



Modelling Employment and Nuclear Power in a CGE Model: The Example of the German *Energiewende*

CEEM Conference “Effets sur l’emploi des choix dans le secteur électrique”

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1. Overview
2. The CGE model NEWAGE
 - ➔ Modelling nuclear power
 - ➔ Modelling (un)employment
3. Results of selected IER-studies
4. Summary and outlook

The German *Energiewende*

- The German *Energiewende* comprises long-run goals and measures in order to
 - ⇒ Reduce GHG emissions
 - ⇒ Promote renewable energies
 - ⇒ Increase energy efficiency
 - ⇒ Phase-out nuclear power until 2021

		2020	2030	2040	2050	
The <i>Energiewende</i> goals	GHG emissions:	-40%	-55%	-70%	-80% to -95%	base year 1990
	Electricity consumption:	-10%	-	-	-25%	base year 2008
	Primary energy consumption:	-20%	-	-	-50%	
	Final energy consumption:	-10%	-	-	-40%	
	RES-share in gross final energy consumption:	18%	30%	45%	60%	
	RES-share in gross electricity consumption:	35%	50%	65%	80%	
	Number of electric vehicles:	1 M	6 M	-	-	
	EU-wide CO ₂ emissions standards for cars:	95 gCO ₂ /km	-	-	-	
	Primary energy consumption in buildings:	-	-	-	-80%	
	Heat demand in buildings:	-20%			CO ₂ neutral new buildings	
	Buildings renovation rate:				Double from 1 % to 2 % p.a.	



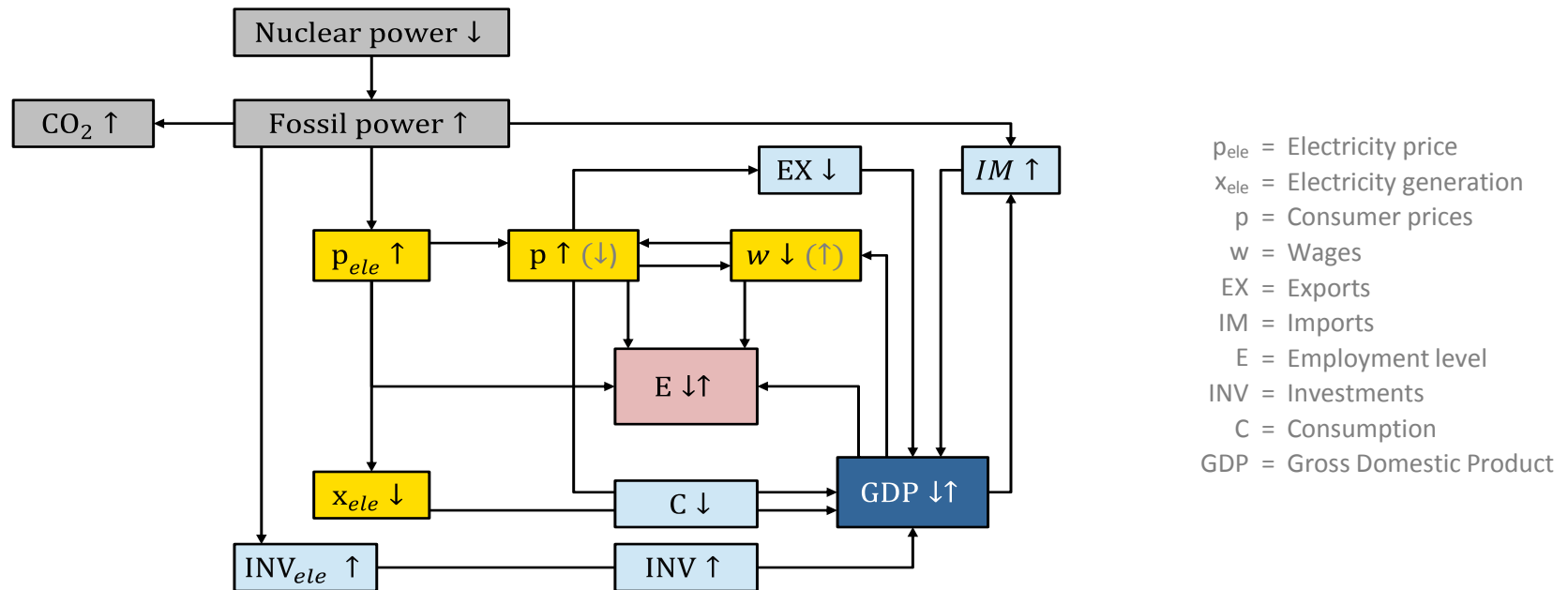
Assessing employment effects with CGE models

- Modelling interactions of economic agents on markets in a closed circle of income
- Economic activities, prices and income as variables
- General equilibrium conditions:
 - Zero profits (firms)
 - Market clearance
 - Budget restriction (households)
- Neoclassical assumptions (perfect competition) can be waved in special markets
 - e.g. labor market \Rightarrow allowing for unemployment
- Modeling employment effects of energy technology investments
 - Where does the funding come from?
 - What are alternative uses of the funding?
 - No forecasts, but ex-ante assessment of different policy interventions (e.g. *Energiewende*) within a consistent framework

Diverse **gross** effects complicate statements about **net** effect

- Gross effects include price effects, supply and demand effects (quantities), investment effects, foreign trade effects, substitution and income effects...

Possible economic effects of phasing-out nuclear power [Fahl & Ellersdorfer, 2004]



- What is the size of the resulting net effect regarding employment levels?



Need for a methodology that covers a closed circle of income



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NEWAGE: Concept and composition

Hybrid features:

Imperfect Labor Market:

- Wage curve differentiation by qualification (skilled, unskilled)
- Rigid wages

Electricity Generation:

Technology based modeling: portfolio with 18 generation options

Household Energy Demand

11 vehicle technologies +
16 buildings technologies

Main data sources:

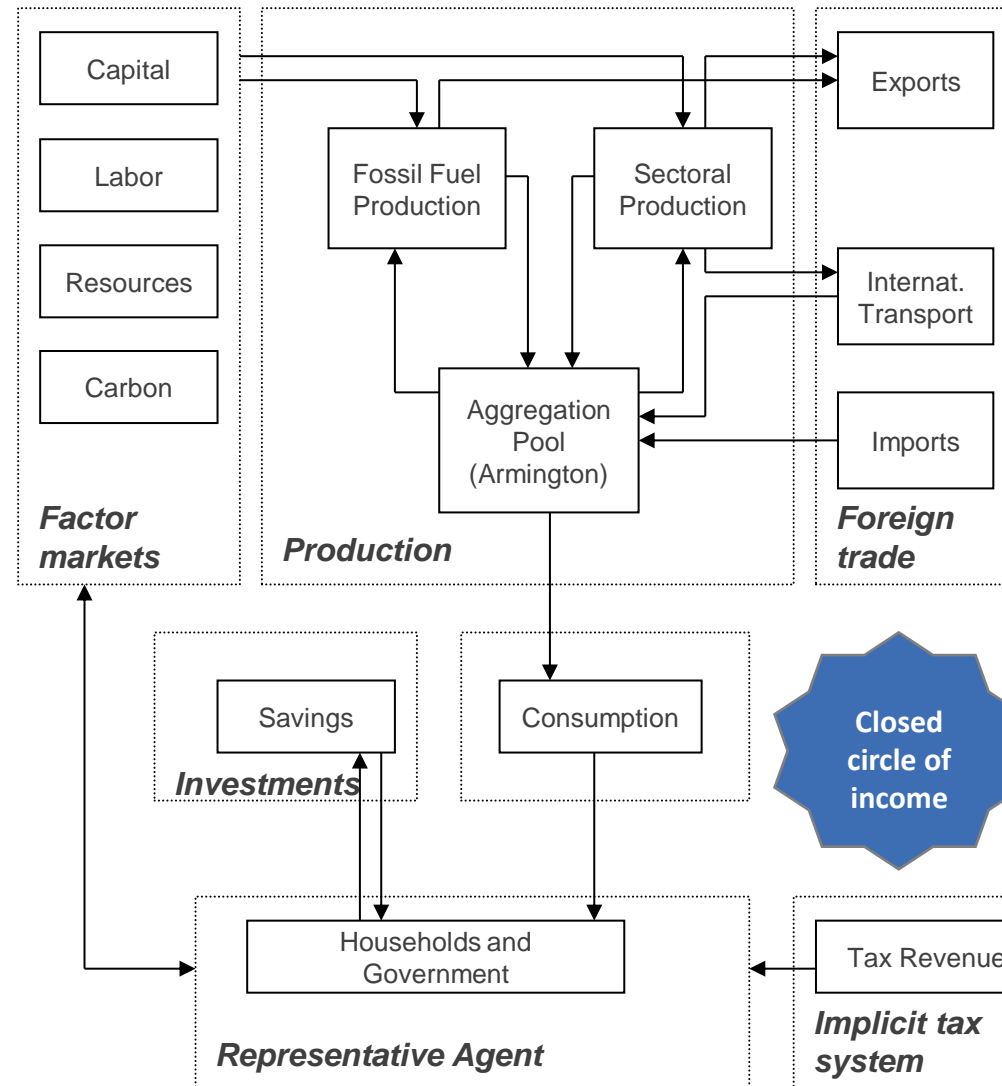
GTAP8, IEA, BoUp-models

Dynamics:

Recursive-dynamic, 2007-2050, 5-year steps

Technological Change:

Autonomous energy efficiency index (AEEI)



Current resolution (18x18x4):

18 sectors:

Coal, Natural gas, Crude oil, Petroleum, Electricity

Iron & Steel, Non-ferrous metals, Non-metallic minerals, Paper, pulp & print, Chemicals, Food & Tobacco,

Motor vehicles, Machinery, Rest of industry,

Buildings, Transport, Agriculture, Services

18 regions:

Germany, Baden-Württemberg (separate)

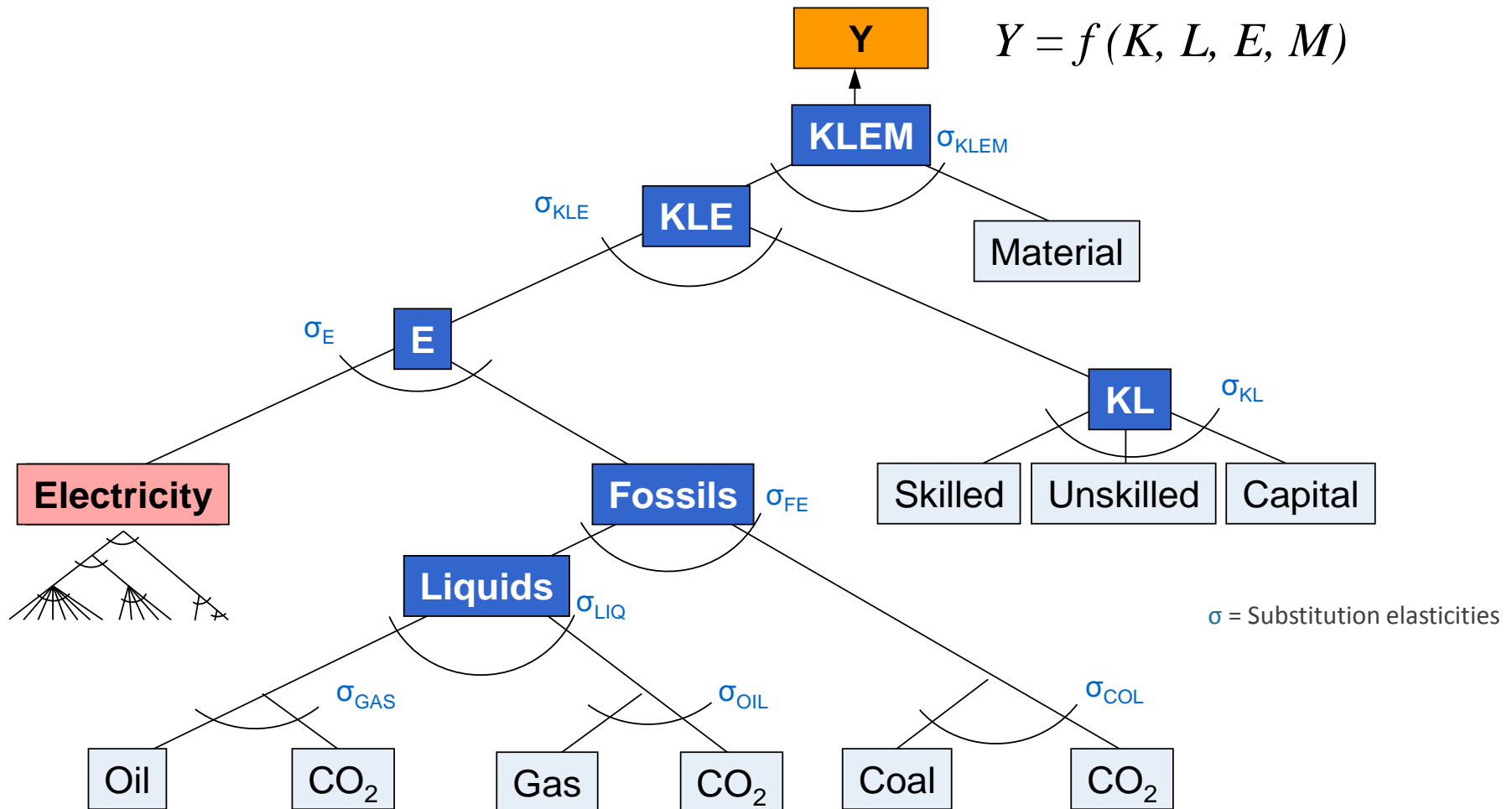
France, Austria, Eastern EU-28, Northern EU-28, Southern EU-28, Switzerland

USA, Rest of OECD

Brazil, Russia, India, China, South Africa

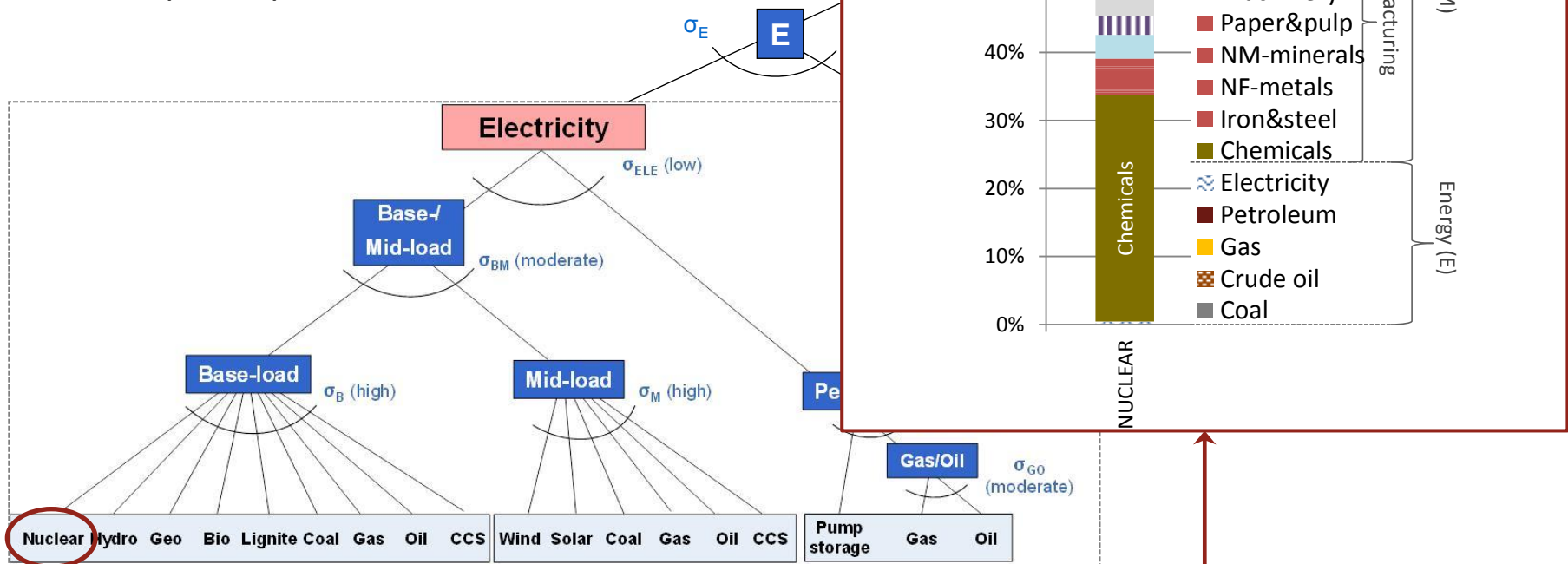
Rest of OPEC, Arabian World, Rest of the World

NEWAGE: CES Production functions



NEWAGE: Modelling electricity generation

- CES nesting of electricity generation technologies
- Each technology is represented as a CES production function demanding KLEM inputs (interdependency with the rest of the economy)
- Electricity generation takes place in extant and new power plants





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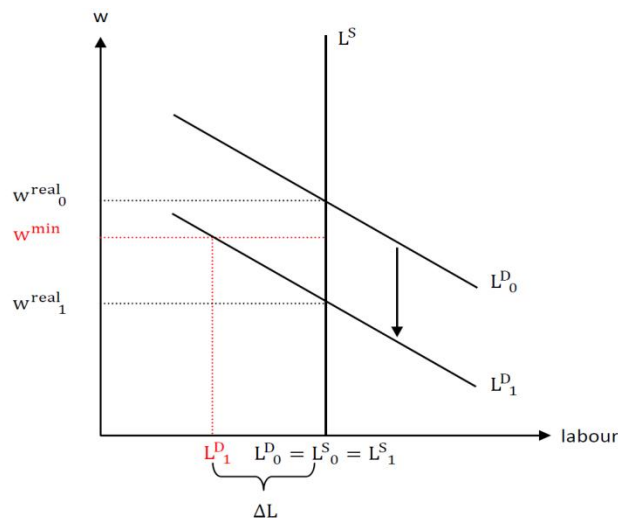
Modelling (un)employment in NEWAGE

- 2 degrees of labor qualification: skilled and unskilled labor
- Corresponding wage functions:

Unskilled labor: Real wage remains constant
(minimum wage)

$$\frac{w_r}{P_r} \geq w_r^{\min}$$

Unemployment through wage rigidities:

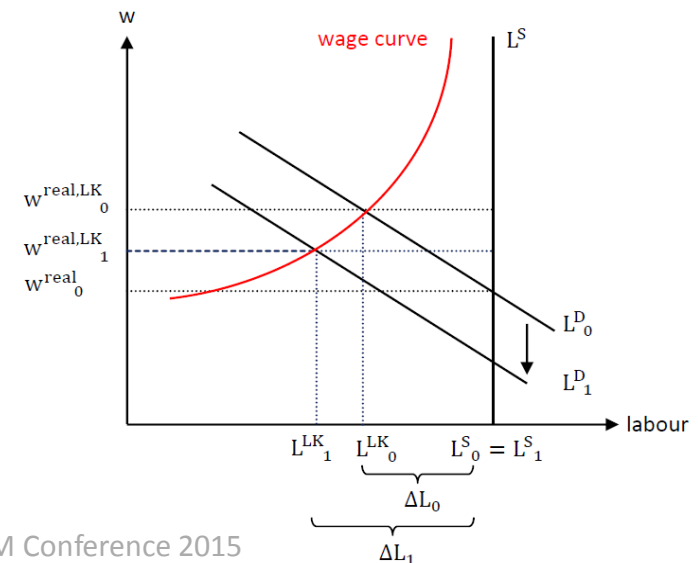


Skilled labor: Wage curve following

Blanchflower & Oswald (1995) $\ln w^{\text{real}} = \beta \ln ur + \alpha$

$$\frac{w_r}{P_r} = \frac{\frac{w_r^{\text{BMK}}}{P_r^{\text{BMK}}}}{ur_r^{\text{BMK}^\beta}} ur_r^\beta$$

Unemployment related to a wage curve:





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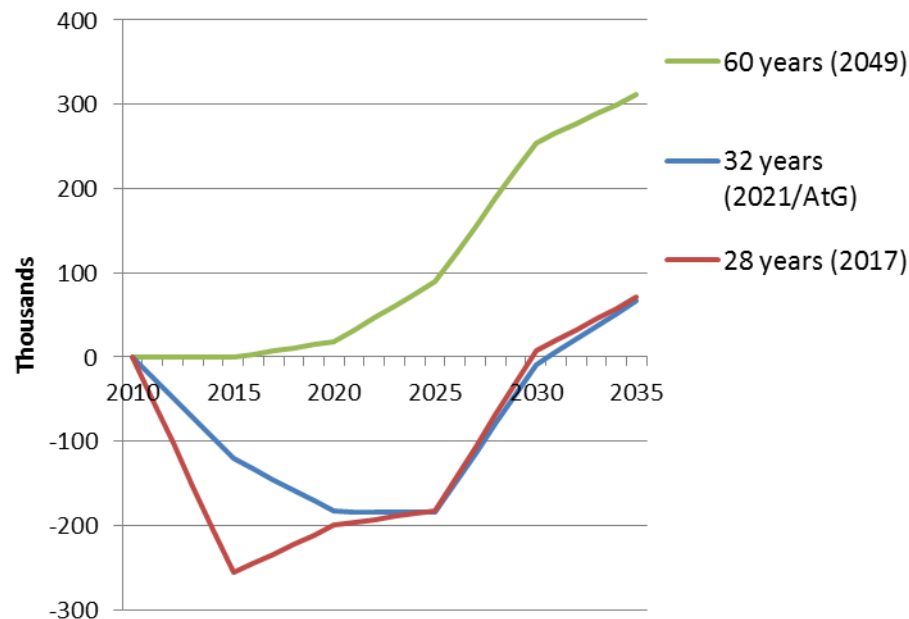
Selected **IER** studies

- **Küster, R. (2009):** „*Climate protection, macro-economy and employment – Analysis of the German and European climate policy strategies using a CGE model*“, Dissertation, Mensch und Buch Verlag, Berlin
- **IER/ZEW (2010):** „*Energy market developments until 2030 – The energy forecast 2009*“, a Study for the German Federal Ministry for Economic Affairs and Technology (BMWi)
- **IER (2011):** „*Effects of changing operational lives of German nuclear power plants – scenario analysis until 2035*“, Institute of Energy Economics and the Rational Use of Energy (IER), University of Stuttgart, Working paper No. 10, June 2011
- **Beestermöller, R. (2012),** “*Net employment effects of renewable energy expansion in Germany*“, Presentation to the Symposium “EnergieCampus”, Stiftung Energie & Klimaschutz Baden-Württemberg, Stuttgart, November 2012
- **Beestermöller, R.,** “*Macroeconomic cost-effectiveness of climate policy instruments in household energy demand*“, ongoing PhD project

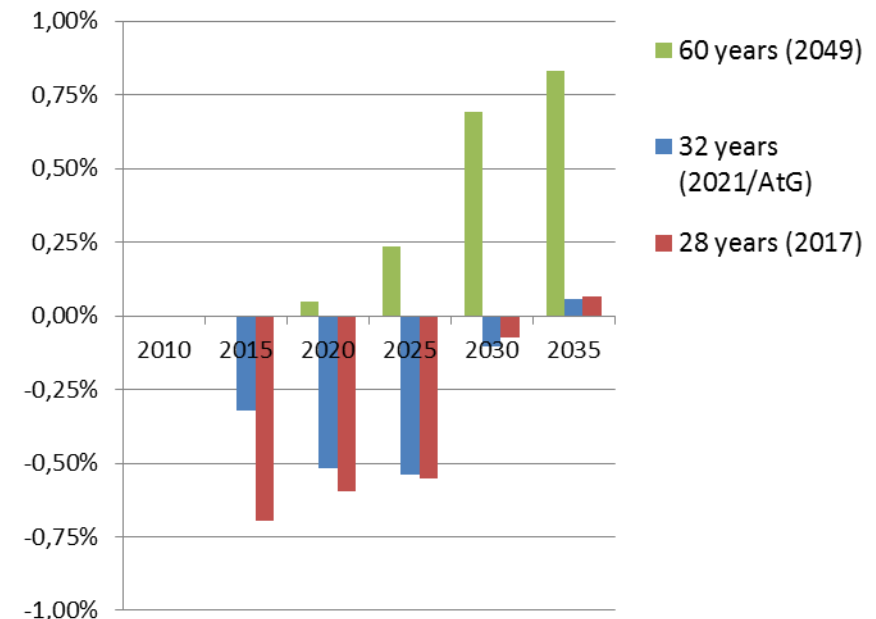
Macroeconomic effects of changing operational lifetimes of German nuclear power plants (IER, 2011)

- **IER (2011):** „Effects of changing operational lifetimes of German nuclear power plants – scenario analysis until 2035“ [in German], Institute of Energy Economics and the Rational Use of Energy (IER), University of Stuttgart, Working paper No. 10, June 2011

Employees in Germany in different nuclear phase-out scenarios compared to the reference scenario (44 years)



Real GDP in Germany in different nuclear phase-out scenarios compared to the reference scenario (44 years)

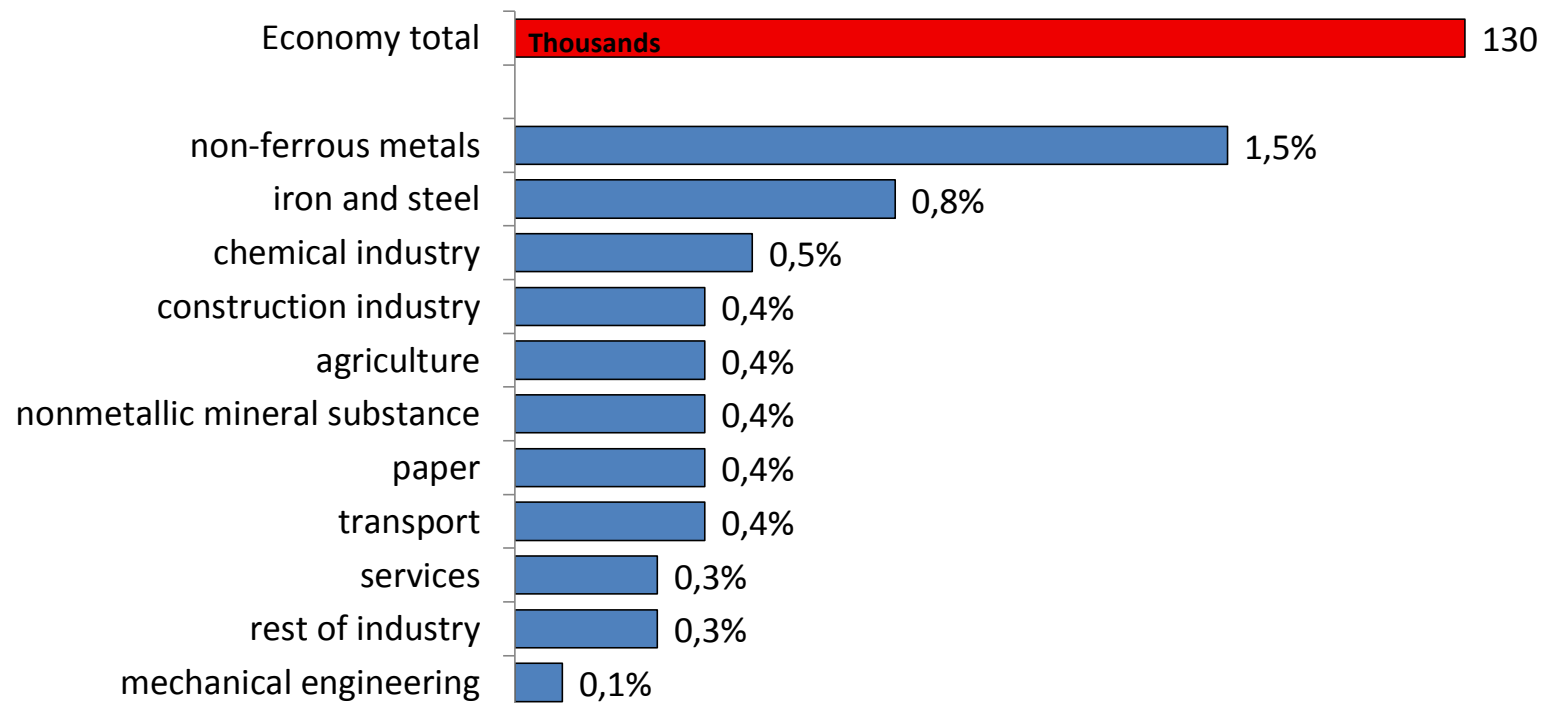




Net employment effects of extending lifetime of nuclear plants from 32 to 40 years in Germany (IER/ZEW, 2010)

- IER/ZEW (2010): „Energy market developments until 2030 – The energy forecast 2009“ [in German], a study for the German Federal Ministry for Economic Affairs and Technology (BMWi)

Change of employees in 2020 when extending lifetime of nuclear plants from 32 to 40 years in Germany



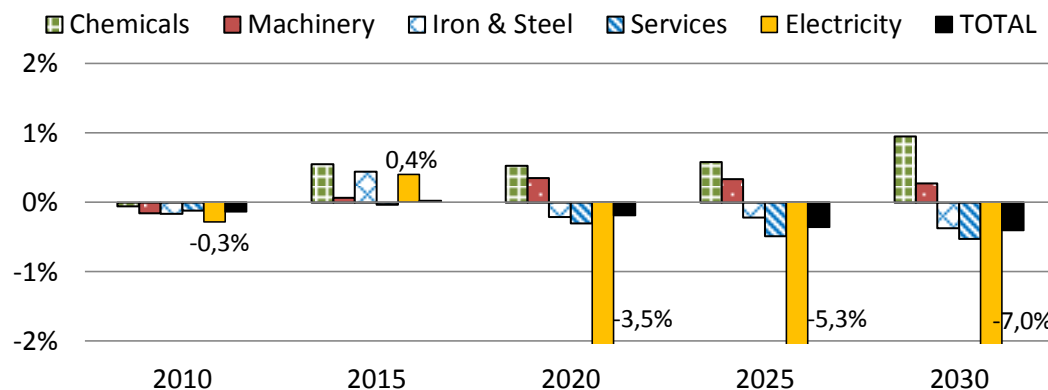
Net employment effects of the renewable energy expansion in Germany

- Beestermöller, R. (2012), "Net employment effects of the renewable energy expansion in Germany" [in German], Presentation to the Symposium "EnergieCampus", Stiftung Energie & Klimaschutz Baden-Württemberg, Stuttgart, November 2012

Renewable energies share of gross electricity generation

	2020	2030
Reference scenario	28%	37%
Expansion scenario	35%	50%

Employment effects of selected industries in Germany 2010-2030 (relative to the reference scenario)



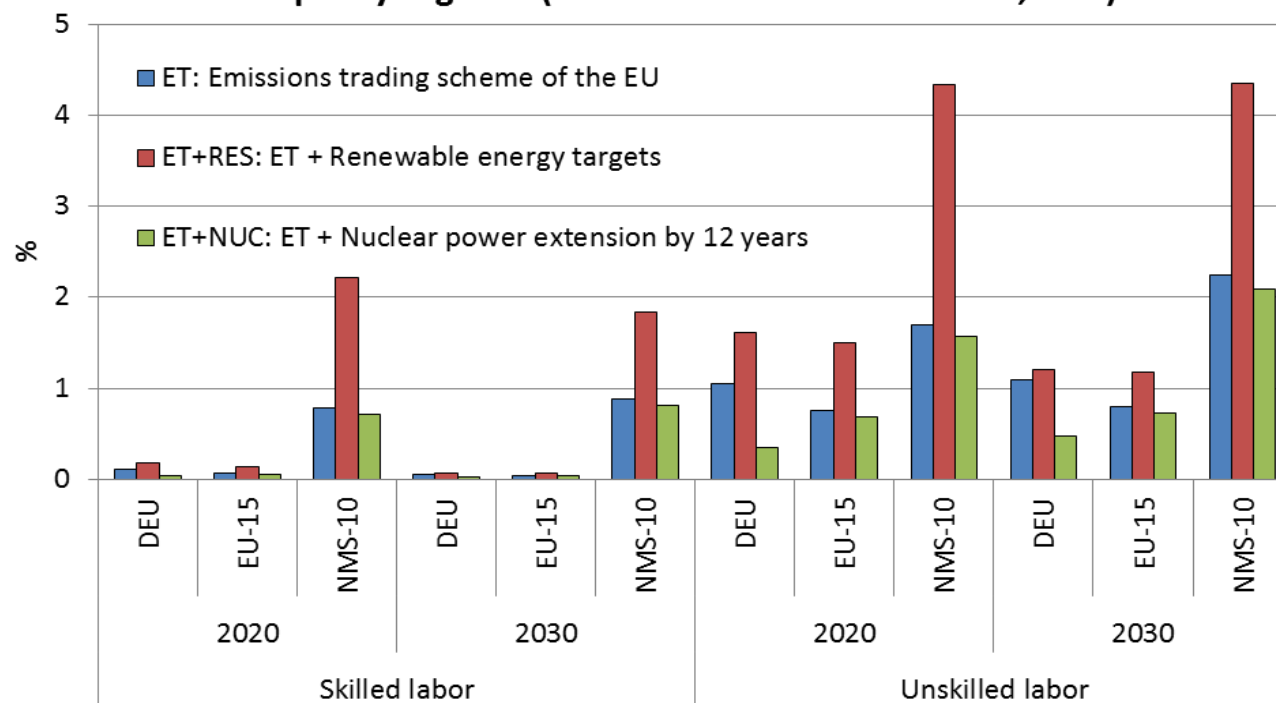
Total net employment effect in Germany until 2030 in the expansion scenario (Difference to the reference scenario in person years)

	2010 to 2030
Cumulative sum	-1.952.000
On average per year	-98.000

Change of the unemployment rate in the EU under different climate policy regimes (Küster, 2009)

- **Küster, R. (2009):** „Climate protection, macro-economy and employment – Analysis of the German and European climate policy strategies using a CGE model“ [in German], Dissertation, Mensch und Buch Verlag, Berlin

Changes of the unemployment rate in the EU under different climate policy regimes (relative to the base scenario, in %)

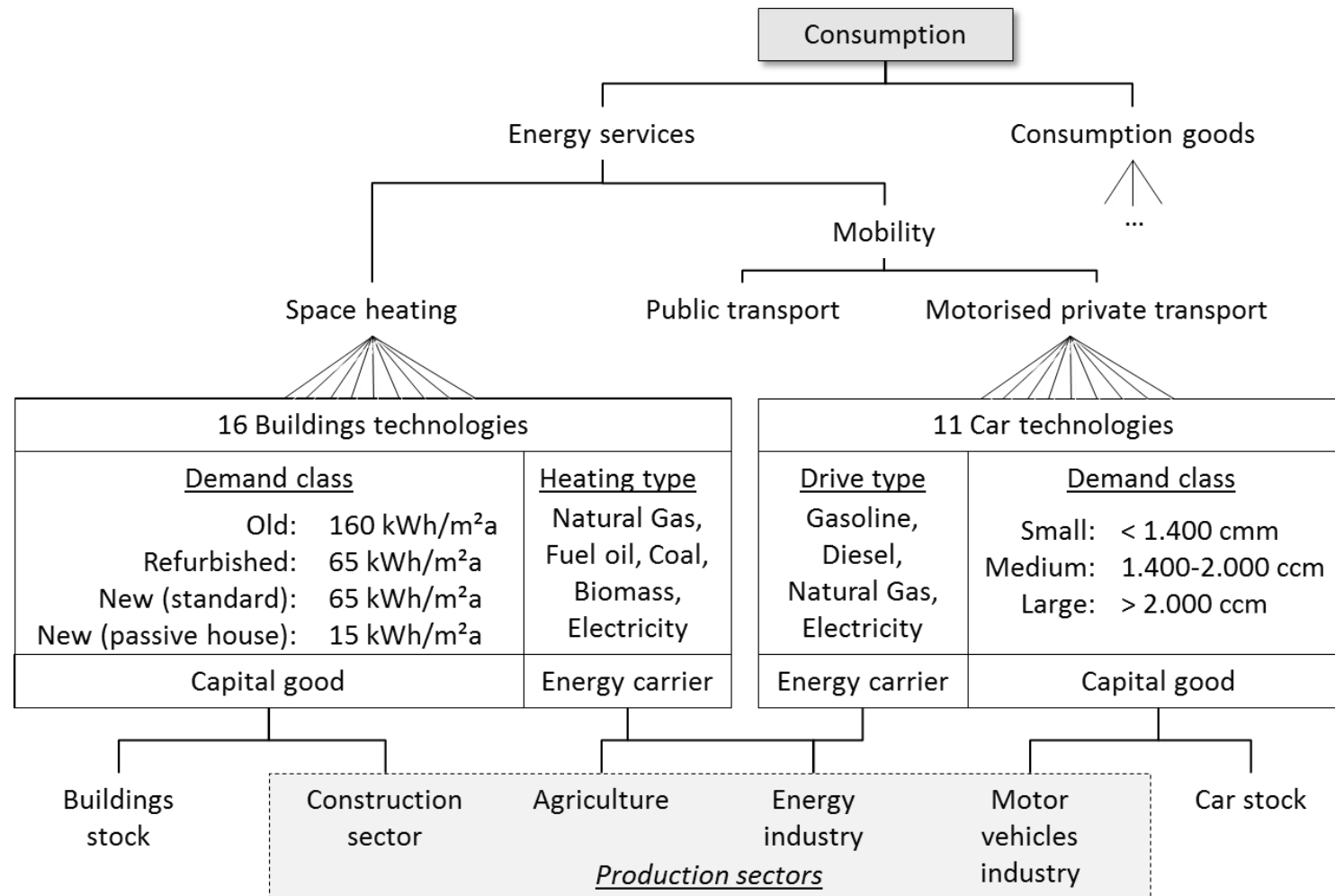


DEU	Germany
EU-15	EU-15 (w/o Germany)
NMS-10	EU New Member States



Macroeconomic cost-effectiveness of climate policy instruments in household energy demand (ongoing PhD project)

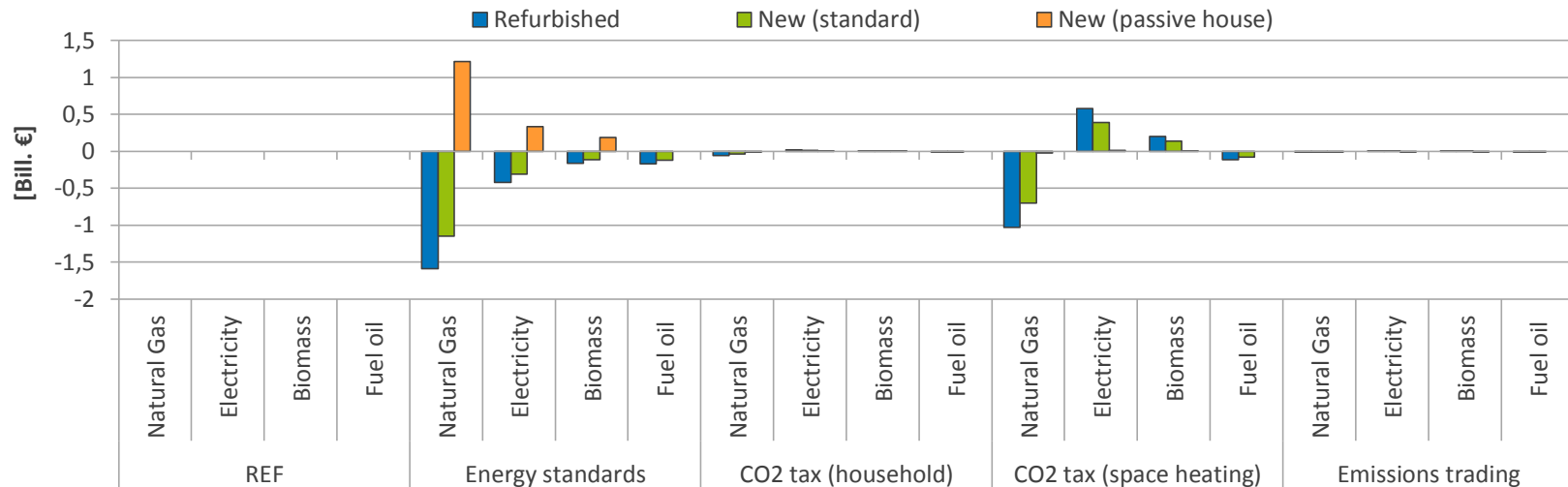
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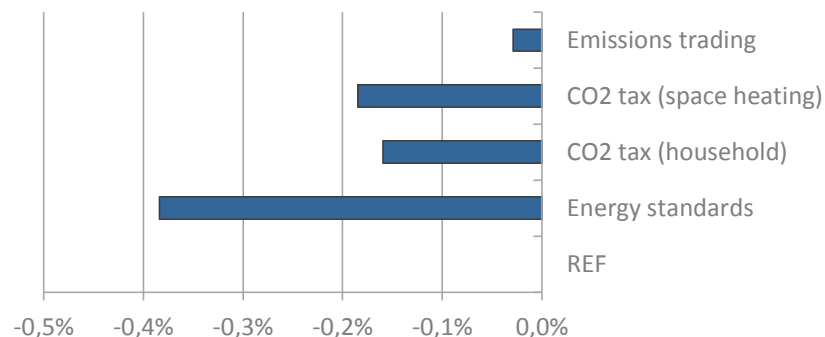
Macroeconomic cost-effectiveness of climate policy instruments in household energy demand (ongoing PhD project)

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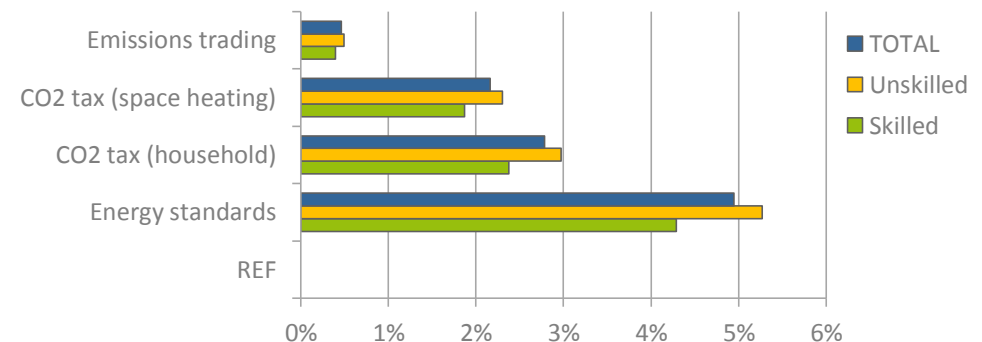
Change in household demand for new building types in Germany (difference to the reference scenario)



GDP change in Germany (relative difference to REF, in %)



Unemployment rate changes in Germany (relative difference to REF, in %)





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Summary and outlook

- The CGE model NEWAGE has the following hybrid features:
 - 18 electricity generation technologies
 - 11 vehicle technologies
 - 16 buildings technologies
 - Imperfect labor markets (unemployment)
- The closed-circle-of-income-approach allows to...
 - ... conduct macroeconomic ex-ante comparisons of different policy interventions (e.g. taxes/subsidies, emissions trading) on a global scale
 - ... assess competing investment projects (endogenous financing \Rightarrow investments = savings)
 - ... account for relative price changes (e.g. wages)
 - ... quantify net effects (e.g. net employment effects)
- Ongoing research projects
 - Competitiveness effects and macroeconomic impacts of carbon leakage options in ETS phase IV
 - Distributional impacts of European energy and climate policies