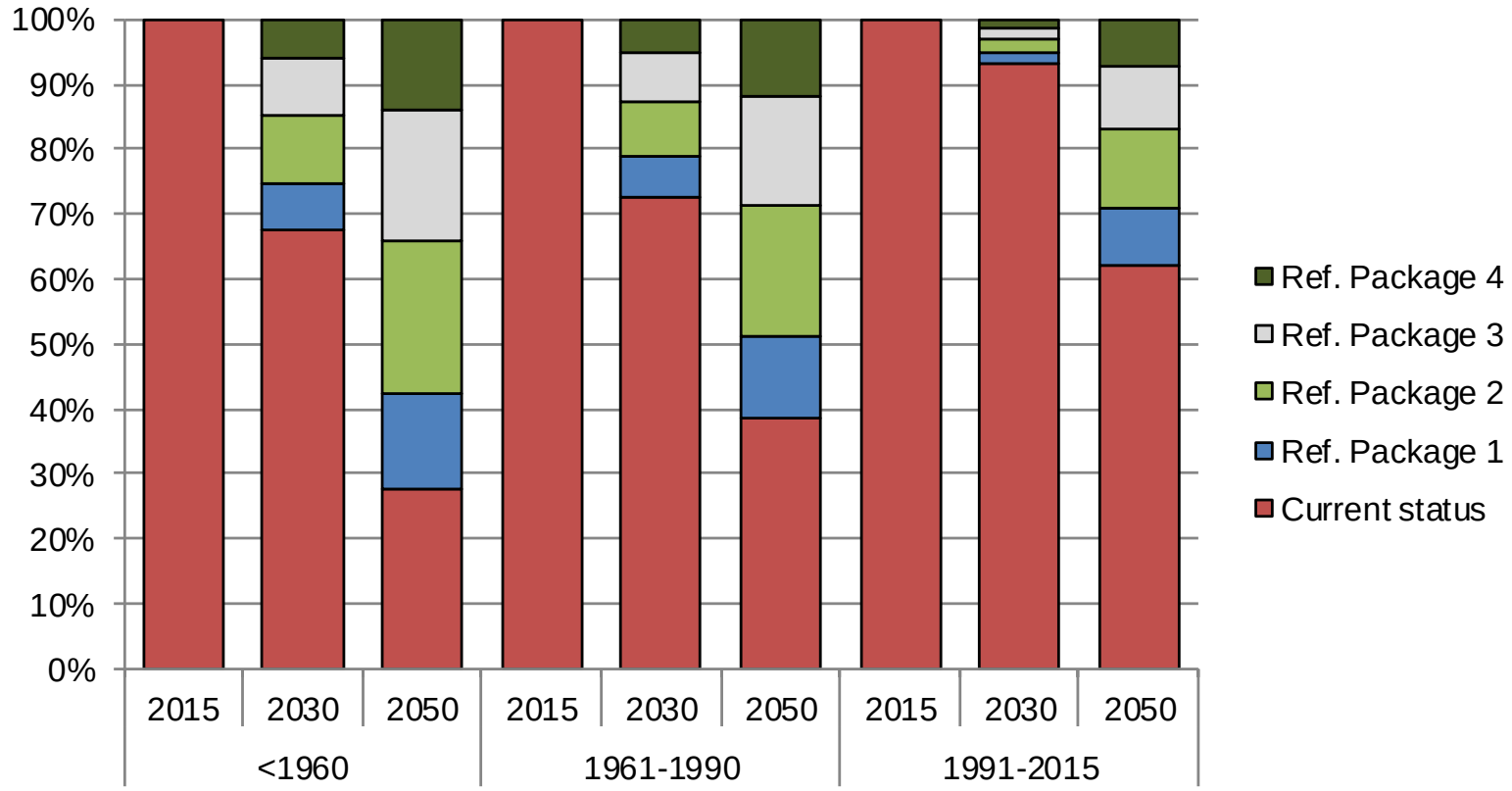
FORECAST

- **Bottom-up** model
- Refurbishment measures by **building element**
- Choice of measure applied according with the **lifetime** of the building element and the associated **costs**
- **Decision from the investor perspective** (behavioral aspects)
- Different building cohorts by building age and building type

BASELINE SCENARIO

- Delivered H/C **demand**
- Total H/C **investment**

Distribution of refurbishment packages in the baseline scenario



In the baseline

- Model can choose between 4 refurbishment packages and “doing nothing”
- Energy prices and specific energy demand are main decision drivers

Methodology

H/C demand **TARGET** scenario

Building Stock Data

- Surface
- Occupation
- Building Age
- Typology
- Elements lifetime
- Technologies incl. labor costs

Baseline

- Energy prices
- Regulatory framework conditions

Target considerations

- Fixed percentages of extra savings: 5,10,15,20 and 25% by increasing refurbishment depth
- Optimization to use the most cost-effective combination of measures for each target.

FORECAST

- Refurbishment measures by **building element**
- Choice of measure applied according with the **lifetime** of the building element and the associated **costs.**
- **Optimization inside the model**

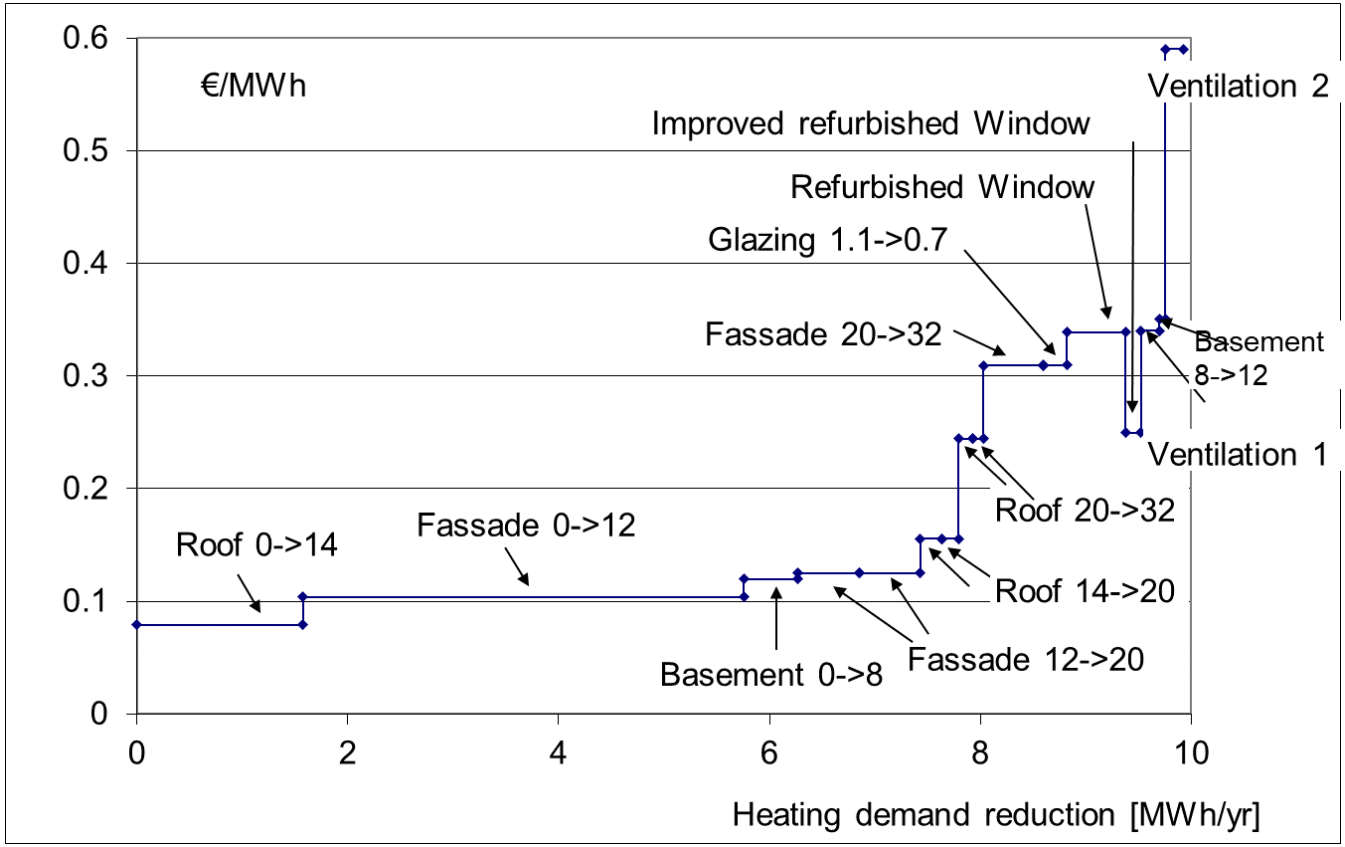
TARGET SCENARIO

- Delivered H/C **demand**
- Total H/C **investment**

- Shows additional savings beyond what is (potentially) achievable with current policy measures – in other words, the savings shown in the cost curves are additional to the baseline.

H/C savings potential and costs

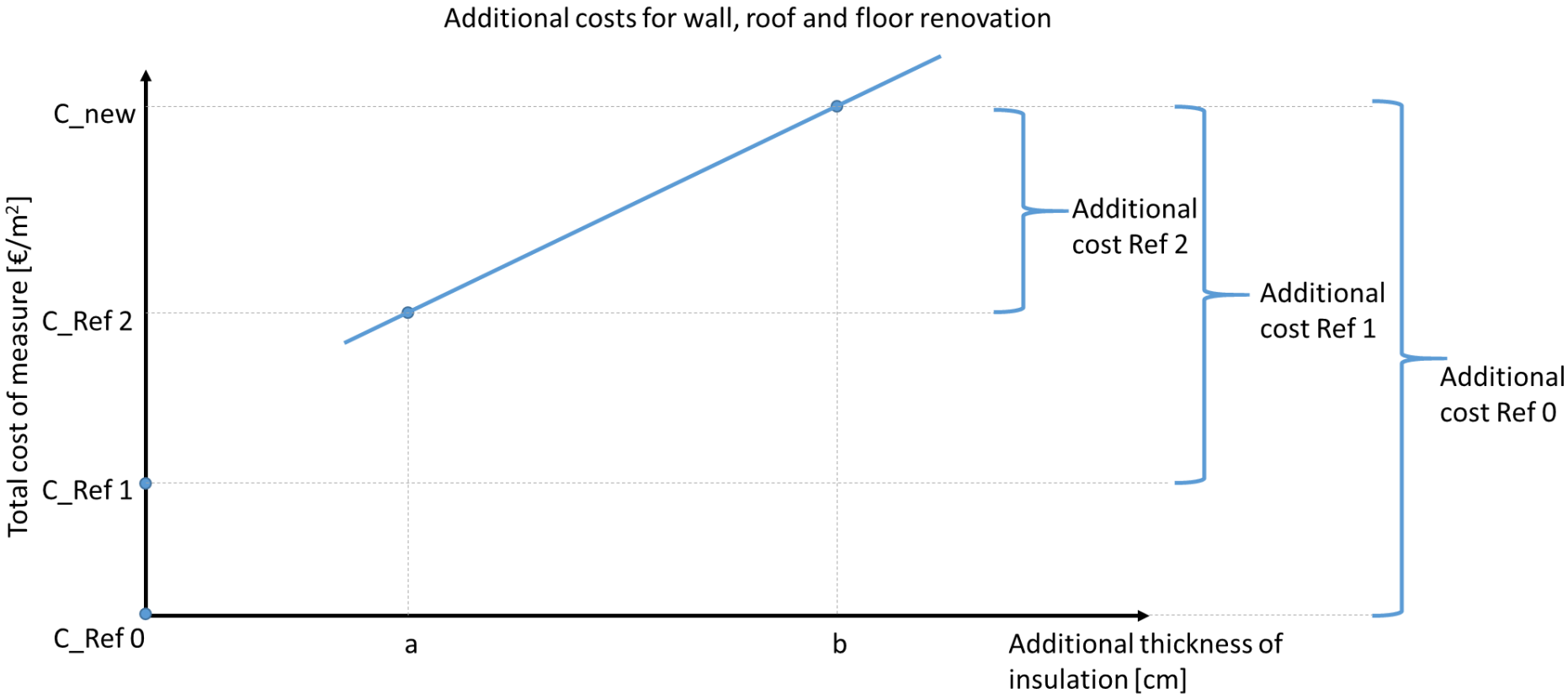
How much H/C savings in the residential building sector – and at which cost?



- Representative refurbishment measures and related investment costs
- The calculated cost-curves show total cumulative investments → not annualized costs

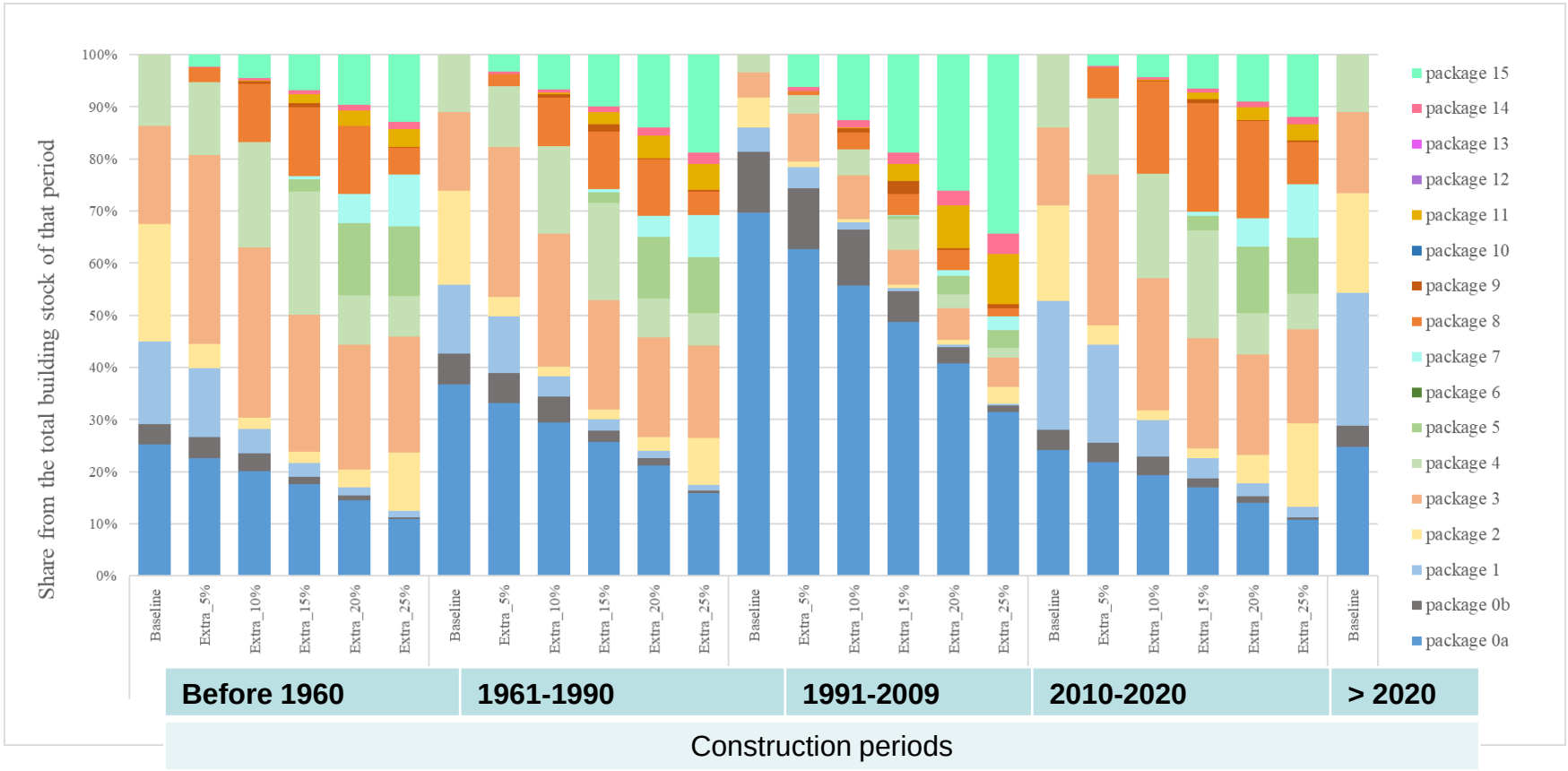
H/C savings potential and costs

How much H/C savings in the residential building sector – and at which cost?



- Only additional costs considered

Distribution of refurbishment packages to reach additional savings in 2050

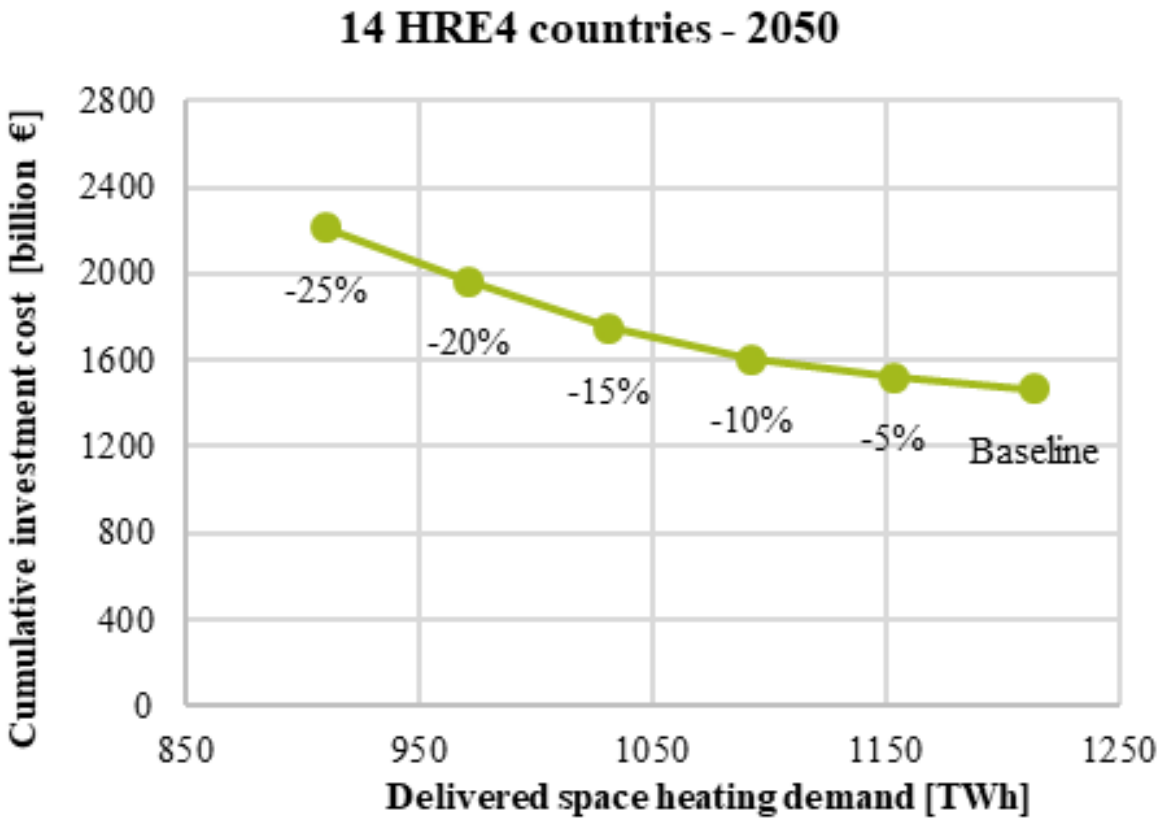


Additional efficiency gains can be achieved

- if buildings undergoing refurbishment target higher efficiency gains
- when more buildings are undergoing refurbishment measures

RESULTS

Cost-potential curves for reducing delivered heat demand



- The heat savings in the baseline scenario require an overall investment of approx. €1.500 billion (minus 20% energy demand until 2050)
- Approx. another €600-€700 billion needs to be invested to achieve 25% more savings

RESULTS
Cost-potential curves

- We calculate an additional 350 TWh savings on top of the baseline scenario until 2050 given the respective assumptions regarding changes in refurbishment behaviour

- Depending on the additional and available measures
  - different sets of refurbishment packages are needed
  - costs to achieve additional savings vary

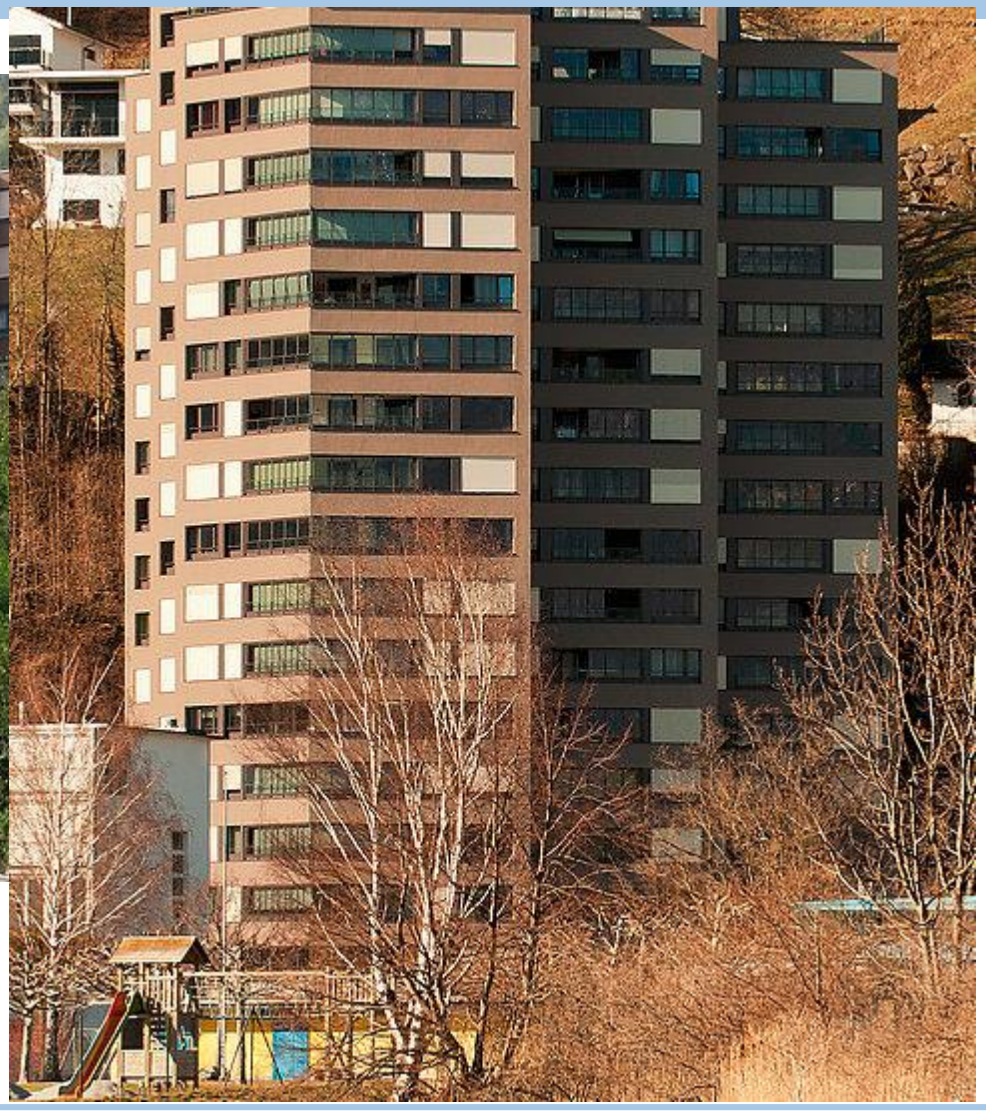
- In Nordic countries, the specific cost per kWh saved is higher as compared to southern countries due to climatic reasons, current state of building stock and efficiency rates of equipment

- Savings potentials on top of the baseline for buildings after 2020 are limited

Summary and conclusions

- The majority of the extra savings revealed by this work for the residential sector are achieved by implementing more ambitious renovation measures than implemented in the baseline for buildings that undergo a renovation anyway
- Further savings are achieved by increasing the refurbishment rate considered for the baseline scenario (i.e. doing renovations in buildings which are untouched in the baseline scenario)
- As potential additional costs for increasing the refurbishment rate (e.g. subsidies) are not considered in this analysis, “migration” to increase the refurbishment rate are underestimating specific costs
- It is important to note that implementing only one of these strategies does not open up the full potential of additional savings
- In order to exploit all the additional H&C savings effectively, stronger policy instruments are required, which address missed opportunities in current policy and financial frameworks especially in terms of building refurbishment

Not only theoretical calculations…



Discussion and outlook

Cost-potential curves

- Further comparative analysis by sector and countries
- Include annualization of costs
- Adding more details on cooling as cooling demand will increase in the future – efficient applications and solutions from the beginning needed

Project Participants
www.heatroadmap.eu

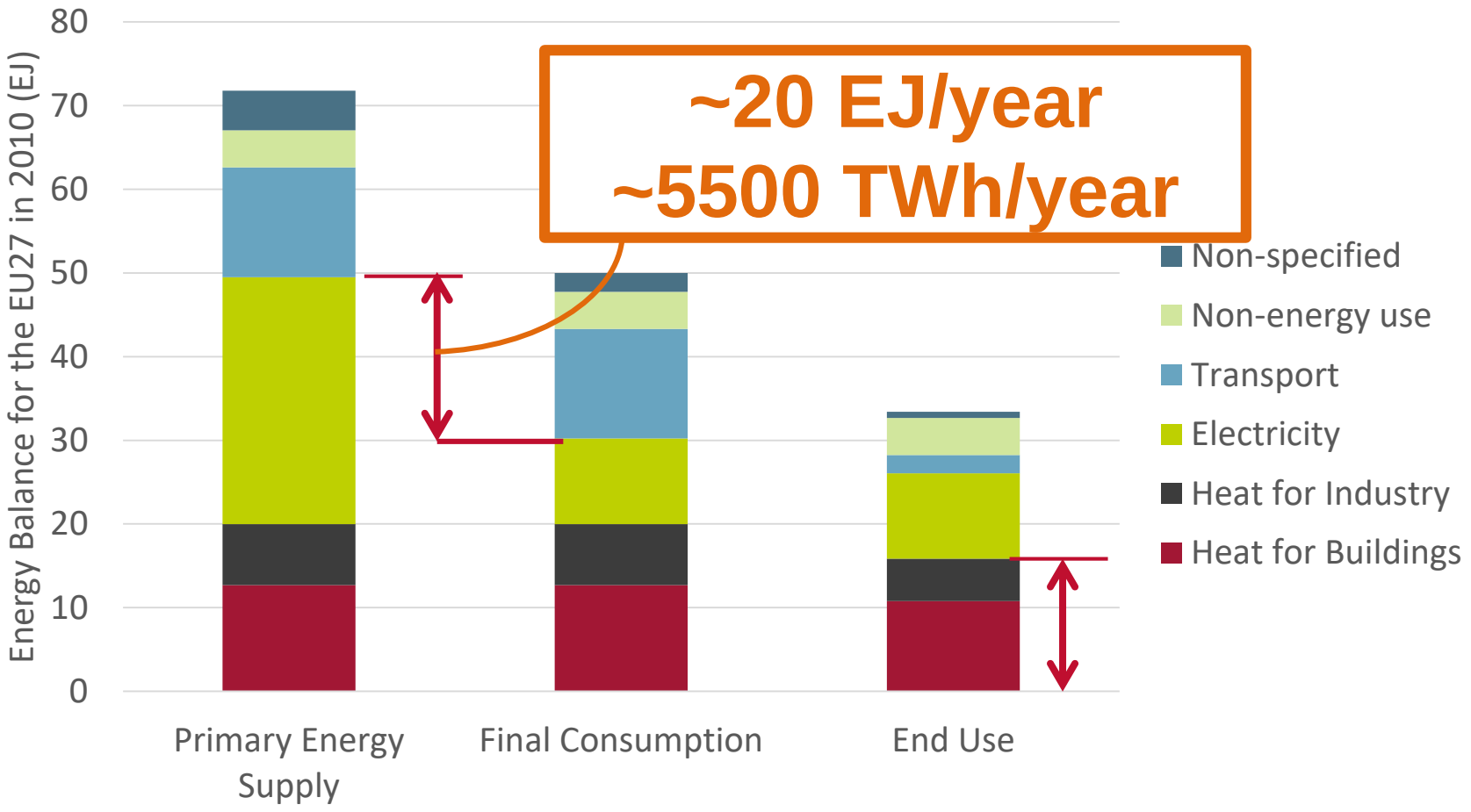
Thank you for your interest!

Your contact: ulrich.reiter@tep-energy.ch

Back up slides

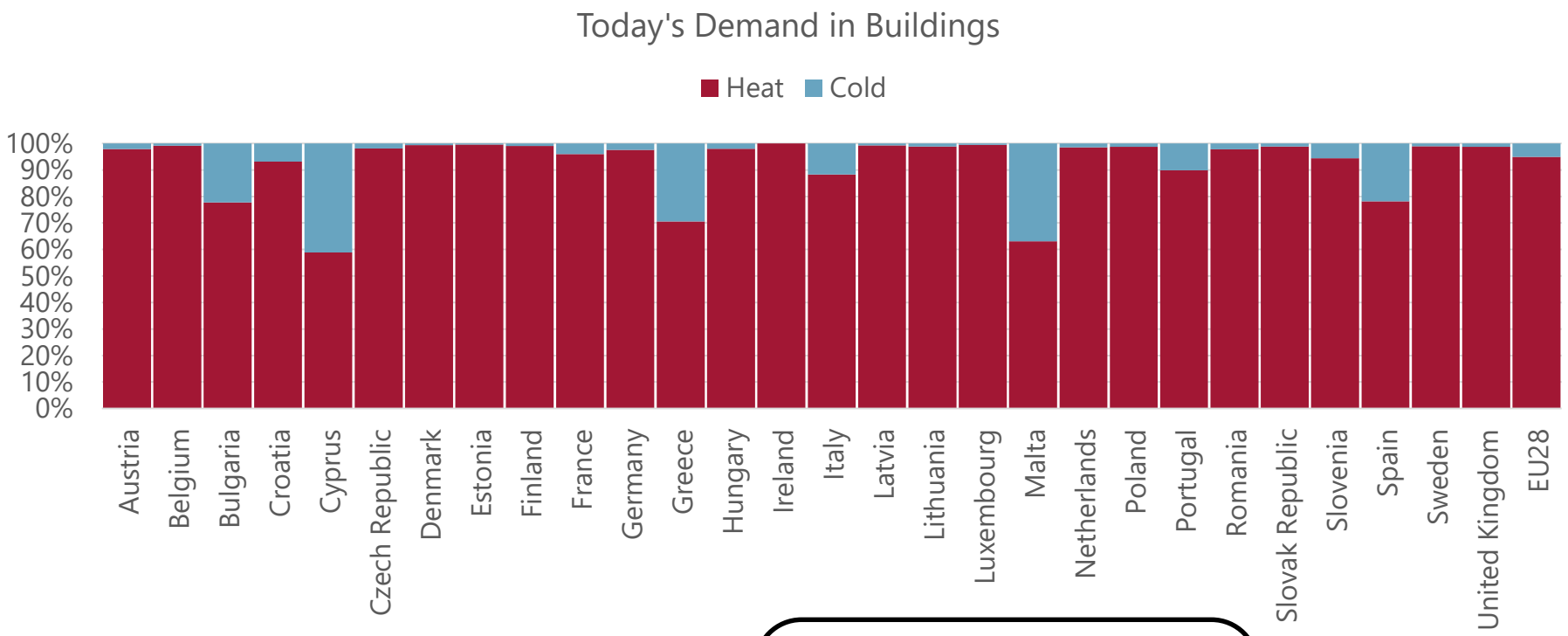
	ID Code	Refurbishment Package
Baseline Packages	P0a	No renovation
	P0b	Overhaul: repair and brush renovation, no energy efficiency improvement
	P1	Only windows (low)
	P2	Window and wall (low)
	P3	Window and wall and roof (middle)
	P4	Window and wall and roof and floor (high)
Additional packages for the extra savings goals	P5	Building on package 4, window and wall and roof and floor (higher)
	P6	Building on package 4, window and wall and roof and floor (highest)
	P7	Building on package 4, window and wall and roof and floor ("passive house")
	P8	Window (high) and roof (higher)
	P9	Only walls (low)
	P10	Window (higher)
	P11	Window and wall (higher)
	P12	Window (middle) and roof (middle) and floor (high)
	P13	Windows and roof and floor (higher)
	P14	Roof (middle) and floor (high)
	P15	Roof and floor (highest)

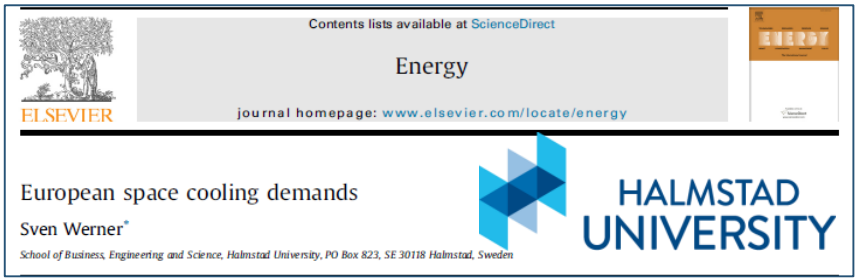
Lots of Heat to Supply District Heating: More excess heat in Europe than all of the heat demand in buildings



Profiling Heating & Cooling

Today: Heat Demand Much Bigger than Cooling Demand in Building





HRE4

Fraunhofer ISI

Universiteit Utrecht

TEP

w.heatroadmap.eu
)HeatRoadmapEU

Framework assumptions

Model parameter	Source	Assumption for projection
Economic drivers (GDP, value added industry and tertiary)	EU Ref 2016 (see Capros et al. 2016)	As EU Ref 2016
Energy prices (wholesale)	EU Ref 2016	As EU Ref 2016
CO_2 prices	EU Ref 2016	As EU Ref 2016 (87 €/t CO2 in 2050)
Population	EU Ref 2016	As EU Ref 2016
Number of households	EU Ref 2016	As EU Ref 2016
Industrial production	FORECAST benchmarked with EU Ref 2016	Continous development, no radical changes
HDDs and CDDs	Eurostat	Projection of past long term trend
End-user energy prices	2015 priced from Eurostat	Todays taxes and levies to remain fixed;projection of wholesale prices
Discount rates		Reflecting end-consumer
Number of Employees	As EU Ref 2016	Regression analysis based on population forecast

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Policy assumptions: „Current Policy implementation“

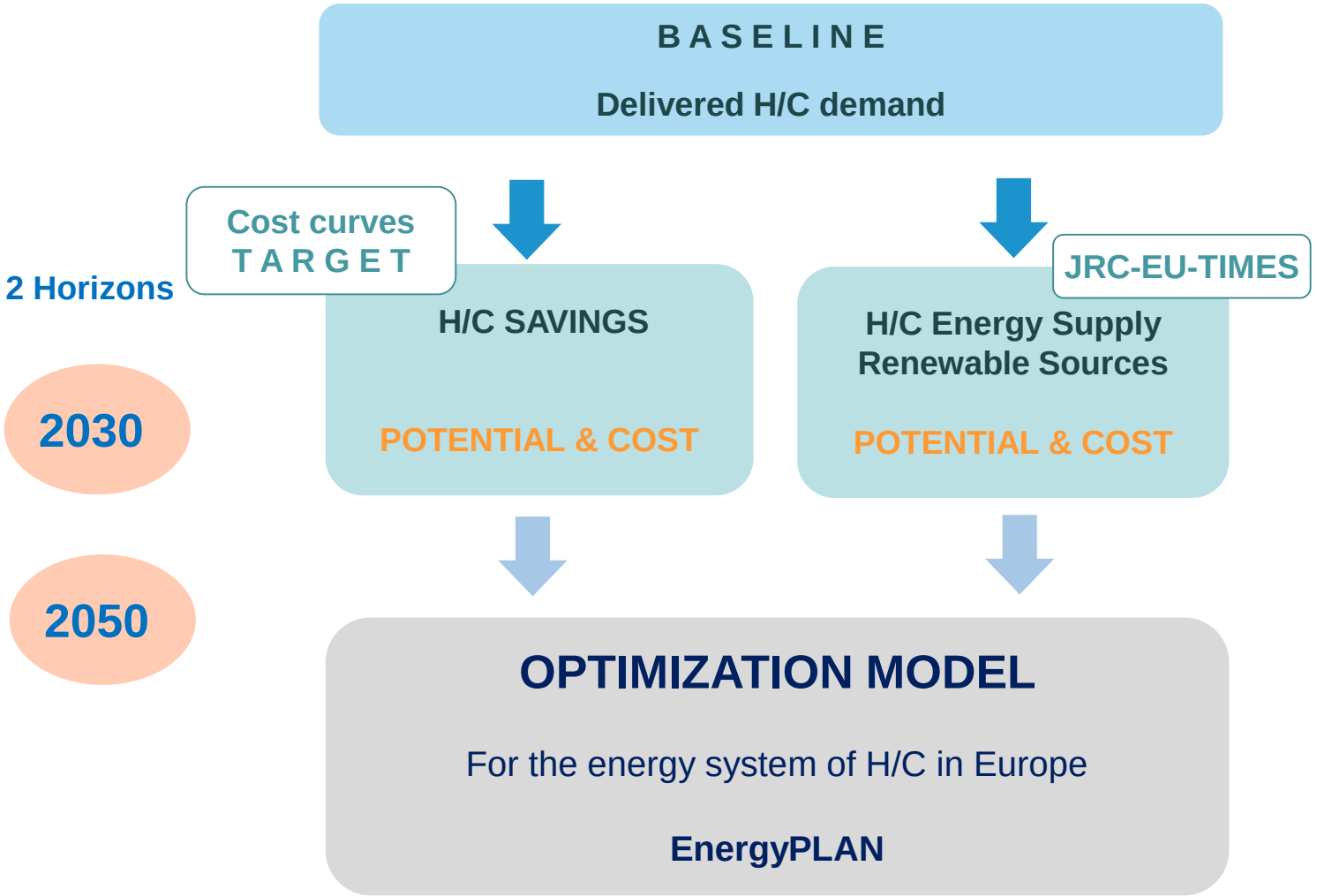
	EU leg.	Interpretation for baseline scenario
Regulations / Information		
Energy efficiency standards for renovation	EPBD	National building code requirements 2015 or planned tightening as far as data is available. Compliance below 100 %. If no codes are effective: standards similar to new buildings with a certain time lag.
Energy efficiency standards new buildings	EPBD	National building code requirements 2015 or planned tightening as far as data is available. Compliance below 100 %.
Renovation rate	EED (indirectly)	Where applicable: continuation of past and current renovation rates by country
Financial policies and economic instruments		
Energy saving obligation	EED	Energy saving obligations of about 1-1.5 % per year, but national differences in exceptions and alternative systems
Energy and CO_2 taxation	ETD	Taxes varying by fuel and sector. Constant tax as relative share of energy price assumed
EU Emission allowances	ETD	CO_2 price: increase to 90 EUR/tCO_2-equ in 2050 Scope of EU ETS to remain as in phase 3
Subsidies for building renovation	National	Continuation of national subsidy programs

Abbreviations: EPBD: Energy Performance of Buildings Directive, EED: Energy Efficiency Directive, ETD: Emissions Trading Directive, National: National measures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

RESULTS

H/C demand **BASELINE** scenario



Heat Roadmap Europe 4

2 Horizons

2030

2050

H/C SAVINGS

POTENTIAL & COST

H/C Energy Supply
Renewable Sources

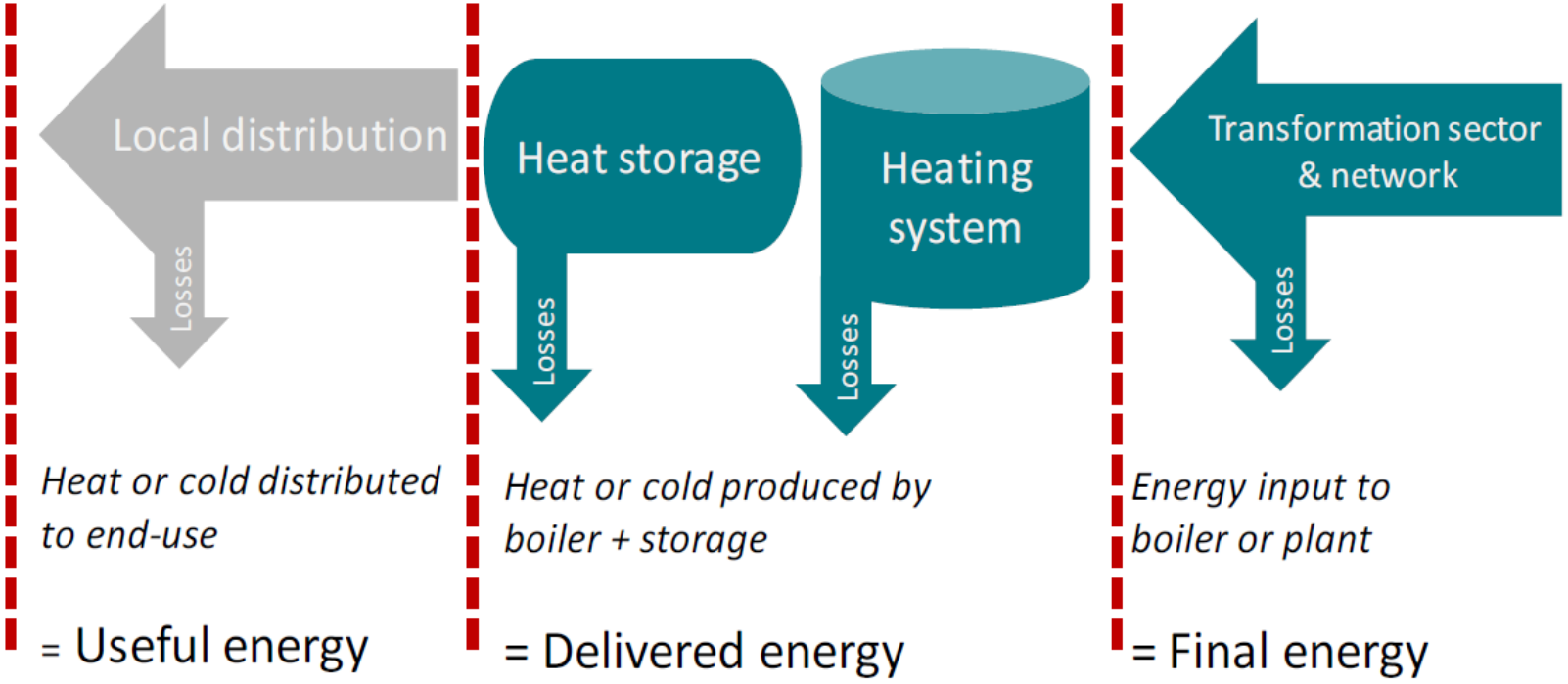
POTENTIAL & COST

OPTIMIZATION MODEL

For the energy system of H/C in Europe

Heat Roadmap Europe 4

Delivered Energy



➡ the choice of H/C supply technologies is excluded from this analysis.

Methodology

H/C demand **TARGET** scenario

Building Stock Data

- Surface
- Occupation
- Building Age
- Typology
- Elements lifetime
- Technologies and labor costs

Baseline

- Total savings baseline scenario
- Total cost baseline scenario

Target considerations

- Fixed percentages of extra savings: 5,10,15,20 and 25%
- Optimization to use the most cost-effective combination of measures for each target.

FORECAST

- Refurbishment measures by **building element**
- Choice of measure applied according with the **lifetime** of the building element and the associated **costs.**
- **Optimization inside the model**

TARGET SCENARIO

- Heat and Cooling **demand**
- **Total Cost of savings**

Results
cooling

Not included

- Free cooling options
- Feedback loop between insulating the building and changes on G values are not considered.

Overview

- **Context EU:** H/C demand share and final use.
- **Heat Roadmap Europe → HRE 4**

- H/C has the highest share in the total final energy demand (Approx 50%)