Final BRISKEE Conference and eceee annual policy seminar
Wednesday, 29 November 2017, Brussels

Results from the techno-economic and macro-economic modelling

Michael Hartner (TU Wien), Rainer Walz and Mathias Pfaff (Fraunhofer ISI)

BRISKEE

Behavioural response to investment risks in energy efficiency

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 649875. This presentation only reflects the authors' views and EASME is not responsible for any use that may be made of the information it contains.

Meso Level – techno economic modelling of household´s investment in energy efficiency until 2030

Approach:

Analysis of survey results

Heating/thermal retrofitting | Appliances

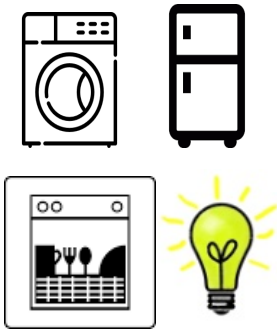
Implementation and sensitivity analysis on discount rates

Model Invert/EE-Lab | Model FORECAST

Scenario definition and quantification

Current policy | Intensified measures | Actor related measures

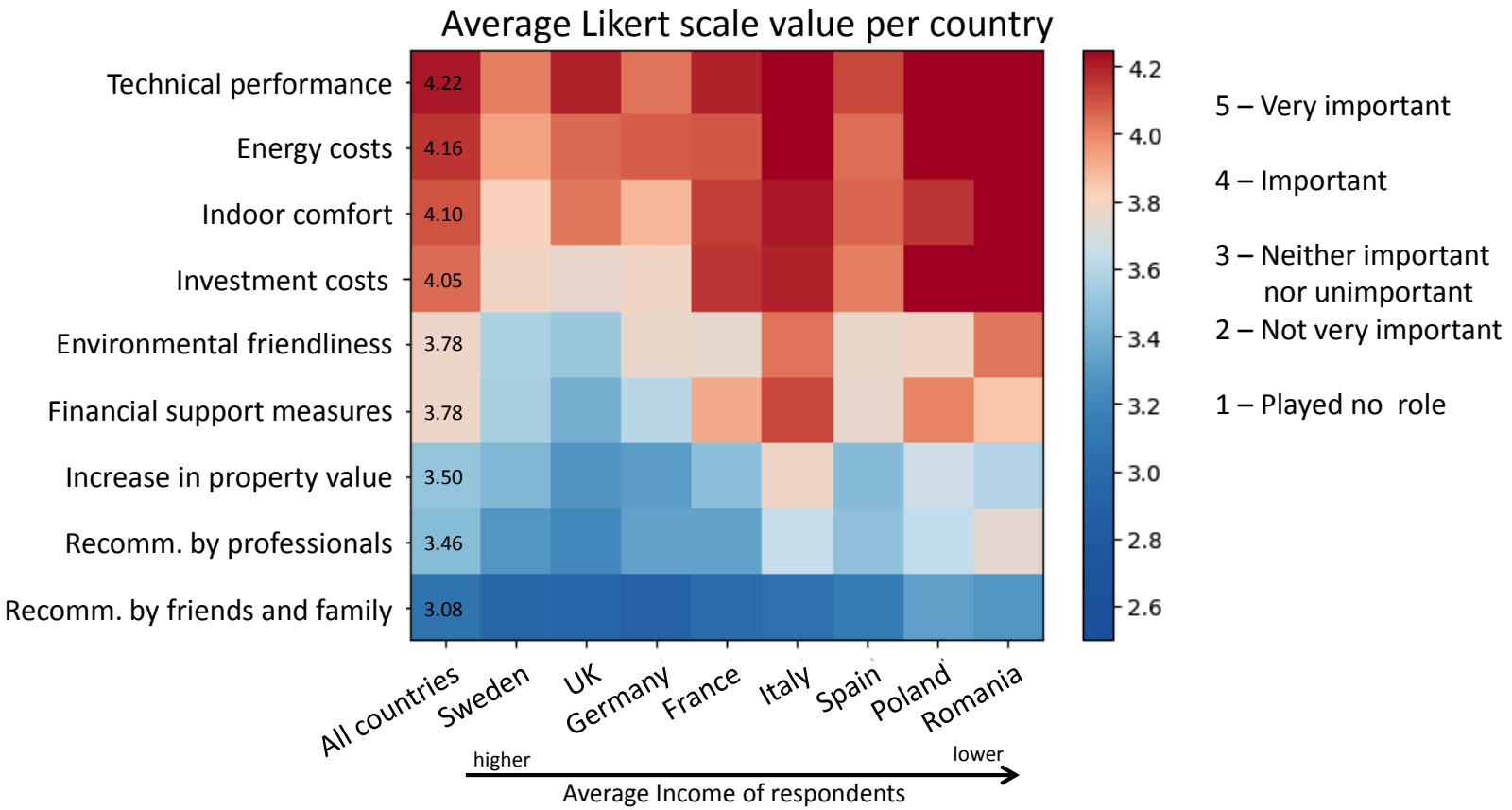
Results analysis – investments and spendings for macro models



RESULTS FOR HEATING AND THERMAL RETROFITTING

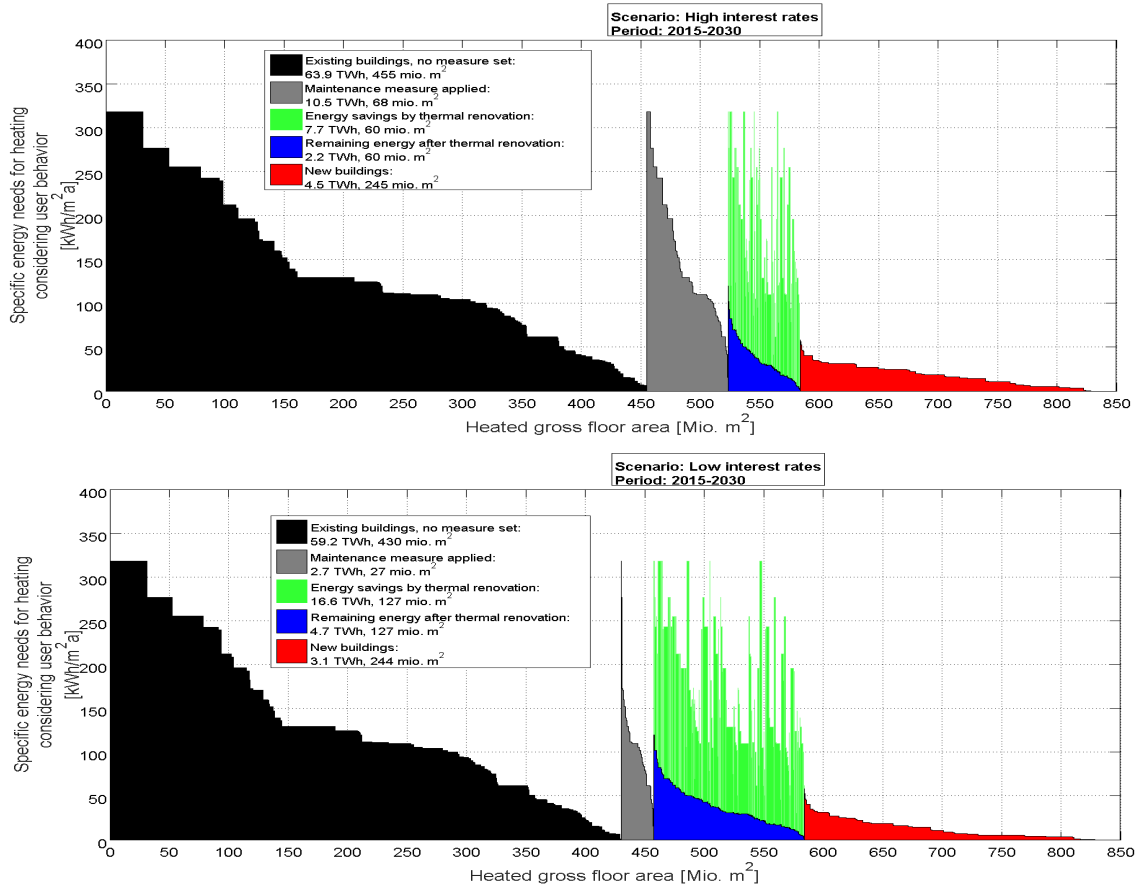
Model used: Invert/EE-Lab (www.invert.at)

What matters for investments in heating systems and thermal refurbishment



Heating – impact of discount rates on thermal renovation – example Belgium

- Discount rates have a significant impact on modelling results
- Difference in final energy demand in 2030 is between 5% and 15% between low discounts rates of 2% versus a 20% discount rate scenario
- Lowering discount rates can significantly increase thermal renovation activities
- But impact is limited by investment cycles and other policies (e.g. standards)

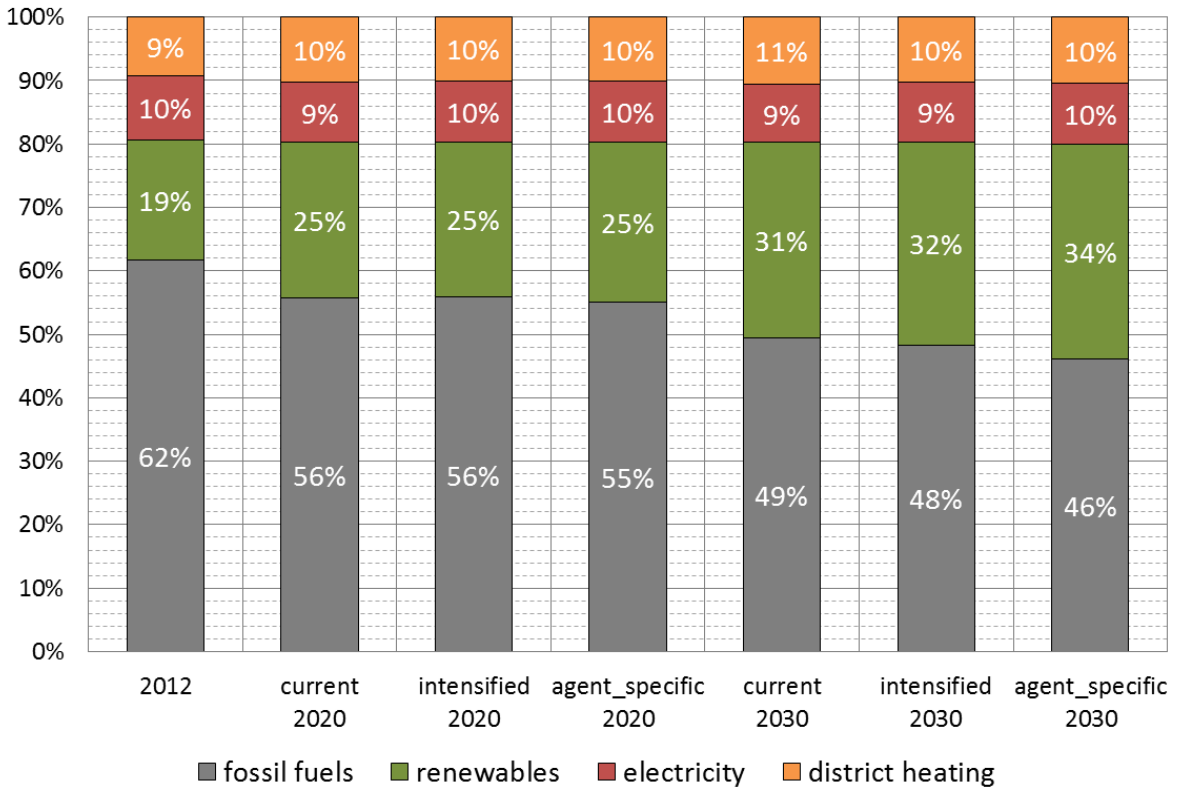


Scenarios for heating and cooling in BRISKEE

Scenario name	Explanation
1) Current-policy scenario	**Policies which have been decided or already implemented.** - Renewable Energy Directive - Energy Efficiency Directive, - Directive on Energy Performance of buildings - Ecodesign Directive - National policies (Mure Database
2) Intensified-measures	**National policy approaches are the same but intensified** - Higher subsidies for renewable heating systems and retrofitting - Higher standards for thermal performance of buildings
3) Actor-related measures	**Policy measures affecting the discount rate of low income agents** - Discount rates of low income agents are reduced to the level of median income - reduction of discount rates between 2% and 5%

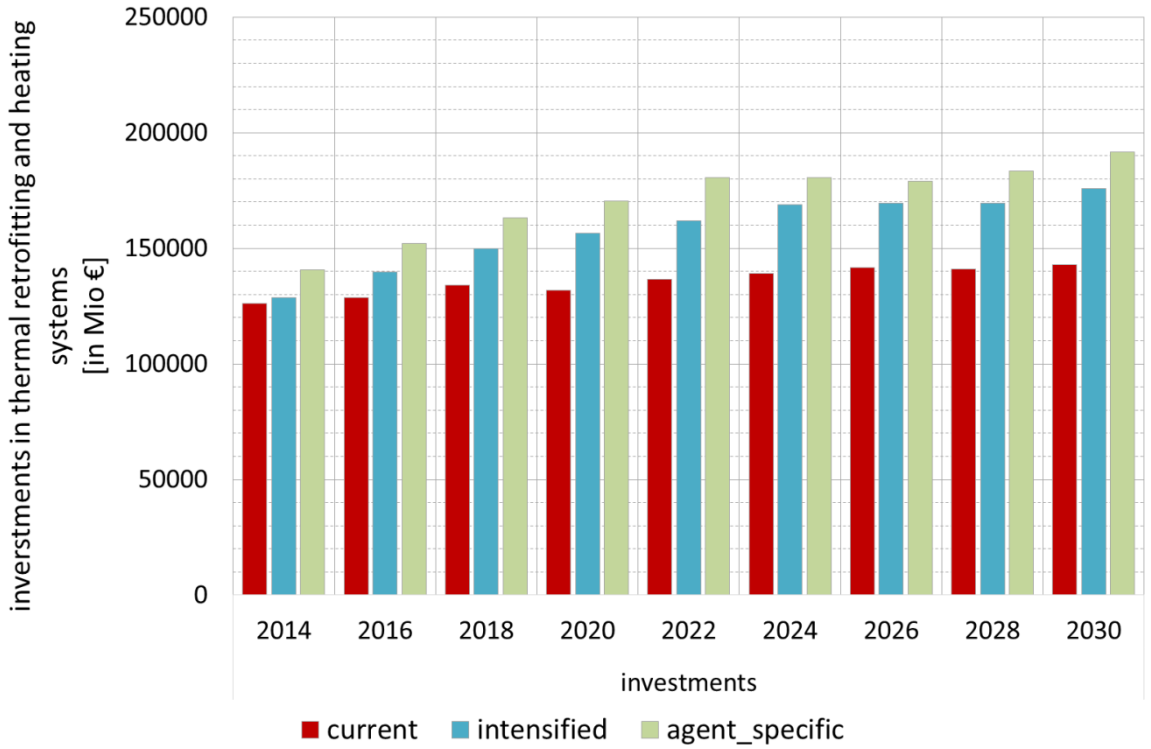
Heating and Cooling – Final energy demand for EU28 in 3 scenarios

- Final energy demand is expected to decrease in all 3 scenarios (17% in Current policy scenario) - reductions of space heating demand
- Intensified-measures lead to -22% reduction of final energy demand compared to 2012, actor related scenario: -23%
- Also the share of renewables increase - 34% compared to 32% in intensified-measures scenario (heat pumps and solar thermal), still high shares of natural gas



Heating and Cooling – Investments for EU28 in 3 scenarios

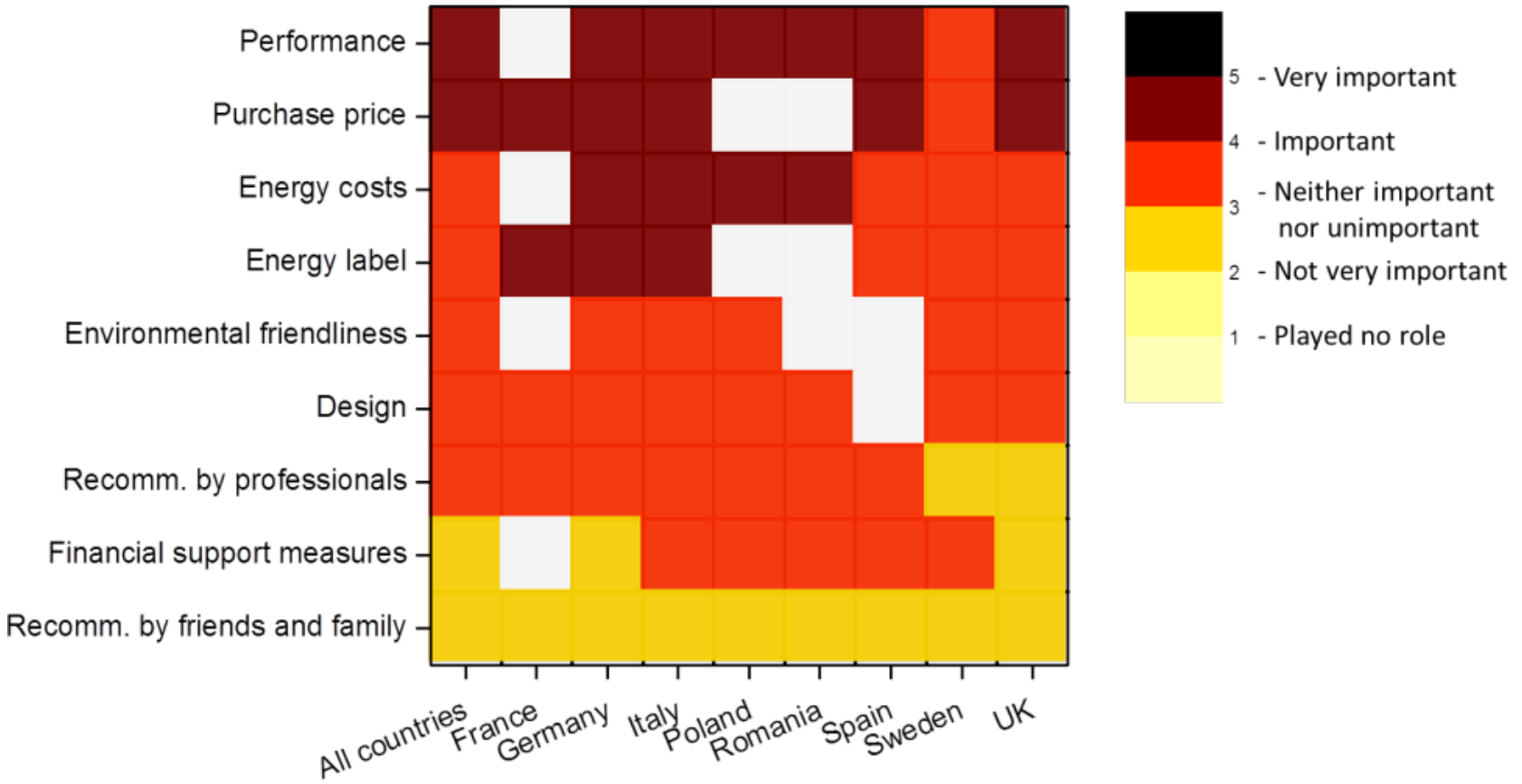
- Significantly more investments in thermal retrofitting and heating systems when low interest rates are assumed for low income households. (+9% more than in the intensified scenario)
- Annual expenditures on energy carriers decrease by -18.6% in the intensified vs. -21.6% in the actor related scenario compared to base year 2012



RESULTS FOR APPLIANCES

Model used: FORECAST (www.forecast.eu)

What matters for investments in appliances according to the BRISKEE survey

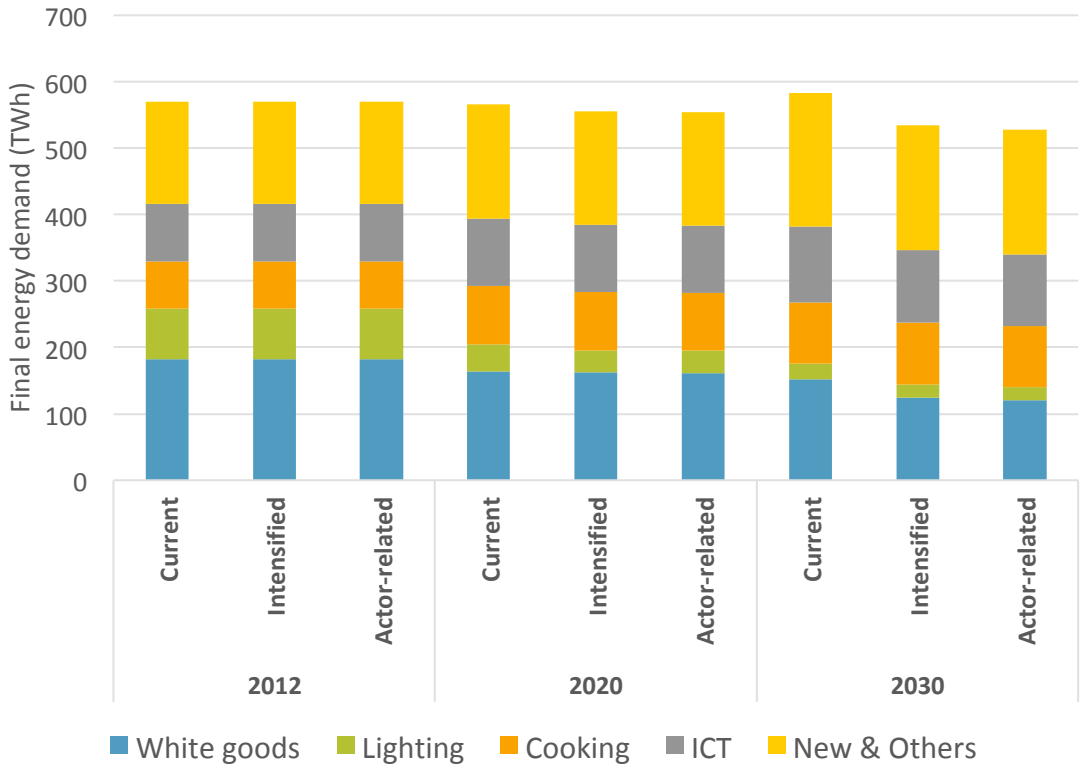


Scenarios for appliances in BRISKEE

Scenario name	Explanation
1) Current-policy scenario	**Policies which have been decided or already implemented.** - Ecodesign Directive - Additional national labelling measures - Adopted for refrigerators, , dishwashers, stoves and lighting individually - Average efficiencies for TV, desktop computers, AC
2) Intensified-measures	**National policy approaches are the same but intensified** - Higher minimum standards - Labels are rescaled - More efficient devices are available earlier
3) Actor-related measures	**Policy measures affecting the discount rate of agents** - Lower discount rate (from 20% to 2%) - Environmentally concious consumer group introduced - Subsidies for very efficient appliances (important for low income according to survey)

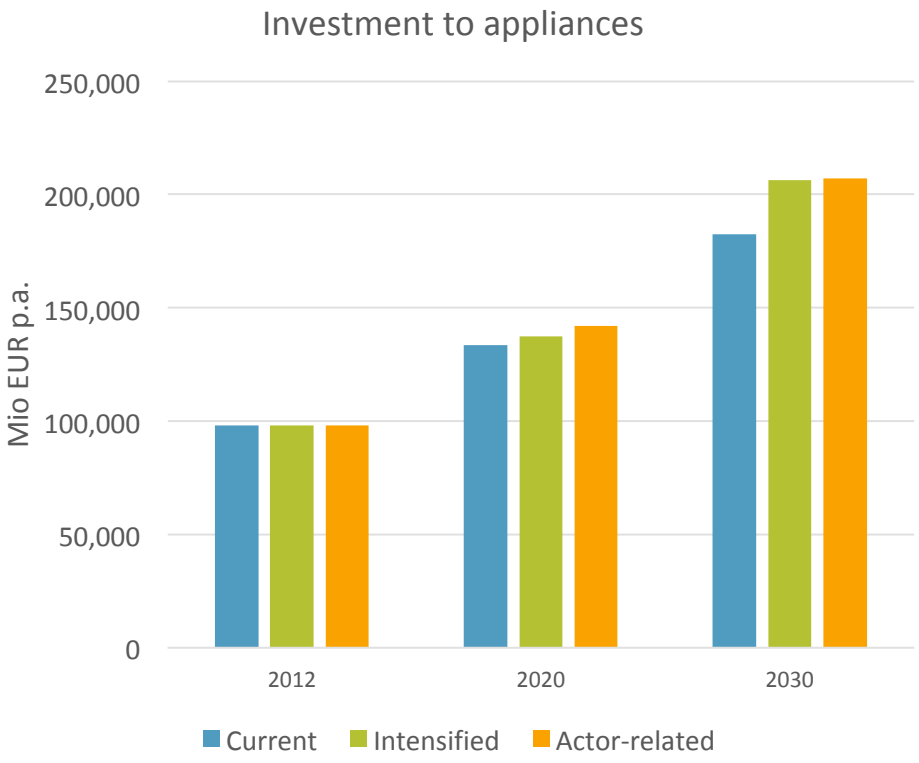
Appliances - Final energy demand for EU-28 in 3 scenarios

- Slight increase in final energy demand in current policy scenario
- Significant decrease in the intensified policy scenario in particular for energy consumption of white goods
- Actor related measures for low income agents only lead to small effects



Appliances - Investment for EU-28 in 3 scenarios

- Investments increase in all scenarios, for intensified and actor related scenario more than doubled
- More appliances are purchased per household compared to base year in particular in currently low income countries
- More energy efficient appliances are expected to be significantly more expensive – also an explanation for less effect of monetary actor related measures
- Energy expenditures are expected to decrease by -10% compared to the current policy scenario



Summary and key findings I

- It is crucial to **include non-monetary decision criteria** to model investments in energy efficiency measures and **consider the technical lifetime of buildings and heating systems** for scenarios on heat demand
- The meaning and effect of **implicit discount rates depend on the implemented decision algorithm** which vary substantially across models
- In total **final energy demand** of the residential sector **is expected to decrease** until 2030 for all calculated scenarios. -6% in the intensified and -8% in the actor-related scenario – mainly triggered through reductions of space heating demand
- **Shares of renewables in heating and cooling** increase significantly in scenarios with lower discount rates. In particular the deployment of **solar thermal systems and heat pumps increases.** Natural gas still shows high market shares until 2030.
- Policy measures **addressing the investment behavior** of agents can significantly **increase** the **share of renewable energy carriers** in the building stock. Policy costs?

Summary and key findings II

- **The final energy demand for appliances remains approximately constant.** Energy demand for **lighting strongly decreases** in all scenarios. Energy demand **for ICT increases strongly** – early measures
- **Ecodesign** proves to be the **most effective instrument for appliances** while improved **labelling also contributes** to more energy conscious purchase behaviour.
- A **programme subsidising** the purchase of very efficient white goods appliances **for low-income households** in all EU member states only leads to **minor savings** in the model. Highly efficient appliances need to become significantly cheaper to reach a major market uptake.

Final BRISKEE Conference and eceee annual policy seminar
Wednesday, 29 November 2017, Brussels

Results from WP 4: Macroeconomic Effects

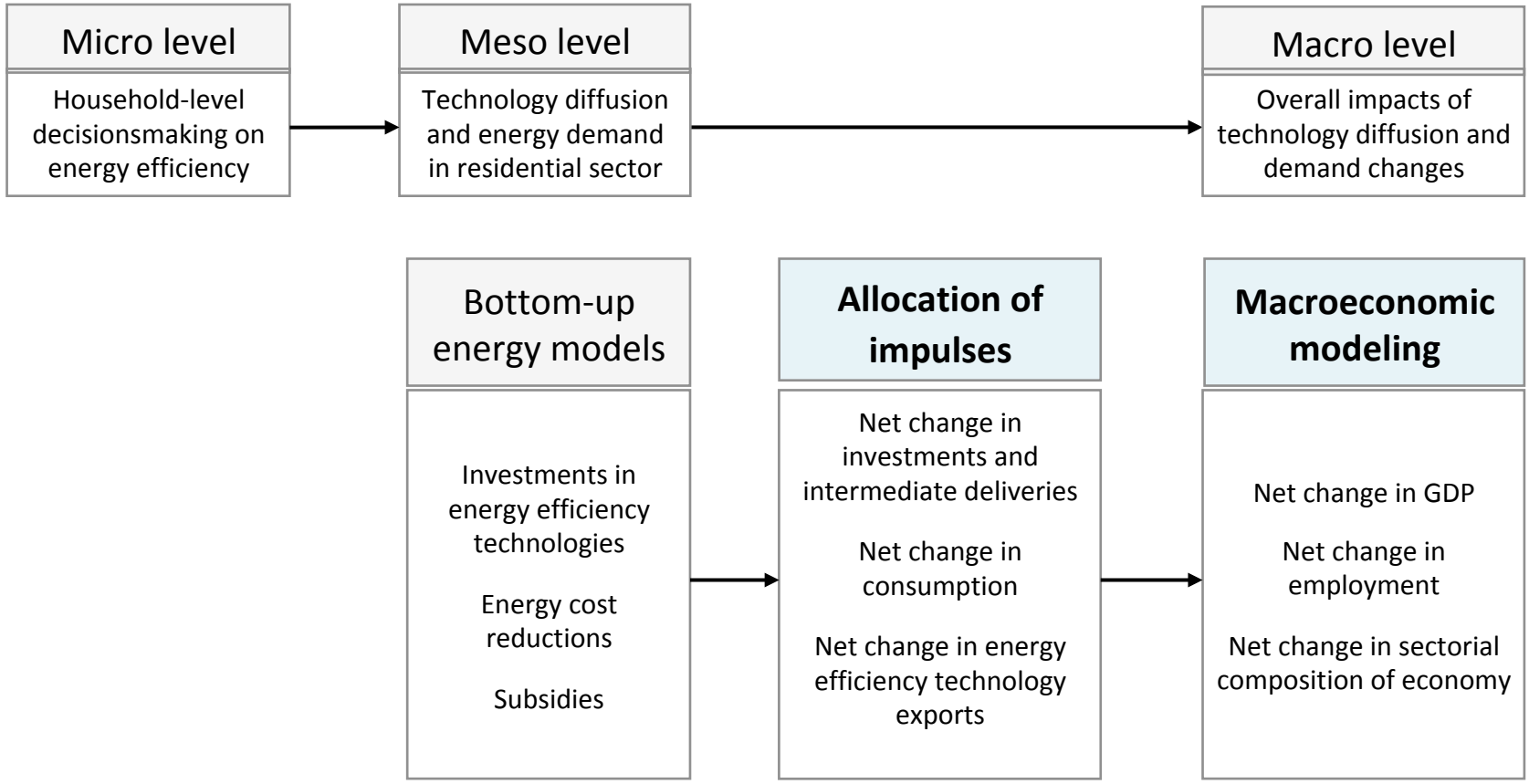
Rainer Walz and Matthias Pfaff, Fraunhofer ISI

BRISKEE

Behavioural response to investment risks in energy efficiency

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 649875. This presentation only reflects the authors' views and EASME is not responsible for any use that may be made of the information it contains.

Objective of WP 4 and integration into overall modelling approach



Description of macroeconomic mechanisms

Effects resulting from investments (positive impulses)

- Increased production and employment in these sectors and upstream sectors
- Enhanced chances of domestic producers to increase their technology exports

Effects resulting from energy cost reduction (negative impulses)

- Reduced production and employment in energy sectors and upstream sectors

Effects resulting from compensation of impulse differences

- conservative assumption: if investment impulse is higher than cost saving impulse, there is a compensating reduction in consumption

structural effects of impulses

Macroeconomic income effects

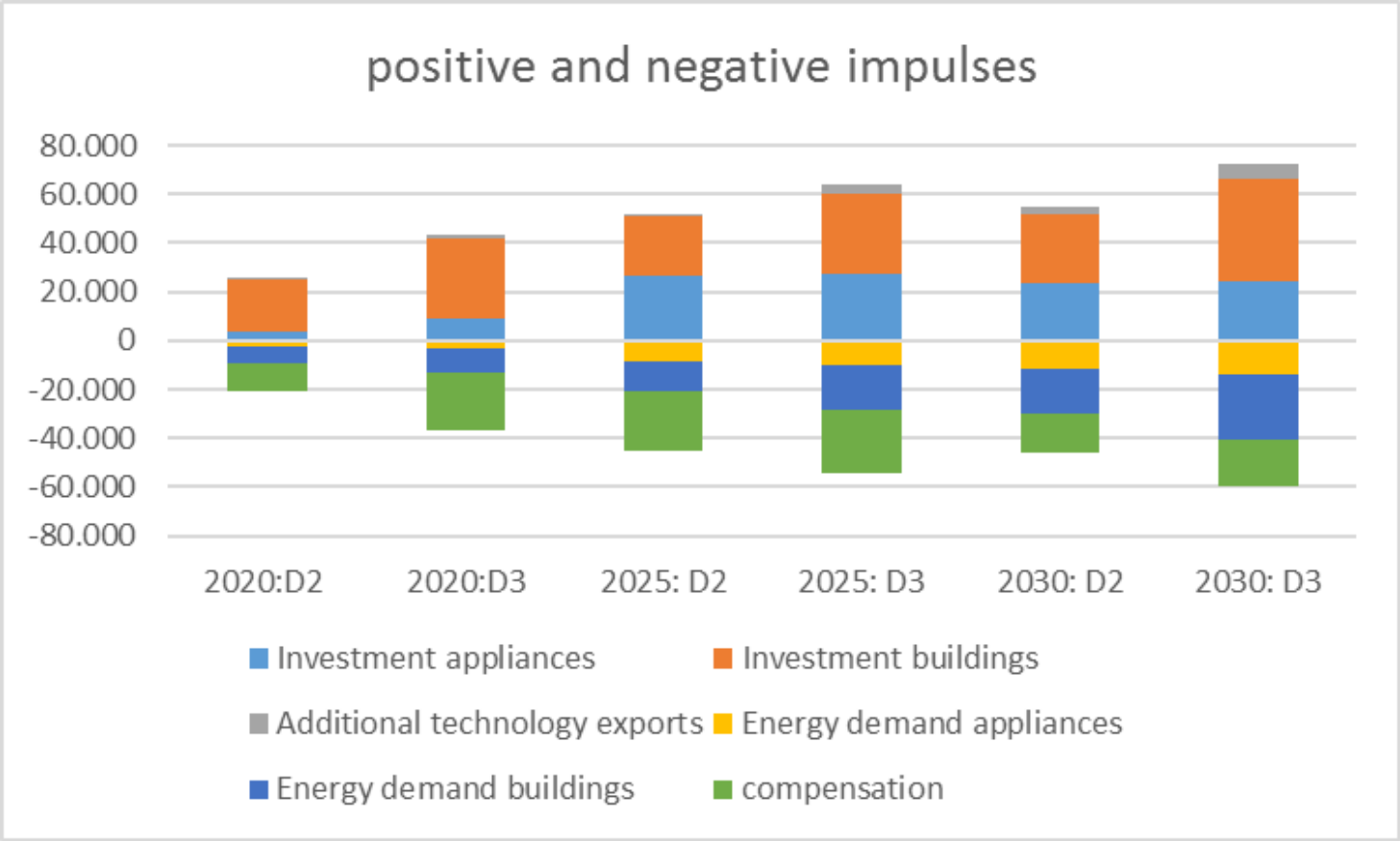
- Changes in production of investment and consumption goods lead to changes in income (inducement of multiplier effects), which also effects further structural changes of the economy

Changes in structural composition of economy lead to

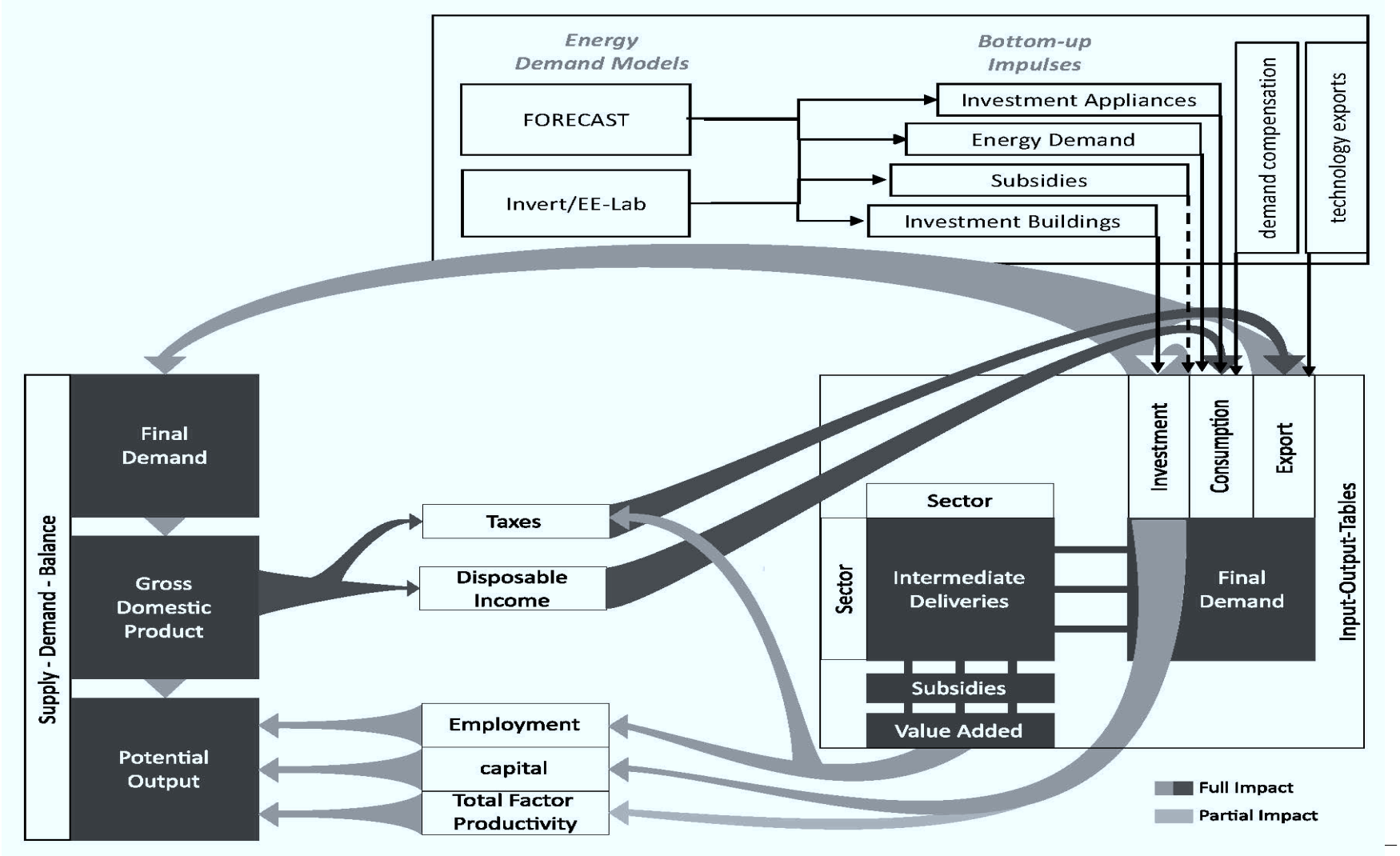
- changes in overall import
- changes in overall labour intensity of an economy

induced macro-economic effects

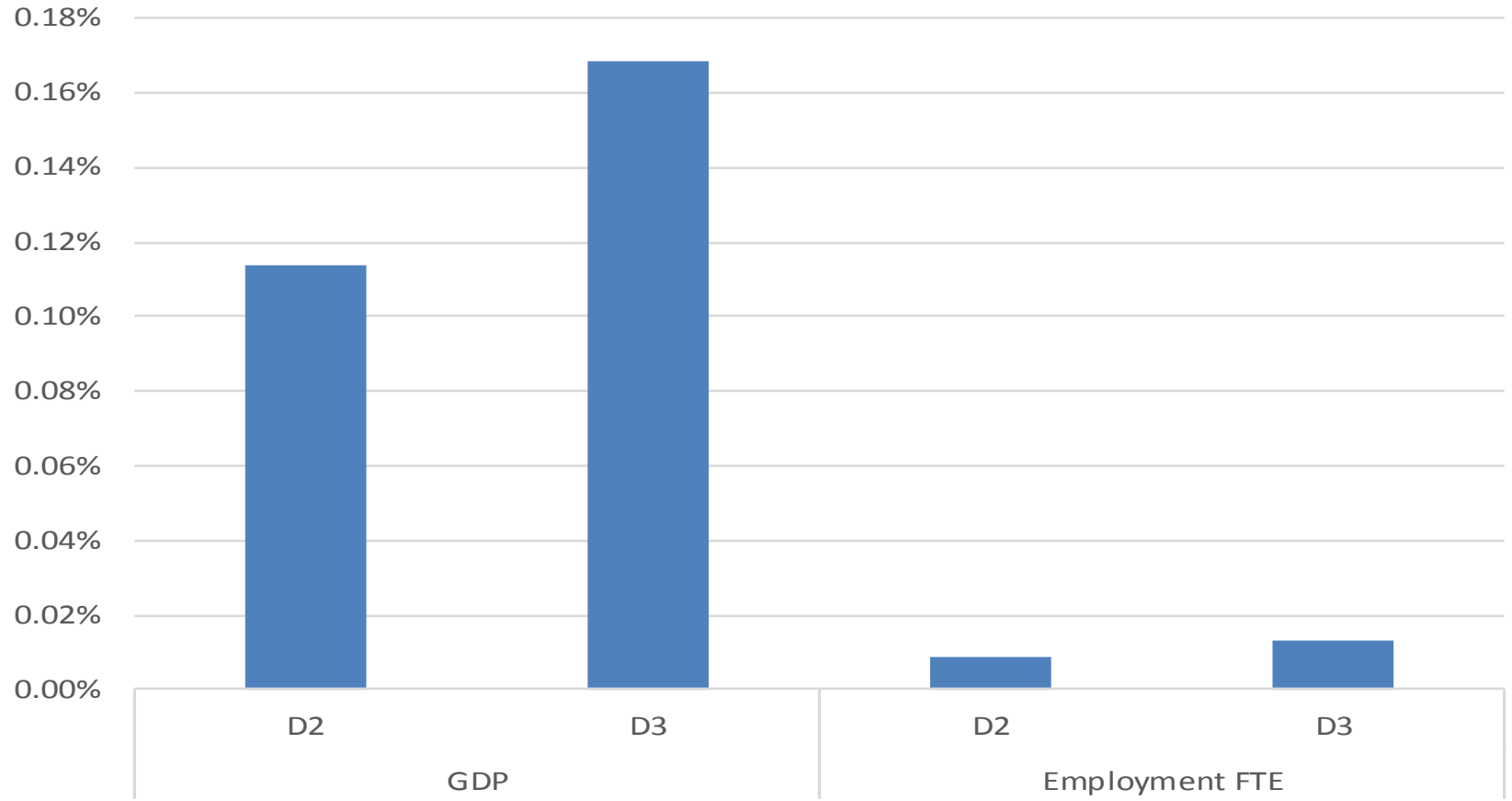
Impulses on the EU28 level (Million € 2005)



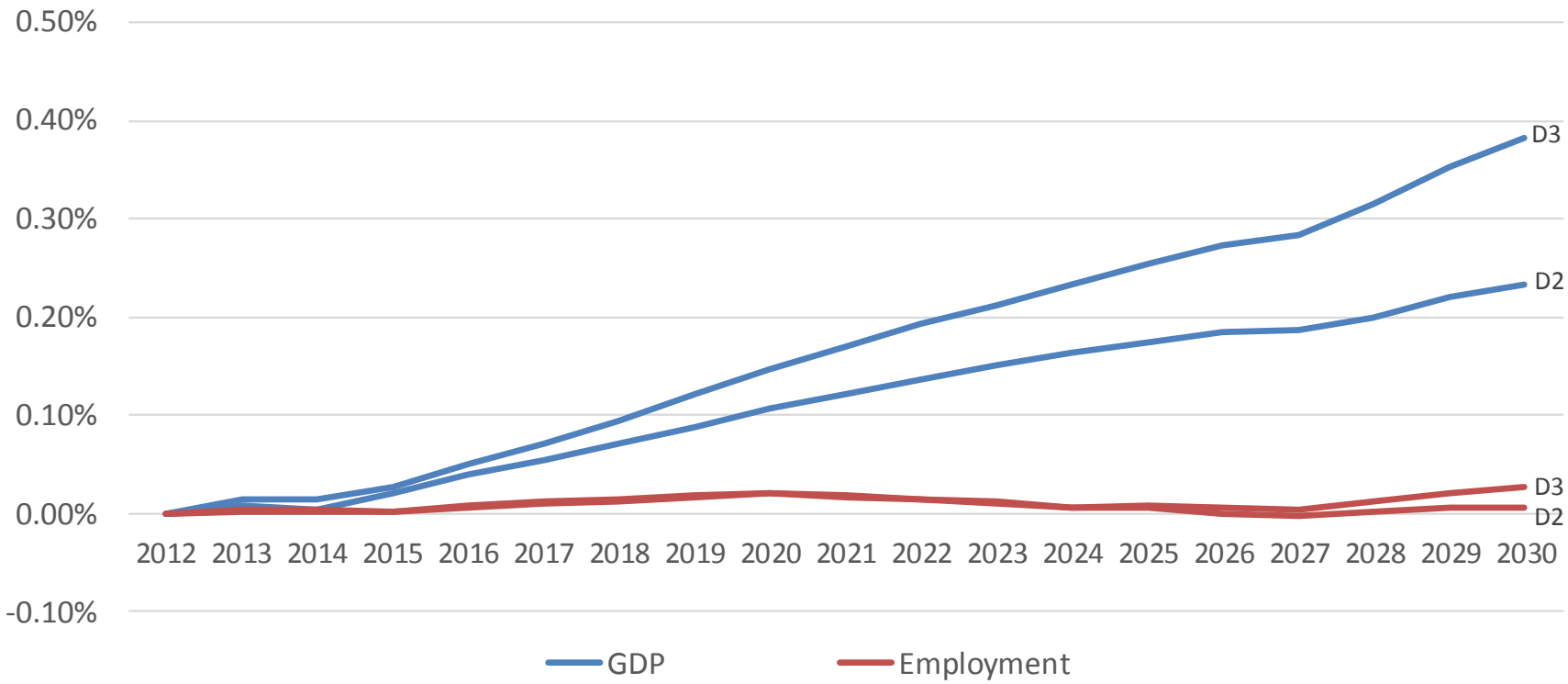
ASTRA EC – Model overview and impulses



Results for the EU28, 2012-2030
Relative GDP and employment change

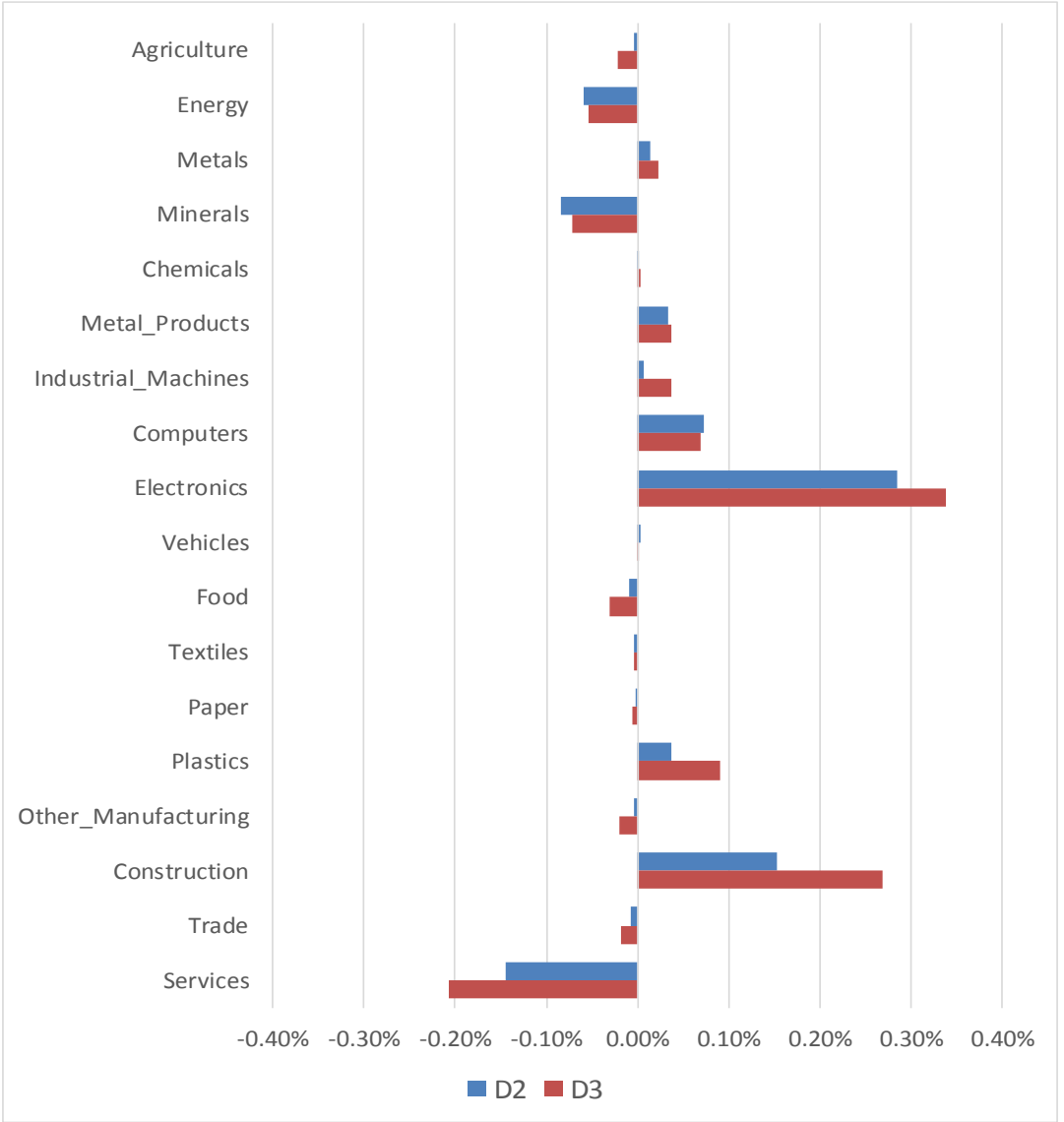


Results for the EU28
Development of GDP and employment



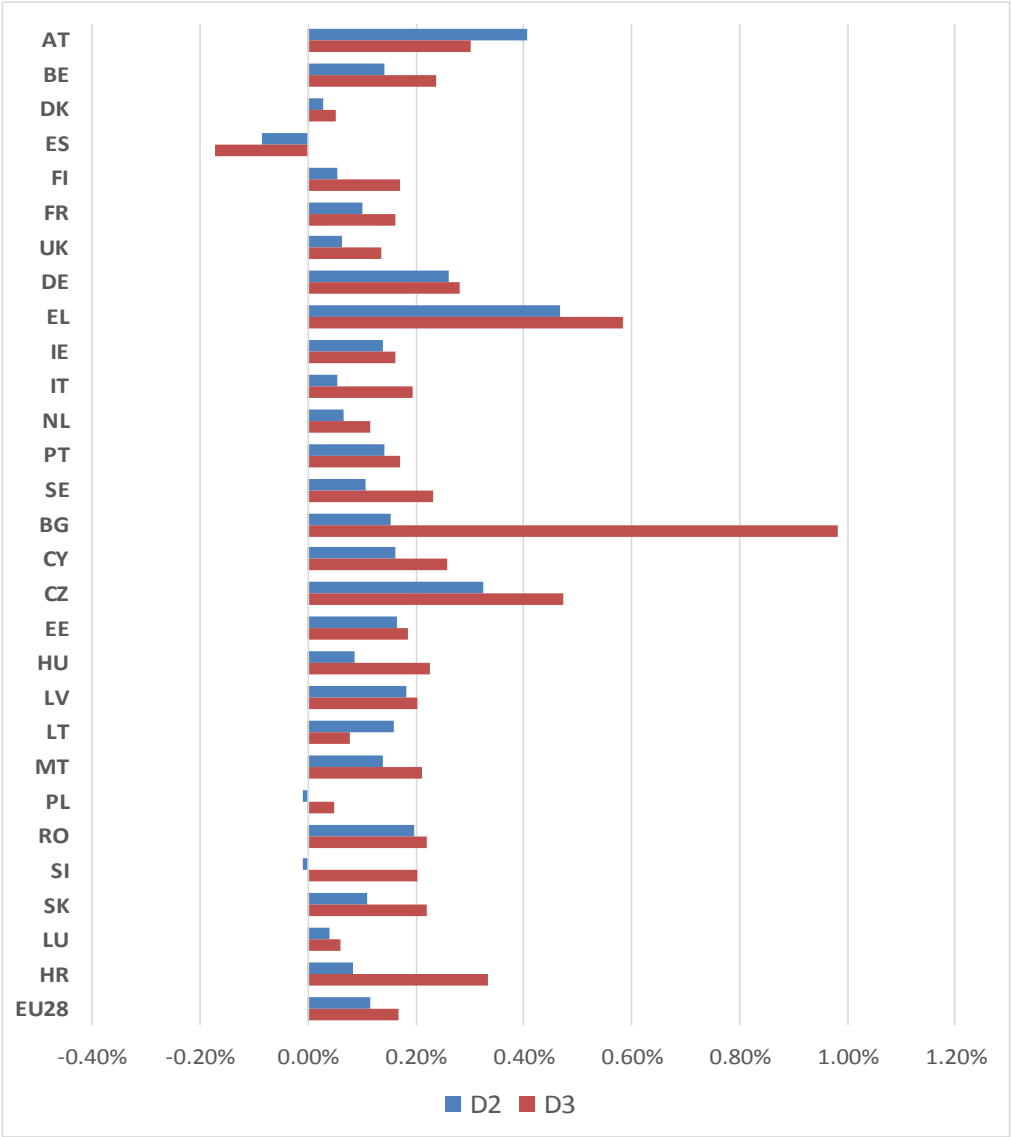
EU28 2012-2030

Relative employment changes on sector level



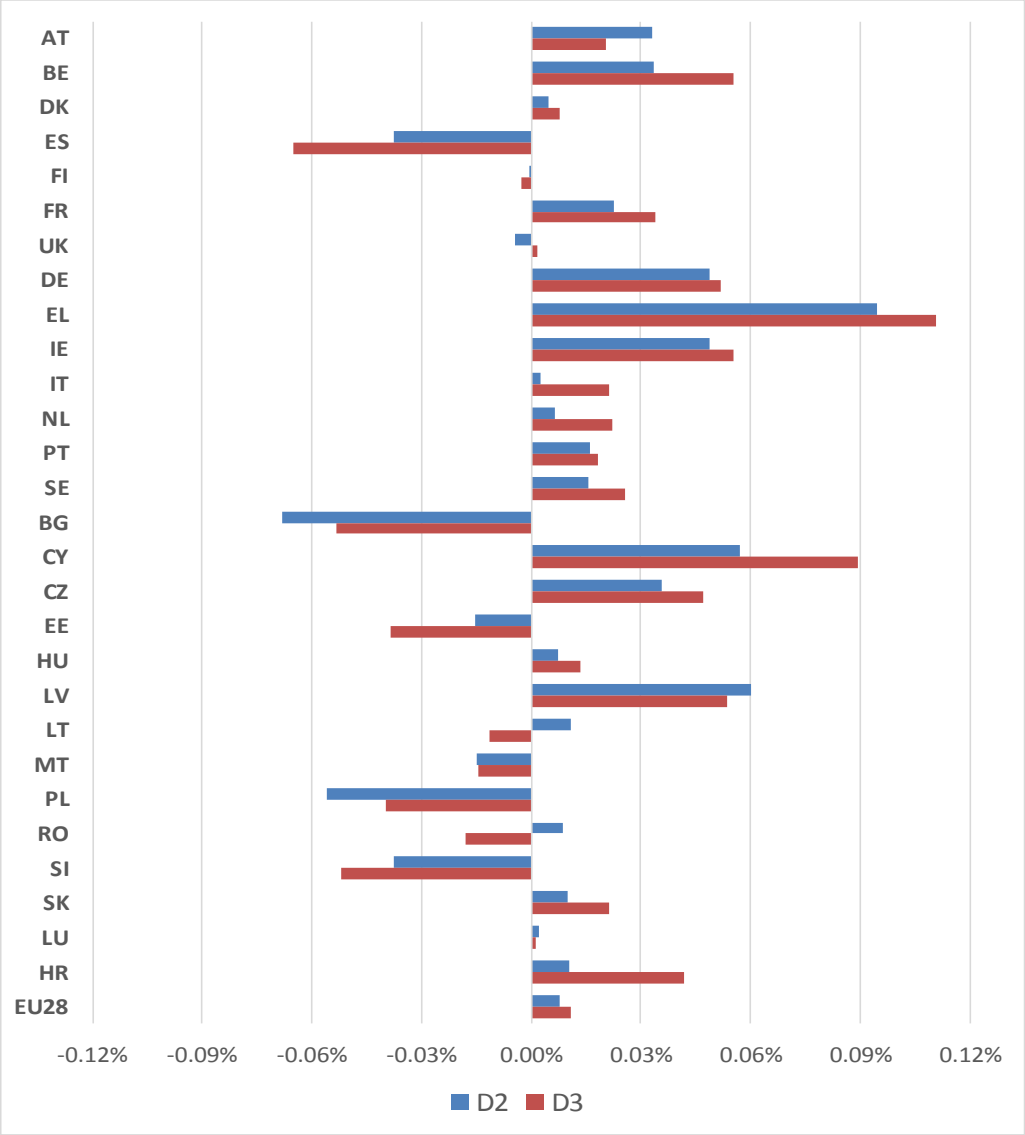
Country level 2012-2030

Relative GDP changes



Country level 2012-2030

Relative employment changes



Interpretation

Positive effects are robust: results show lower limit of positive effects

- conservative assumption with regard to Keynesian effects (impulse compensation)
- positive effects of investment continue after 2030, negative effects of compensation occur before 2030: consumption compensation will turn positive

effects on GDP stronger than on employment

- increased energy efficiency triggers sectors related to manufacturing
- impulse compensation also reduces consumption related to service sectors
- labour intensity in service sector higher than in manufacturing

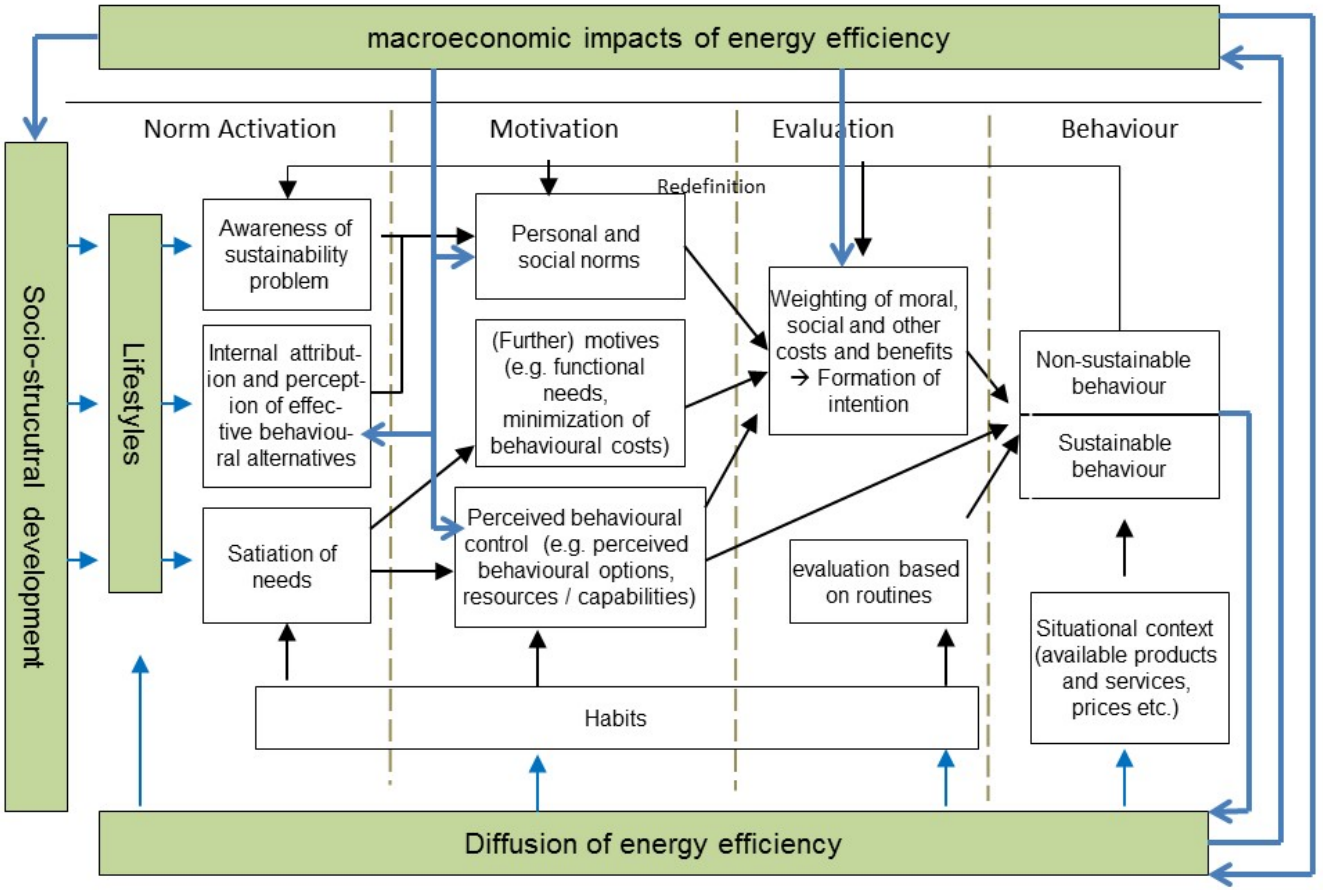
country differences can be explained by

- different structure of impulses for country
- different structural composition of the economy
- differences in labour intensity and import intensities of value chains

Outlook research: enhancing analysis by feedbacks between micro and macro level

spillover from changing IDR to overall macroeconomic consumption behaviour?

feedback from macroeconomic effects to environmental behaviour?



Source: Fraunhofer ISI, adapted from Bamberg&Möser 2007 and Klöckner 2013

THANKS FOR YOUR ATTENTION!

- QUESTIONS AND DISCUSSION

FOR MORE INFORMATION PLEASE VISIT OUR WEBSITE
WWW.BRISKEE-CHEETAH.EU/BRISKEE/

WP2 – DELIVERABLES ON MICRO-LEVEL + SURVEY
WP3 – DELIVERABLES ON MESO-LEVEL MODELLING
WP4 – DELIVERABLES ON MACRO-LEVEL MODELLING
WP5 – DELIVERABLES ON POLICY RECOMMENDATIONS

For more information please check our website

www.briskee.eu

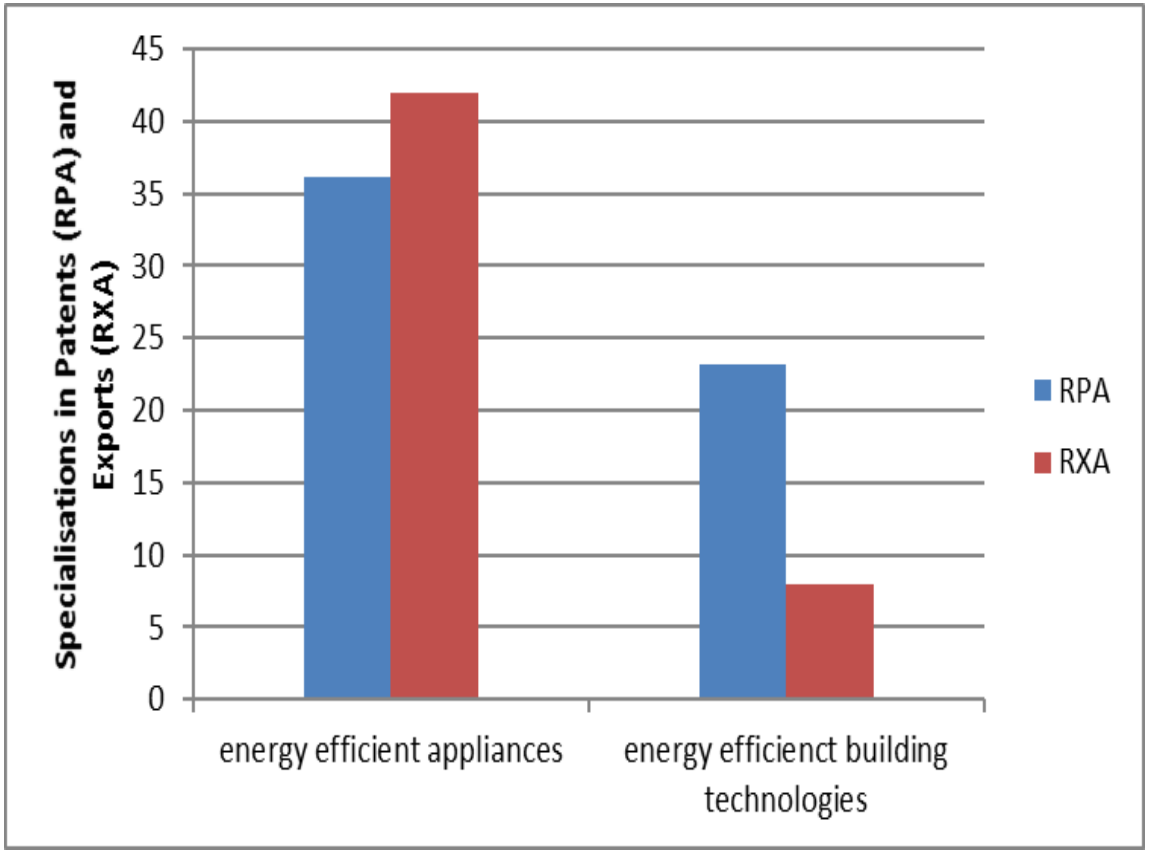
Impulses from energy models

Impulses	Model variable/sector affected
Investment and exports in energy efficient heating technologies and insulation	Investment sectors, constructions
Investment in energy efficient appliances	electronics and computing equipment
Reduced energy expenditures due to heating technologies and insulation	energy sector
Reduced energy expenditures due to efficient appliances	energy sector
Consumption changes due to changes in disposable income	Consumption (final goods and service sectors)
Subsidies	Consumption, government expenditures

EU as lead supplier on world market

Success factors for lead supplier position

- demand advantage (EU = D2, D3 scenario)
- transfer and export advantage (EU = positive RXA)
- technological advantage (EU = positive RPA)
- system advantage
- regulatory advantage (EU = D2, D3 scenario)



Source: Fraunhofer ISI

Geographical focus: EU-28
Survey in 8 countries

France

Germany

Italy

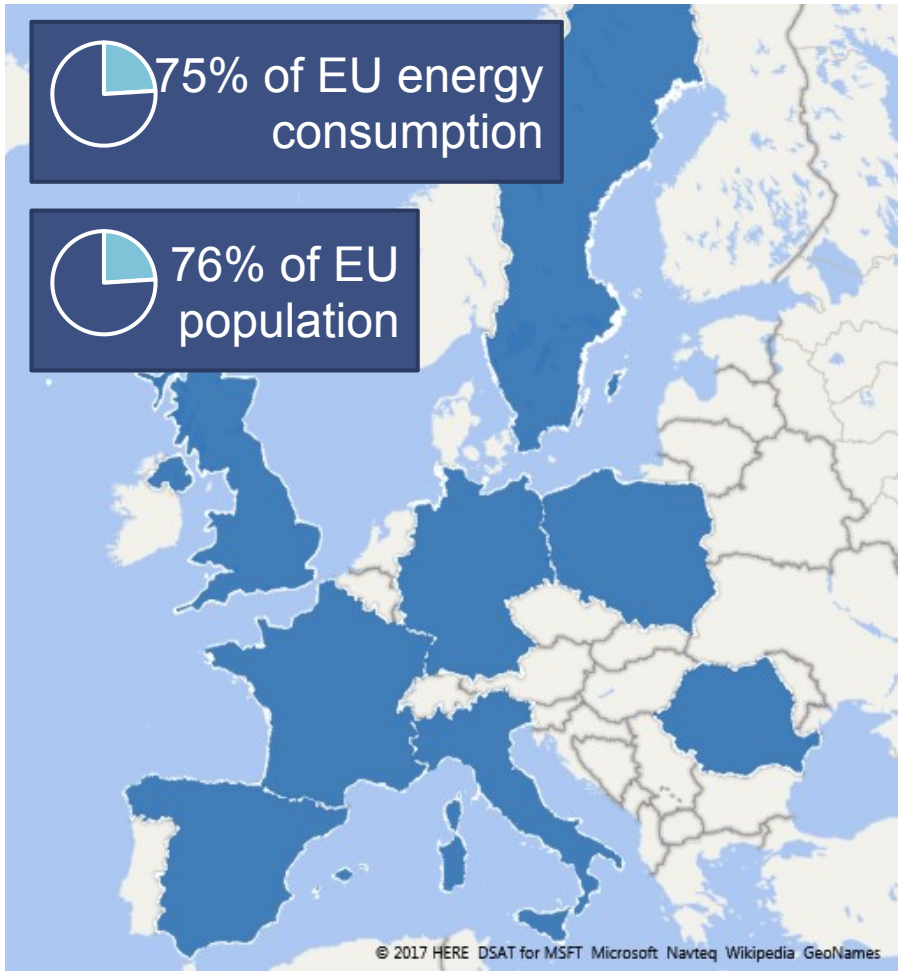
Poland

Romania

Spain

Sweden

UK



Micro level – Energy efficiency technology adoption in households

Multi-country household survey on effects of time & risk preferences on EET adoption

Micro-econometric analysis

Meso level – Energy efficiency policy and household investment behavior

Integration of empirical findings into models for residential buildings (Invert/EE-Lab), appliances (FORECAST)

Macro level – Macro economic effects of energy policy

Translation of results from energy modelling into input to macroeconomic modelling (ASTRA)

WP3 – Energy demand modelling - Intro

Scope:

- Temporal scope: Annual energy demand projections until 2030
- Sectoral scope: Energy demand for residential buildings (Invert/EE-Lab) and residential appliances (FORECAST)
- Geographic scope: EU 28 (at the level of individual member states)
- Economic perspective: Energy costs and investments.
- Supply and efficiency options: Heating systems, appliances, investments in thermal refurbishment, energy carriers

Energy uses in FORECAST-Residential

Large appliances (white goods): refrigerators, freezers, washing machines, dryers, dishwashers

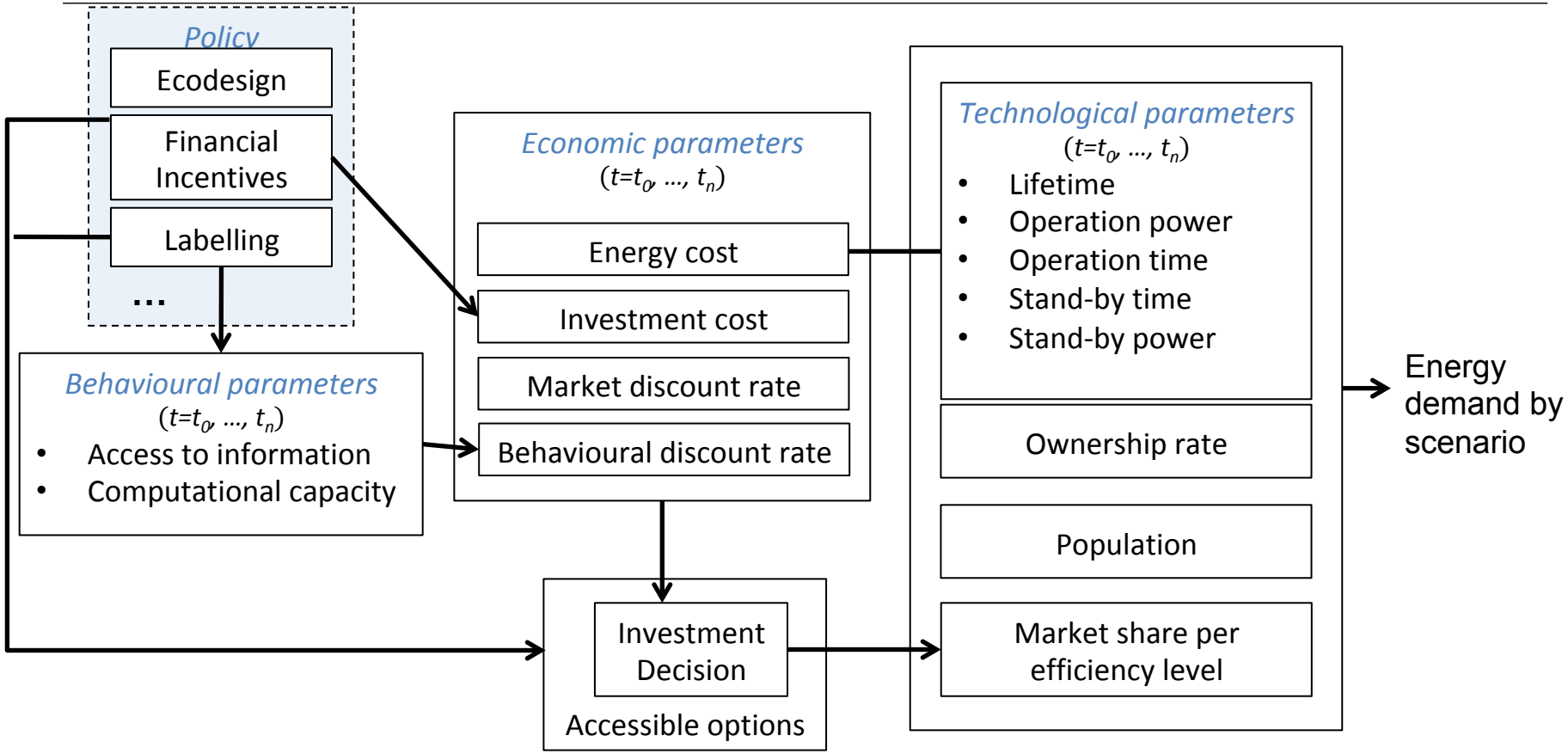
Information and Communication Technologies ICT: televisions, desktop computers, computer screens, routers, laptop computers, set-top boxes

Lighting

Cooking

New & Others: energy using devices not covered in the previous points, including small appliances, such as tablet computers, toasters and phones

Overview FORECAST-Residential



Heating and Cooling in the residential sector - INVERT/EE-Lab

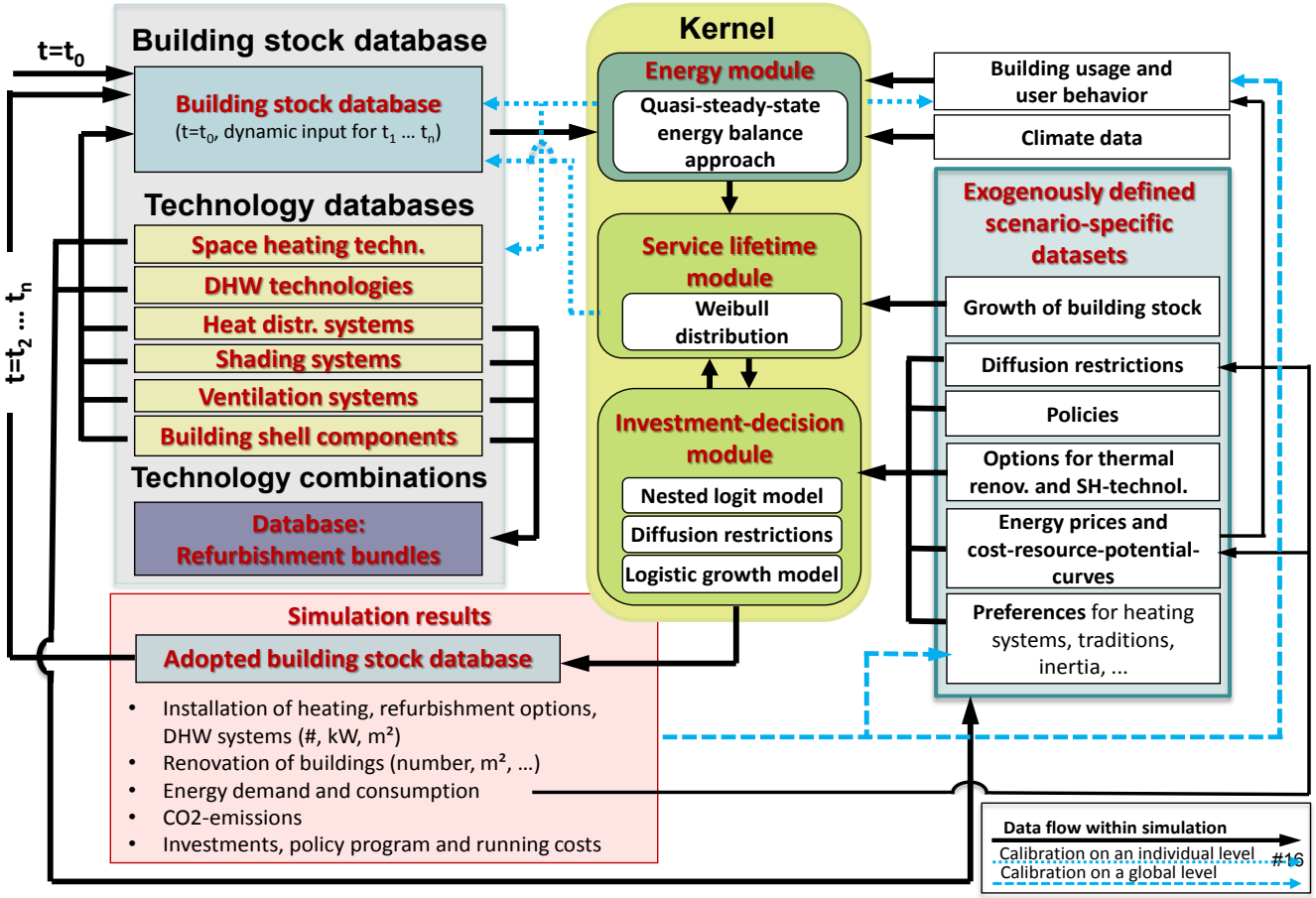
- Building stock model based on annual heating and cooling demand calculations for aggregated (>1000 building segments per country)

- Development of thermal condition of buildings and of heating systems is based on a nested logit approach – main drivers are cost related but additional parameters influence the decisions in the model (e.g. importance of comfort, factor for sustainability, information awareness)

- Decision makers are implemented as agents (e.g. Owner occupier, housing association, low income owner) and distributed over the building stock in the model.

- Each agent can be associated with a distinct discount rate (e.g. low income have higher discount rates in the initial set up of the model). We have to be careful when comparing this discount rate with references in the literature because we add other factors which are often summarized in the discount rate

Heating and Cooling in the residential sector - INVERT/EE-Lab

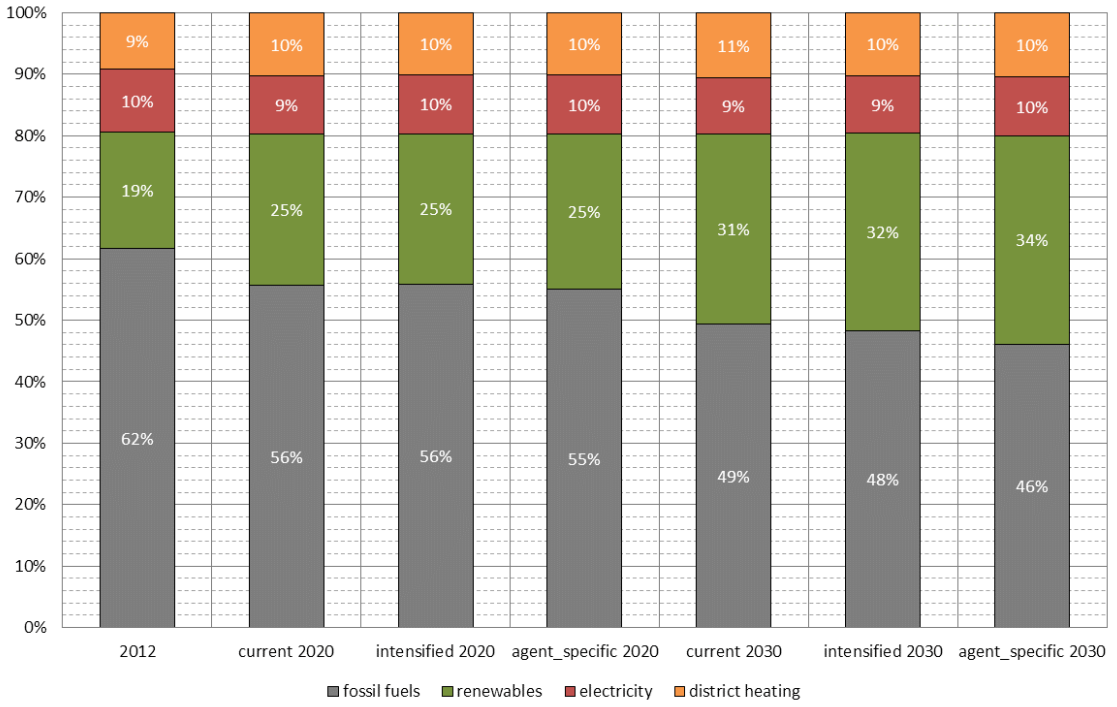


Technological scope: Different purchase price categories

„Low cost“	„Medium cost“	„High cost“
lighting	White goods	Thermal retrofit and heating

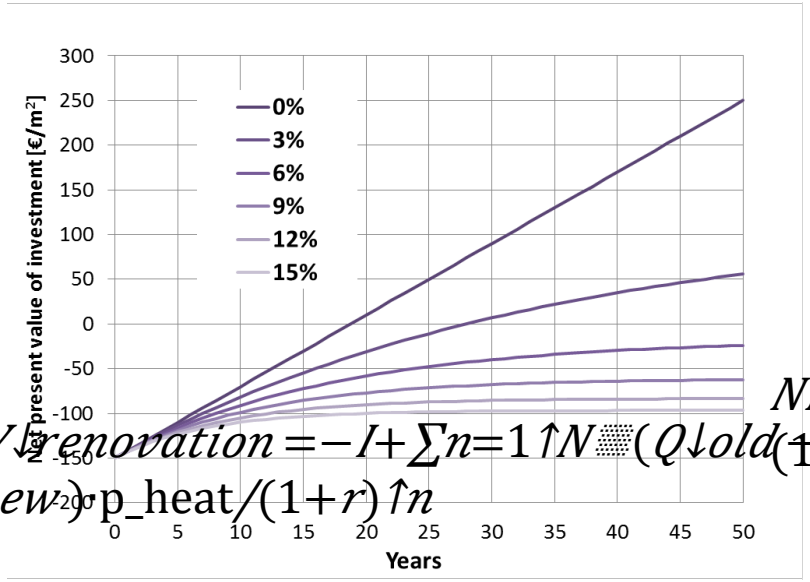
Heating and Cooling – Energy carrier mix in EU 28 in 3 scenarios

- Intensified measures also lead to higher shares of renewables
- Share of fossil fuels decreases to less than 50% - strong reductions of fuel oil and coal, still high shares of natural gas
- Lower discount rates of low income agents significantly increases the shares of renewables to 34% compared to 32% compared to intensified-measures scenario
- Strong increase of solar thermal and heat pumps
- Heat pumps vs. Direct electric heating

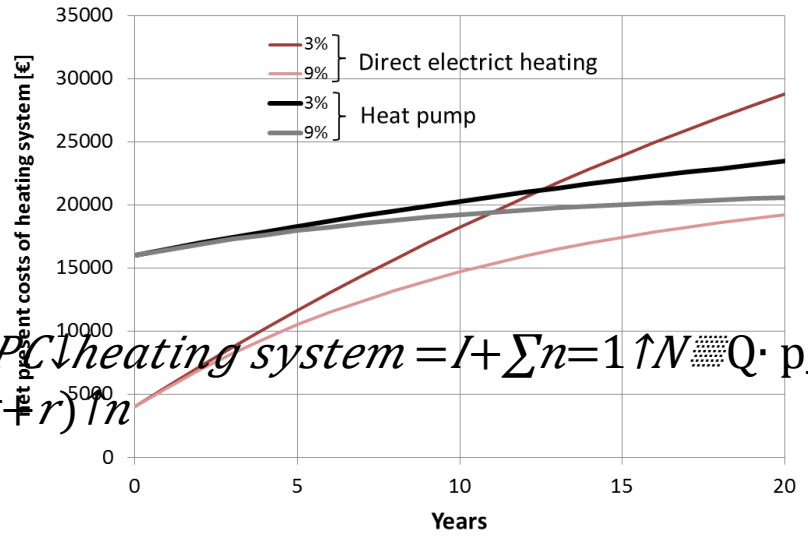


Heating and Cooling – the role of discount rates

- Discount rates (*r*) influence the value of future cash flow in investment appraisals
- High impact on thermal renovation investment decision because of long lifetime of measures (>20 years and up to more than 50 years)
- Also high impact on investments in heating systems. High discount rates make investments in efficient and renewable heating technologies less likely
- Example: Heat pumps versus direct electric heating

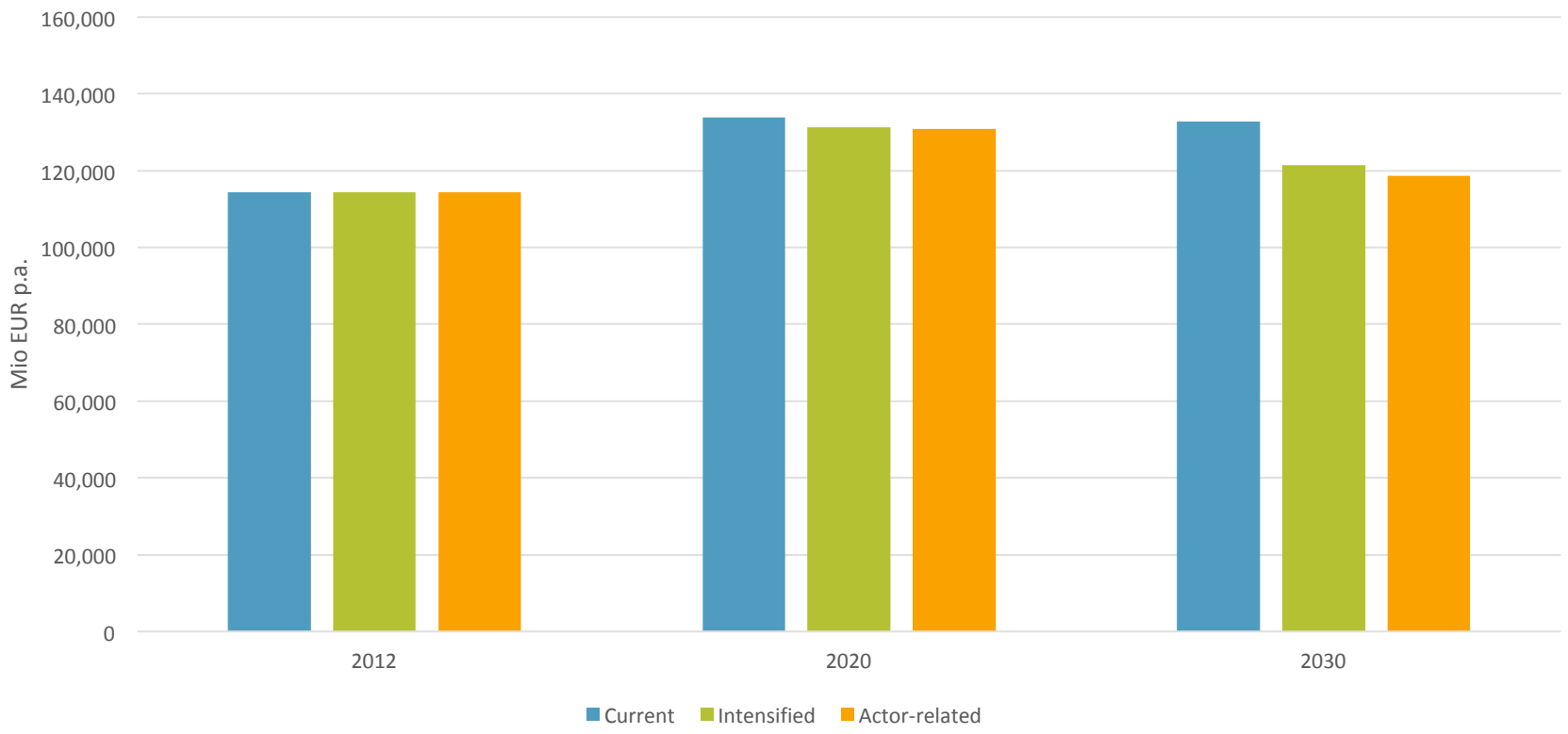


$$NPV_{renovation} = -I + \sum_{n=1}^{N} (Q_{old} - Q_{new}) \cdot p_{heat} / (1+r)^n$$



$$NPC_{heating\ system} = I + \sum_{n=1}^{N} Q \cdot p_{electrici} / (1+r)^n$$

Appliances - Energy costs in the EU-28



Scenarios for heating and cooling in - INVERT/EE-Lab

Scenario name	Explanation
Current-policy scenario	The “Current-policy scenario” considers targets and measures concerning RES-H/C and energy efficiency which have been decided or already implemented. On the European level, the relevant policy implications are particularly set by the Renewable Energy Directive, the Energy Efficiency Directive, the Directive on Energy Performance of buildings, and the Ecodesign Directive.
Intensified-measures scenario	The intensified measures scenario assumes that the policies which are implemented currently are intensified; however, the policy approaches remain the same. For example, a country that currently relies on minimum efficiency standards would continue to use this approach; however, the standards would be defined in a more ambitious way. Monetary subsidies for thermal renovation and renewable heating systems are increased in all member states
New actor-related measures scenario	The new actor-related measures scenario assumes that energy efficiency policy is complemented by new policy measures affecting the discount rate of low income agents. The discount rates of low income agents are reduced to the level of median income building occupants – reduction of discount rates between 2% and 5% depending on initial assumptions in member states

Scenarios for heating and cooling in - INVERT/EE-Lab

Scenario name	Explanation
Current-policy scenario	The “Current-policy scenario” considers targets and measures concerning RES-H/C and energy efficiency which have been decided or already implemented. On the European level, the relevant policy implications are particularly set by the Renewable Energy Directive, the Energy Efficiency Directive, the Directive on Energy Performance of buildings, and the Ecodesign Directive.
Intensified-measures scenario	The intensified measures scenario assumes that the policies which are implemented currently are intensified; however, the policy approaches remain the same. For example, a country that currently relies on minimum efficiency standards would continue to use this approach; however, the standards would be defined in a more ambitious way. Monetary subsidies for thermal renovation and renewable heating systems are increased in all member states
New actor-related measures scenario	The new actor-related measures scenario assumes that energy efficiency policy is complemented by new policy measures affecting the discount rate of low income agents. The discount rates of low income agents are reduced to the level of median income building occupants – reduction of discount rates between 2% and 5% depending on initial assumptions in member states