# MODELING THE INDUSTRY SECTOR FOR DECISION MAKING FOR MID TO LONG-TERM ENERGY EFFICIENCY PLANNING


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Centre for Applied Mathematics, Mines ParisTech
EDF R&D Renardières

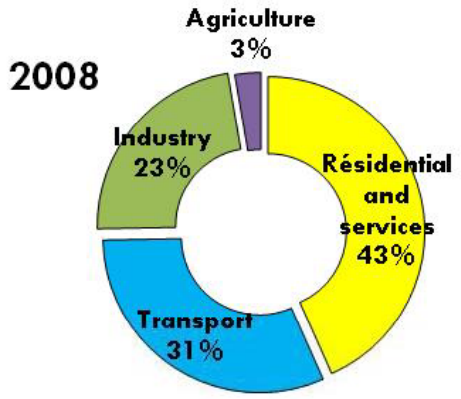
# Overview of the presentation

- Context
- Objectives
- Model : MARKAL-TIMES for industry
  - Approach for:
    - Non-energy intensive industry (NEI)
    - Energy intensive industry (EI)
  - Specificities for each model
- Results
  - Results for NEI
  - Results for EI
- Conclusion

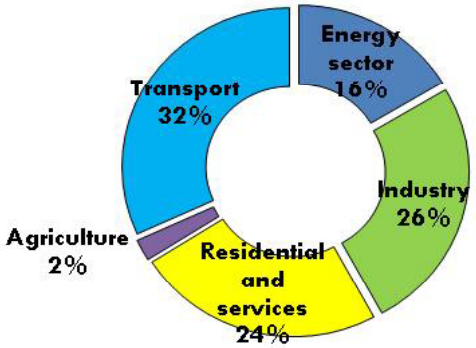
# Context



- The European Union sets a series of demanding **climate and energy targets** to be met by 2020 (**20/20/20 EU scheme**):
  - Reduces its own emissions at least 20% below 1990 levels,
  - Reduces energy consumption by 20% by improving energy efficiency,
  - And increases the proportion of renewable resources at least 20% in the energy mix.
- Importance of Industrial sector in France




Total final energy consumption




Total $CO_2$ emissions

# Objectives



- Modelling a detailed representation of the industry sector
- Assess the overall industry energy reduction potential
- Identify the path for new efficient technologies
- In mid term have a detailed model for France (EDF)
- Zoom on some key sectors (iron & steel, food and drink industry…)

# Model TIMES for industry 1/5



- Different modeling approach in the case of industry due to the sectoral heterogeneity.

- Traditional Industry segmentation in homogeneous families for modeling
  - Energy intensive industries (EI) (iron &steel, cement, sugar…)
  - Non Energy intensive industries (NEI) (Food & Drink, electric &electronic instruments…)

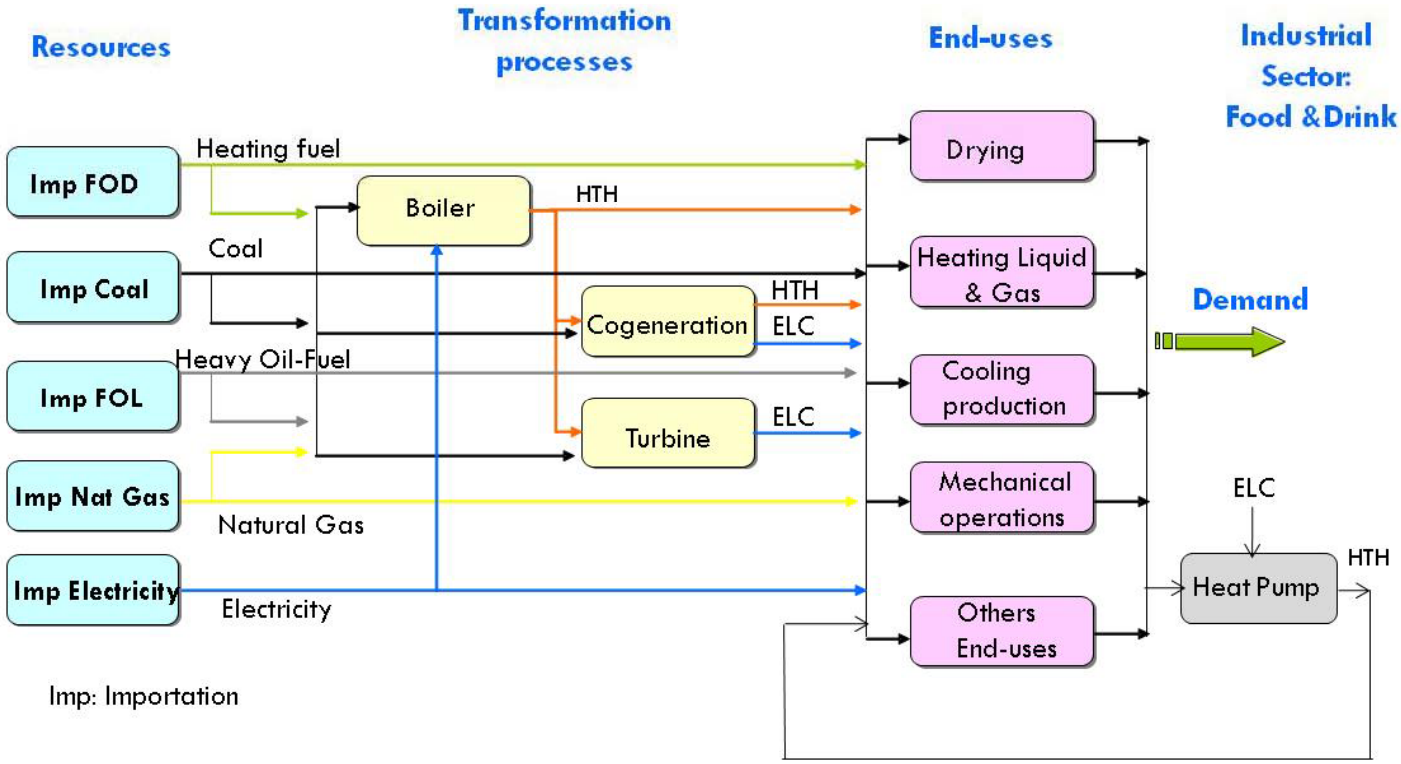
- Determination of the characteristics of the frontier

- Limits considered in the industrial segmentation
  - Share of energy costs in production value (2.5%)
  - Energy intensity (7 GWh/M€)
  - Energy consumed in production site (10 GWh/site)

# Model TIMES for industry 2/5



- **Sectoral Approach for Non Energy Intensive industries (NEI)**
  - Modeling by Energy End-uses (Dry, Heat treatment…) (Generic model)
  - Detailed TIMES model regarding subsectors
  - Focusing only on Food & Drink industry (F&D) which encompasses 33 subsectors as a study case (Analysis of heat recovery by Heat pumps (HP) systems).

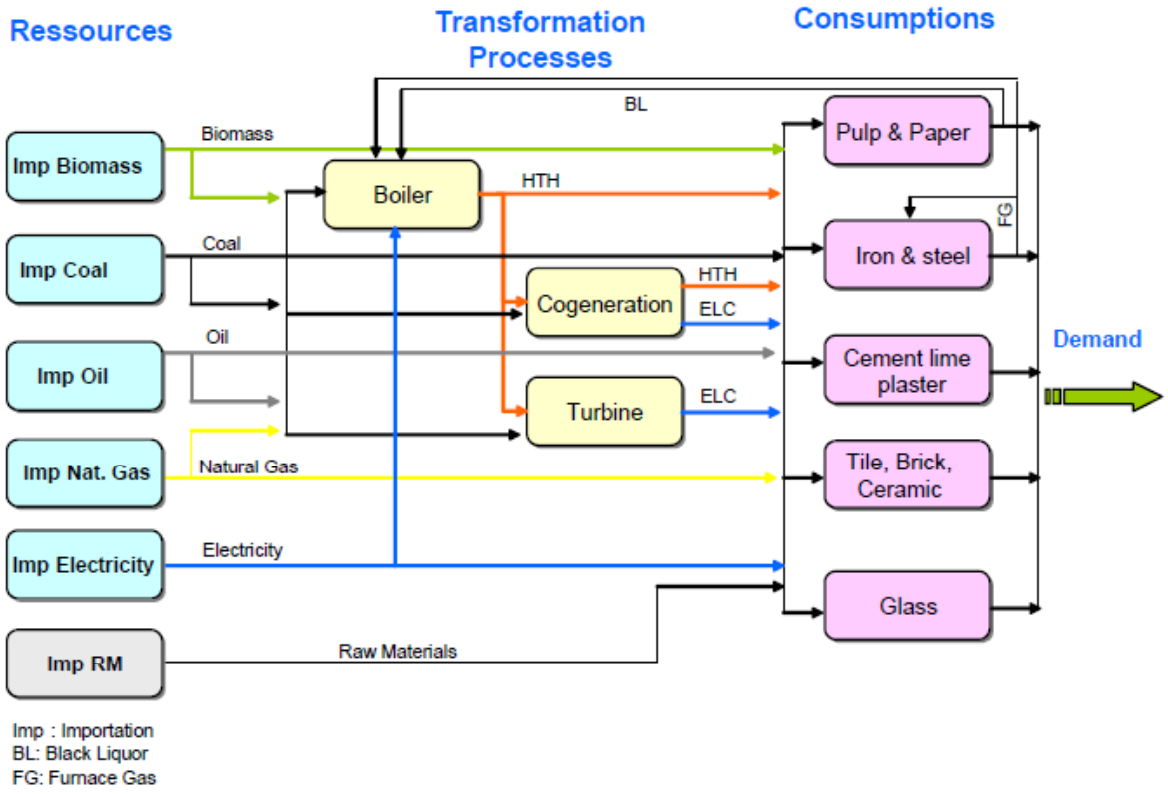


# Model TIMES for industry 3/5



- **Sectoral Approach for Energy Intensive industries (EI)**
  - Modeling by processes
    - Exchange of commodities between industries studied
    - Grouping of country necessary
  - Why detailed TIMES model for important energy intensive industries:
    - To reduce energy consumption
    - To reduce environmental impacts
    - To improve exchange between Industries.
  - Focusing on selected sectors

    Iron & Steel, Cement



# Model TIMES for industry 4/5



- **Specificities of the model for NEI (Food & Drink industry)**
  - A time horizon from 2001 to 2020 due to smaller lifetime of technologies and higher structural effect
  - Energy prices forecasting different from energy intensive industries
  - A demand indicator which is suitable for NEIs is Value added (M€)
    - Due to myriad of goods (no necessary physical links) and double counting
  - Scenarios:
    - **Scenario BAU "Business-as-usual"**
    - **Scenario HP**: Considering the existence and a possible impact of HP in energy consumption from 2010.
  - Results:
    - Assess the possibilities of HP in terms of energy and $CO_2$ emissions.
    - Tracking the important energy savings (in which subsector? In which energy end-use? In which temperature range of heat consumption?)
    - Reduced cost for heat pump penetration

# Model TIMES for industry 5/5



- **Specificities of the model for EI (Iron & Steel industry)**
  - A time horizon from 2000 to 2050
  - Energy prices from other models (POLES)
  - Demand forecast by sectoral experts
  - Scenarios:
    - **Scenario BAU "Business-as-usual"**
    - **Scenario Factor 4:** Division of $CO_2$ emissions by 4
  - Results:
    - Global tendencies for the future energy mix.
    - Assess the possibilities of future best technologies to impose reduction $CO_2$ emission by factor 4.
    - Associated costs for these choices
    - Global vs individual effort

# Results for NEI analysis

# Energy system evolution

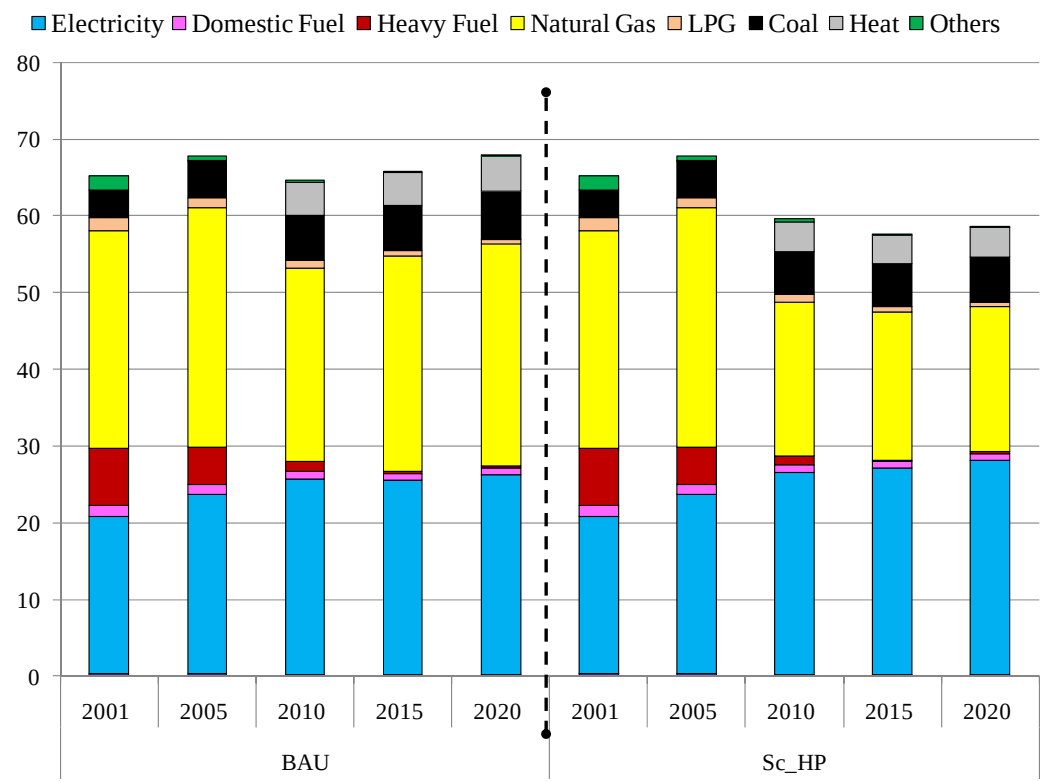


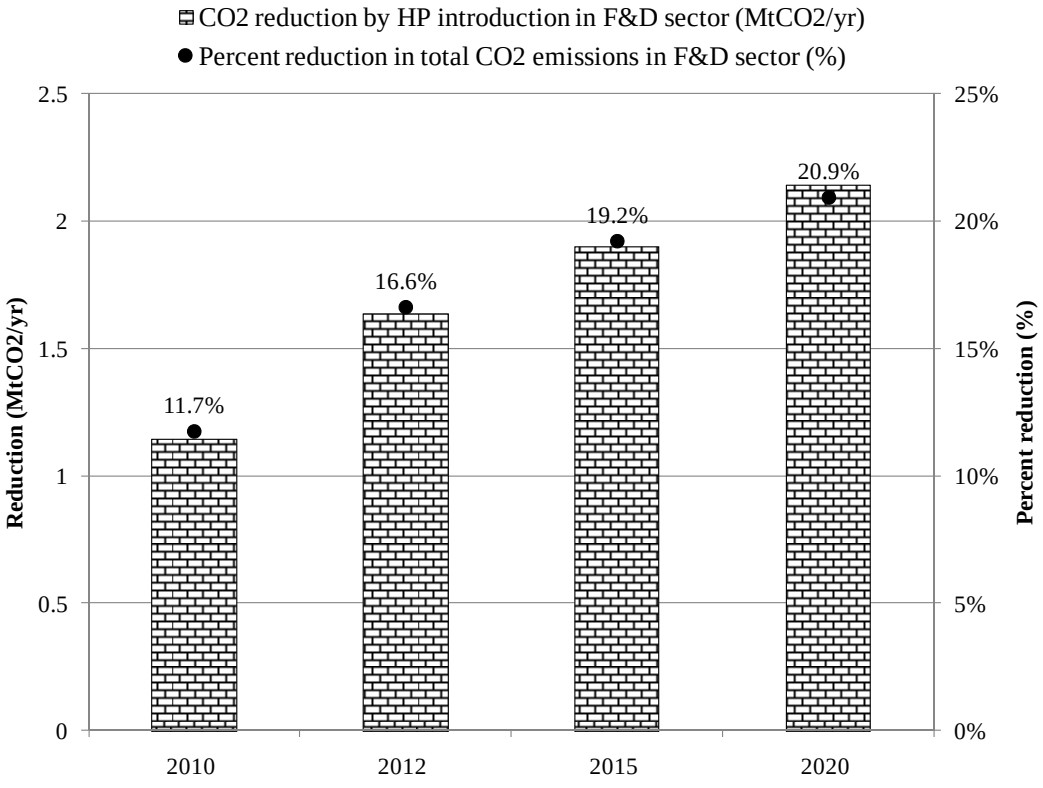
- **Final Energy Consumption (in TWh)**

**About 9,5 TWh of Energy Savings up to 2020**

- **$CO_2$ emissions (in Mt)**

**2.1 Mt$CO_2$ avoided up to 2020**

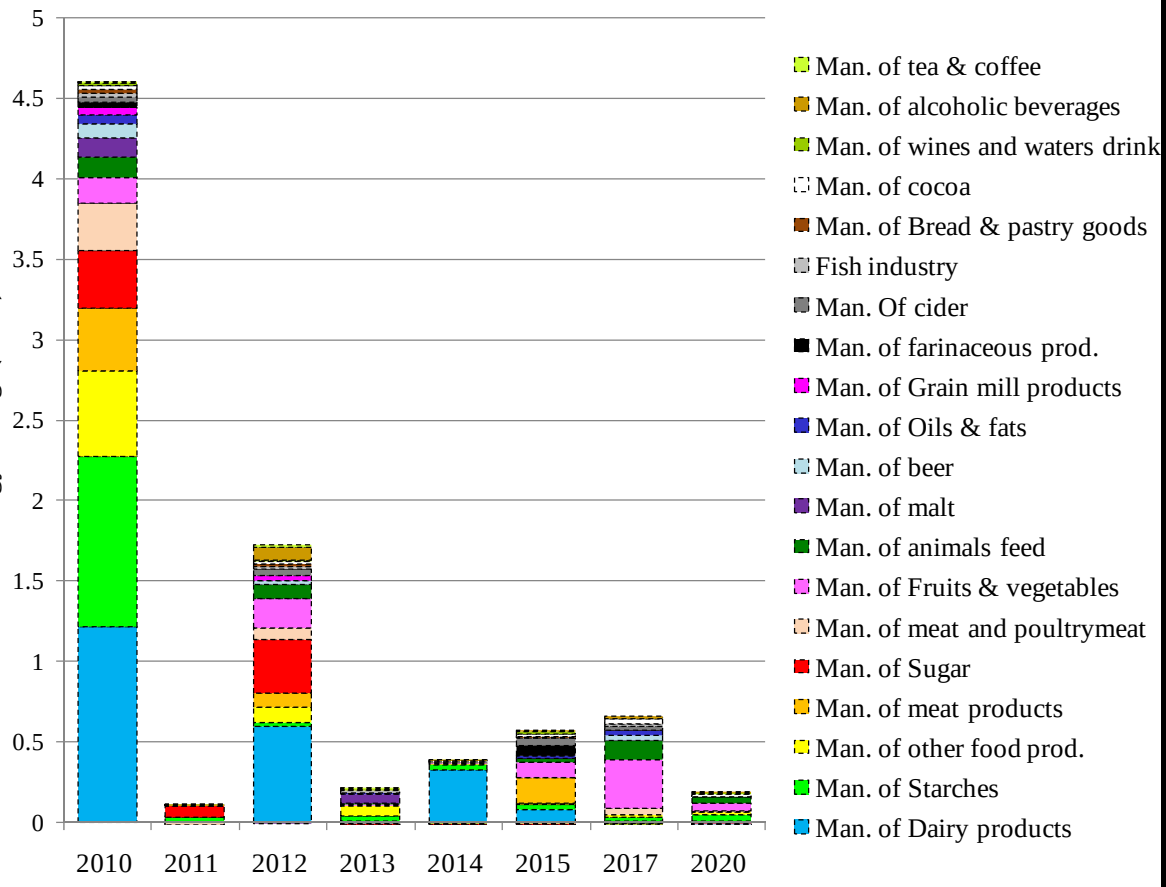


# Analysis by F&D subsector



- **Energy savings (in TWh)**

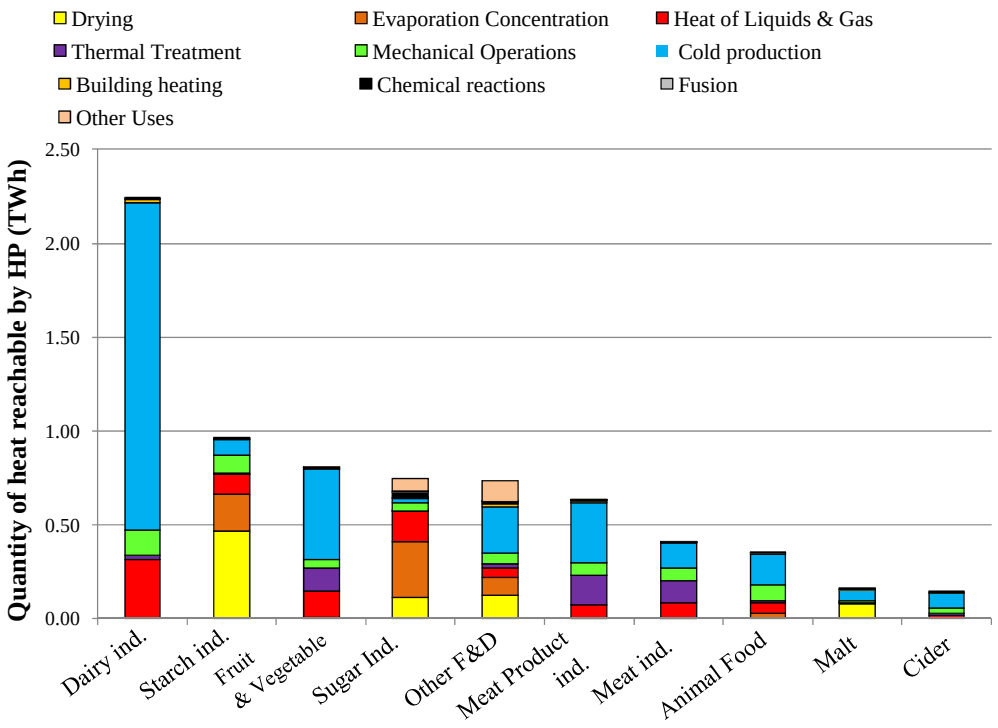


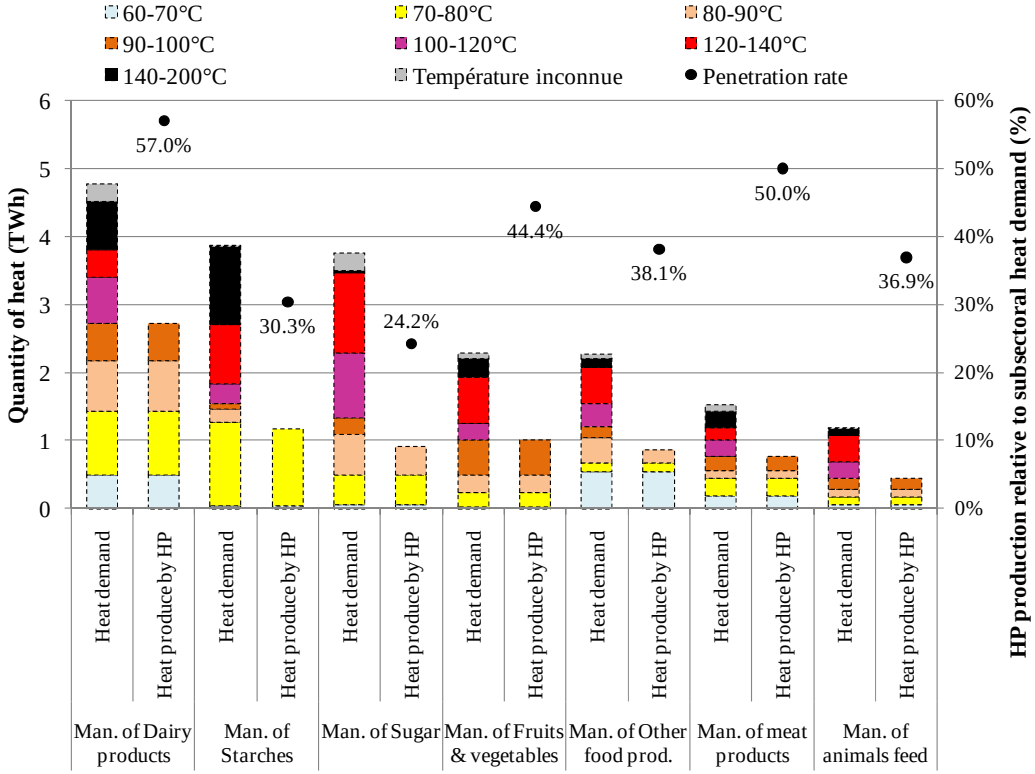

| | Rate of HP spread |
|---|---|
| Man. of Dairy products | 27.6% |
| Man. of Starches | 11.8% |
| Man. of Fruits & vegetables | 10% |
| Man. of Sugar | 9.2% |
| Man. of other food prod. | 9.0% |
| Man. of meat products | 7.7% |
| Man. of meat and poultrymeat | 5.0% |
| Man. of animals feed | 4.5% |
| Man. of Oils & fats | 2.3% |
| Man. of malt | 1.9% |
| Man. of cider | 1.8% |
| Man. of beer | 1.7% |
| Man. of cocoa | 1.4% |
| Man. of alcoholic beverages | 1.3% |
| Man. of farinaceous prod. | 1.2% |
| Man. of Grain mill products | 1.0% |
| Fish sector | 0.8% |
| Man. of Bread & pastry goods | 0.7% |
| Man. of tea & coffee | 0.6% |
| Man. of wines and waters drink | 0.5% |

# Analysis by F&D subsector



- **Potential of energy efficiency in energy end-uses for and range temperature economically achieved for the most important subsectors**

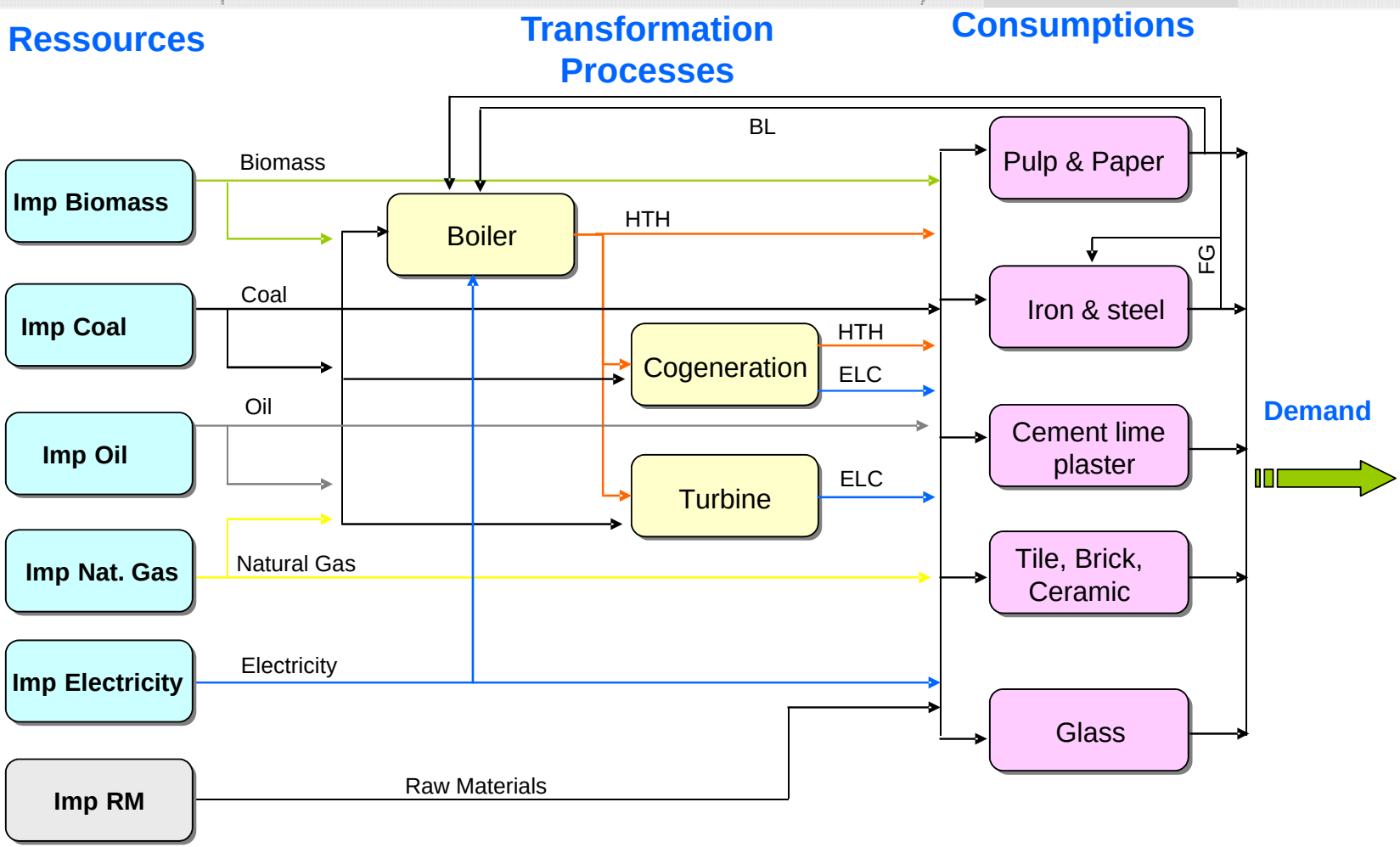


# Results for EI

# Energy intensive Industries 1/5

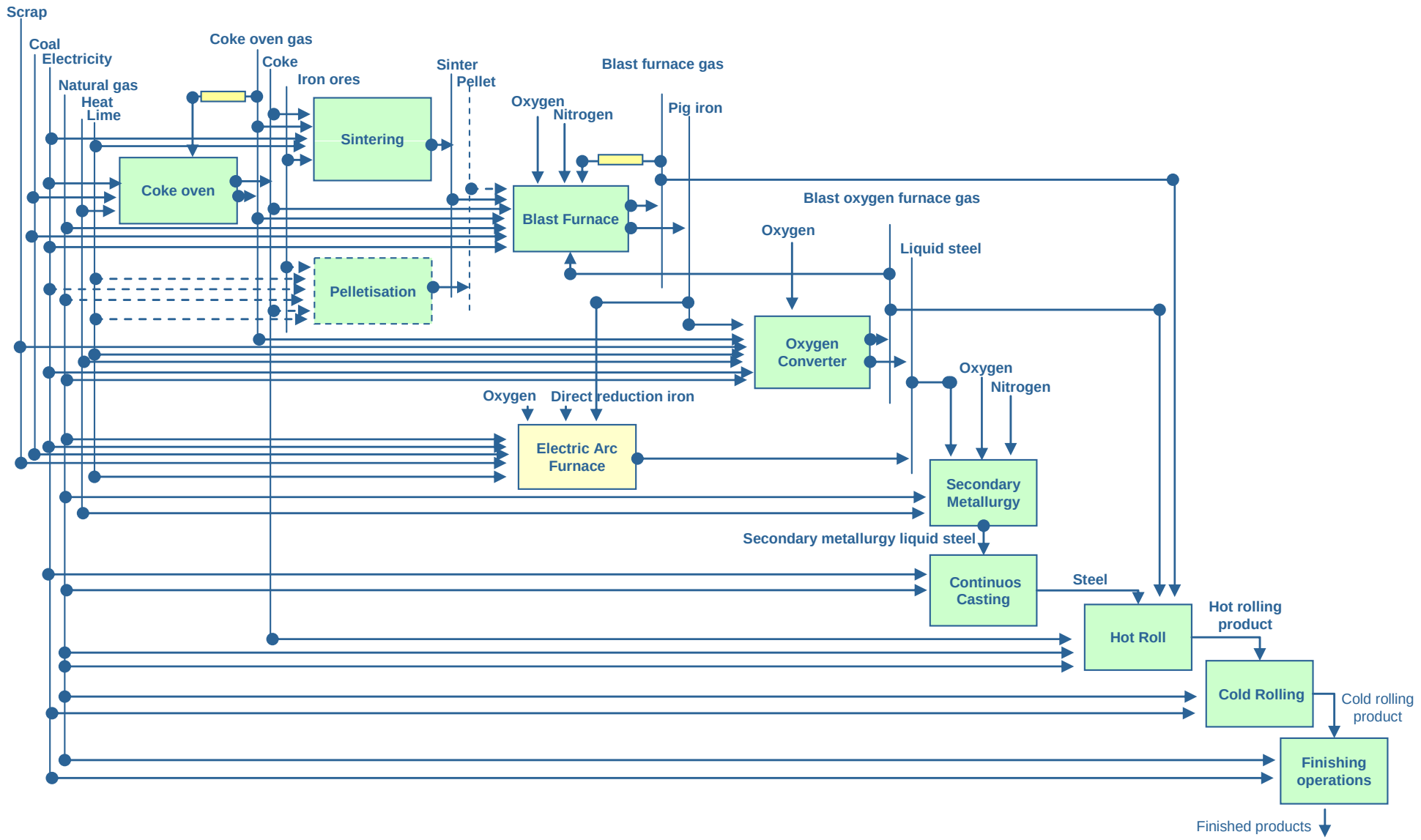





Imp : Importation
BL: Black Liquor
FG: Furnace Gas

# Energy intensive Industries 2/5

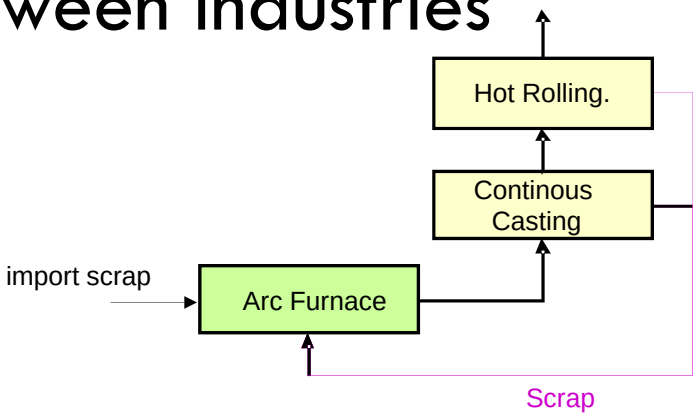


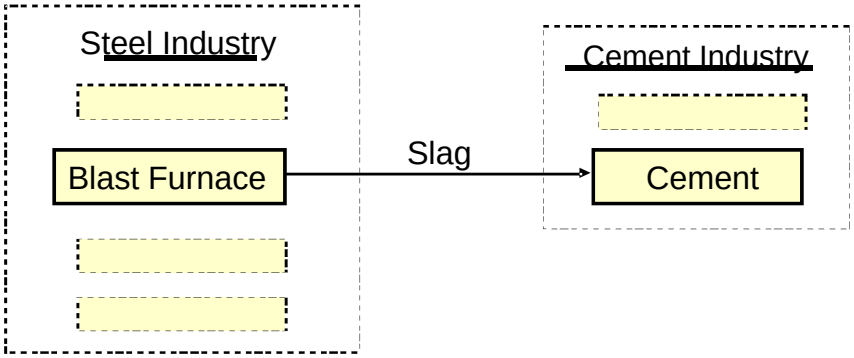


# Energy intensive Industries 3/5



- To avoid missing data:
  - Grouping country to have better representation of residual capacity
  - France as benchmark for boiler
- Environmental constraints are separated by country
- Valorization of scrap inside and between industries

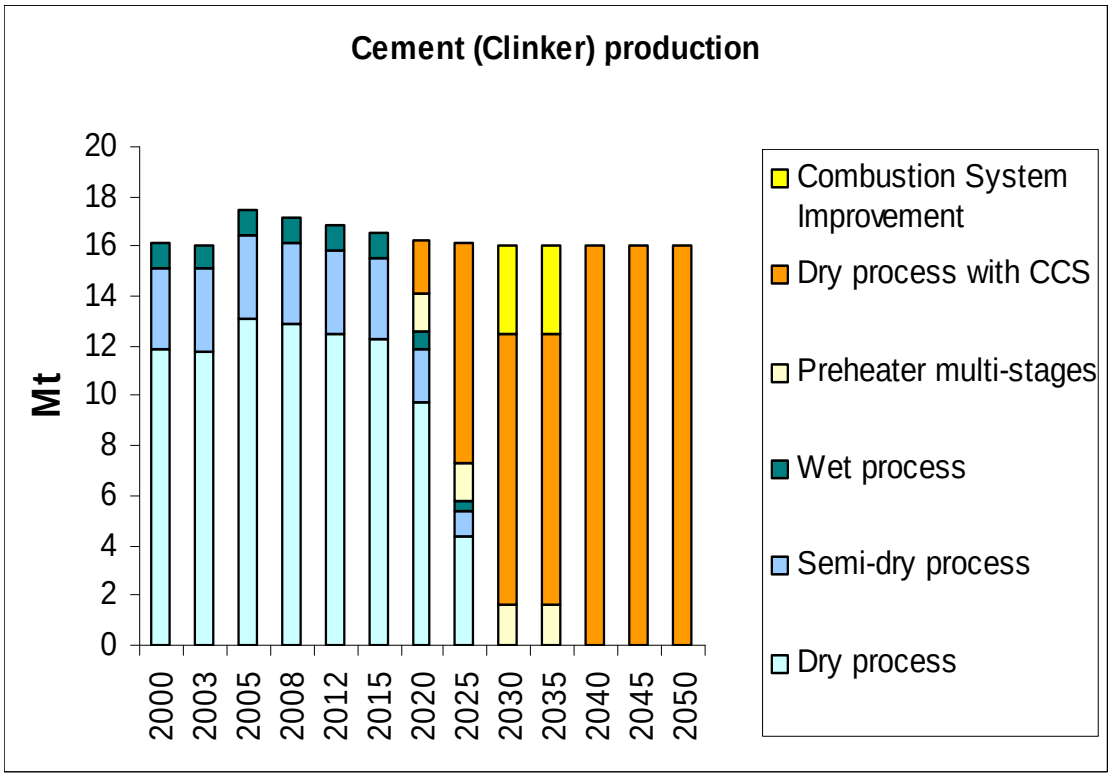



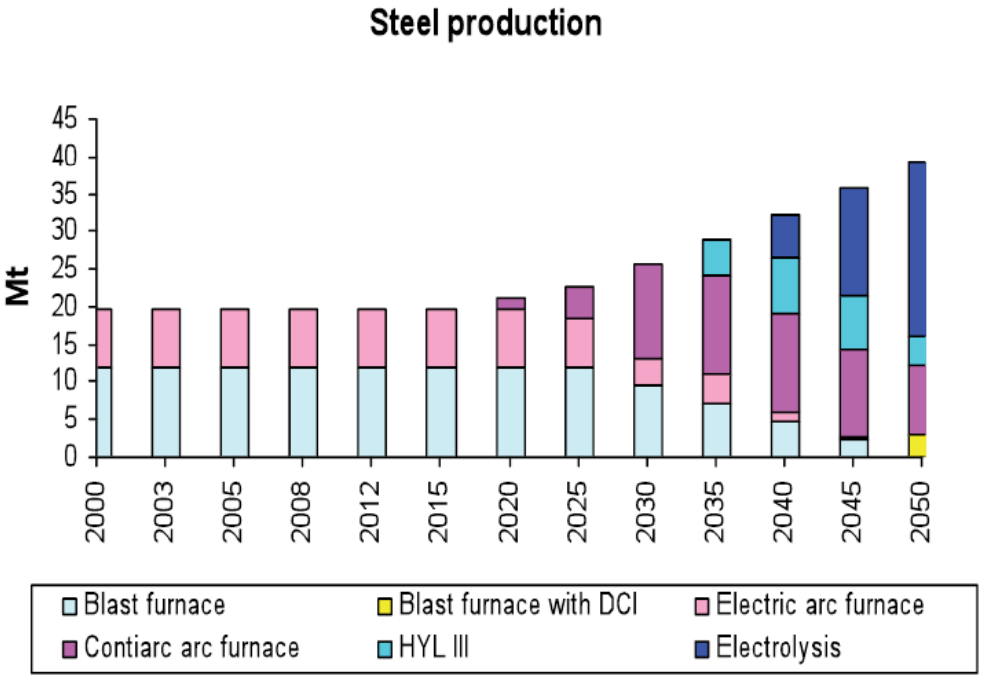



# Energy intensive Industries 4/5



- Iron & steel and Cement structure changes under scenario factor 4 for $CO_2$

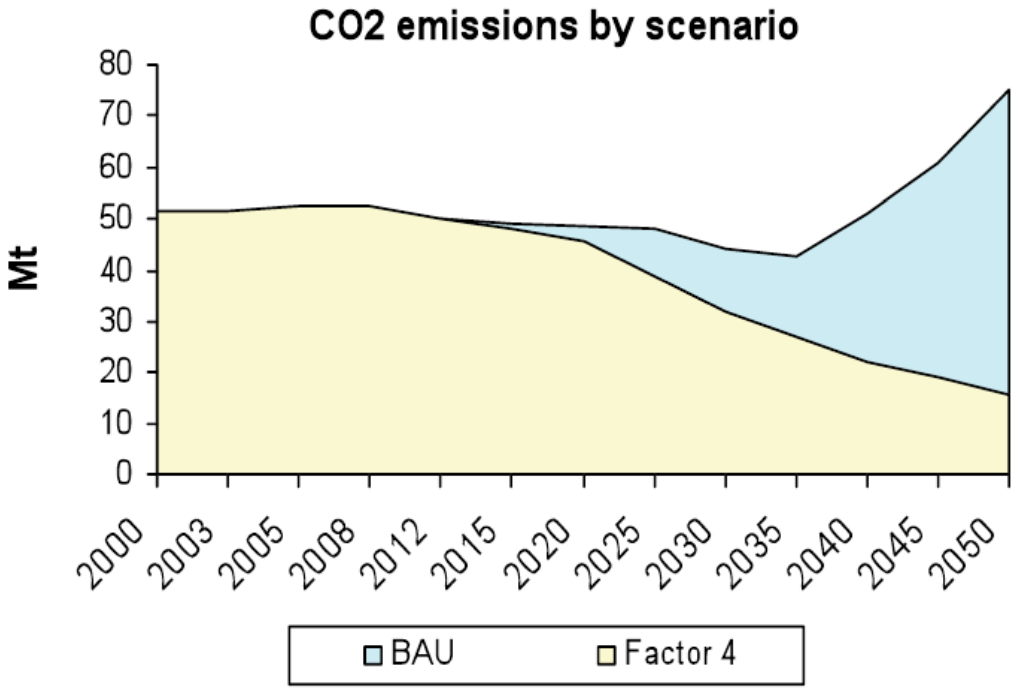


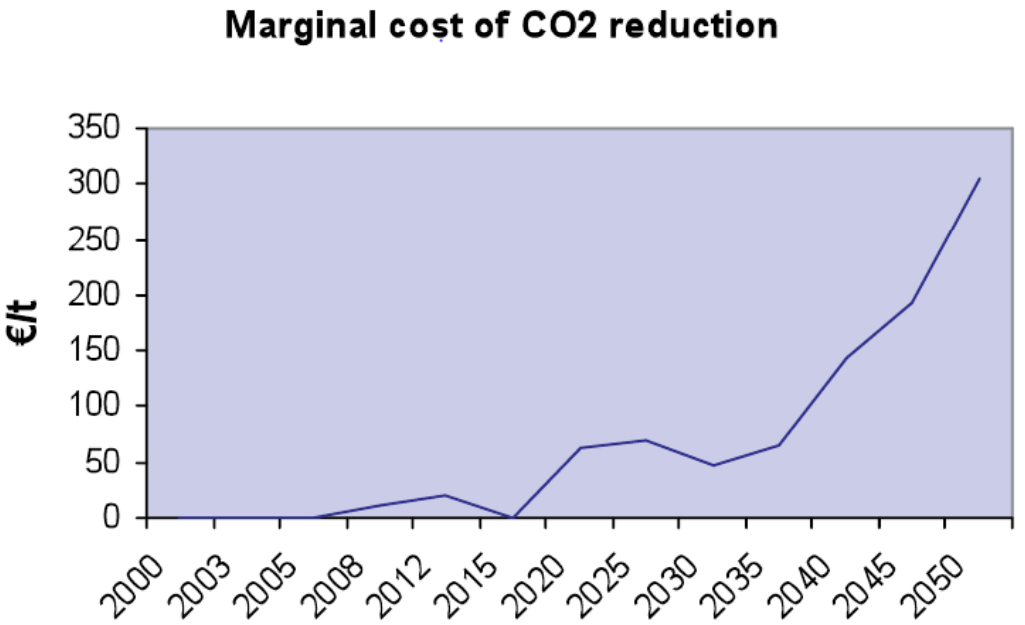



# Energy intensive Industries 5/5



- Some results for France
- $CO_2$ abatement costs



# Conclusions



- Different way of modeling the structure (Process vs End-uses)
- A clear frontier is determined between EI and NEI for modeling
- Different kind of demands, time horizon and energy prices
- Analysis of the results for different applications
- EI for long term technology and climate purpose while NEI for mid term and energy efficiency purpose
- Data very wide and difficult to collect for EU for both industries
- Lot of work to do to apply the NEI generic structure to all the other sectors

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# THANK YOU
# FOR YOUR ATTENTION