Effects of a White Certificate trading scheme on the energy system of the EU-27

Ralf Kuder

Institute of Energy Economics and the Rational Use of Energy

University of Stuttgart

08.09.2009, Vienna

Overview

- Introduction
- Energy efficiency
- Method
  - TIMES PanEU-model
  - Scenario definition and white certificates
- Results and key effects on the European Energy System (EU-27)
  - Electricity generation and Primary Energy Consumption
  - Final energy consumption and Emissions
  - Costs
- Conclusion

Introduction

EU 20/20/20 targets

- Reduction of energy consumption of 20% till 2020 by improvements of energy efficiency [EU20/20/20: emission reduction, renewable energy sources]
- Highlighting the importance of energy efficiency as part of EU energy and climate policy

Goals of Energy efficiency improvements:

- Reduction of emissions
- Security of supply (reduced import dependency of oil and gas)
- Reducing energy related costs
- Competitiveness of European industry (positive impact on labour market)

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Energy efficiency

Definition EU

- Ratio between an output (output of performance, service, goods or energy) and input of energy Source: Directive 2006/32/EC, April 2006

EU 20/20/20 target

- Reduction of primary energy consumption in 2020 compared to a reference development (PRIMES) [target in absolute terms]

Use of IEA (Focus on Industry)

- Industrial sub-sectoral energy intensity as proxy for energy efficiency
  Source: worldwide trend in energy use and efficiency, OECD/IEA 2008

Implementation

- White certificate as possible measure to increase energy efficiency

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TIMES PanEU – model description (I)

General model characteristics

- Energy system model
- Technology oriented bottom-up model
- Perfect foresight
- Objective function: Minimization of total costs (optimisation model)
- Multiregional model with trade processes (electricity, bio fuels)
- Starting point: EU-Project NEEDS

TIMES PanEU – model description (II)

Specification: **TIMES PanEU**

- Modelling horizon 2000 – 2050
- 12 time slices (4 seasonal, 3 day level)
- 30 region model (EU 27 + IS, NO, CH)
- Country specific differences (characterisation of new power plants, load curves, availability factors for renewable energy sources, ...)
- Detailed electricity exchange balances
- Emissions: Greenhouse gas emissions and Pollutants
- Sectors: Public and industrial electricity and heat supply, conversion, industry, residential, commercial, transport and agriculture

Scenario definition and white certificates

Scenario	Description
REF	▪ Business as usual [**Ref**eren**c**e case] ▪ -21% CO_2 reduction till 2020 in ETS sector
FEC	▪ -21% CO_2 reduction till 2020 in ETS sector ▪ Reduction target **F**inal **E**nergy **C**onsumption [white certificates for FEC]
FEC_450ppm	▪ -21% CO_2 reduction till 2020 in ETS sector **+** 450ppm target till 2050 ▪ Reduction target **F**inal **E**nergy **C**onsumption [white certificates for FEC]
PEC	▪ -21% CO_2 reduction till 2020 in ETS sector ▪ Reduction target **P**rimary **E**nergy **C**onsumption [white certificates for PEC]
PEC_450ppm	▪ -21% CO_2 reduction till 2020 in ETS sector **+** 450ppm target till 2050 ▪ Reduction target **P**rimary **E**nergy **C**onsumption [white certificates for PEC]

Certificates	Description
White Certificates	▪ EU-27 cap with European-wide trade of certificates for FEC/PEC

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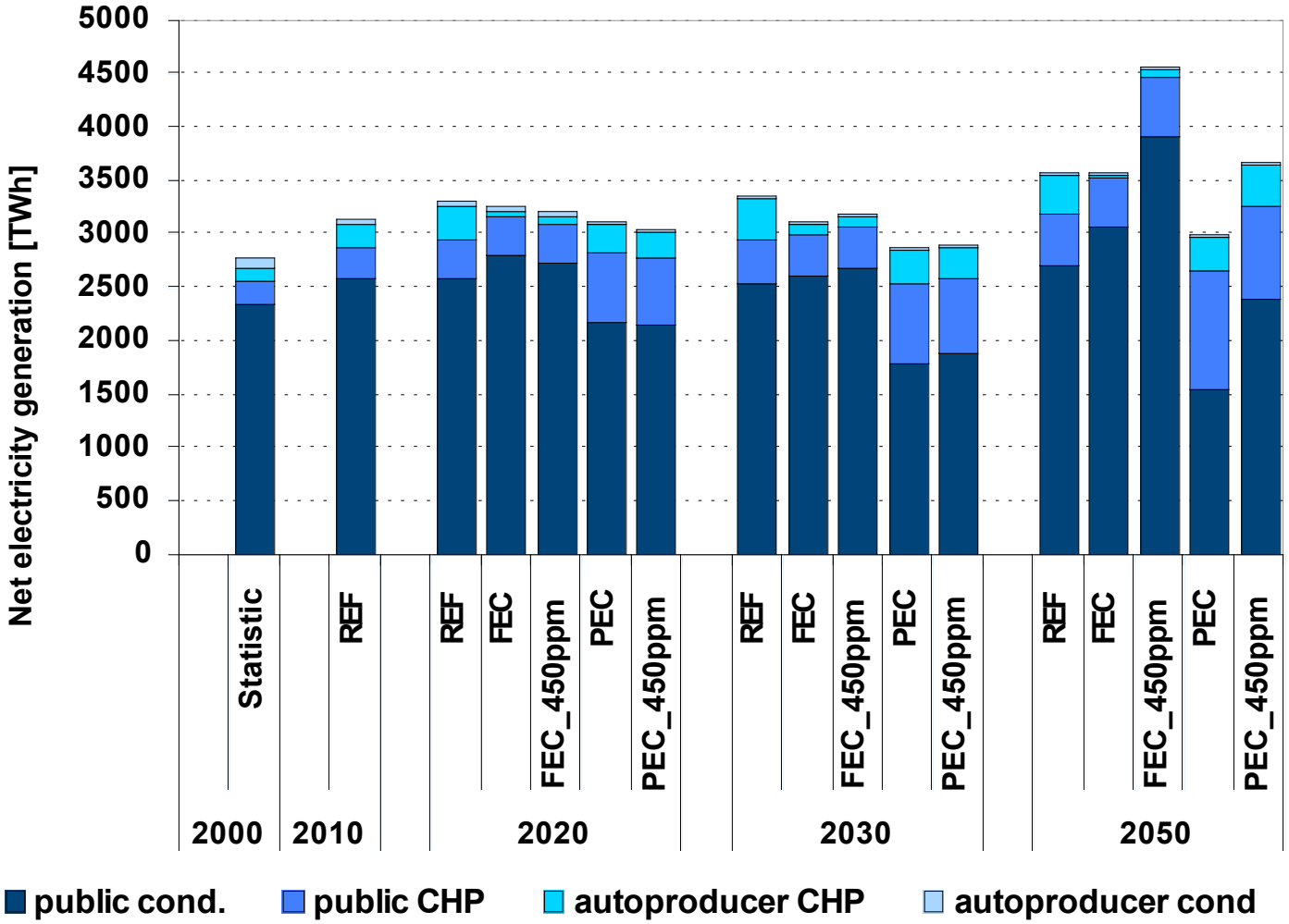
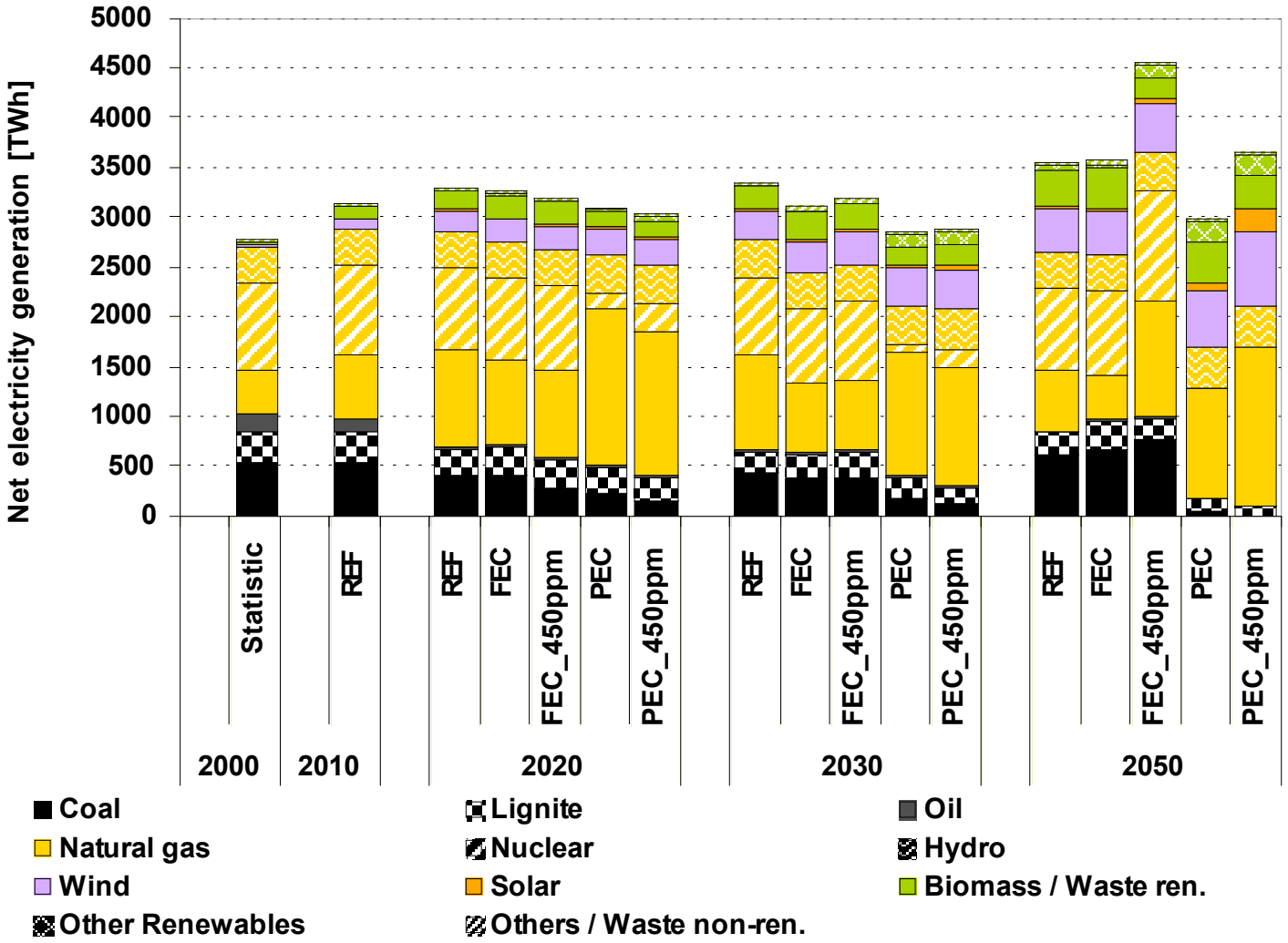
Net electricity generation by technology (EU-27)



Key effects:

- **FEC:** Increase of public generation from condensing power plants/ decrease auto production (industry)
- **PEC:** Increase public CHP/ decrease public condensing plants (total decrease)
- **450ppm:** Increase of electricity generation in both scenarios

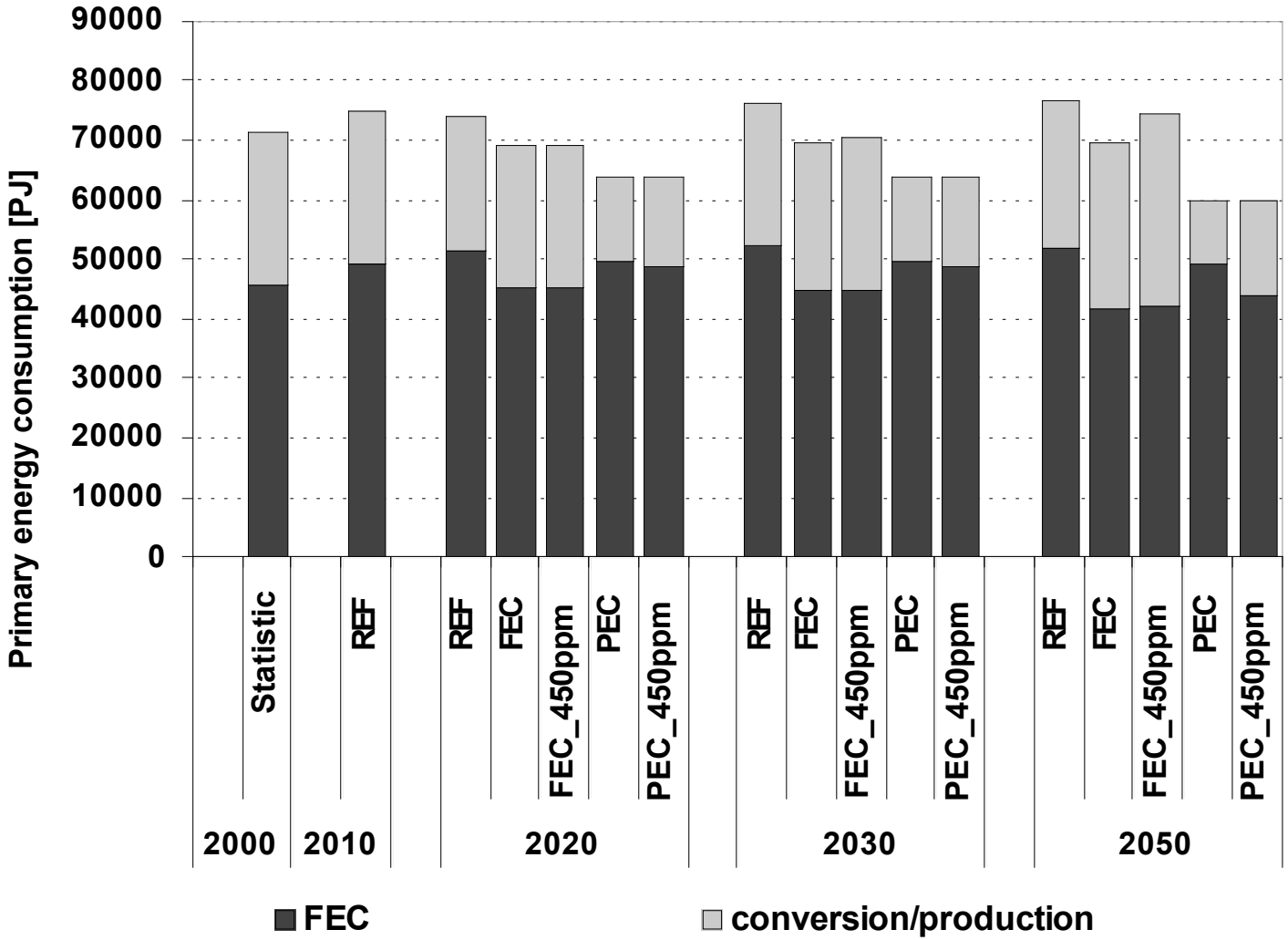
Net electricity generation by energy carrier (EU-27)



Key effects:

- **FEC:** less industrial gas fired CHP's / more public coal-fired
- **FEC_450:** Increased use of CCS
- **PEC:** main influence from efficiency (partly statistical effect): Decline of nuclear and coal, rise of gas (mainly in CHP) and other renewables

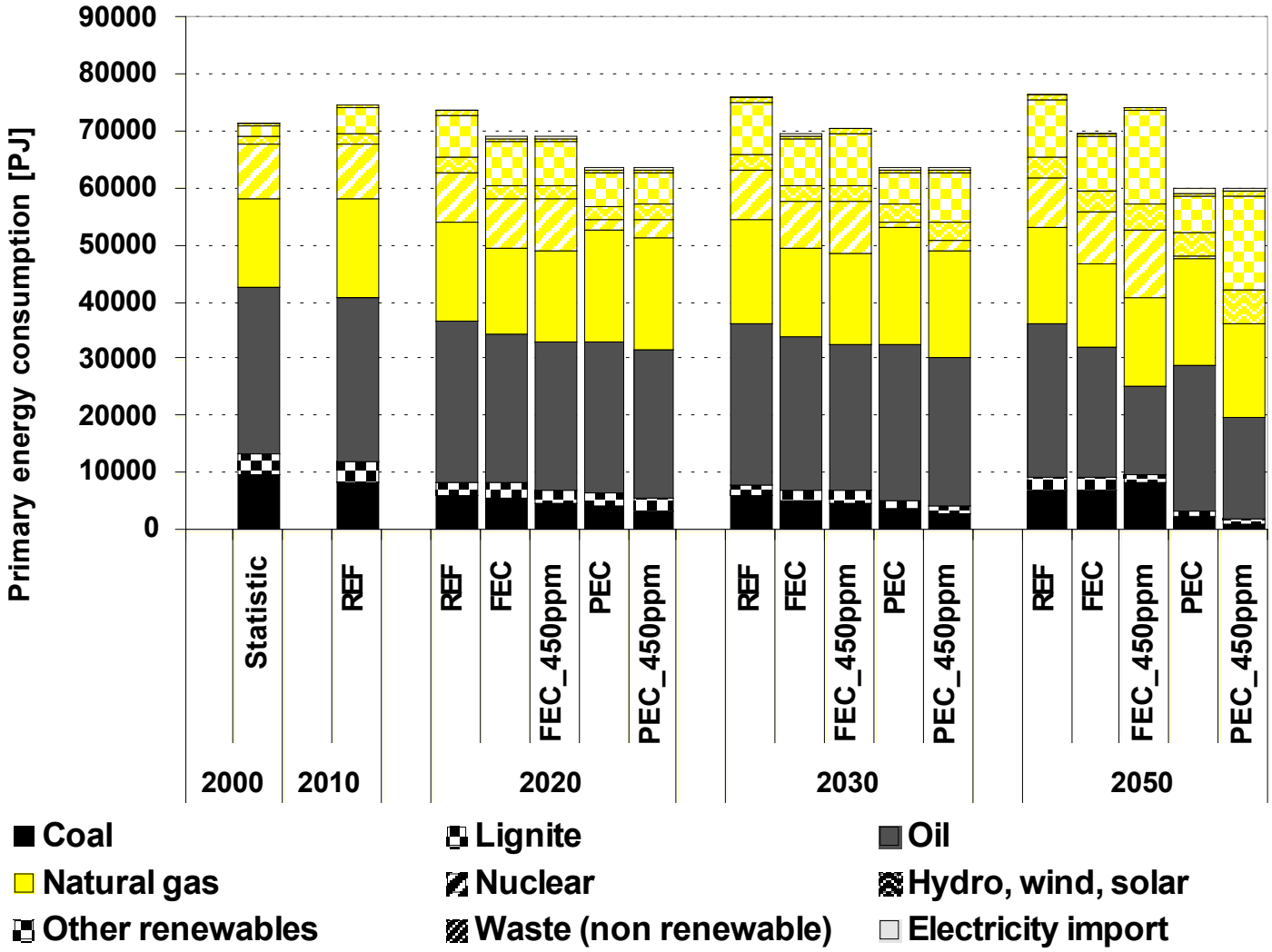
Primary energy consumption (EU-27)



Key effects:

- **white certificate trade:** Impact beginning in 2020
- **FEC_450:** higher use in conversion/ production (higher elec. generation + CCS)
- **PEC:** Restriction fulfilled in conversion/ production
- **PEC_450:** also effect in end use sectors

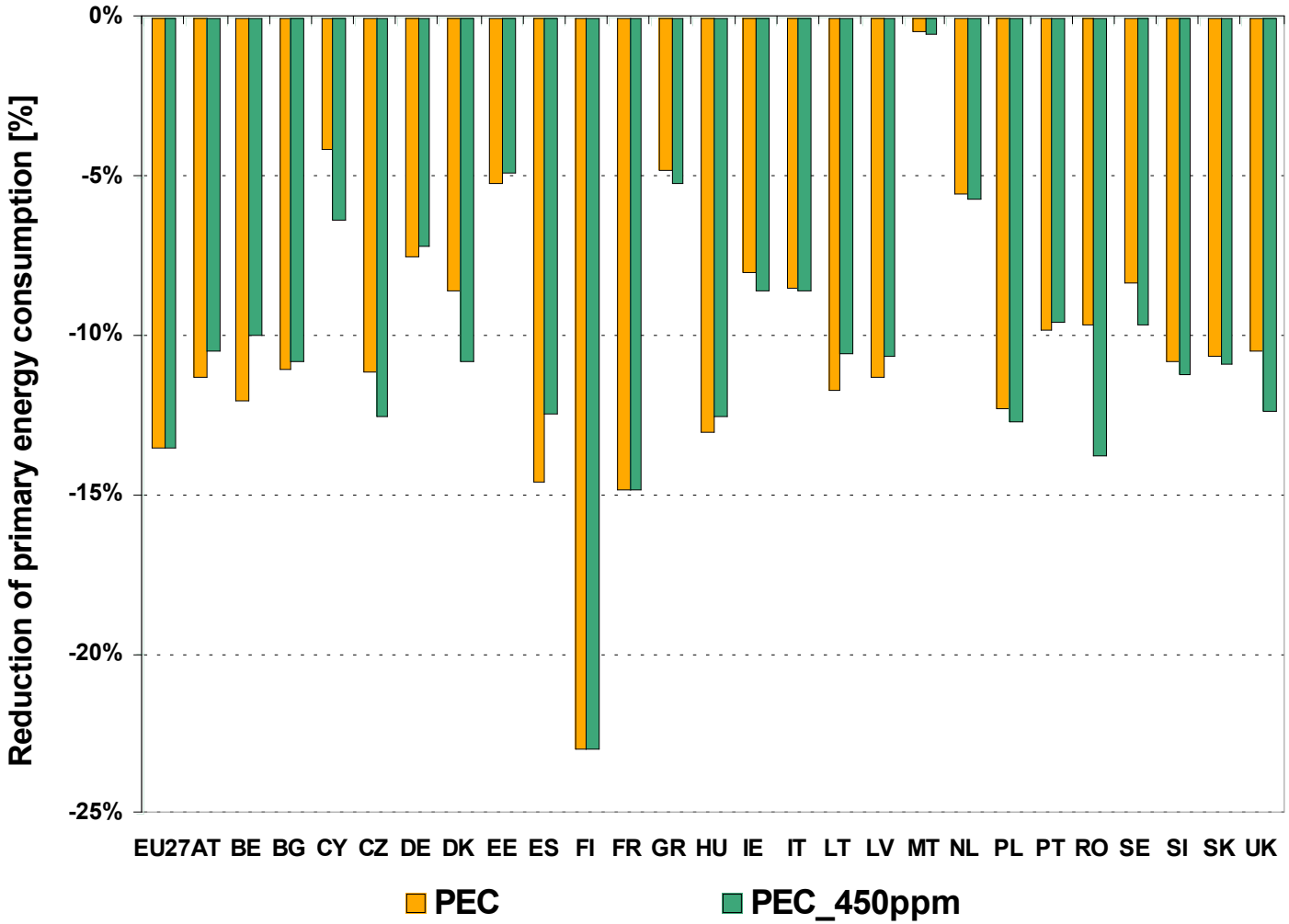
Primary energy consumption by energy carrier (EU-27)



Key effects:

- **FEC:** mainly reduction of gas (industrial CHP) and oil
- **PEC:** Decrease of nuclear and coal, increase of gas (public CHP)
- **450_ppm:** in both scenarios higher use of renewable energy sources and less oil

Burden sharing: Reduction of primary energy consumption [scenarios compared to REF in 2020]

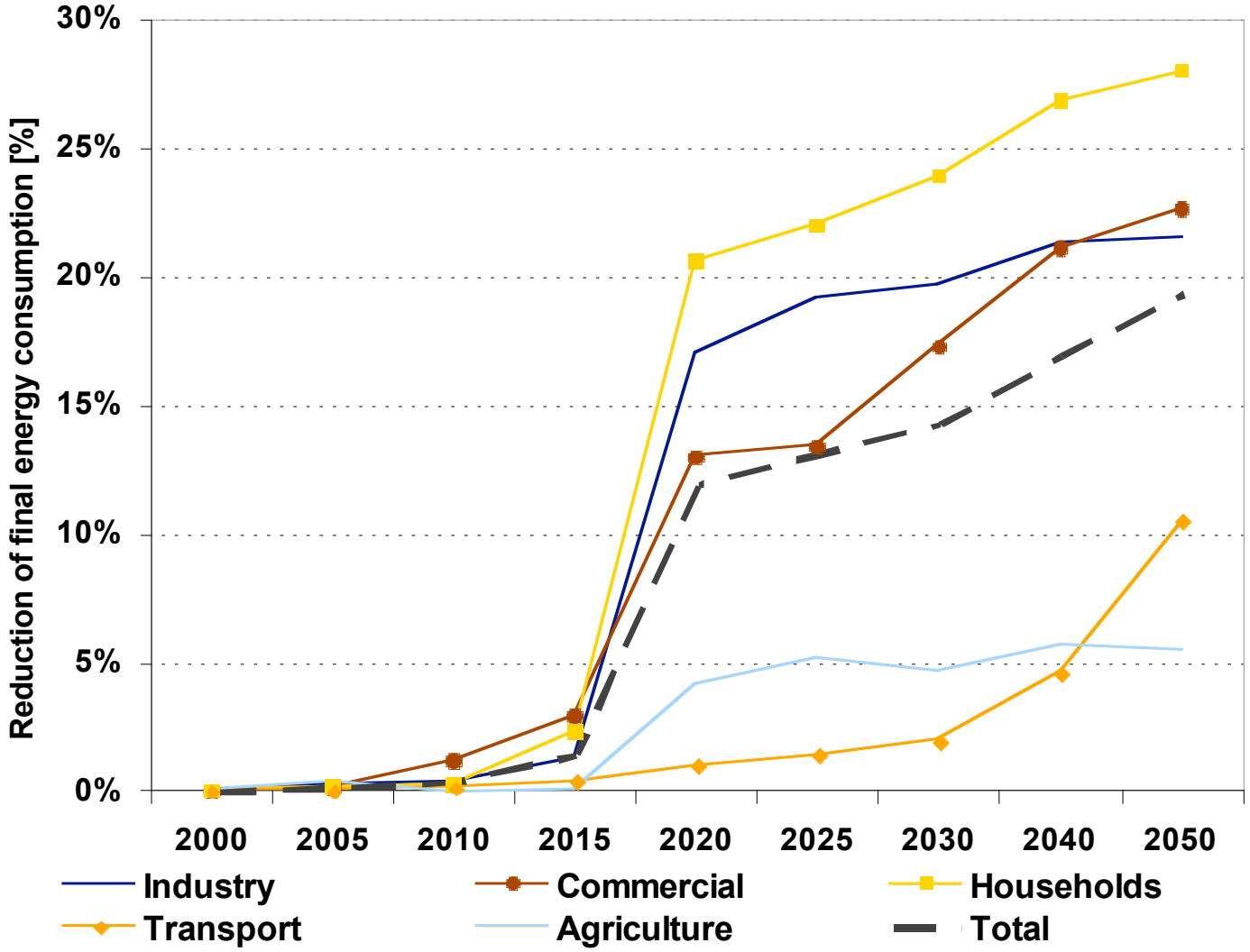


Key effects:

- **Key driver:** the main influence has the conversion/ production sector, especially the electricity generation
- **Burden sharing:** according to changes in electricity generation (less nuclear/coal); also changes in electricity trade

Reduction final energy consumption by sector (EU-27)

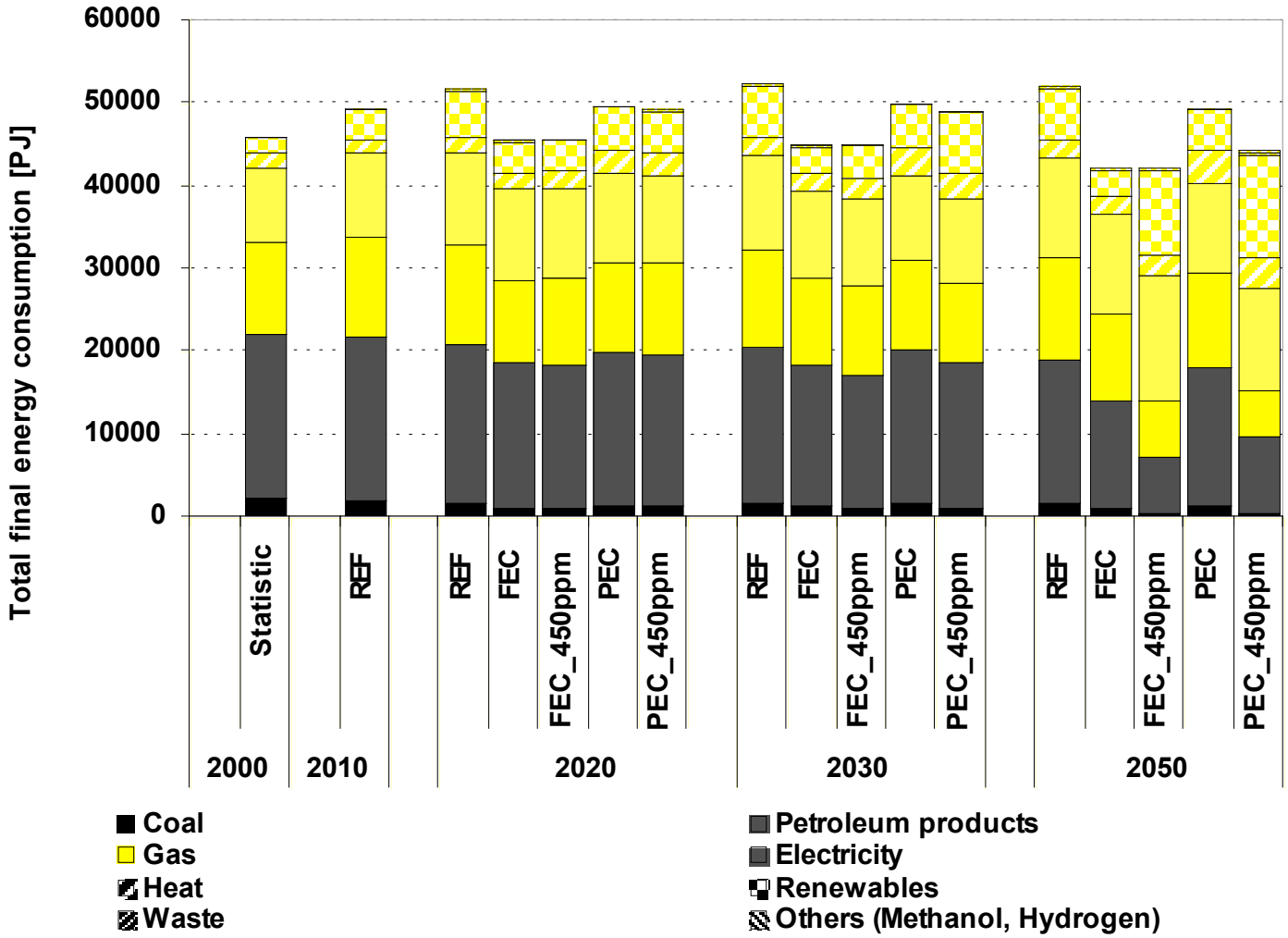
[scenario FEC compared to REF]



Key effects:

- **Sector view:** reduction mainly in residential and industry (main driver: space and process heat supply)
- **2025:** also clear reduction in commercial sector
- **Transport:** no clear reduction before 2040

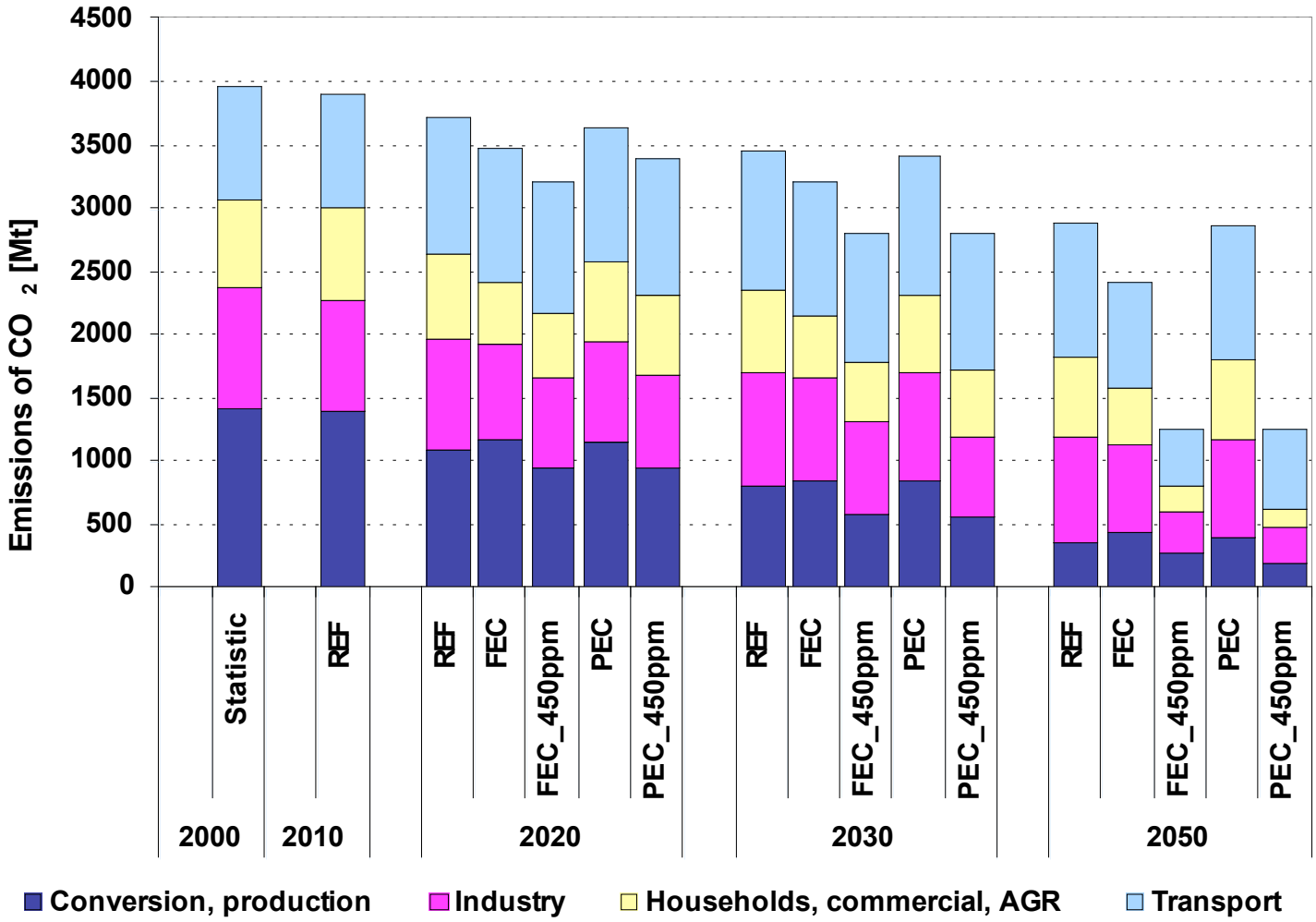
Final energy consumption (EU-27)



Key effects:

- **FEC:** less renewables
- **450ppm:** in both scenarios higher share of electricity and renewables, less oil
- **PEC:** just small changes compared to scenario REF (shift to district heat, less renewables)

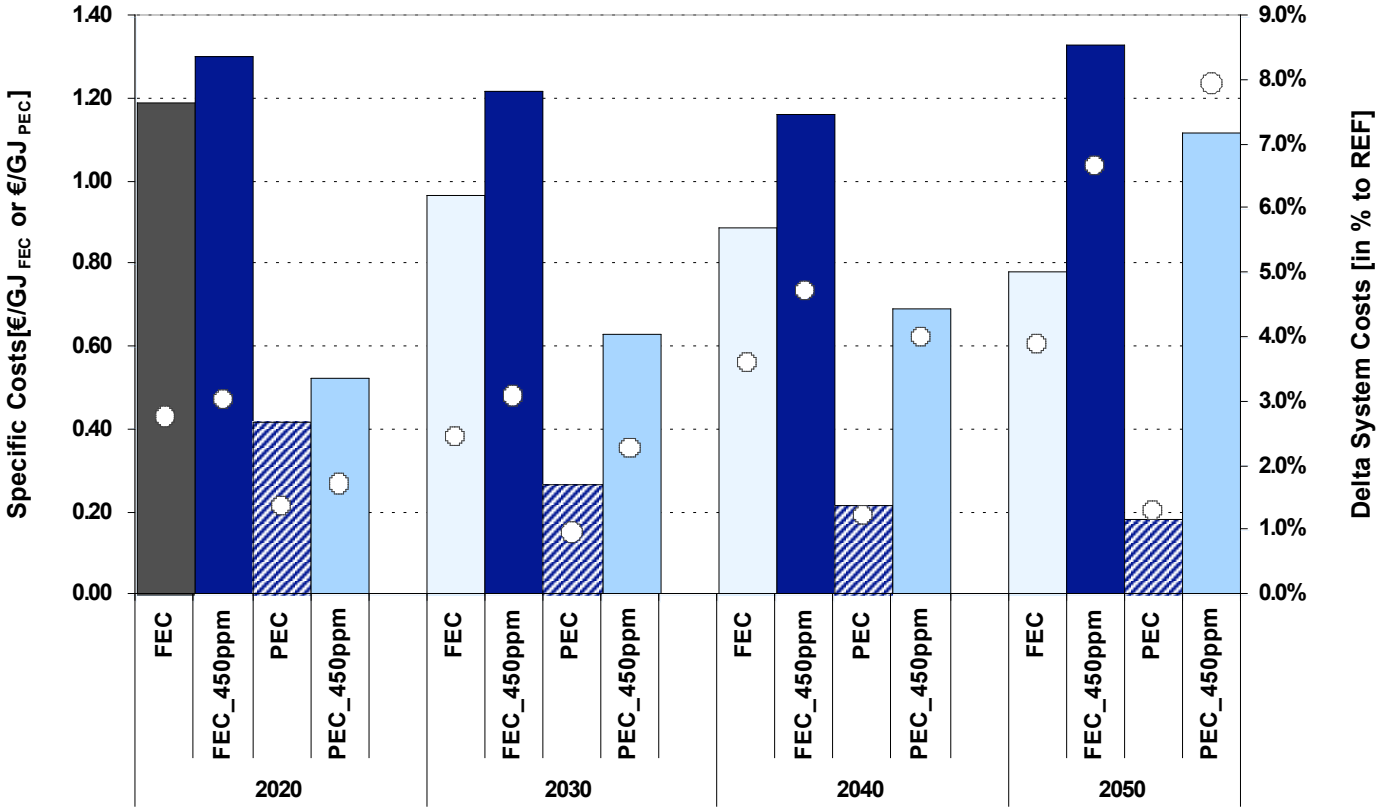
CO_2-Emissions (EU-27)



Key effects:

- **PEC:** same level of emissions like REF; higher emissions in conversion/ production
- **FEC:** shift of emissions to conversion/ production sector, reduction in industry
- **450ppm:** different reduction strategies

Costs of white certificates and overall costs



Key effects:

- **450ppm:** In both scenarios leads 450ppm target to higher costs
- **FEC:** costs of FEC always above PEC due to less flexibility (FEC: reaching target only in end use sectors; PEC almost completely in conversion/Production)
- **PEC_450:** dominated by climate costs

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Conclusion (I)

Key findings

- **White certificates based on final energy [FEC]:**
  - shift of conversion losses to public sector (increase of electricity from public condensing power plants, less from industrial autoproducer)
  - stronger effect on emissions, but to higher costs (compared to PEC)

- **White certificates based on primary energy [PEC]:**
  - main changes in production / conversion, key driver efficiency
  - Just small effects on emissions (independent targets)
  - No clear improvement of security of supply (reduction nuclear and biomass, increased use of gas)

=> PEC (representing EU target): EU intention of energy efficiency improvements not fulfilled

Conclusion (II)

Key findings

- **White certificates based on final energy + 450ppm [FEC_450ppm]:**
  - clearly higher use of electricity (including considerable use of CCS, also more nuclear and renewables)
  - high end use energy efficiency (electricity based applications)

  => more emissions in conversion/production (compared to PEC_450), less in end use sectors (different strategy to fulfil 450ppm target)

- **White certificates based on primary energy + 450ppm [PEC_450ppm]:**
  - high share of CHP's, strong use of wind, solar and other renewables

  => Efficiency (end use + mainly conv./prod.) and renewables in end use sectors

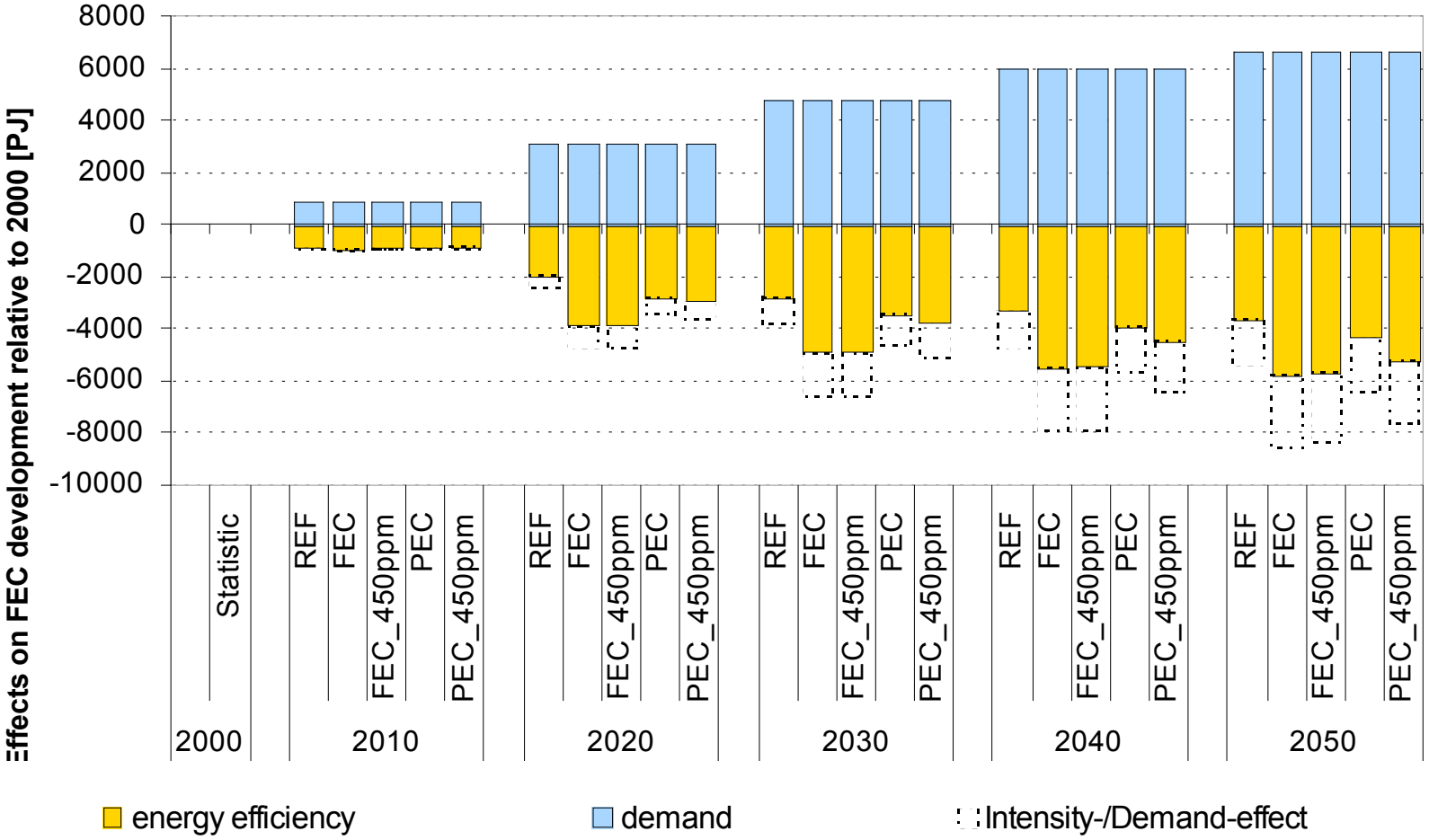
contact:

Ralf Kuder

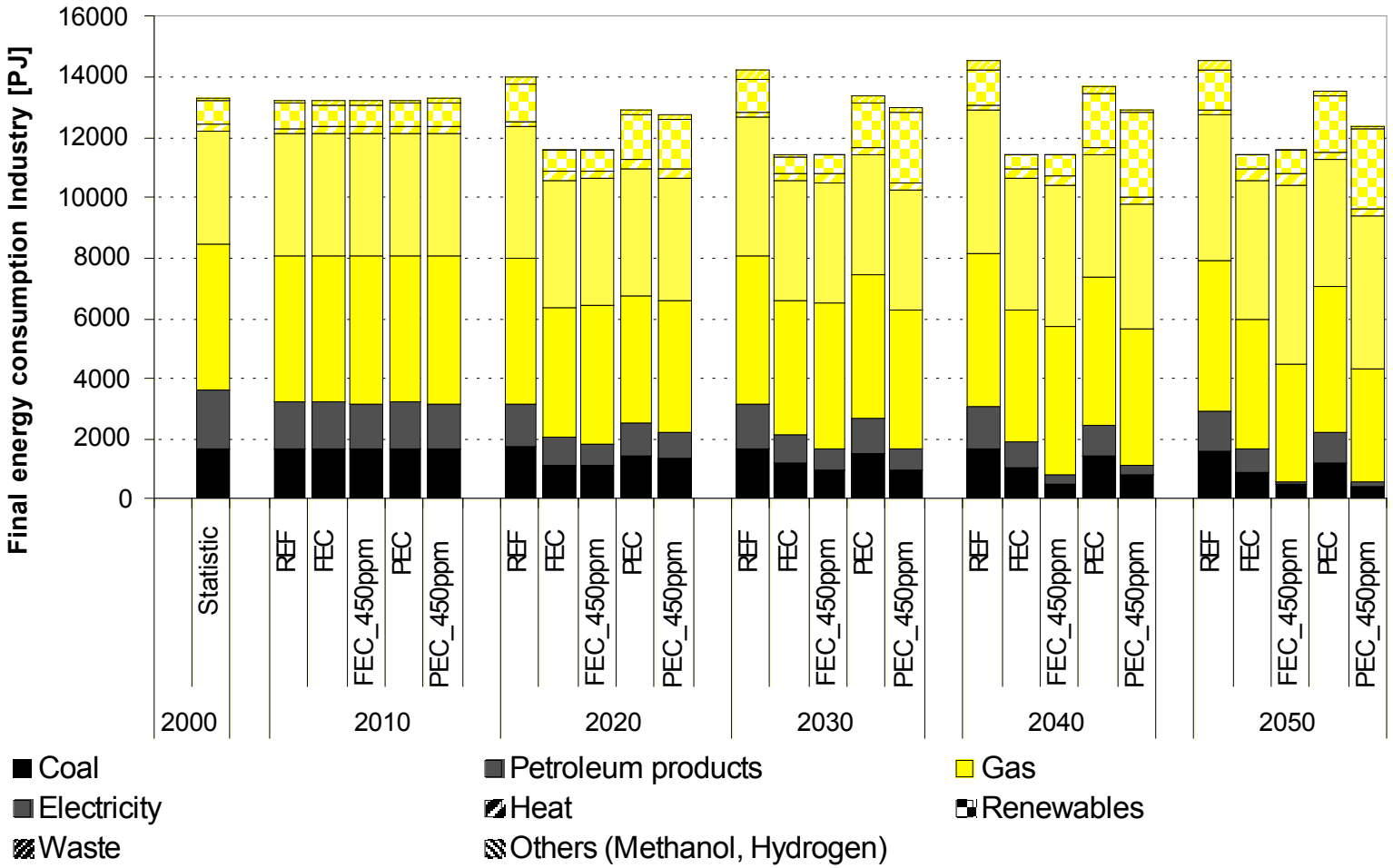
IER [Institute of Energy Economics and the Rational Use of Energy]
ralf.kuder@ier.uni-stuttgart.de

BACKUP

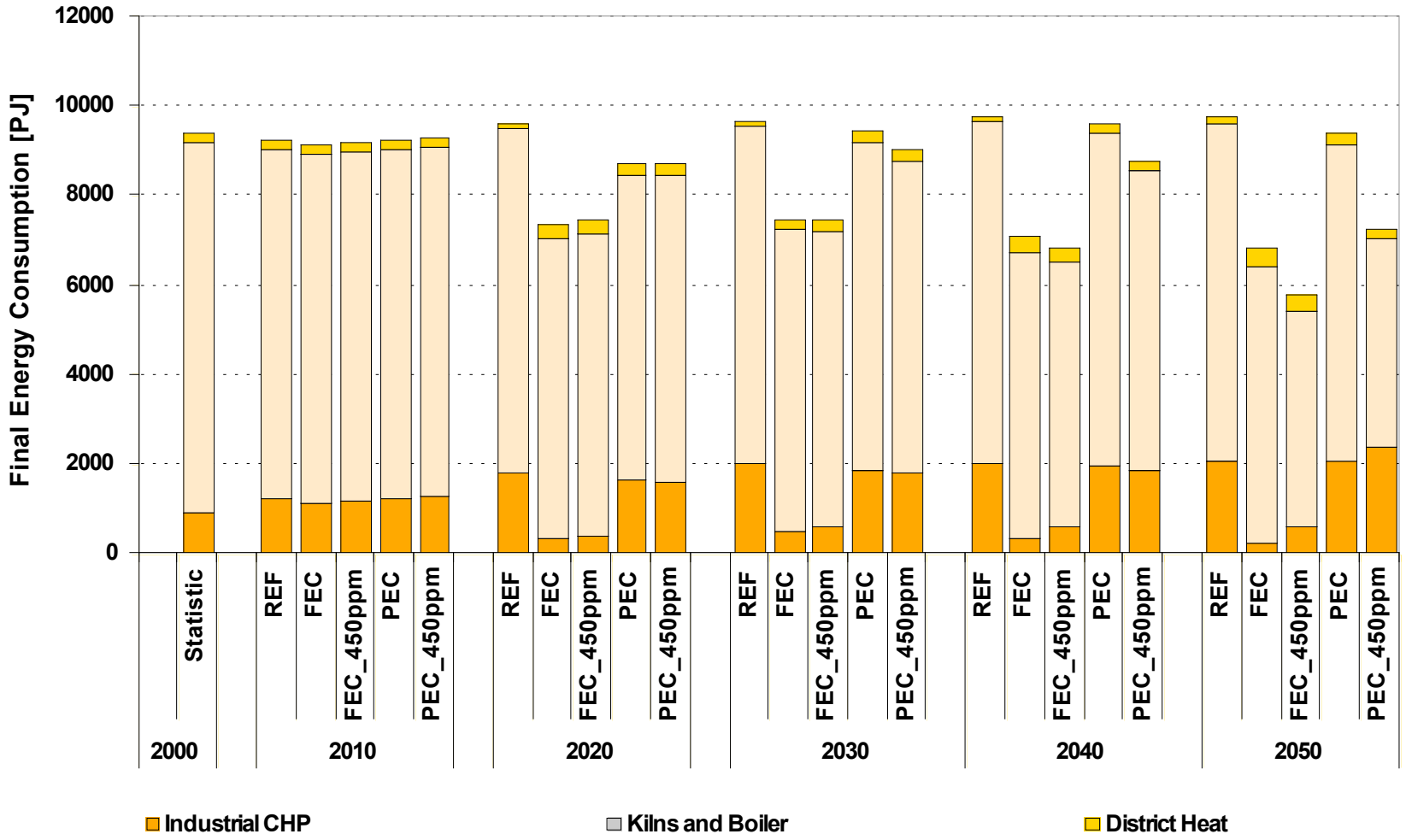
Reduced FEC by energy efficiency improvements (Industry EU-27)



Final energy consumption Industry (EU-27)



Heat supply Industry from fuels by generation technologies (EU-27)



Energy efficiency indicators

Scenario	2000	2010	2020	2030	2040	2050
REF	100.0	88.3	73.3	61.2	51.6	44.2
FEC	100.0	87.9	64.5	52.4	42.9	35.6
FEC_450ppm	100.0	88.0	64.5	52.4	43.0	35.7
PEC	100.0	87.9	70.5	58.3	49.2	41.8
PEC_450ppm	100.0	87.9	69.8	57.3	47.1	37.4

Scenario	2000	2010	2020	2030	2040	2050
REF	100.0	86.3	67.6	57.3	48.4	41.8
FEC	100.0	86.1	63.3	52.4	43.9	38.1
FEC_450ppm	100.0	86.2	63.3	53.1	46.8	40.6
PEC	100.0	86.0	58.5	48.0	39.2	32.7
PEC_450ppm	100.0	86.0	58.5	48.0	39.2	32.7

Scenario	Description	UNIT	2020	2030
PRIMES	Primary energy consumption	PJ	82378	83933
EU target (in PJ)	Primary energy consumption	PJ	65903	67147
REF	reduction primary energy to PRIMES	%	-10.2%	-9.1%
FEC	reduction primary energy to PRIMES	%	-15.9%	-16.9%
FEC_450ppm	reduction primary energy to PRIMES	%	-15.9%	-15.8%
PEC	reduction primary energy to PRIMES	%	-22.3%	-23.9%
PEC_450ppm	reduction primary energy to PRIMES	%	-22.3%	-23.9%