

Arbitrage between Energy Efficiency and Carbon Management in the Industry Sector: An Emerging vs. Developed Country Discrimination

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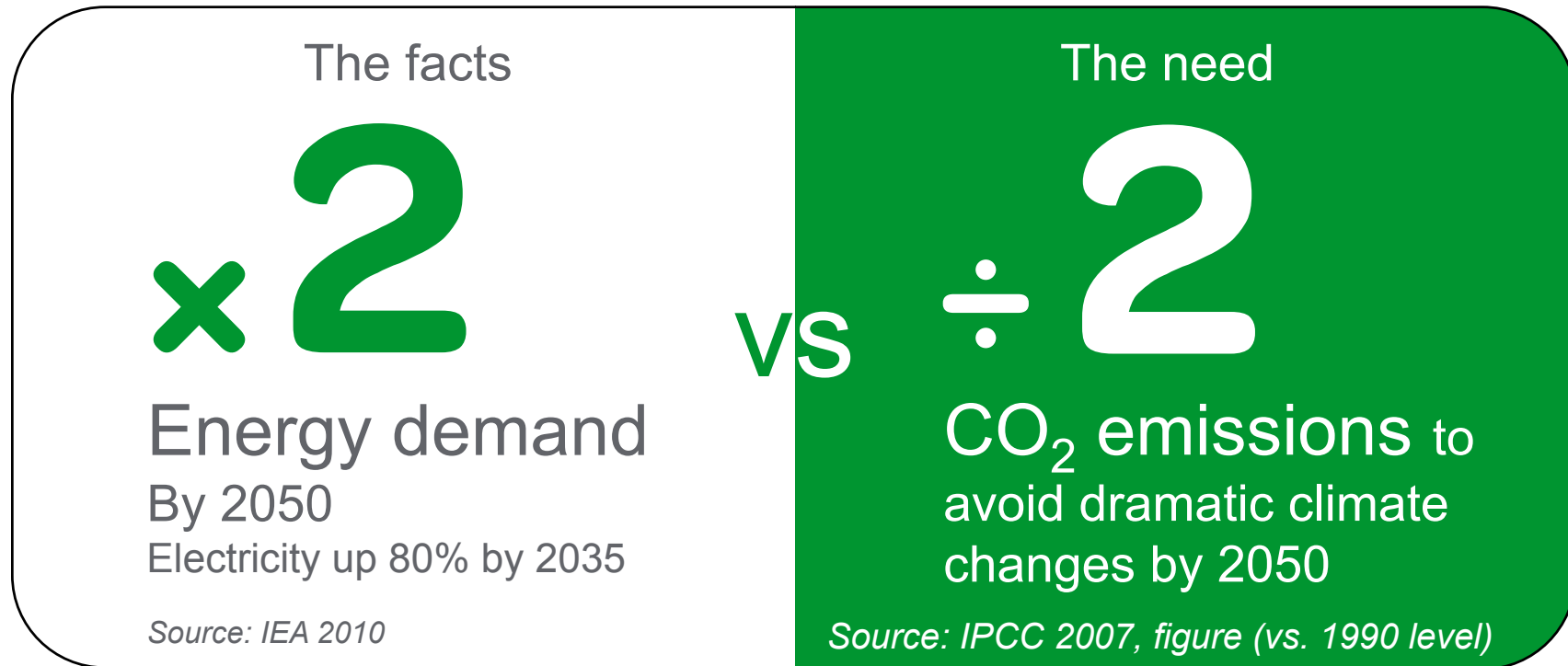
M. Thiboust , V. Mazauric – Schneider Electric

June 4th, 2015

IEW – Abu Dhabi – UAE



The energy dilemma is here to stay



Energy scarcity,
Demography
Resource access
Energy prices

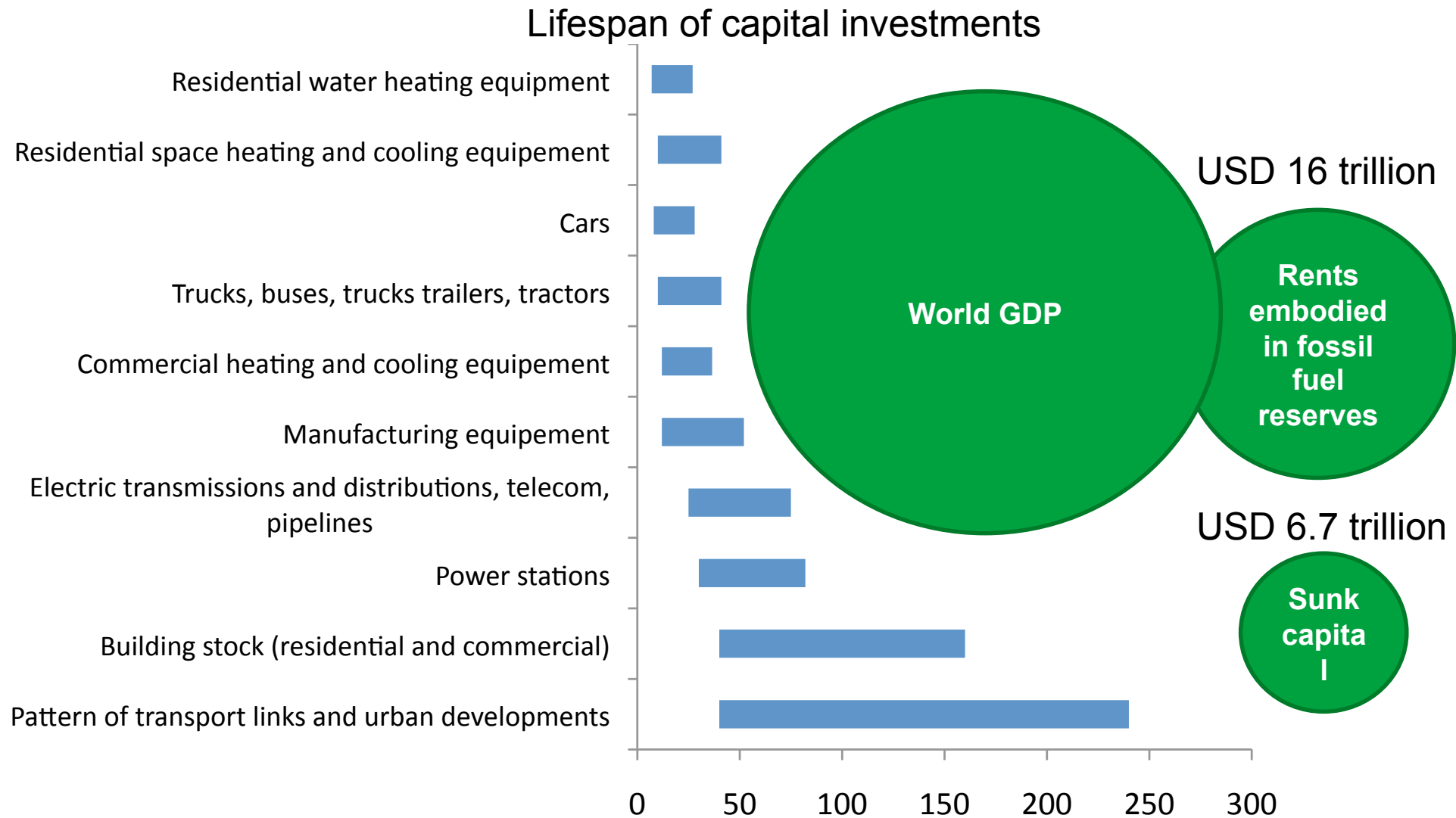
GHG emissions
Climate change

• Dispersed
generation
vs.
dense urban zone
• Energy efficiency

Reliability
of supply

The “big picture” for changing

Build a technology path to overcome the inertia



Source: OECD (Forthcoming) Green Growth Studies: Energy; World Bank.

Abatement strategies and competitions

- Energy efficiency:

- Demand side included in the techno
- Supply side add-ins, extra invests

→ Usually defined as input (to reach...)

- CO₂-free technologies:

- CCS extra consumption
- Nuclear risk, waste
- Renewables reliability

→ Potentially compete with EE...

- Beyond the forecast...Long-term exercises!

- “bottom-up” technology models are relevant for industry

www.modelisation-prospective.org

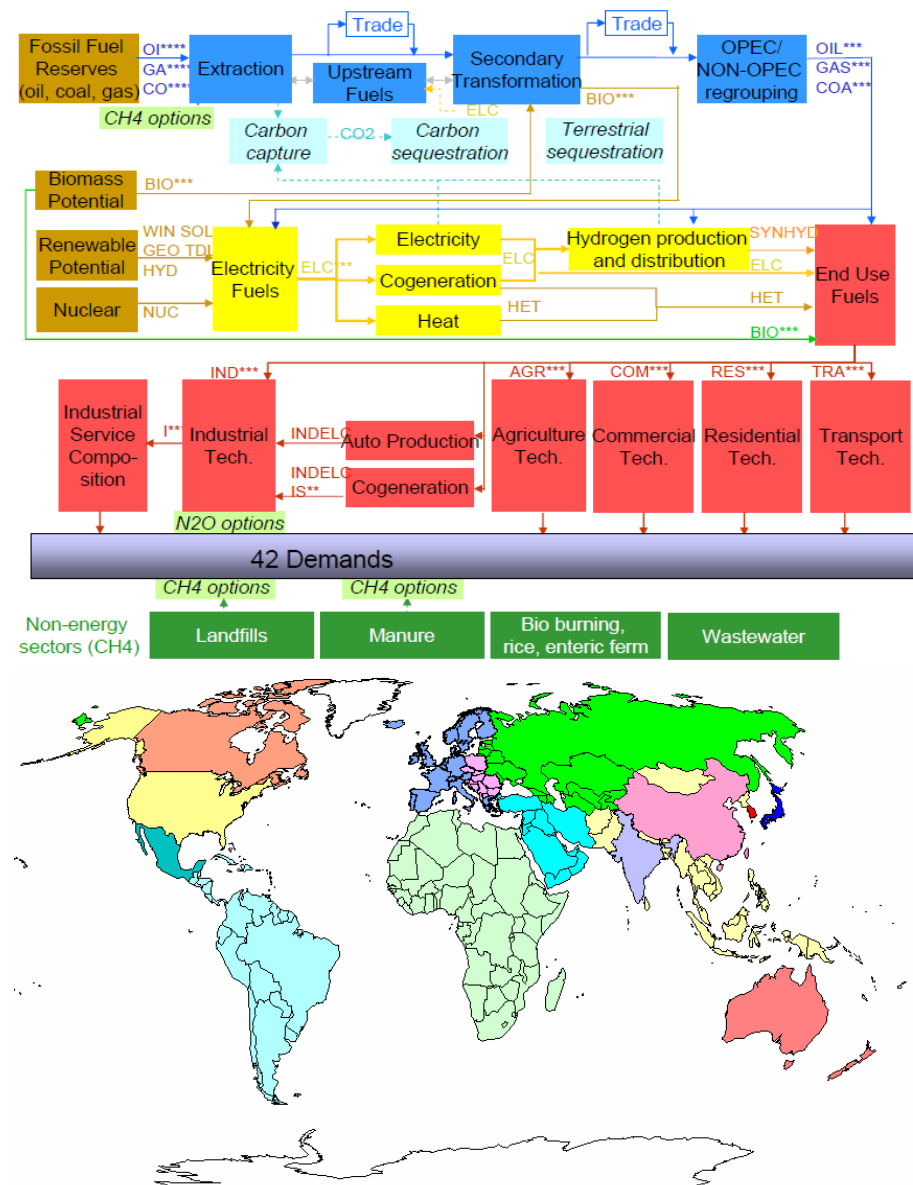


Modeling issues

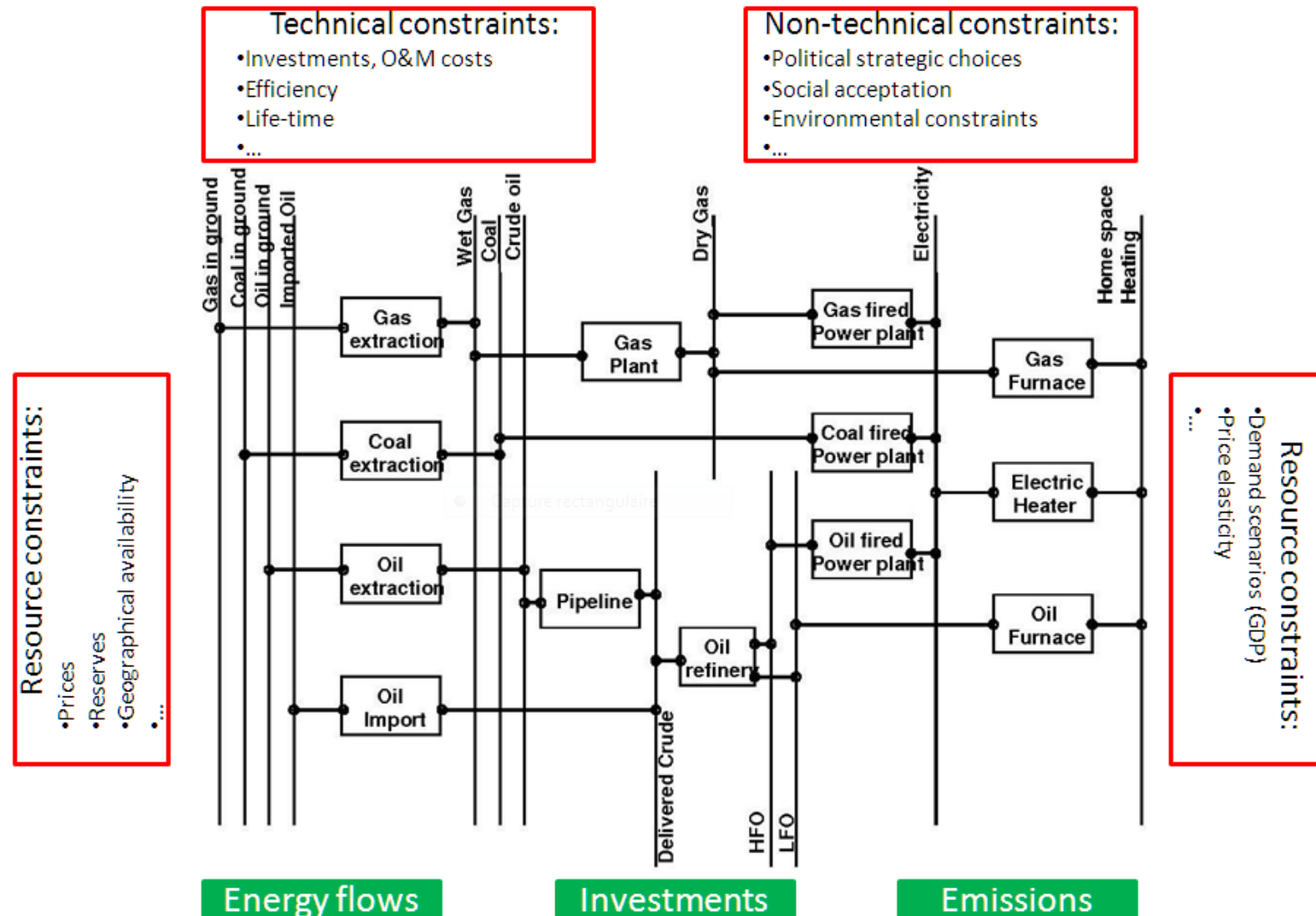
- The TIAM-FR model:

A technical linear optimization model driven by demand achieving a technico-economic optimum:

- for the reference energy system:
 - 3,000 technologies,
 - 500 commodities;
- subject to a set of relevant technical and environmental constraints
- over a definite horizon, typically long-term (50 years)
- 15 regional areas

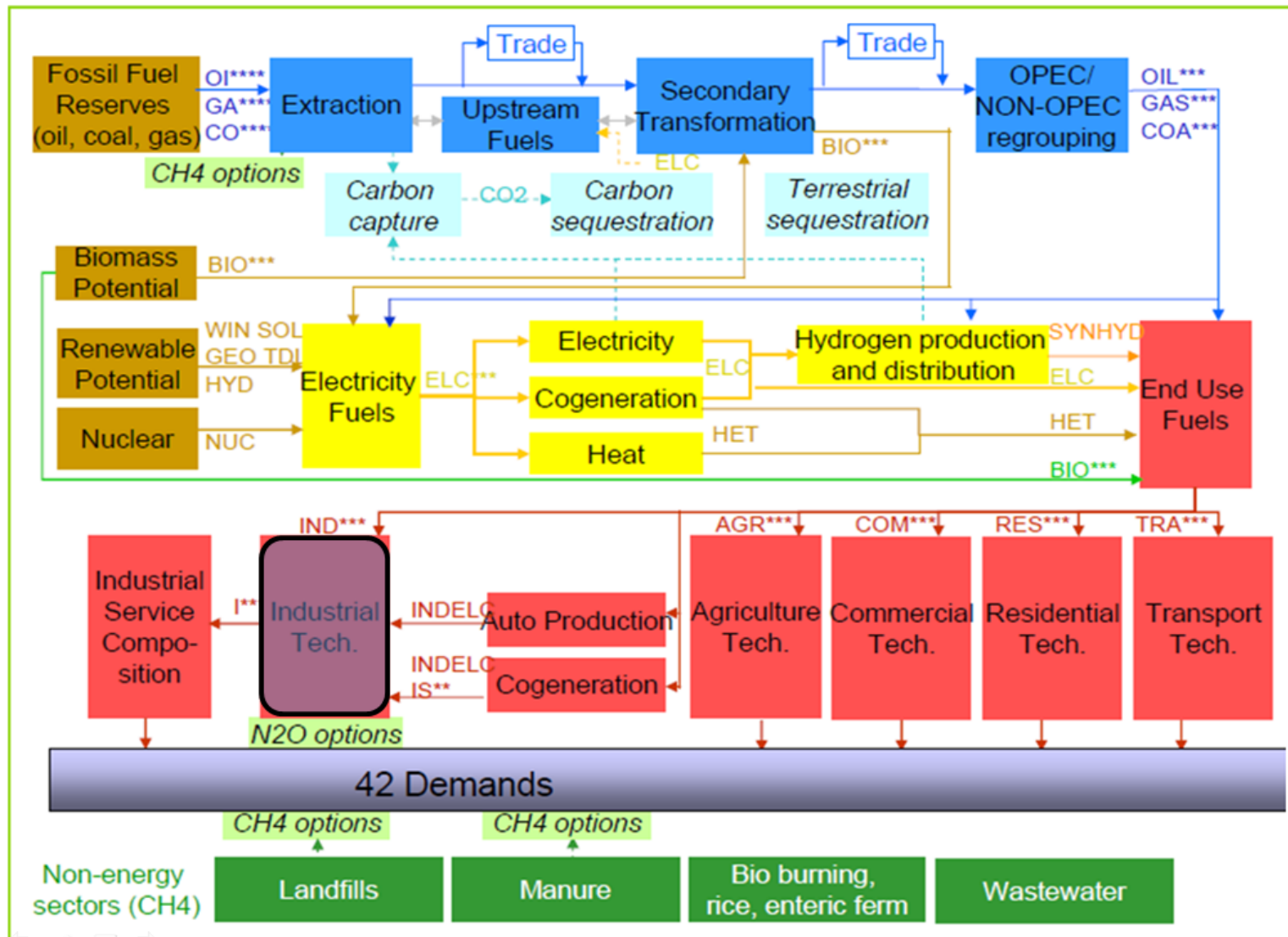


Reference Energy System *within the TIMES formalism*

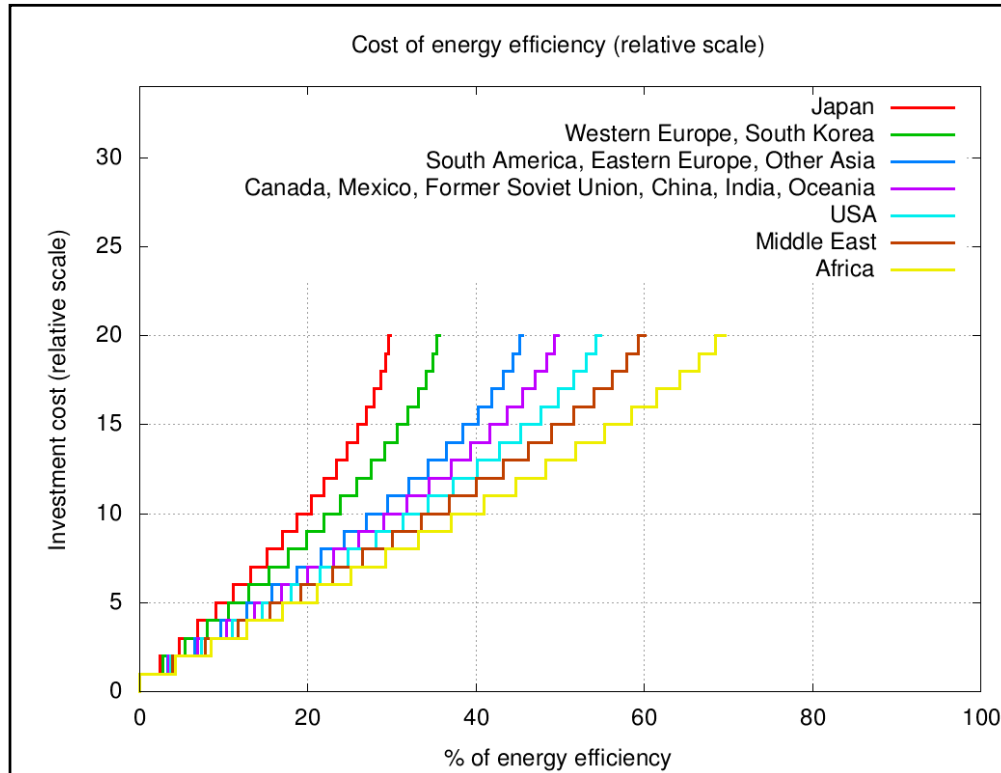


Energy efficiency modeling

Global Reference Energy System: *Industry-sector disaggregation*



Energy efficiency implementation costs



- **Model refinement:**

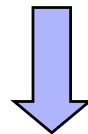
- Provide the cost of the next EE step for an already achieved level (demand side)

- **The model selects the rate of EE to implement at the demand side:**

- for each sector and
- each region

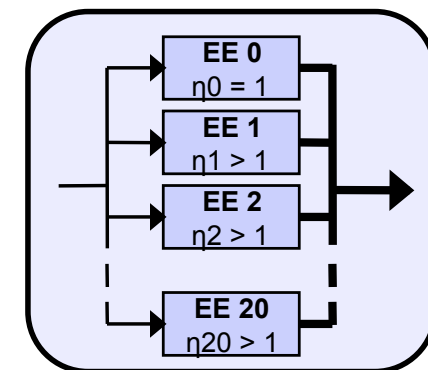
according to the competition with other abatement technologies (CCS...)

For each region and each sector



$\eta_1, \eta_2, \dots, \eta_{20}$
 $\text{cost}_1, \text{cost}_2, \dots, \text{cost}_3$

DS-EE technologies



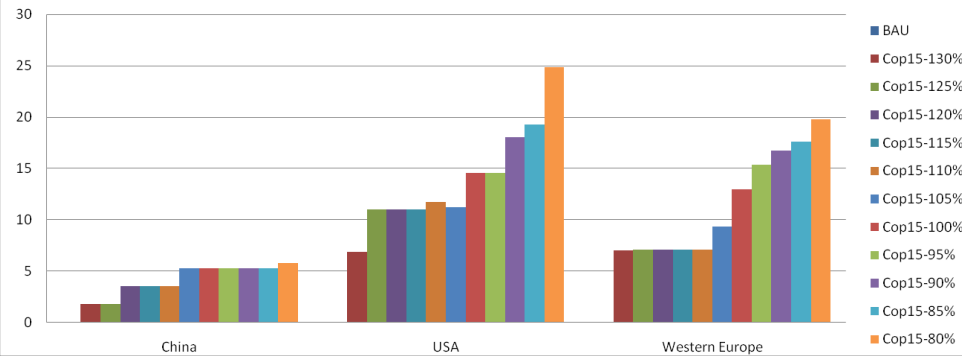
Climate scenarios for 2020

	Europe	USA	China
Business As Usual	No constraint		
COP15 – 80%	20% more constrained than COP15		
COP15 – 85%	15% more constrained than COP15		
COP15 – 90%	10% more constrained than COP15		
COP15 – 95%	5% more constrained than COP15		
COP15	20% on emissions (1990)	17% on emissions (2005)	40% on Carbon intensity (2005)
COP15 – 105%	5% less constrained than COP15		
COP15 – 110%	10% less constrained than COP15		
COP15 – 115%	15% less constrained than COP15		
COP15 – 120%	20% less constrained than COP15		
COP15 – 125%	25% less constrained than COP15		
COP15 – 130%	30% less constrained than COP15		

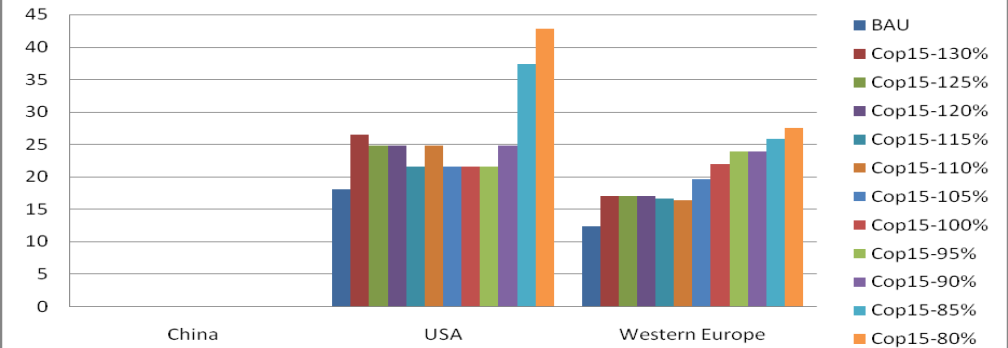
Results

Energy Efficiency implementation in industry

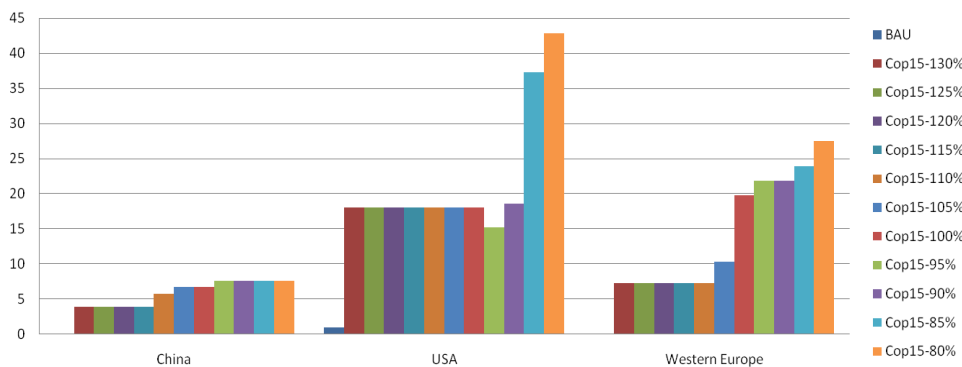
Percentage of EE in the chemistry industry in 2020



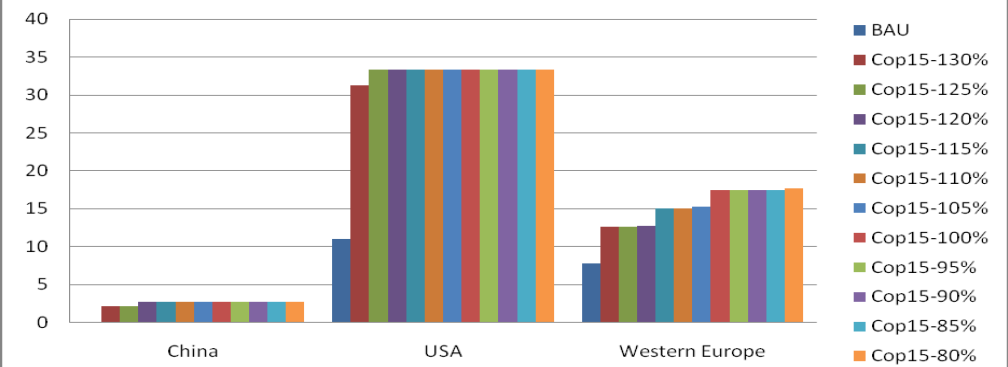
Percentage of EE in the iron and steel industry in 2020



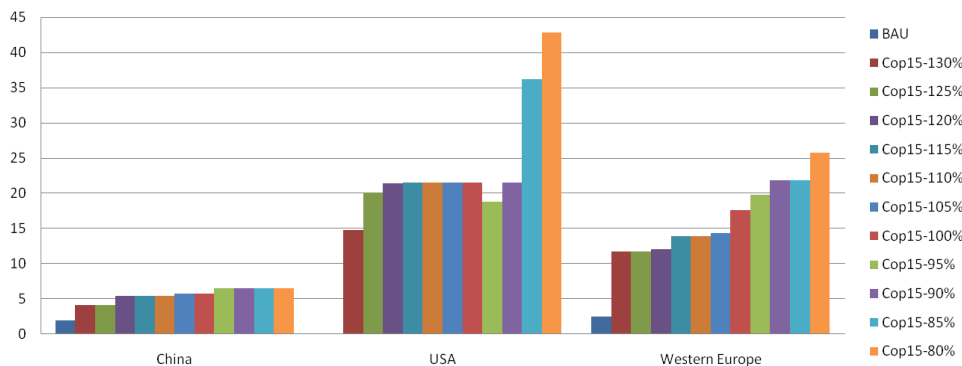
Percentage of EE in the non-metal minerals industry in 2020



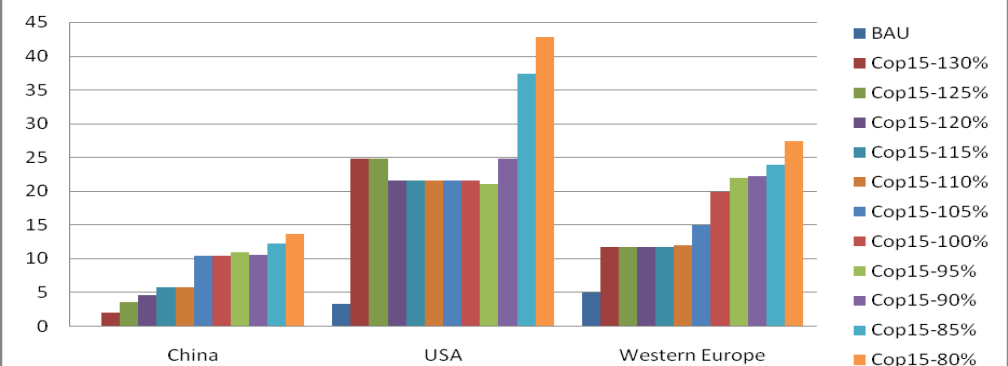
Percentage of EE in the non ferrous metals industry in 2020



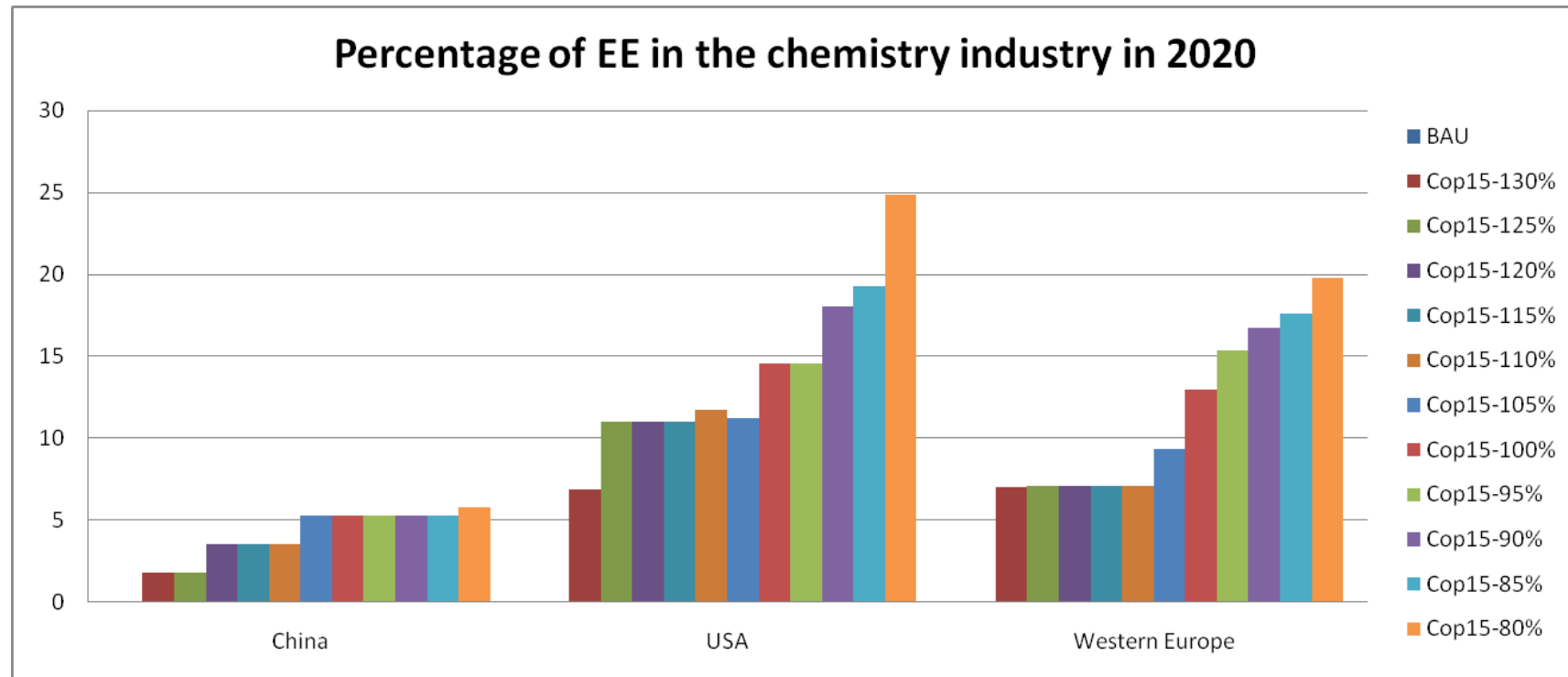
Percentage of EE in the pulp and paper industry in 2020



Percentage of EE in other industries in 2020



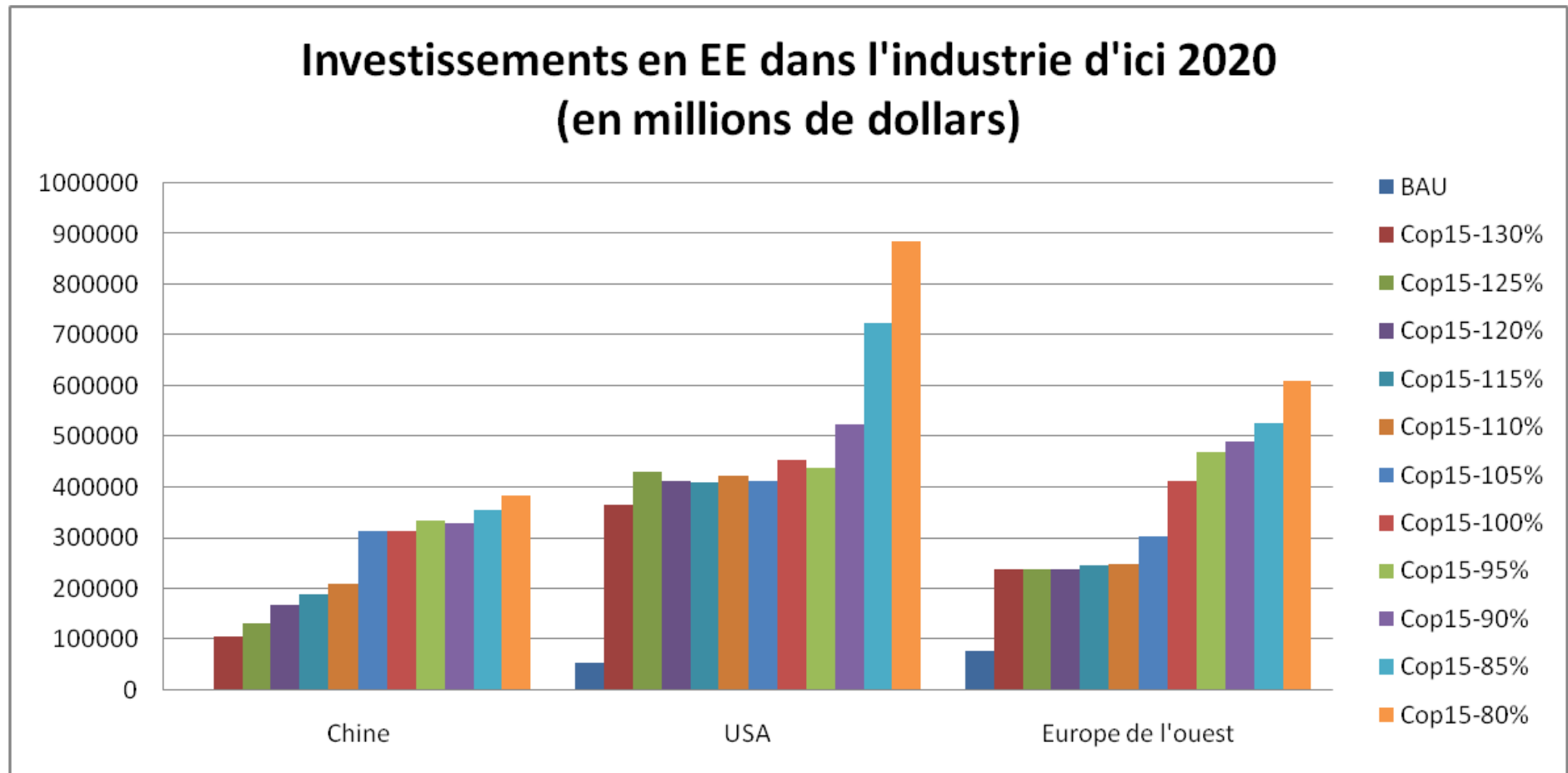
Rate of energy efficiency implemented at the demand side in the industry sector



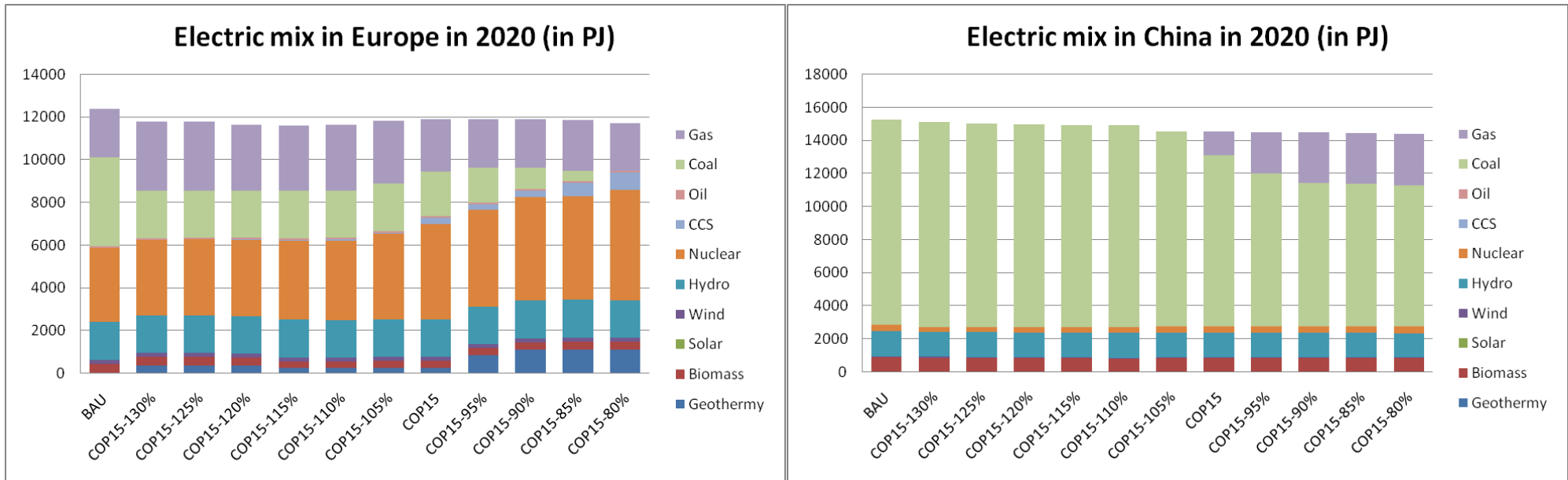
- No implementation for BAU
 - Investments are driven by the climate constraint, not by the economic returns
- The rate grows with the climate constraint
- China has the lower rate of implementation
- Stronger sensitivity for USA and Europe than for China

Energy Efficiency market in industry

- No saturation for USA and Europe



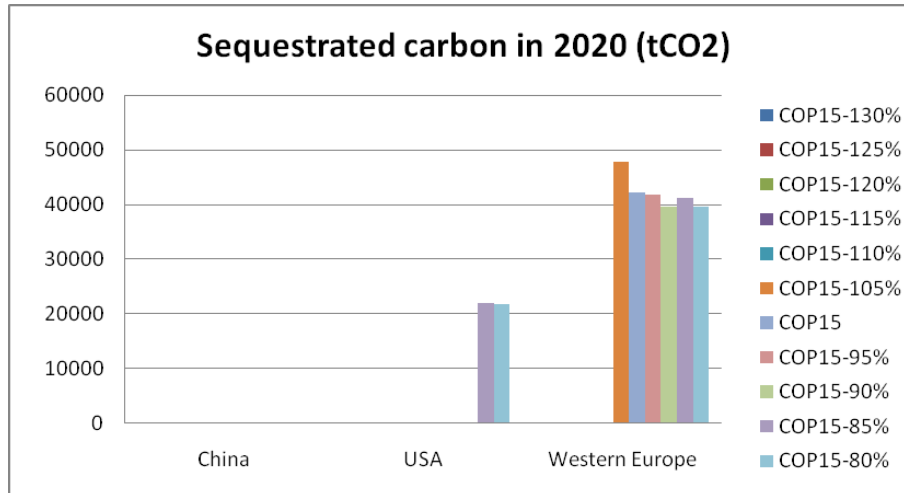
Generation Mix sensitivity



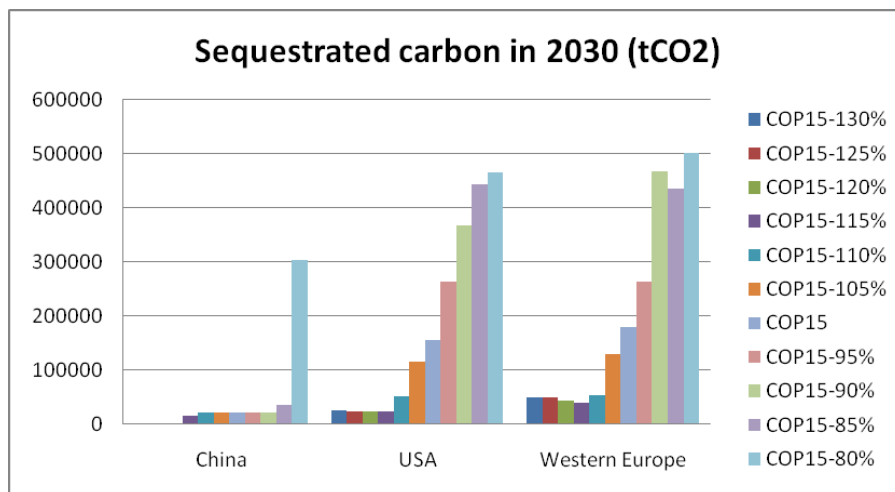
- Low sensitivity to a weaker constraint
- High sensitivity to a stronger constraint
 - Coal substitution by nuclear, gas, geothermy
 - Coal phase-out for Cop15-80% !

- Vanishing sensitivity to a weaker constraint
 - BAU til COP15-105% !
- High sensitivity to a stronger constraint
 - Replacement of coal by gas

Competition with CCS



- Low level of CCS in 2020
- Only driven by EE potential saturation in Europe



- CCS is a long-term solution

Conclusion

- No implementation of EE technologies for BAU
 - Investments are driven by the climate constraint, not by the economic returns
- The rate grows with the climate constraint
 - China has the lower rate of implementation due to clean generation competition
 - Stronger EE-sensitivity for USA and Europe than for China to climate pledges
- CCS appears as a marker of EE saturation

Remark: The study was done with no nuclear limitation (no post Fukushima policy)

A tight equation towards sustainability

- Demography:

- Rise of energy systems in developing countries
- Refurbishment of existing capabilities in developed countries
- Urban population, from 50% today to 80% in 2100, claims for high density power networks

- *The Earth: An isolated chemical system*

- Fossil (and fissil) fuels depletion:
 - Peak oil around 2020
 - Peak gas around 2030 (excluding shale gas)
 - Around two centuries for coal or Uranium
- Climate change:
 - Whole electrical generation provides **45% of CO₂ emissions**
 - **Global efficiency** of the whole electrical system is just **27%** (37% for all fuels)
 - Despite a thermodynamic trend toward reversibility

- *The Earth: A fully open energy system*

- Domestic energy is 10.000 times smaller than natural energy flows:
Solar direct, wind, geothermy, waves and swell
- But very diluted and intermittent