



# Impact of emission reduction and energy saving targets on the industrial heat supply in the EU-27

– model based analysis with TIMES PanEU

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# Overview

- Introduction
- Approach
  - i. TIMES PanEU model and modelling of the industrial sector
  - ii. Scenario definition
- Results and key effects (EU-27)
  - i. Primary and Final Energy Consumption
  - ii. CHP and industrial heat supply
  - iii. Emissions and costs
- Conclusion



# Introduction

## Energy policy and the industrial sector in the EU-27

- EU 20/20/20 targets: Emissions / Efficiency /Renewables
  - i. **Interaction** of different policy targets (focus: GHG + Primary Energy)
  - ii. Influence on industrial sector
  - iii. Focus on **heat supply** technologies
- Characteristics of industrial sector
  - i. Energy consumption dominated by **heat demand**
  - ii. Use of heat on different **temperature levels**
  - iii. Use of specific production processes, non subsector specific cross-cutting technologies and energy supply technologies



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# TIMES PanEU – model description

## Model characteristics

- Technology oriented Energy system model
- Bottom-up model
- Perfect foresight
- Modelling horizon 2000 – 2050 with 12 time slices (4 seasonal, 3 day level)
- Objective function: Minimization of total costs
- Multiregional model (30 regions) with internal trade processes (electricity, bio fuels) and country specific differences (characterisation of power plants, load curves, availability factors for renewable energy sources, ...)
- Sectors: Public and industrial electricity and heat supply, conversion, industry, residential, commercial, transport and agriculture



## Industry sector in TIMES PanEU

### energy intensive industries

- Iron&Steel, Aluminium, Copper
- Ammonia, Chlorine
- Cement, Lime, Glass
- Pulp & Paper

- Process orientated Reference Energy System
- Demand for final products in natural units (Mt) and based on a link with a general equilibrium model (NEWAGE)

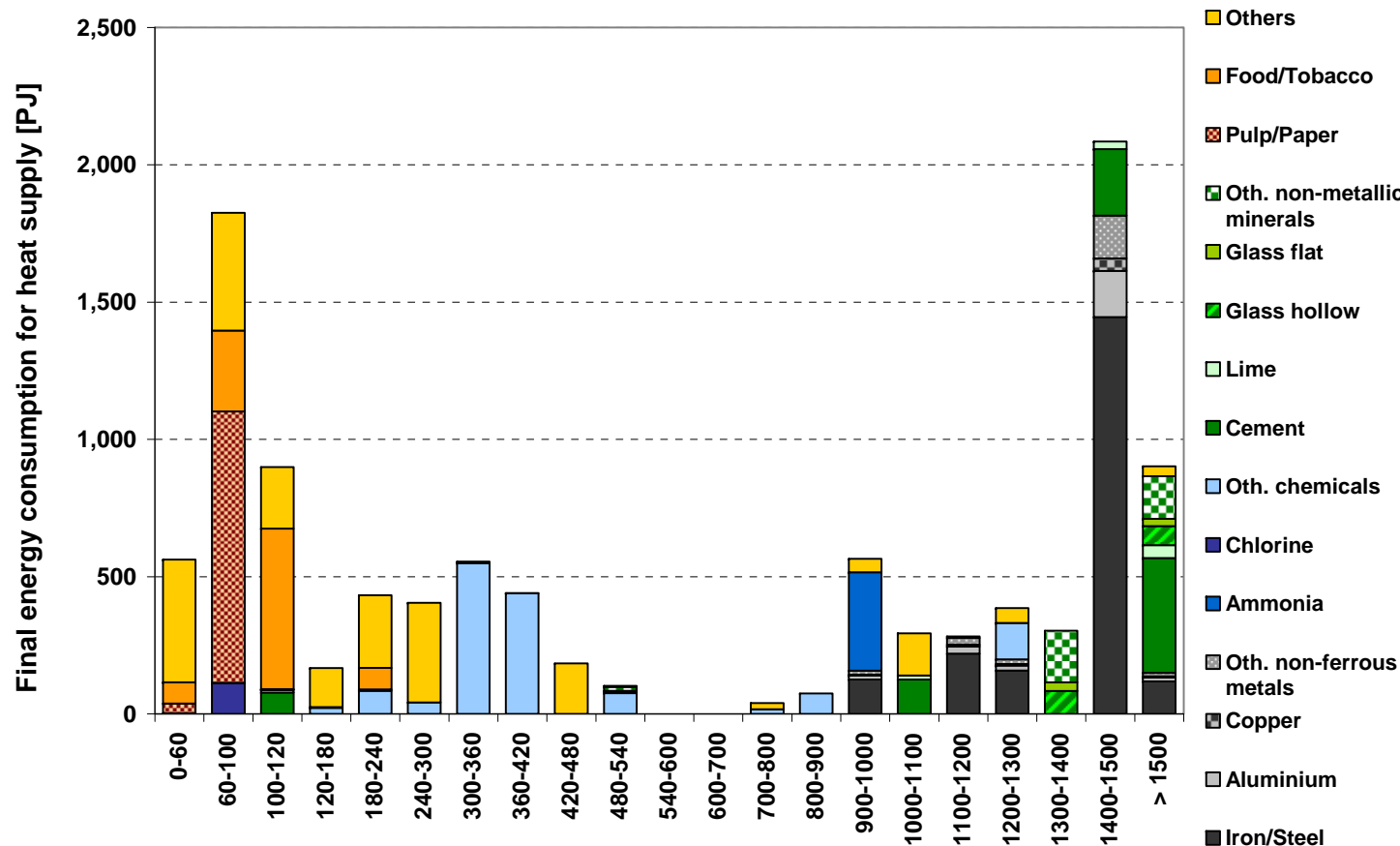
### non-intensive industries

- Other NF-metals, Other chemicals, Other NM-Minerals
- Food & Tobacco
- Other Industries

- Standard structure of 5 main energy uses (Steam, Process heat, Machine drive, Electro-chemical, Others)
- Food & Tobacco + Others: additional energy uses like space heat, hot water, cooling, pumps
- Demand for energy uses (PJ)



# Heat demand of industrial sector (EU-27)



- Temperature level of heat demands determines CHP potential
- Use of CHP => till about 550°C
- Key sectors for CHP: Pulp & Paper, Chemicals, Food & Tobacco and Other industries



## Scenario definition

|  | PEC target [ <b>P</b> rimary <b>E</b> nergy <b>C</b> onsumption]<br>(2010-2050) |             |             |
|--|---|-------------|-------------|
| GHG target<br>[ <b>G</b> reenhouse <b>G</b> as emissions]<br>(1990-2050) | 0%  | -10%        | -20%        |
| -56%   | GHG56   | GHG56_PEC10 | GHG56_PEC20 |
| -75%   | GHG75   | GHG75_PEC10 | GHG75_PEC20 |
| -80%   | GHG80   | GHG80_PEC10 | GHG80_PEC20 |



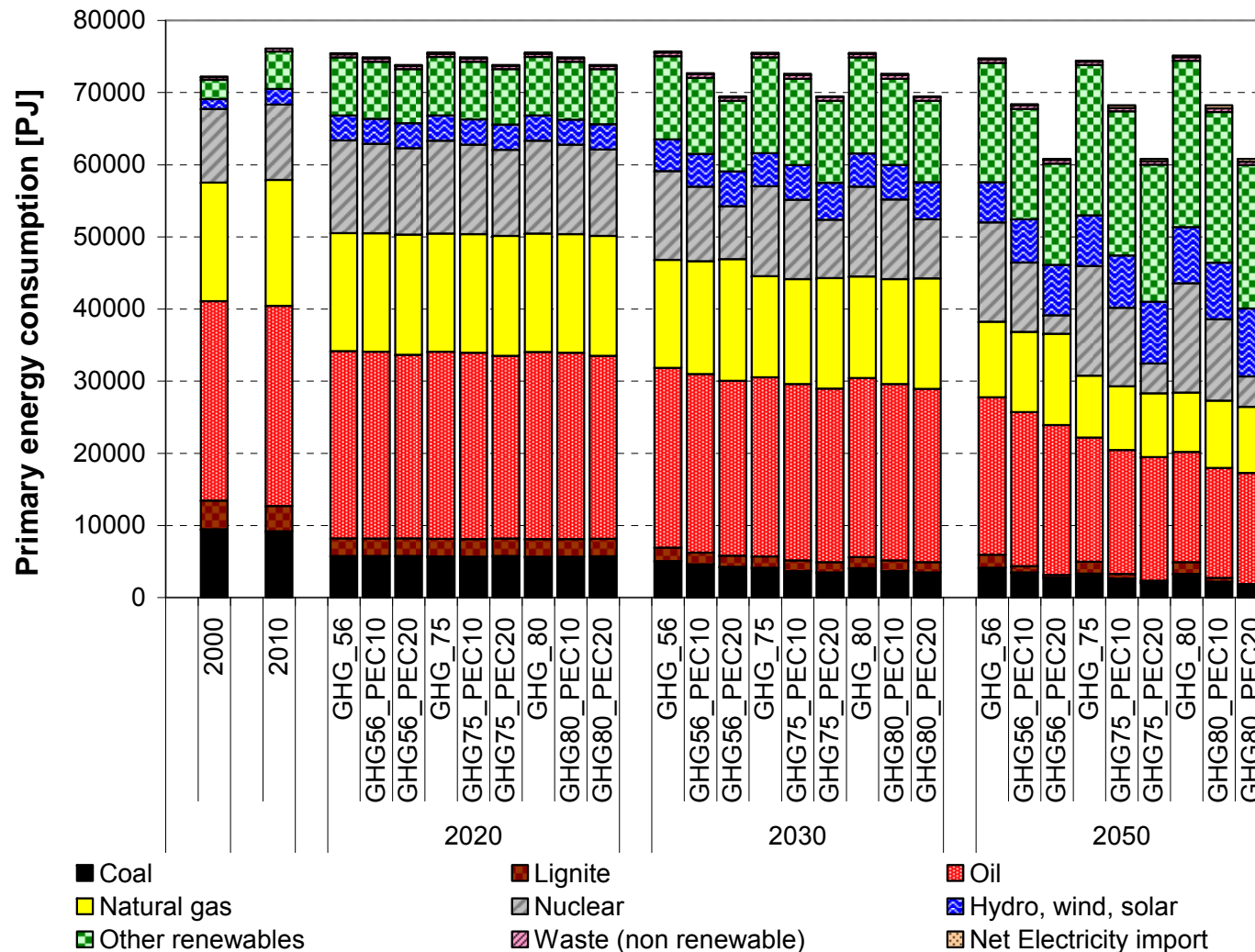


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# Primary Energy Consumption (EU-27)



- GHG target:

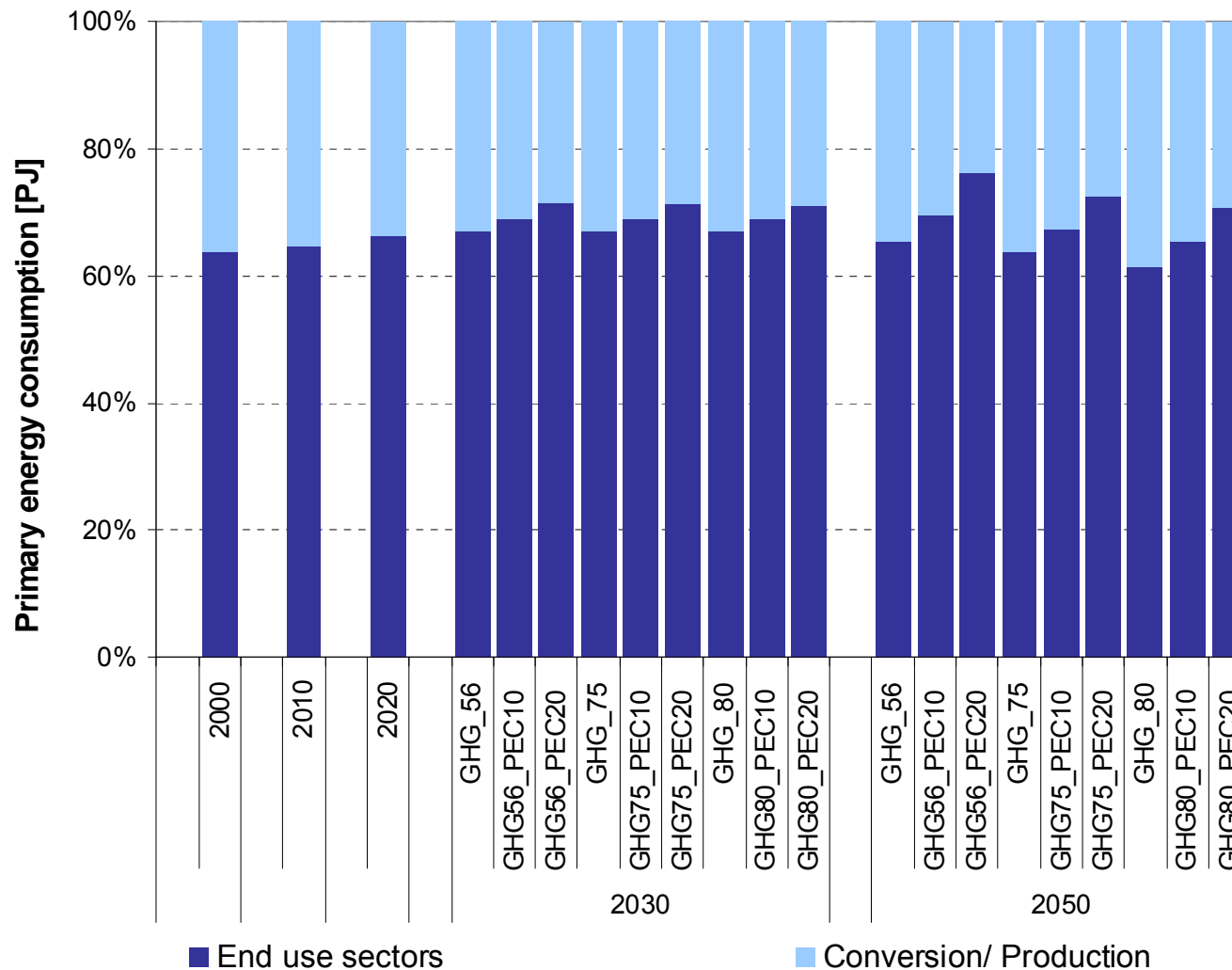
- i. Total PEC just slightly influenced by GHG target
- ii. Effects balance out (efficiency; renewables/CCS/ nuclear)

- PEC target:

- i. Use of more efficient technologies (conversion + end use)
- ii. Influence of balancing method (less nuclear more wind and PV)



# Primary Energy Consumption (EU-27)



- GHG target:

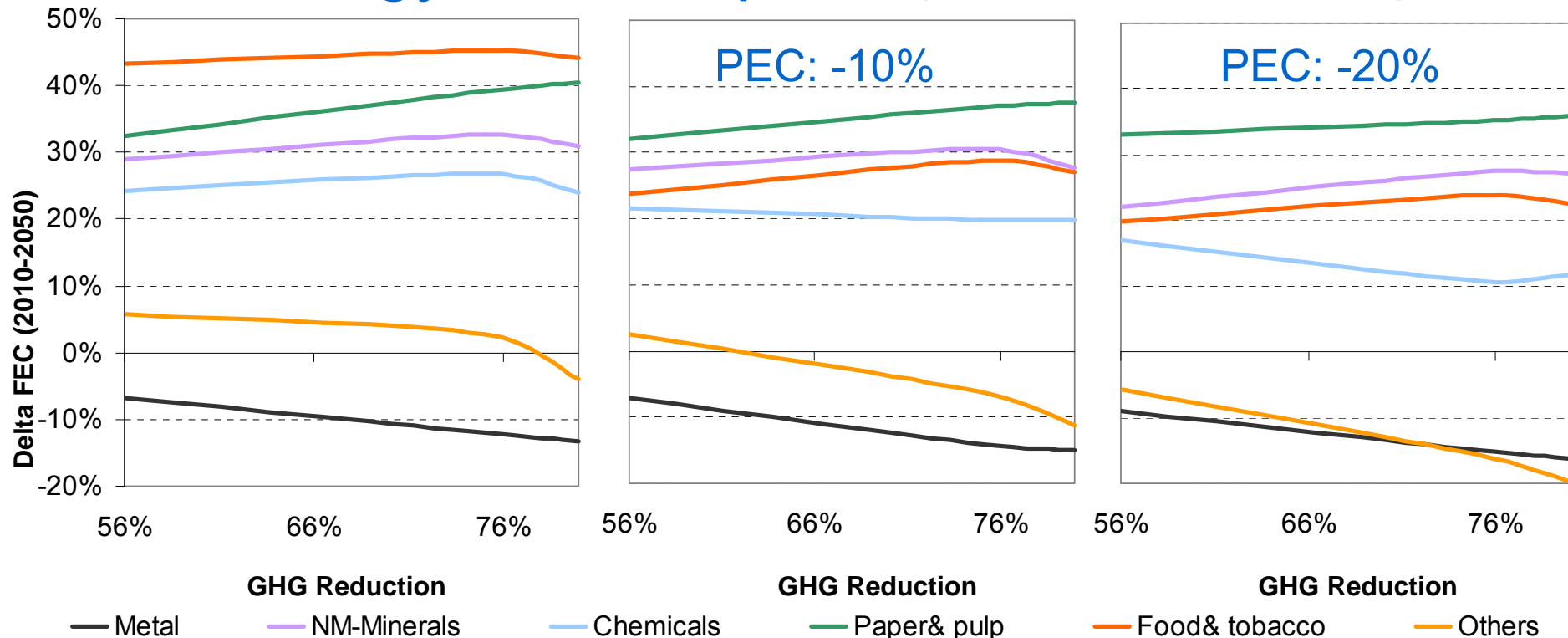
- i. Stricter target leads to higher use of Electricity => higher conversion losses/share of conversion

- PEC target:

- i. Main contribution by the conversion sector
  - ii. Stricter target leads to less use of Electricity + high share of wind, solar, hydro => reduced conversion losses



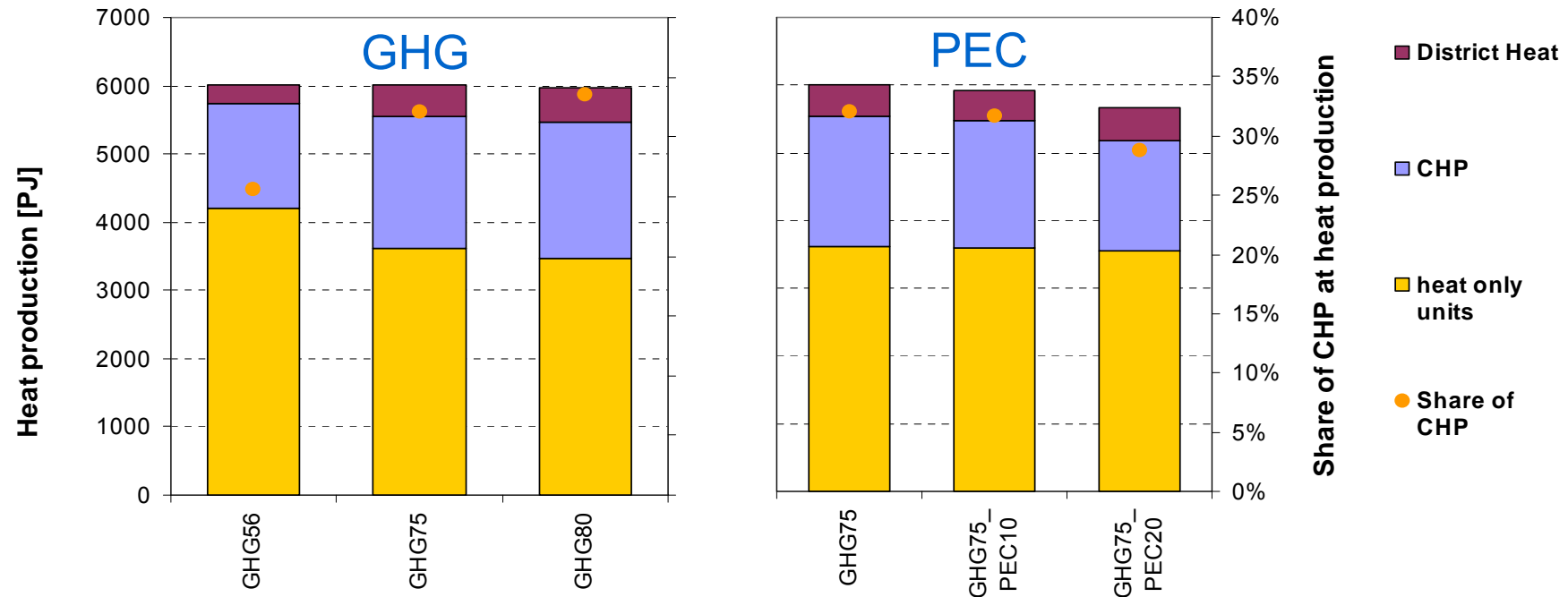
## Final Energy Consumption (Delta 2010-2050)



- In general: Increasing final energy consumption mainly driven by increasing production levels (clear decrease in specific consumption)
- Stricter GHG target: higher use of CCS, Renewables or CHP could lead to higher FEC
- Stricter PEC target: Decreasing FEC (more efficient production processes and energy supply, reduced demand for heat, cooling, compressed air)



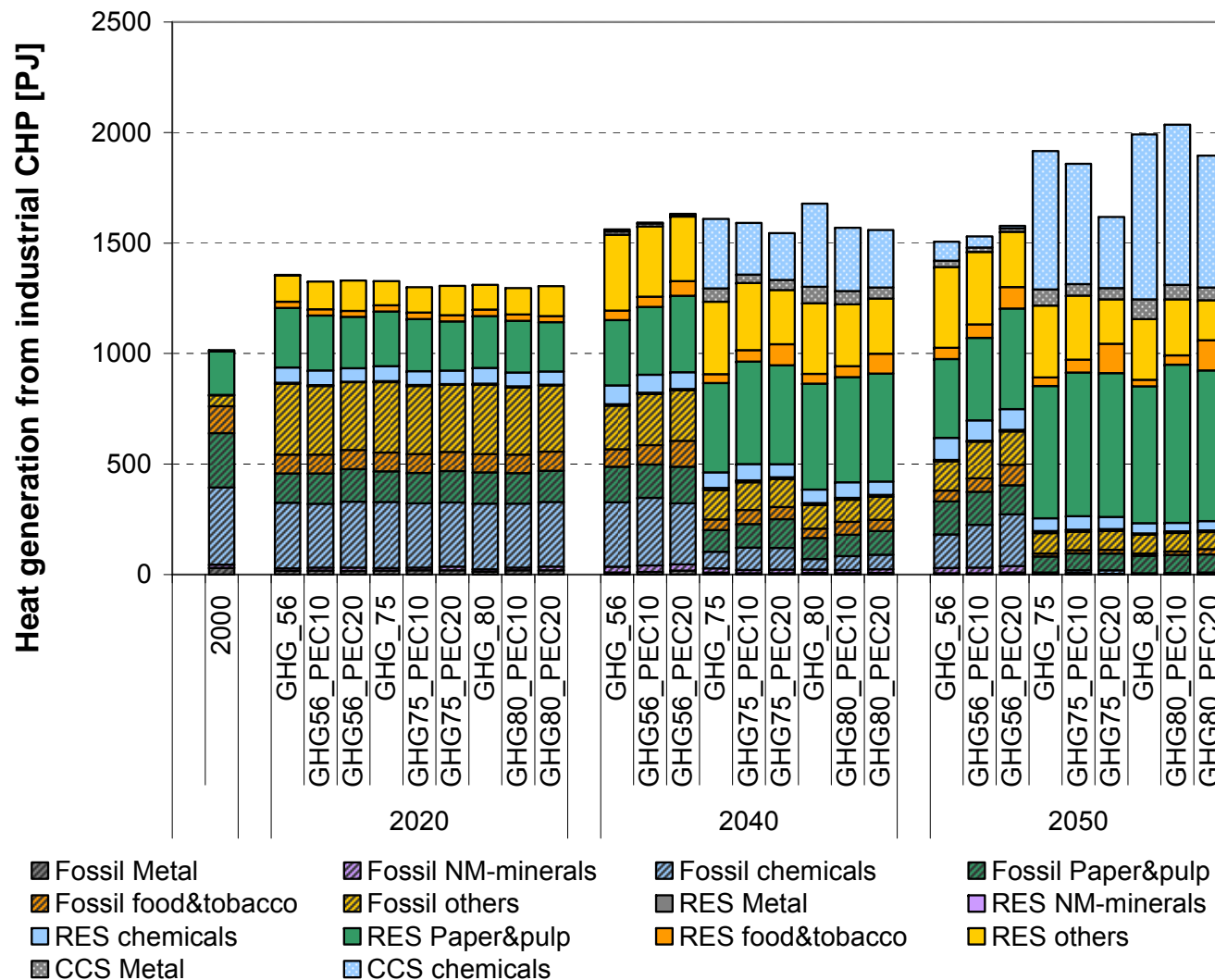
## Industrial heat in 2050 (EU-27)



- GHG target:
  - i. Stricter target leads to higher use of CHP => independent from PEC target (at all PEC levels)
- PEC target:
  - i. Stricter target could lead to a reduced heat demand
  - ii. Less use of CHP => reduced demand for Electricity + lower specific emissions of heat production in heat only generators (including heat pumps, solar heat)



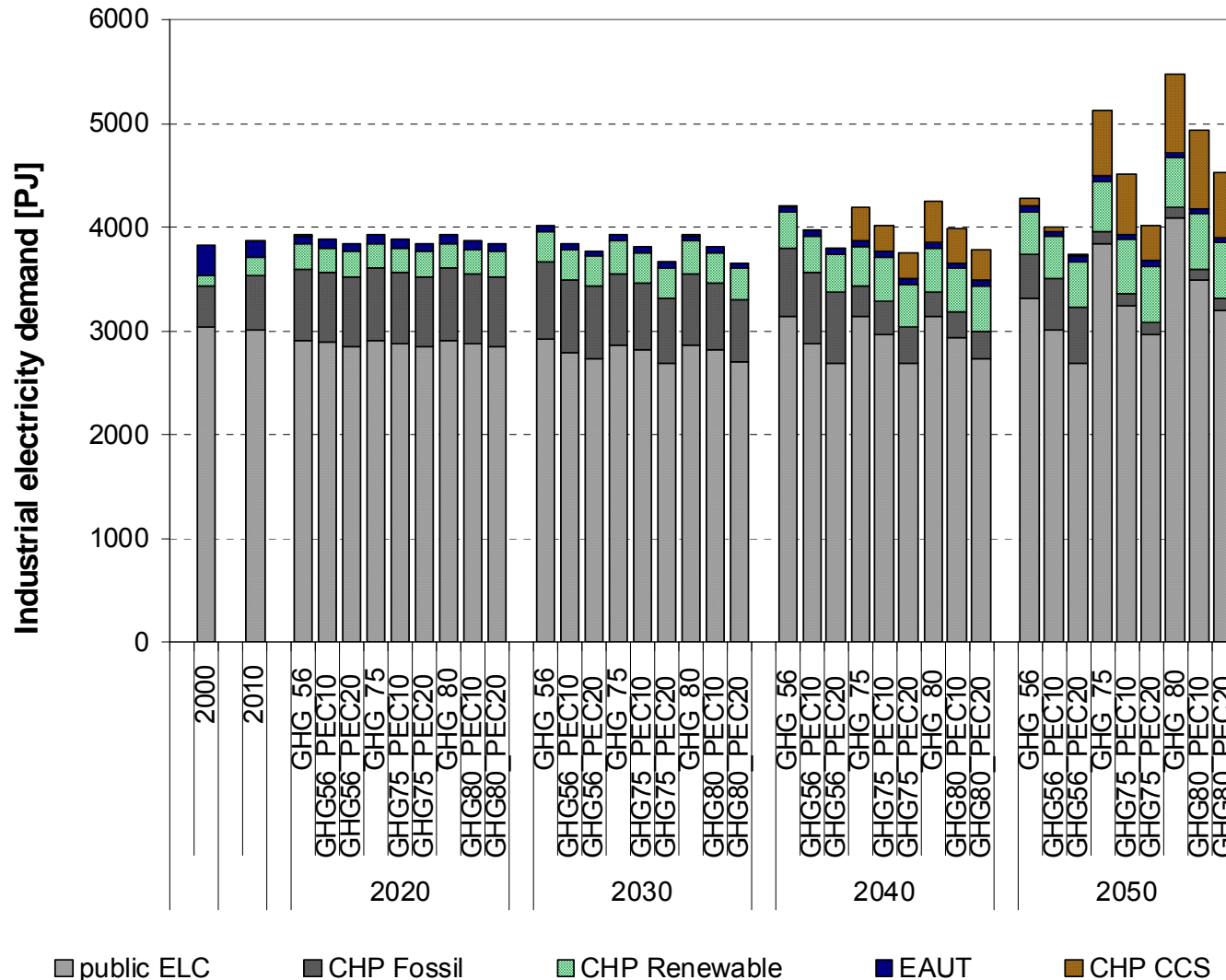
# Heat production from industrial CHP (EU-27)



- In general: increasing heat production in industrial CHP
- GHG: increasing use of renewables + CCS
- GHG 56: increasing PEC target leads to higher use
- GHG 75/80: strict PEC target leads to reduced use of CHP (especially CCS CHP)



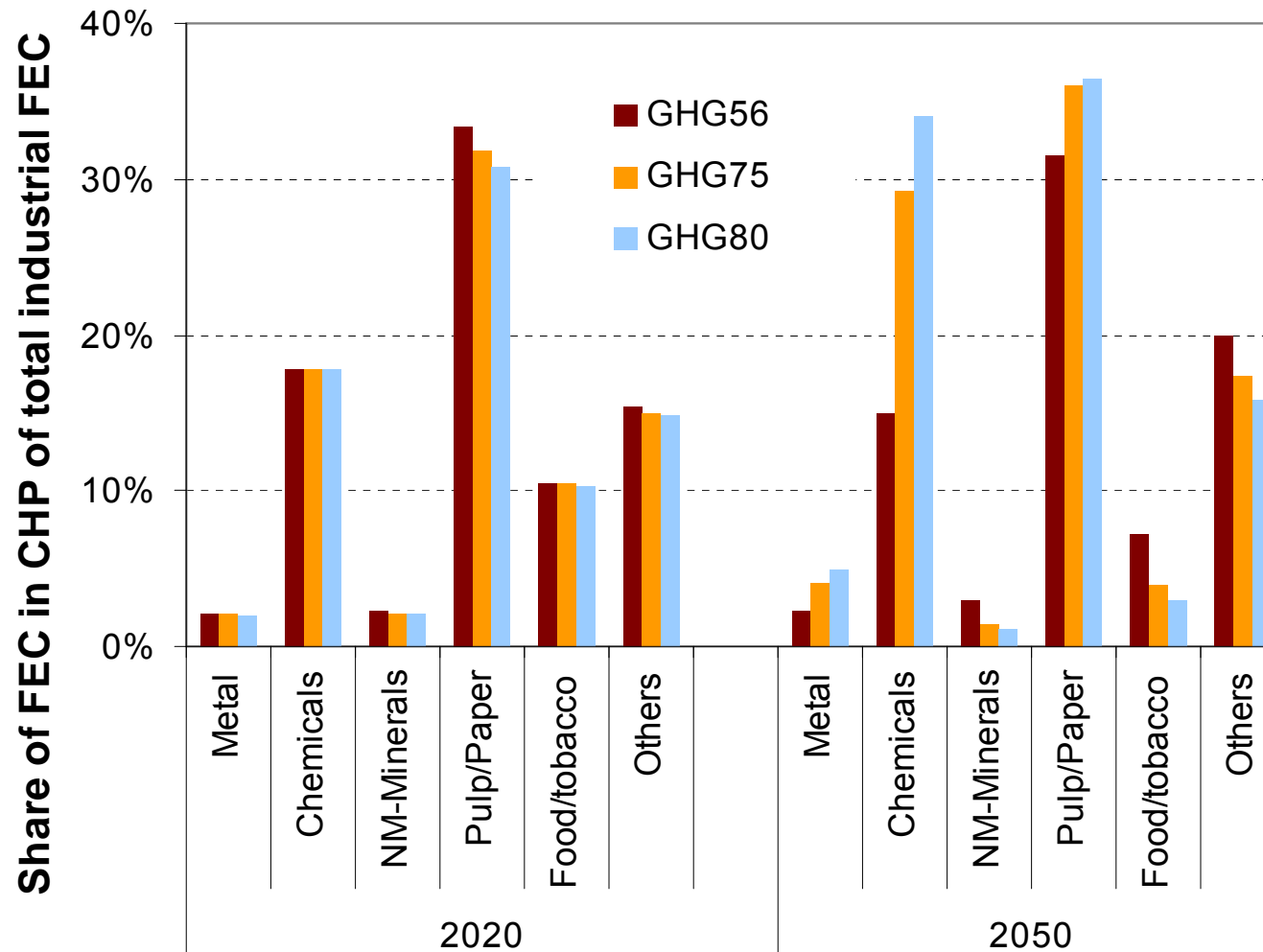
# Industrial Electricity supply (EU-27)



- Increasing industrial electricity demand at stricter GHG target (higher end use efficiency + strong decarbonisation of public electricity generation )
- Decreasing when PEC target is stricter (avoid conversion losses)
- Both targets act in opposite directions



## Share of CHP by sub sector

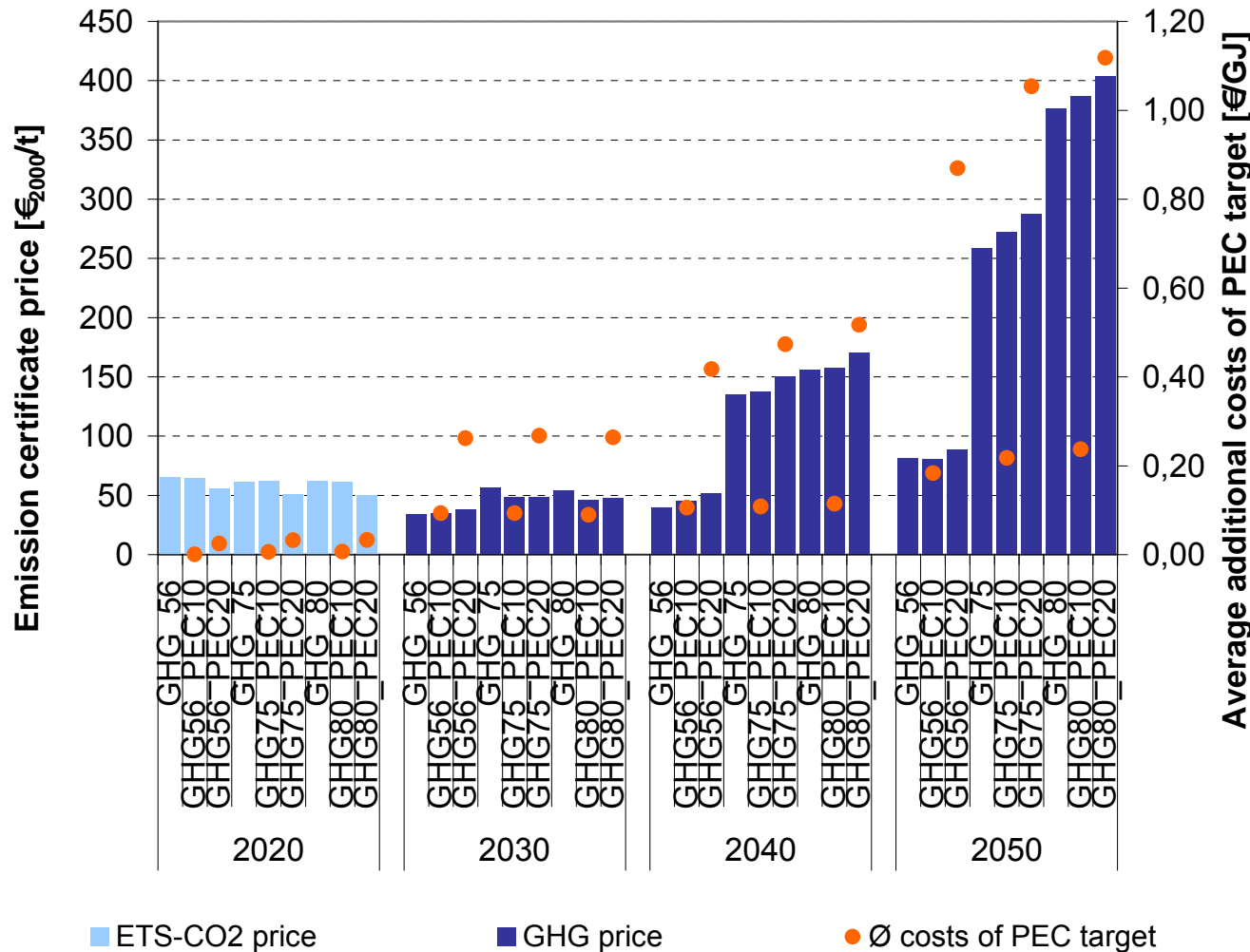


- Industrial FEC dominated by heat demand => different temperature levels determine use of technologies
- Share of CHP limited by temperature level of heat
- Highest shares in Pulp & Paper and Chemical Industry





# Certificate prices and costs

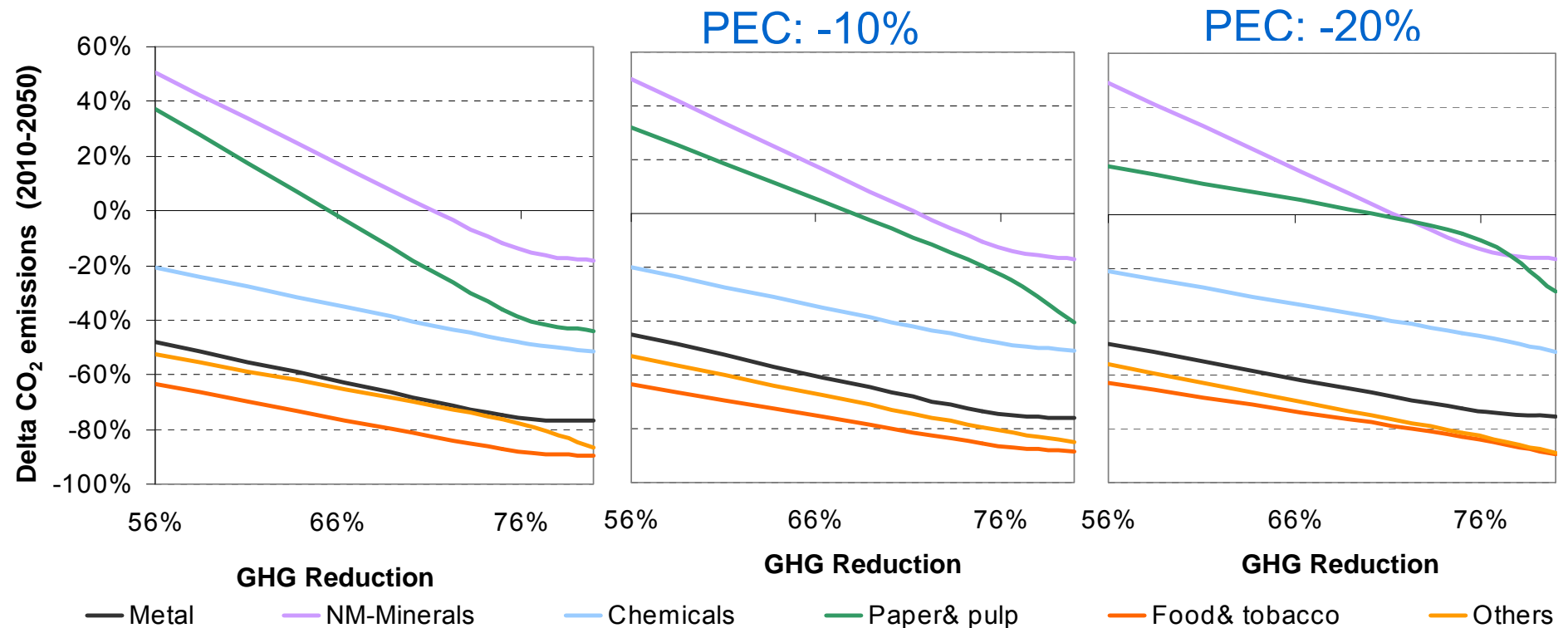


● PEC target:

- i. At GHG target of 75/80%, PEC target increases certificate prices
- ii. Cost efficient ways of emission reduction are blocked by PEC target (CCS, high use of electricity, biomass, Nuclear)
- iii. PEC target increases fuel price in 2050 up to 15-43% (gas, coal)



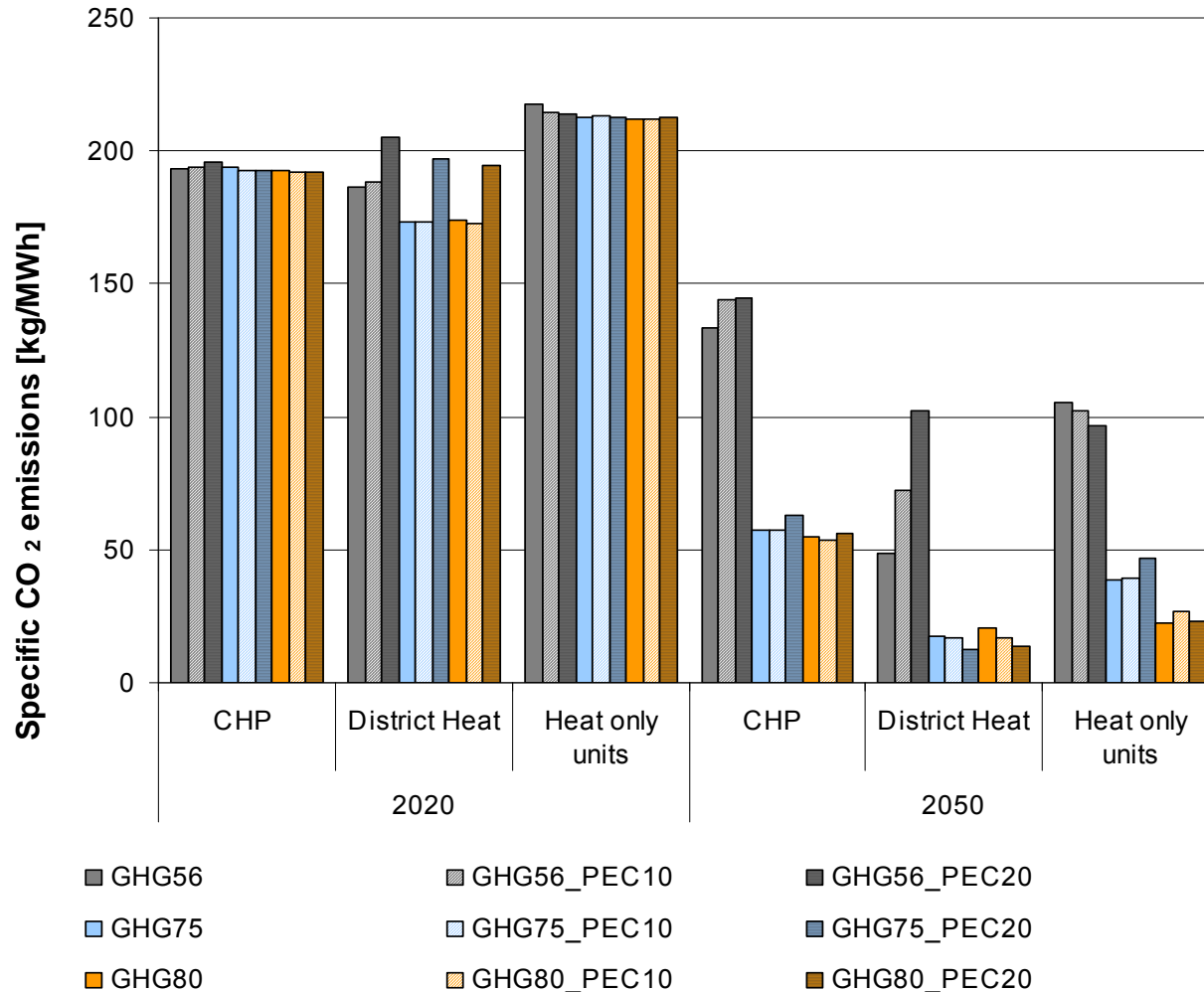
## CO<sub>2</sub> Emissions (Delta 2010-2050)



- Clear reductions in all subsectors at stricter GHG target but different ways of emission reduction
  - i. Focus on electricity, CCS, renewables and CHP in the GHG scenarios
  - ii. Focus on more efficient production processes and saving measures in PEC scenarios



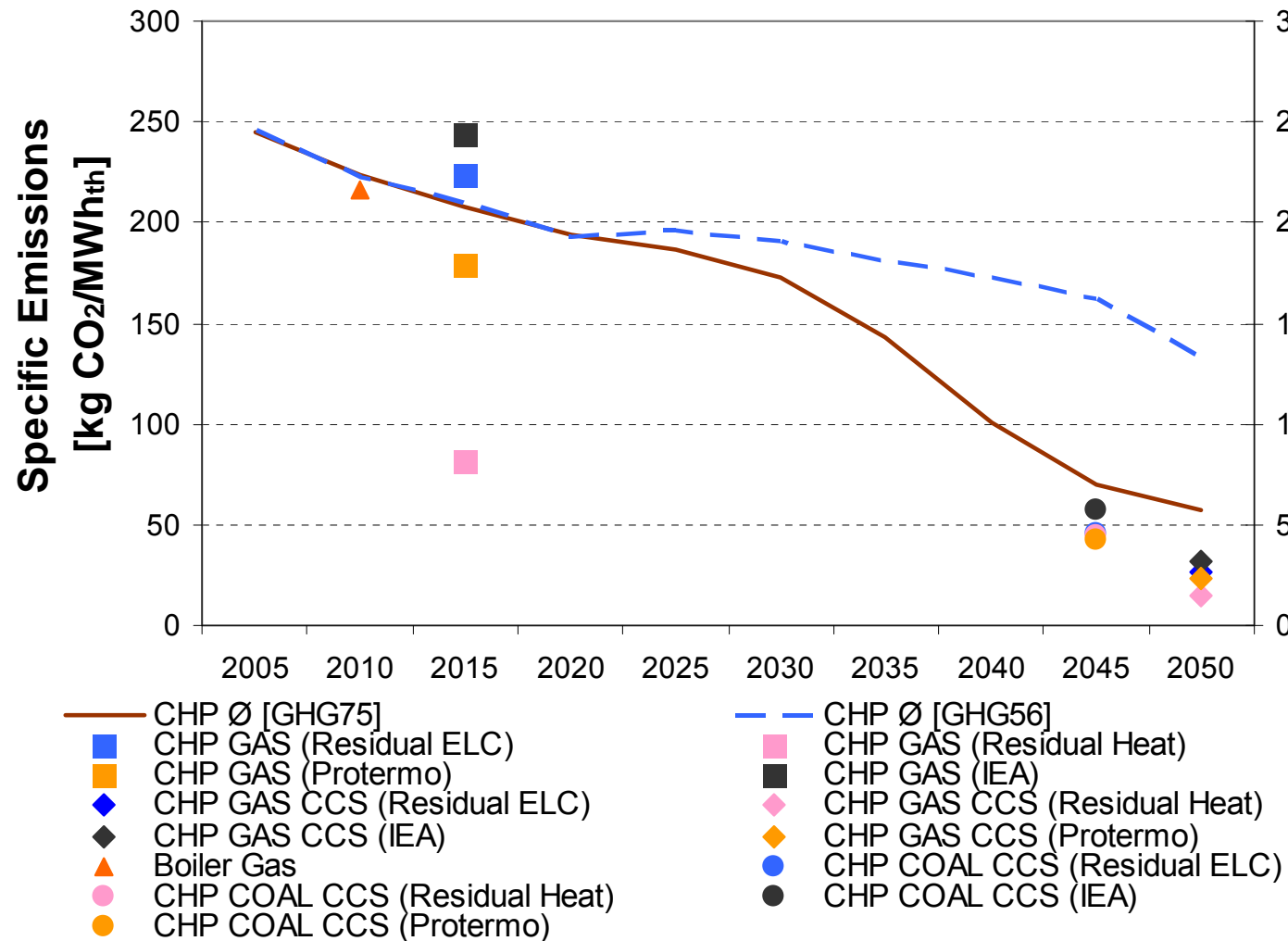
# Specific emissions of heat production (EU-27)



- 2020: highest specific emissions in Boiler => highest share of fossil fuels
- 2020: PEC target leads to increase emissions in district heat => higher use of gas instead of biomass (higher efficiency)
- 2050: lowest specific emissions at district heat => heating plants only renewables + heat pumps and renewables + CCS in public CHP's



# Specific emissions of heat production, allocation methods and technologies



- 2050: specific emissions of heat from industrial CHP decrease down to 57 kg/MWh (GHG75)
- Emissions of fossil fired boiler and fossil CHP are too high under a strict GHG target



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## Conclusion (I)

### Impact of EU targets on industrial heat supply

- Key sectors for CHP are **Pulp&Paper** and **chemical industry**
- At stricter GHG target:
  - i. Higher use of CHP
  - ii. Specific emissions** of fossil fired CHP are too high
  - iii. CHP with CCS or using biomass are necessary
- PEC target:
  - i. Both CCS and biomass in CHP have lower efficiencies and are in **conflict with PEC reduction** target
  - ii. Reduced heat demand instead of extended CHP use and use of heat only units with lower specific emissions
  - iii. Not the cost optimal path to reduce the emissions from industrial heat supply (**higher cost + higher CO<sub>2</sub> prices**)



## Conclusion (II)

### Impact of EU targets on industrial heat supply

- **Balancing method** has influence on FEC (CHP) and also on PEC (quantification of nuclear or wind/PV) => Influence of balancing method on use of technologies under a regime with a target on PEC or FEC
- Different strategies at GHG and PEC target concerning use of electricity and renewables
- **Efficient use of energy** in GHG scenarios => FEC/PEC are higher than in PEC scenarios but at lower costs
- **Non efficient use of energy** in PEC scenarios => additional reduction of energy leads to total higher costs (**non efficient additional decrease of energy intensity**)



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