www.combi-project.eu

COMBI
Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe

Multiple impacts of energy efficiency: approaches, results and insights from the COMBI project

Wuppertal Institut

Johannes Thema, Felix Suerkemper

20 September 2018

IEPPEC Energy Evaluation Academy

COMBI webinar

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649724.
This document reflects only the author's view. The Agency is not responsible for any information it contains.

Agenda

COMBI webinar / IEPPEC Energy Evaluation Academy

- Project background and objectives
- COMBI structure
- COMBI Input data: 21 EEI actions
- Multiple Impact modelling in COMBI
- Key results
- Policy recommendations
- Further research needs
- Live demonstration of the COMBI online tool: https://combi-project.eu/charts/

Project background & objectives

Quantification of multiple impacts of EE

Coordinated by Wuppertal Institut

- Quantification & monetization of multiple impacts
- By EU member state & 21 EEI actions
- Common framework scenarios: based on 21 energy efficiency improvement (EEI) actions
- Extended Cost-Benefit analysis

Air pollution	Resources	Social welfare	Macro economy	Energy system
air pollutants	material footprint	disposable income	employment/ GDP	energy system costs
health	abiotic/biotic	health	public budget	energy security
eco-system	energy/non-energy	productivity	Fossil fuel/ETS prices	
	unused extraction		Terms of Trade	

The University of Manchester · Wuppertal Institut · The University of Manchester · ABUD · Copenhagen Economics · CE · Universiteit Antwerpen

Funded by EU Horizon 2020 EE12 (GA 649724, approx 1M€)

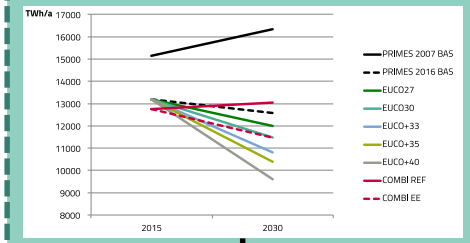
- March 2015 – May 2018

COMBI structure

user settings

Input data

COMBI stock models
→ BAS & EE scenario



- 2030 additional energy savings (1647 TWh)
- additional energy cost savings (225 bn €)
- total investment costs

additional data: stocks, scenario levels etc.

Impacts modelling

Dedicated models

Impact category	models
air pollution (health, eco-systems)	GAINS
resources	MIPS/Lifecycle assessment
health (indoor air quality) productivity	Socio-economic COMBI-model
economy (short/long-term)	Input-Output CGE (CECEM)
energy system energy security	COMBI energy balance model

COMBI online tool

- Physical impacts
- Monetary impacts
- Cost-Benefit calculations

D2.2 EEI action description (+ Annex on scenarios)

D#.1 Literature reviews

D#.4 Quantification reports

D2.1 Synthesis lit. review

D2.4 Synthesis methodology

D2.7 Quantification report

D8.1 Tool manual & document.

D8.2 Policy report

D8.3 Summary brochure

COMBI Input data 1

21 EEI actions

Difference to PRIMES/EED-IA:

- disaggregated stock analysis model → bottom-up development of scenarios
- not complete energy system (excl. agric., only selected EEI actions, excl. supply sector)
- Multiple data sources: mostly EU stats & projects (ENTRANZE, PRIMES, FHG ISI, ECOFYS)

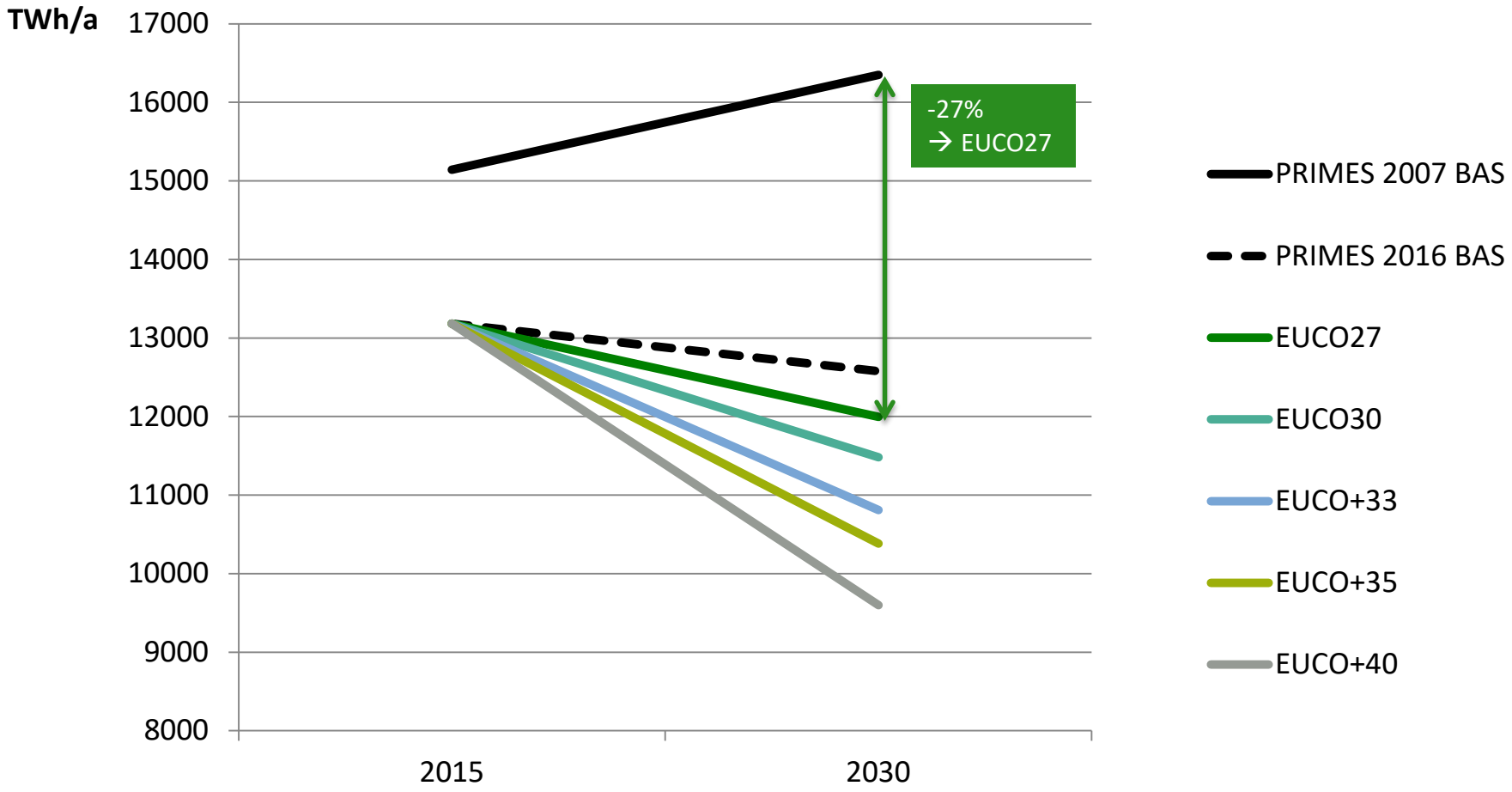
Buildings (residential & tertiary)	Transport	Industry
Actions 1 (residential) **and 5** (non-residential): **refurbishment** of building shell + replacement of building systems (space heating, cooling and ventilation) **Actions 2** (residential) **and 6** (non-residential): energy efficiency improvements of **new dwellings** or buildings, focusing on Passive House standards; **Actions 3** (residential) **and 7** (non-residential): energy efficiency improvements for **lighting** systems; **Actions 4** (residential) **and 8** (non-residential): energy efficiency improvements of **cold appliances** (residential) or product cooling (non-residential).	**Actions 9 and 12: modal shifts** for both passenger and freight transport; **Action 10**: energy efficiency improvements of motorized **two-wheelers**; **Action 11**: energy efficiency improvements of passenger **cars**; **Action 13**: energy efficiency improvements of **public road** transport, i.e. bus or coach; **Action 14**: efficiency improvements of **light duty trucks** (LDTs); **Action 15**: efficiency improvements of **heavy duty trucks** (HDTs).	**Action 16**: energy efficiency improvements of **high temperature process heating** (furnaces, ovens, kilns, dryers, …) **Action 17**: energy efficiency improvements of **low and medium temperature process heating** (boilers and steam systems in general); **Action 18**: energy efficiency improvements of industrial **process cooling and refrigeration**; **Action 19**: energy efficiency improvements of **process specific use of electricity**, mainly electrochemical processes in non ferrous metals and chemicals; **Action 20**: energy efficiency improvements of **motor drive systems**, including pumps, compressed air for utilities, compressed gas/air systems for processes; fans and blowers, and other motor applications; **Action 21**: energy efficiency improvements of heating, ventilation and air-conditioning (**HVAC**) systems in industrial buildings.

→ Outputs by EEI action and country:

- 2030 energy savings (EU total: 1647 TWh)
- energy cost savings (EU total: 131 bn €)
- total investment costs (EU total: 95 bn€ annualised)
- additional data: stocks, scenario levels etc.

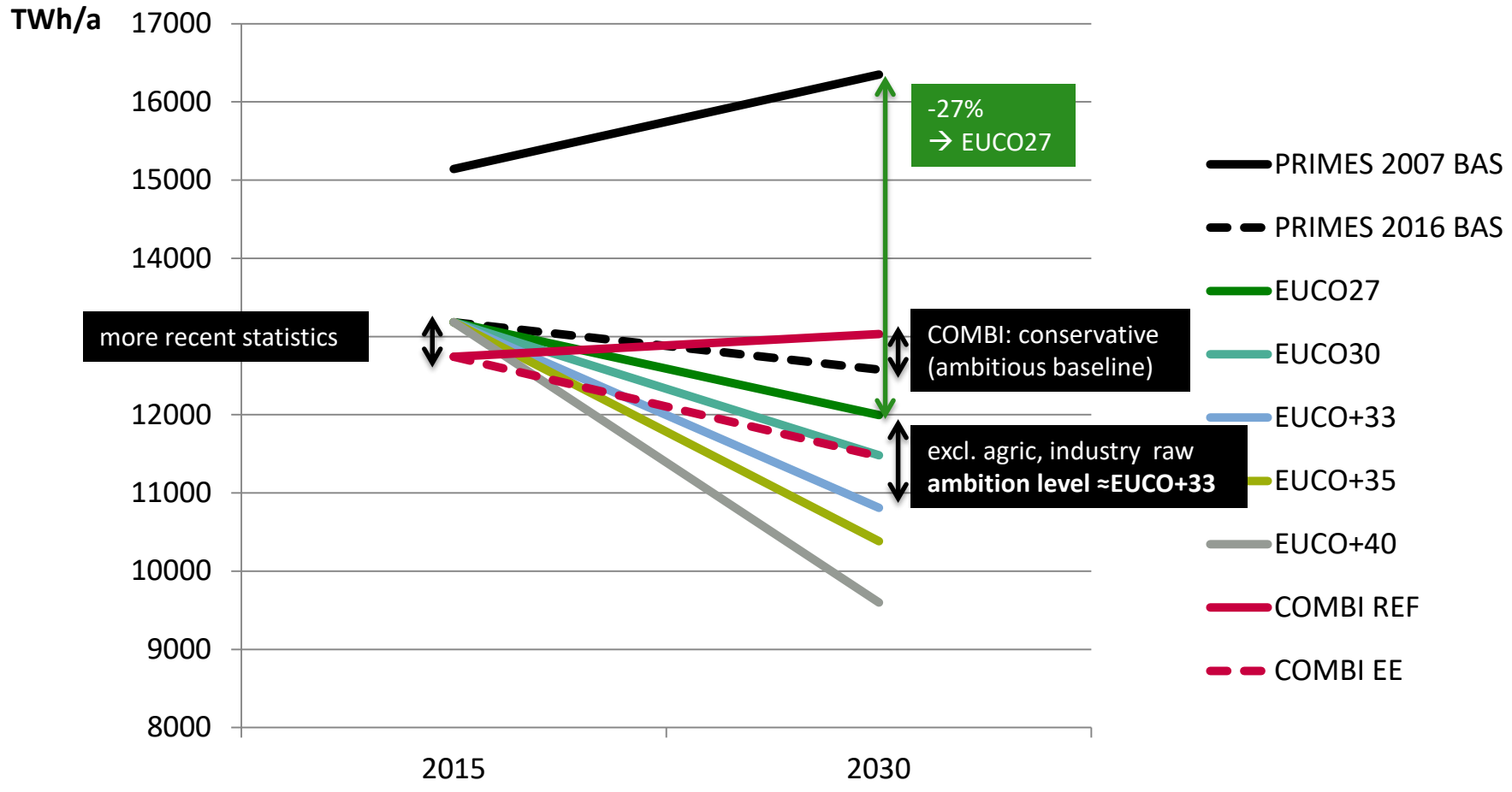
COMBI input data 2

Comparison of COMBI and EED IA (PRIMES 2016) scenarios



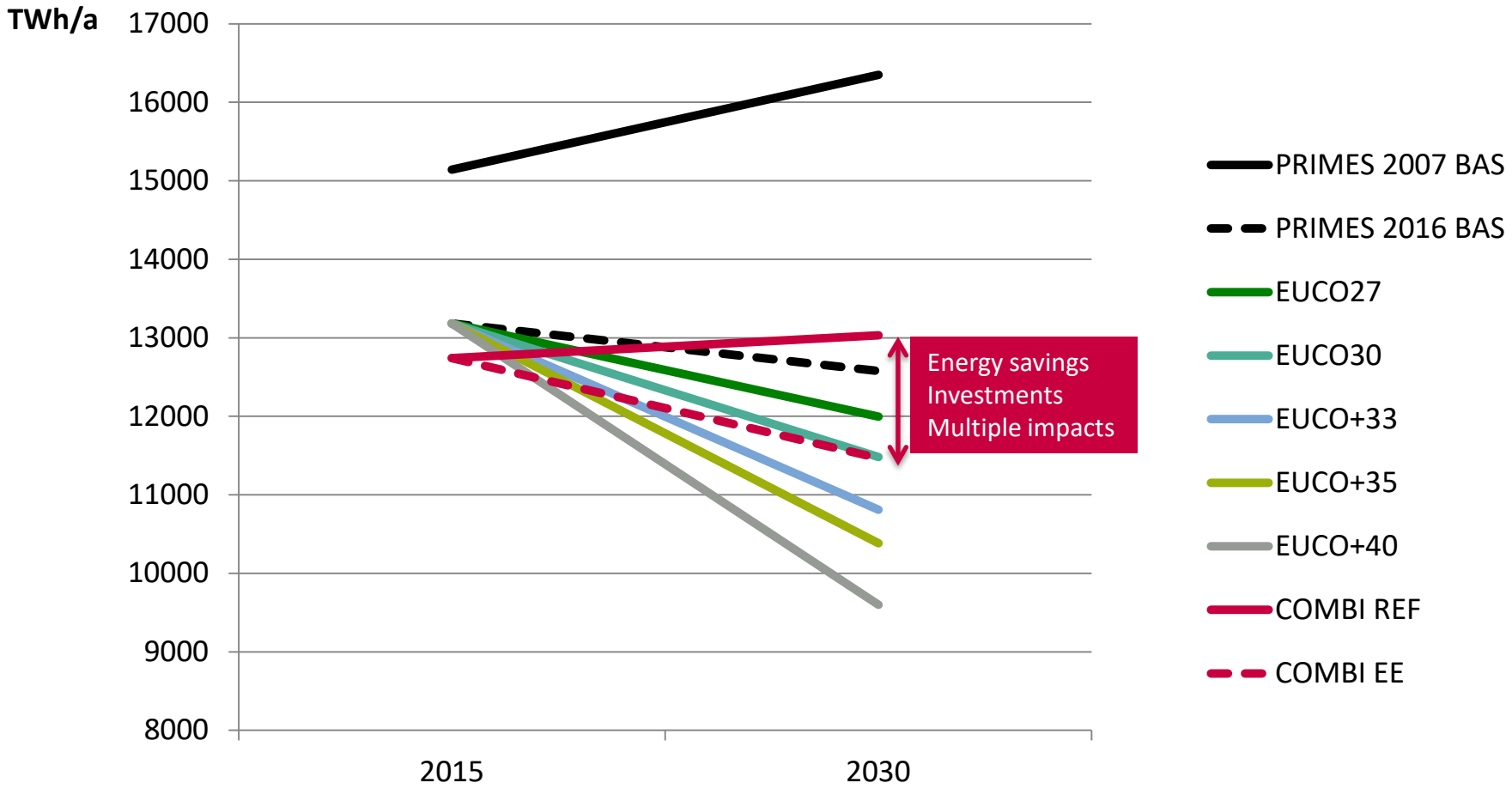
COMBI input data 2

Comparison of COMBI and EED IA (PRIMES 2016) scenarios



COMBI quantifications

Additional savings and impacts



Multiple impact modelling

Overview

Input data

- energy savings

additional data: stocks, scenario levels etc.

- investment costs

Impacts modelling

Impact category	Modelling approach	Impacts covered (additional savings)
Air pollution	GAINS model (IIASA)	Air pollutants (NOx, PM10, PM2.5, SO2, VOC) Affected ecosystem area (acidification, eutrophication) Human health (through air pollution)
Resources	Life-Cycle modelling (Material Input per service unit/MIPS)	Ecological footprint (Biotic materials, fossil fuels, metal ores, minerals, unused extraction)
Social welfare	Socio-economic modelling	Health from indoor pollution Health from building conditions (asthma, excess winter deaths) Labour productivity (residential/tertiary buildings, transport)
Economy	Short-term: Input-Output modelling	Employment GDP Public budget
Economy	Long-term: CGE modelling	Fossil fuel prices EUA prices Structural effects
Energy system	LEAP modelling	Avoided combustion/investment in combustion plants De-rated capacity margin
Energy security	LEAP modelling	Energy intensity Fossil fuel imports Energy security index

COMBI online tool

COMBI key results

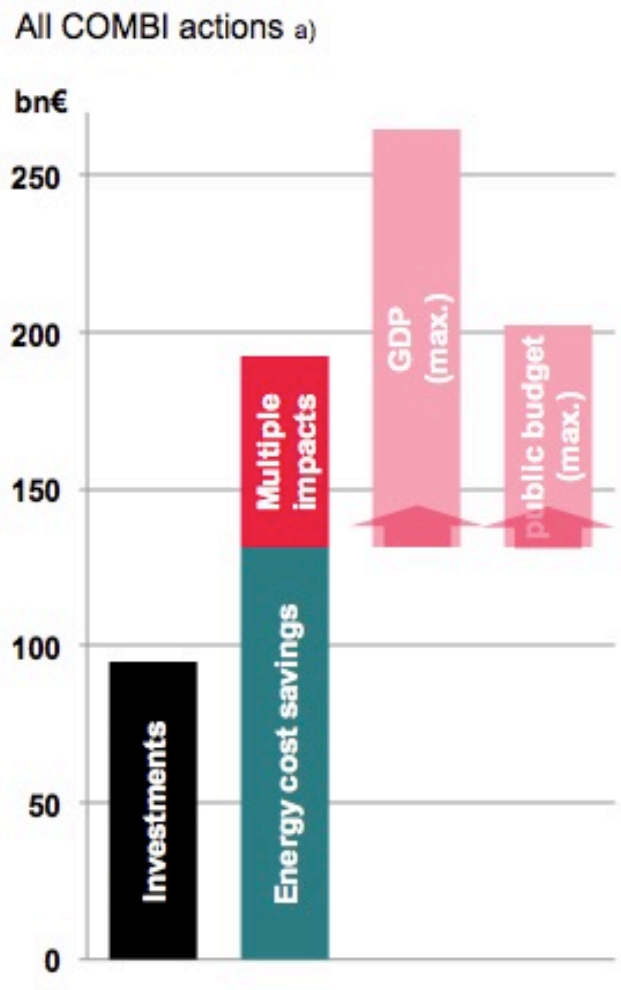
additional

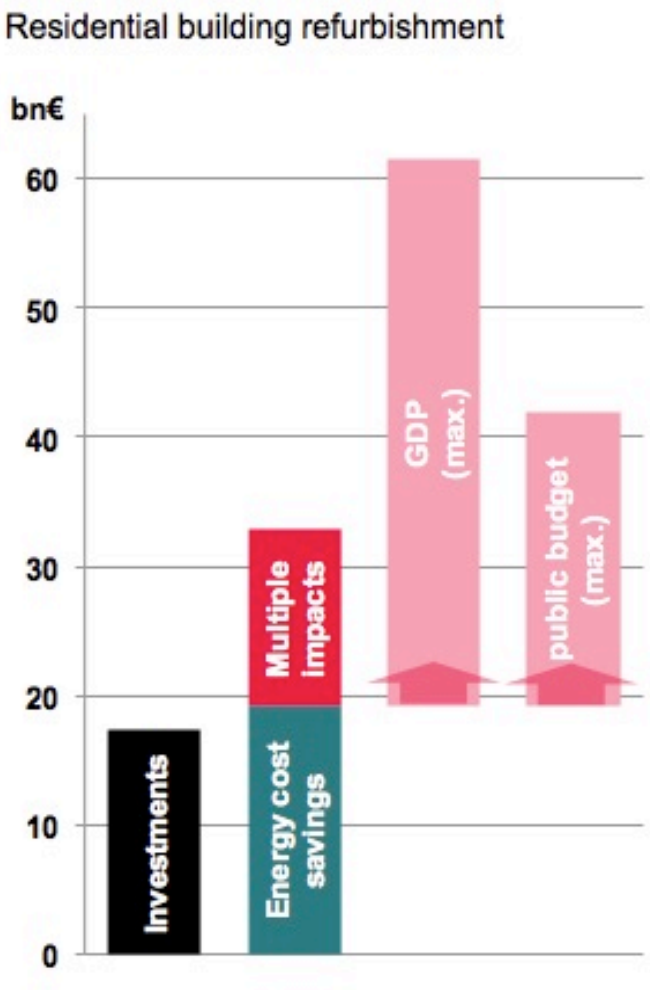
Annualized investment in 2015-2030: 94.6 bn EUR/year
Energy savings: 1647 TWh/year
Avoided climate change emissions: 360–500 Mt CO_2eq

Air pollution	Resources	Social welfare	Economy	Energy system
>10,000 avoided premature deaths due to PM2.5 (460 mn €) and 442 due to O3 (46 mn €) 230,000 YOLLs of avoided life expectancy loss (26 bn €) 300Mt avoided direct CO2eq emissions (17 bn €)	850 Mt savings of material resources	3,000-24,000 avoided premature deaths due to indoor cold (323 mn €-2.5 bn €) 2,700-22,300 avoided DALYs due to indoor dampness related asthma (338 mn €-2.9 bn €) 39mn additional workdays (4.7 bn €)	1% rise in GDP (+161 bn € in GDP) 2.3 mn job-years +86 bn € for public budgets Decrease in fossil fuel prices (1.3% oil, -2% coal, -2.9% gas)	Avoided generation of power from combustibles 257 TWh (11 bn € of avoided investment) Improved energy security up to 5% lower fossil fuel import costs (48 bn €)
WP3 report	WP4 report	WP5 / WP5a report	WP6 report	WP7 report

COMBI key results

Investments, energy cost savings and multiple impacts (bn€ annual in 2030)





[a] all EEI actions except modal shifts which cannot be included to CBA due to no availability of infrastructure investment costs and trucks due to unreliability of out-dated investment costs

COMBI key policy recommendations

EE is a case not only for GHG Mitigation but also for human health, environment, agriculture, economy, public budgets

- Key for policy makers to consider the various (positive and negative) MIs
- Cost-effectiveness of EEI actions: improves substantially from a societal perspective when including MIs (→ omission of MIs leads to an underinvestment in energy efficiency from a societal perspective)

→ **Reliable quantifications**: can support policy makers in selecting those instruments and targets that maximize social welfare

→ **Quantified MI values**: beneficial for their communication and promotion to decision-makers, stakeholders and the general public

→ **Key to involve respective policy departments**: convergence of interest, inter-departmental and cross-sectoral cooperation in policy making to pursue common goals

COMBI

Further research needs

Caveats & interpretation

- **COMBI caveats**
  - sectoral & EEI action coverage
  - many impacts could not/not comprehensively be estimated
  - quantification techniques: model improvements & Integrated Assessment (for feedback loops, overlaps & interactions)
  - impact values level-dependent (non-linear) → applicable only for COMBI scenarios
- **Knowledge base issues**
  - more data & research needed
  - Evolving: BAS/EE/BAT technologies → Continuous model improvements necessary
- **Impact aggregation issues: inclusion to CBA**
  - double counting
  - non-monetary impacts

→ combi-project.eu/tool/

COMBI

Access to project results

COMBI online tool

User mode: Standard | Expert

Calculation: per capita | per GDP | Total

sensitivity: energy prices, discount rates, impact selection

1. Physical | 2. Monetary | 3. Cost-Benefit Analysis

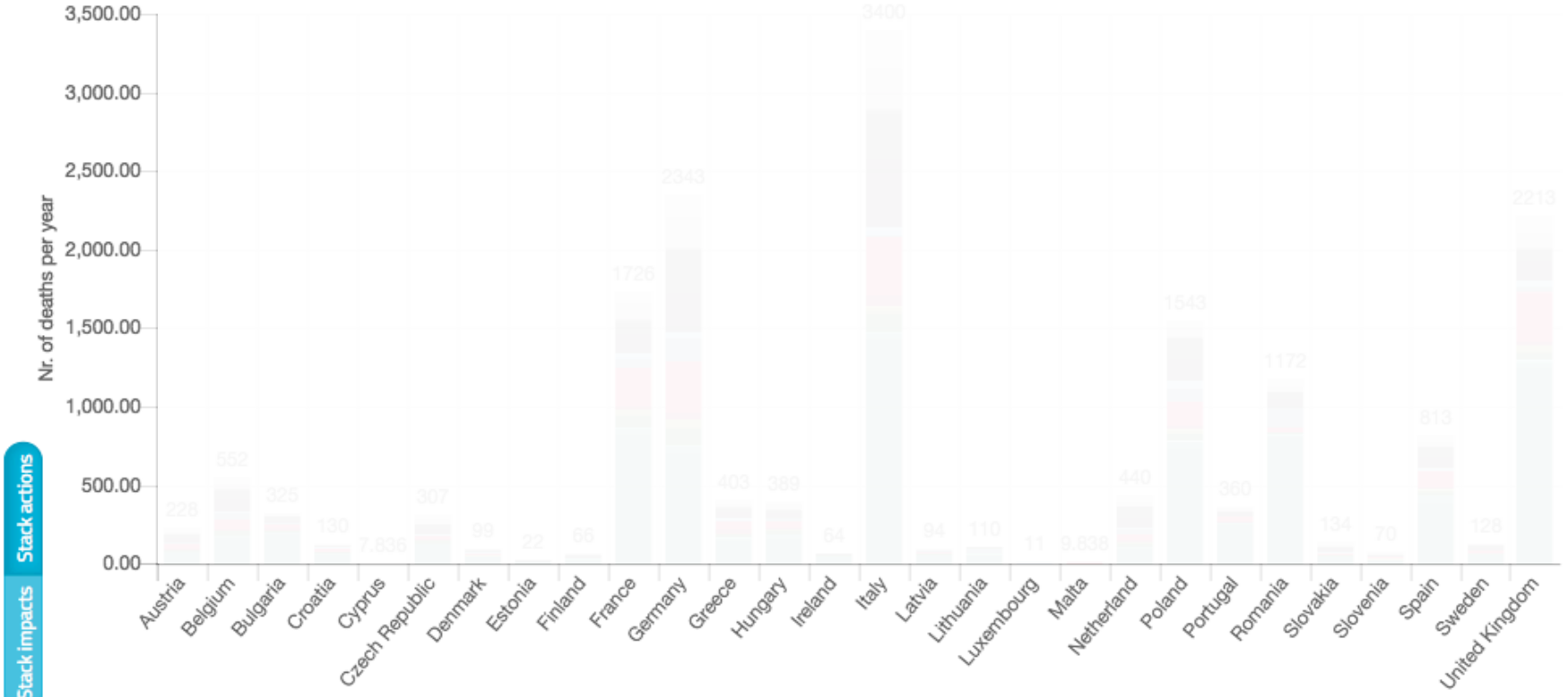
(select one) Impact | Countries | Actions

Avoided mortality (total)

Avoided mortality (nr. of deaths per year) due to lower levels of air pollution (ozone and PM2.5) and avoided excess winter mortality due to improved indoor conditions and lower health risks.

▶ Details on avoided excess winter mortality calculation

▶ Details on mortality from air pollution



Results: avoided mortality

Tool standard mode (pre-aggregated)

User mode: Standard | Expert

Calculation: per capita | per GDP | Total

1. Physical | 2. Monetary | 3. Cost-Benefit Analysis

(select one) Impact | Countries | Actions

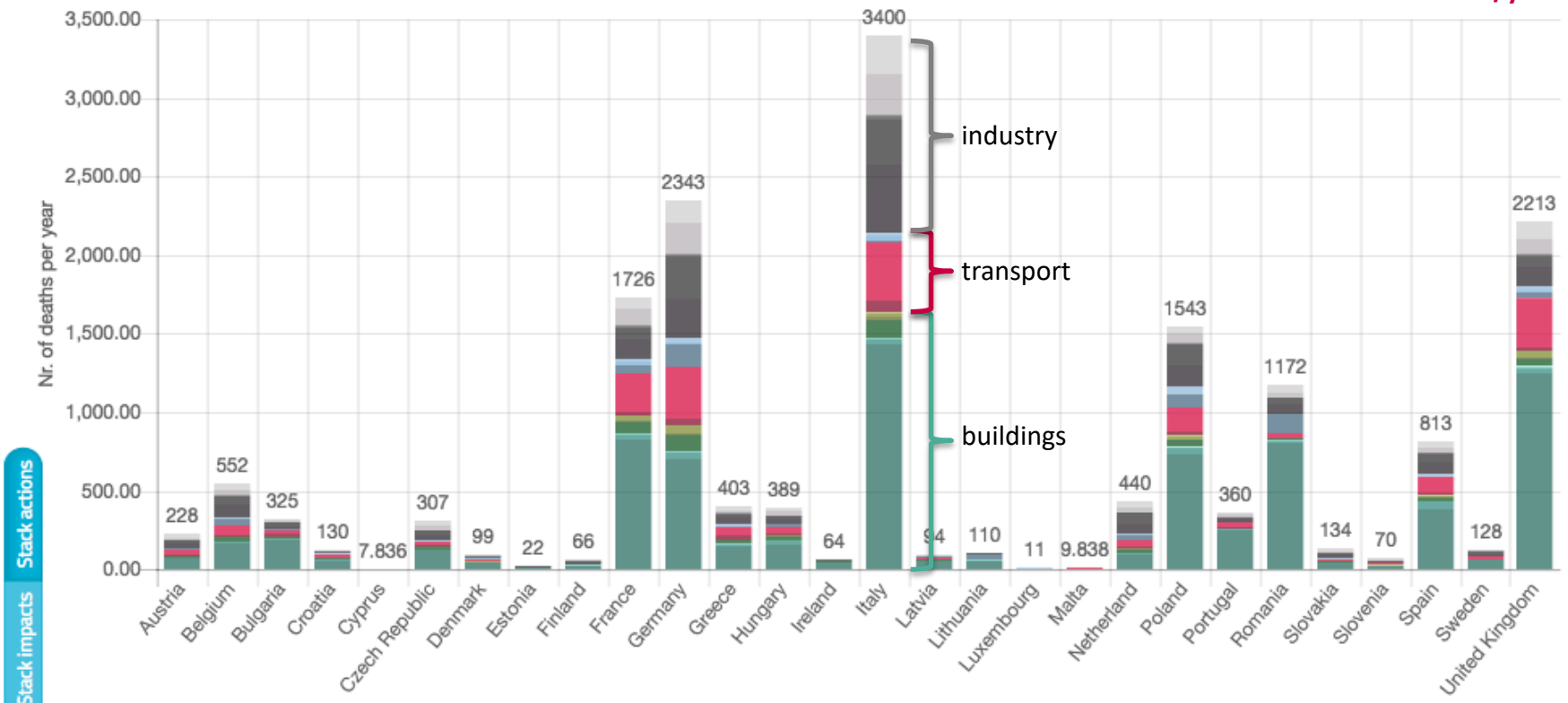
Avoided mortality (total)

Avoided mortality (nr. of deaths per year) due to lower levels of air pollution (ozone and PM2.5) and avoided excess winter mortality due to improved indoor conditions and lower health risks.

▶ Details on avoided excess winter mortality calculation

▶ Details on mortality from air pollution

→ **Total EU: 17k avoided deaths/year**



Stack actions | Stack impacts

Action | Country | Impact

Cost-Benefit Analysis

Marginal energy savings cost curve (excl./incl.* MIs)

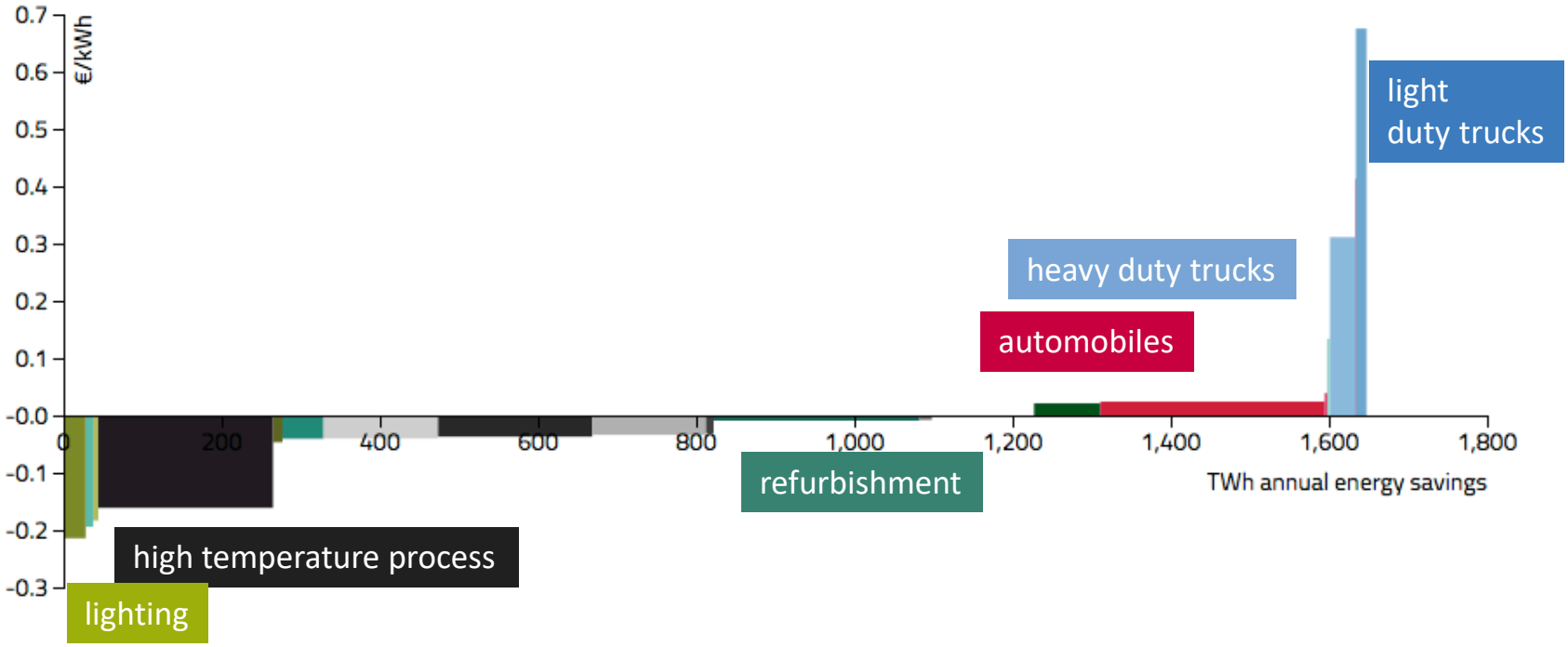
User mode	Standard	Expert	
Calculation	per capita	per GDP	Total
CBA mode	Life-Time	Annualised	
	Levelized	MCC	BCR	CBR
Energy prices	Low	Mid	High
Levelization by	Energy savings		
	GHG emissions		
Discount rate	3		

1. Physical | 2. Monetary | 3. Cost-Benefit Analysis

(select multiple) Impacts | Countries | Actions

Marginal energy savings cost curve (total)

Levelized cost of energy savings (based on selected impacts) by TWh annual energy savings in 2030. Positive values imply net costs, negative values net gains. Note: modal shift actions net value not possible to display as infrastructure investments not quantified in COMBI. Savings potential included with net value 0.



Action | Country

* MIs included for this display: avoided costs of combustibles generation, health & mortality from air pollution & building conditions, productivity, direct GHG emissions. Public budget effect excluded.

Cost-Benefit Analysis

Marginal energy savings cost curve (excl./incl.* MIs)

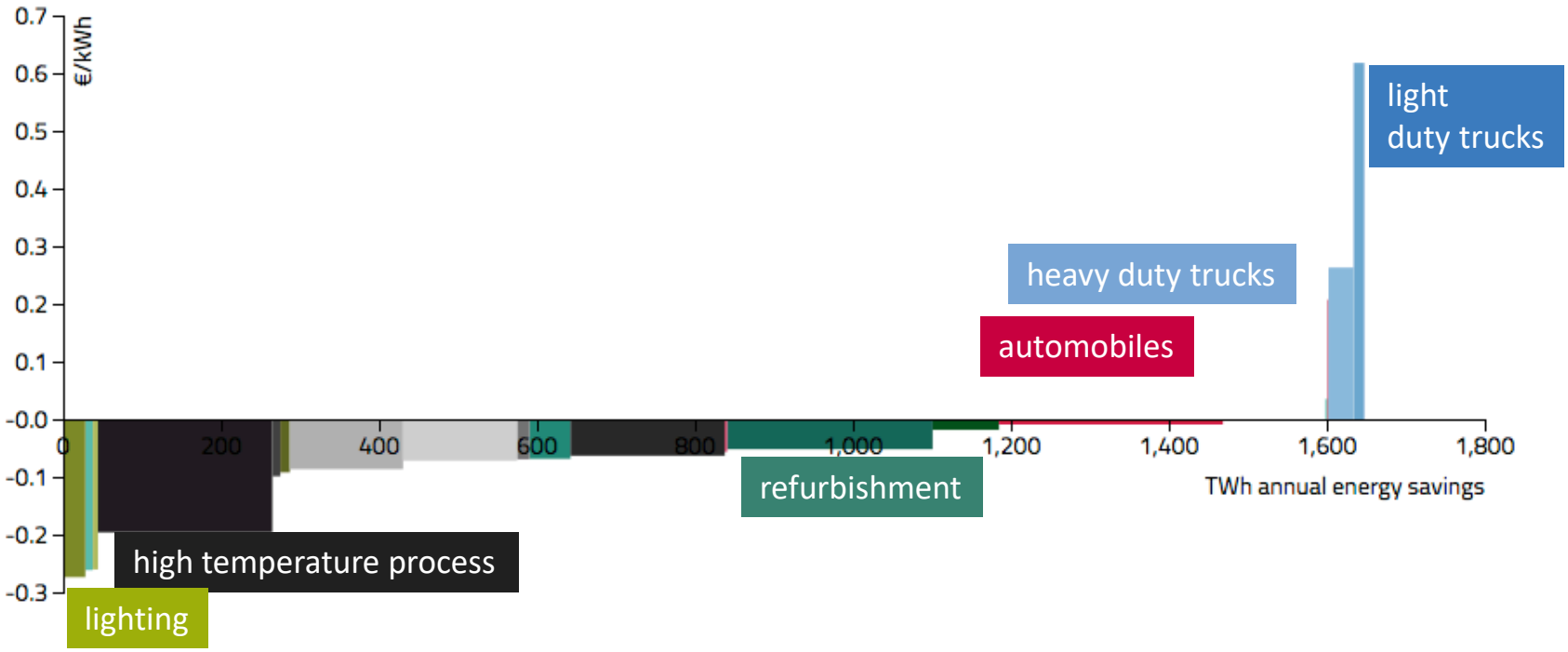
User mode	Standard	Expert	
Calculation	per capita	per GDP	Total
CBA mode	Life-Time	Annualised	
	Levelized	MCC	BCR	CBR
Energy prices	Low	Mid	High
Levelization by	Energy savings		
	GHG emissions		
Discount rate	3		

1. Physical | 2. Monetary | 3. Cost-Benefit Analysis

(select multiple) Impacts | Countries | Actions

Marginal energy savings cost curve (total)

Levelized cost of energy savings (based on selected impacts) by TWh annual energy savings in 2030. Positive values imply net costs, negative values net gains. Note: modal shift actions net value not possible to display as infrastructure investments not quantified in COMBI. Savings potential included with net value 0.



Action | Country

* MIs included for this display: avoided costs of combustibles generation, health & mortality from air pollution & building conditions, productivity, direct GHG emissions. Public budget effect excluded.

Thank you

Johannes Thema, Felix Suerkemper

johannes.thema@wupperinst.org

felix.suerkemper@wupperinst.org

Wuppertal Institute for Climate, Environment and Energy

Division: Energy, Climate and Transport Policy

COMBI
Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe

Wuppertal Institut

COMBI
Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe
online tool

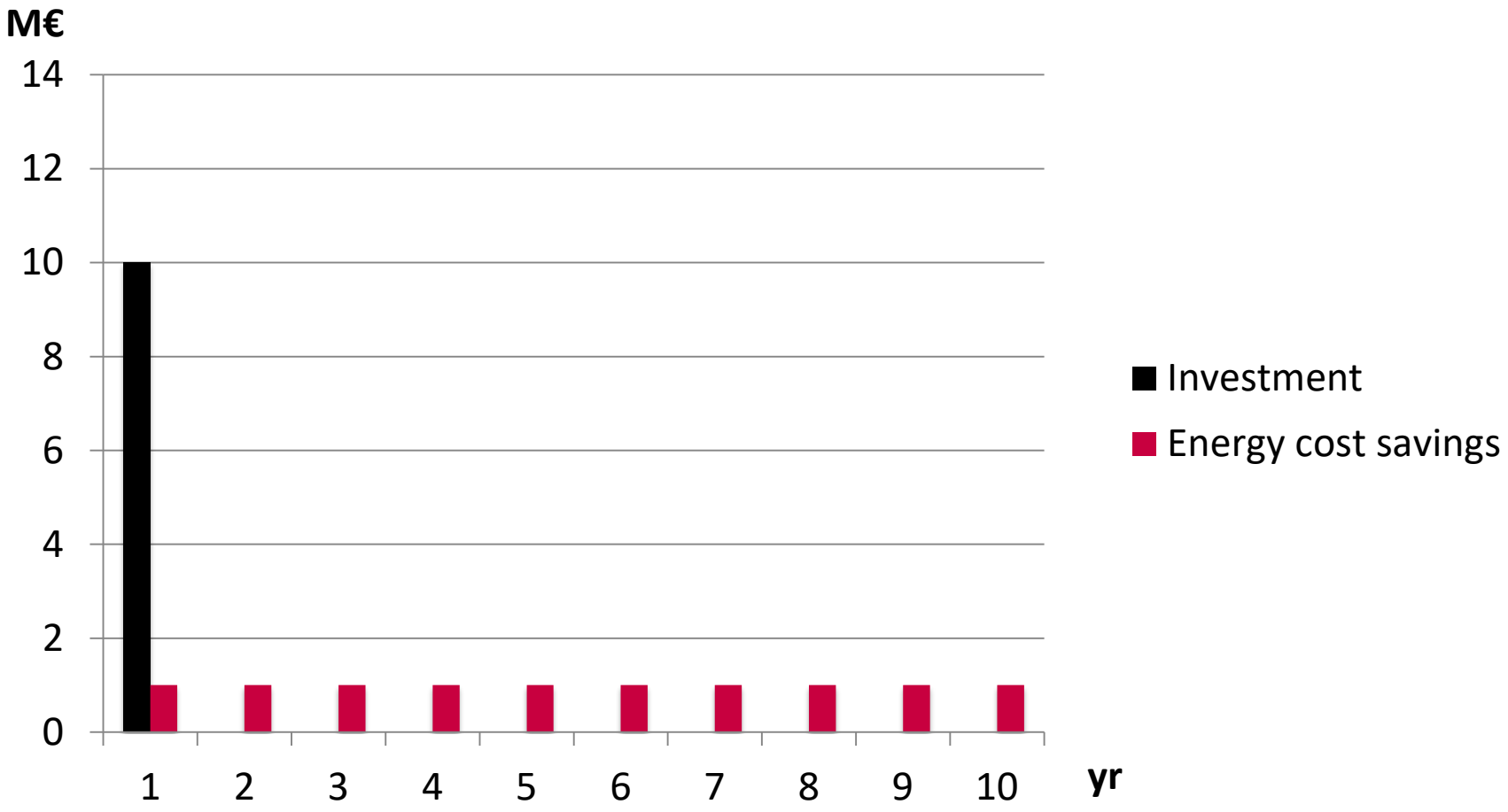
FOLLOW US!

Websites
http://combi-project.eu
www.wupperinst.org
On Twitter
@COMBI_project
@wupperinst

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649724.
This document reflects only the author's view. The Agency is not responsible for any information it contains.

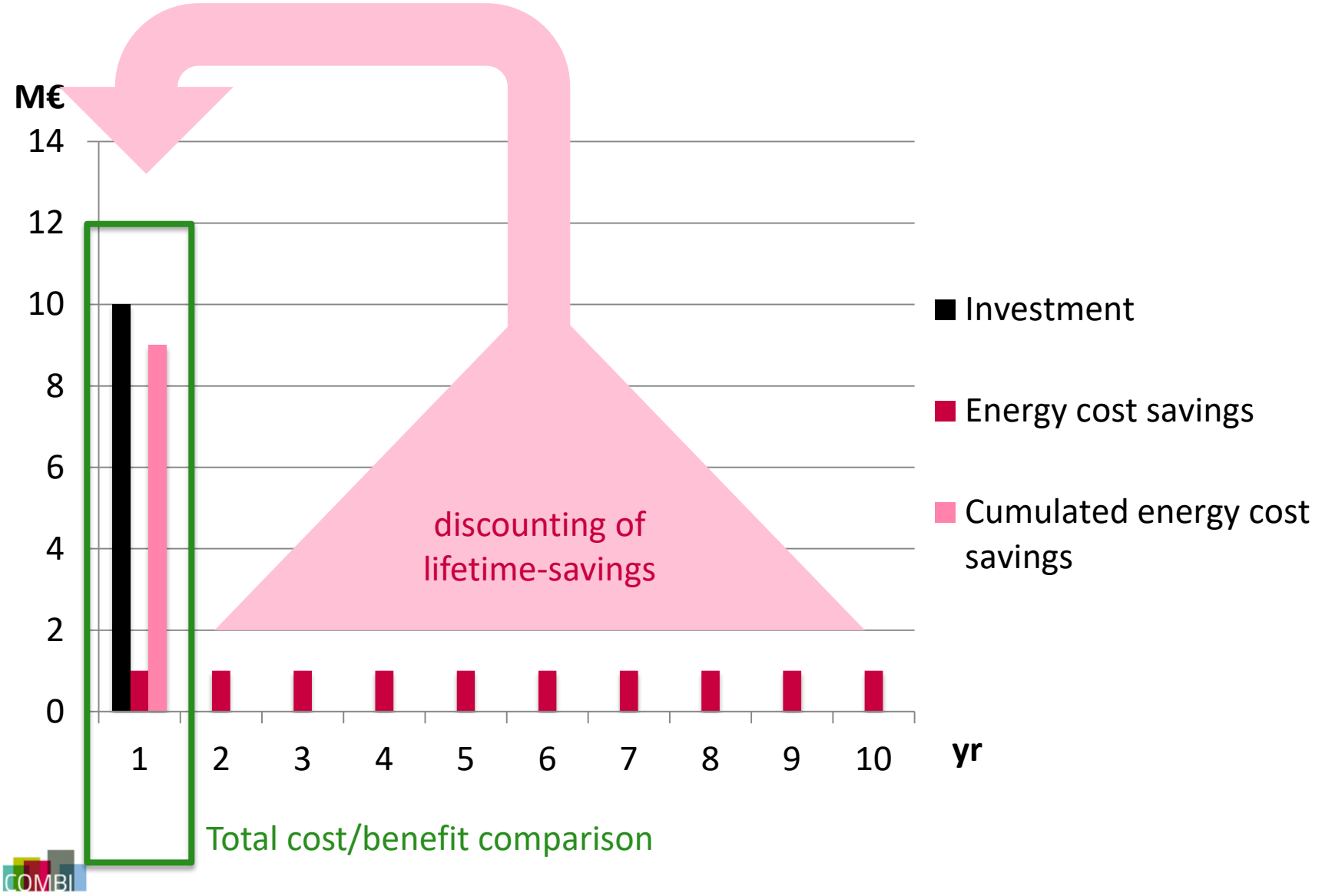
Traditional cost-benefit analysis

Example: CBA of total values



Traditional cost-benefit analysis

Example: CBA of total values



Expanded Cost-benefit analysis

CBA including Multiple Impacts of Energy Efficiency