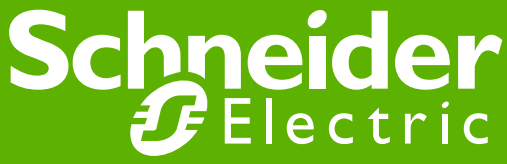
Arbitrage between Energy Efficiency and Carbon Management:
An industry-sectorial study

V. Mazauric, M. Thiboust – Schneider Electric

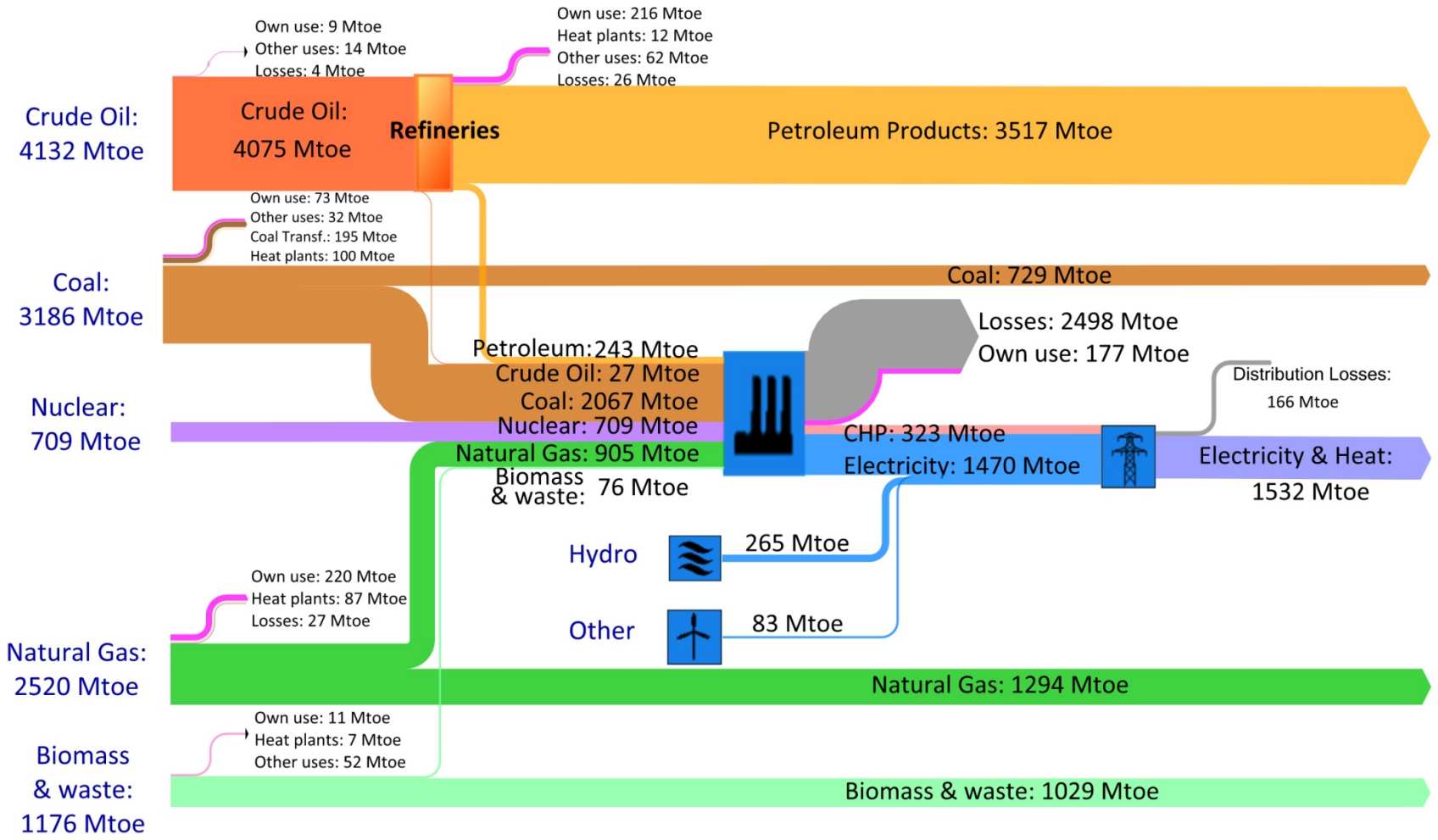
S. Selosse, E. Assoumou, N. Maïzi – Mines ParisTech

June 4th, 2014

ECEEE – Arnhem – The Nethetlands



Energy supply Chain (from IEA 2007)



The energy dilemma is here to stay

The facts

×2

Energy demand

By 2050

Electricity up 80% by 2035

Source: IEA 2010

vs

The need

÷2

CO_2 emissions to avoid dramatic climate changes by 2050

Source: IPCC 2007, figure (vs. 1990 level)

Energy scarcity,
Demography
Resource access
Energy prices

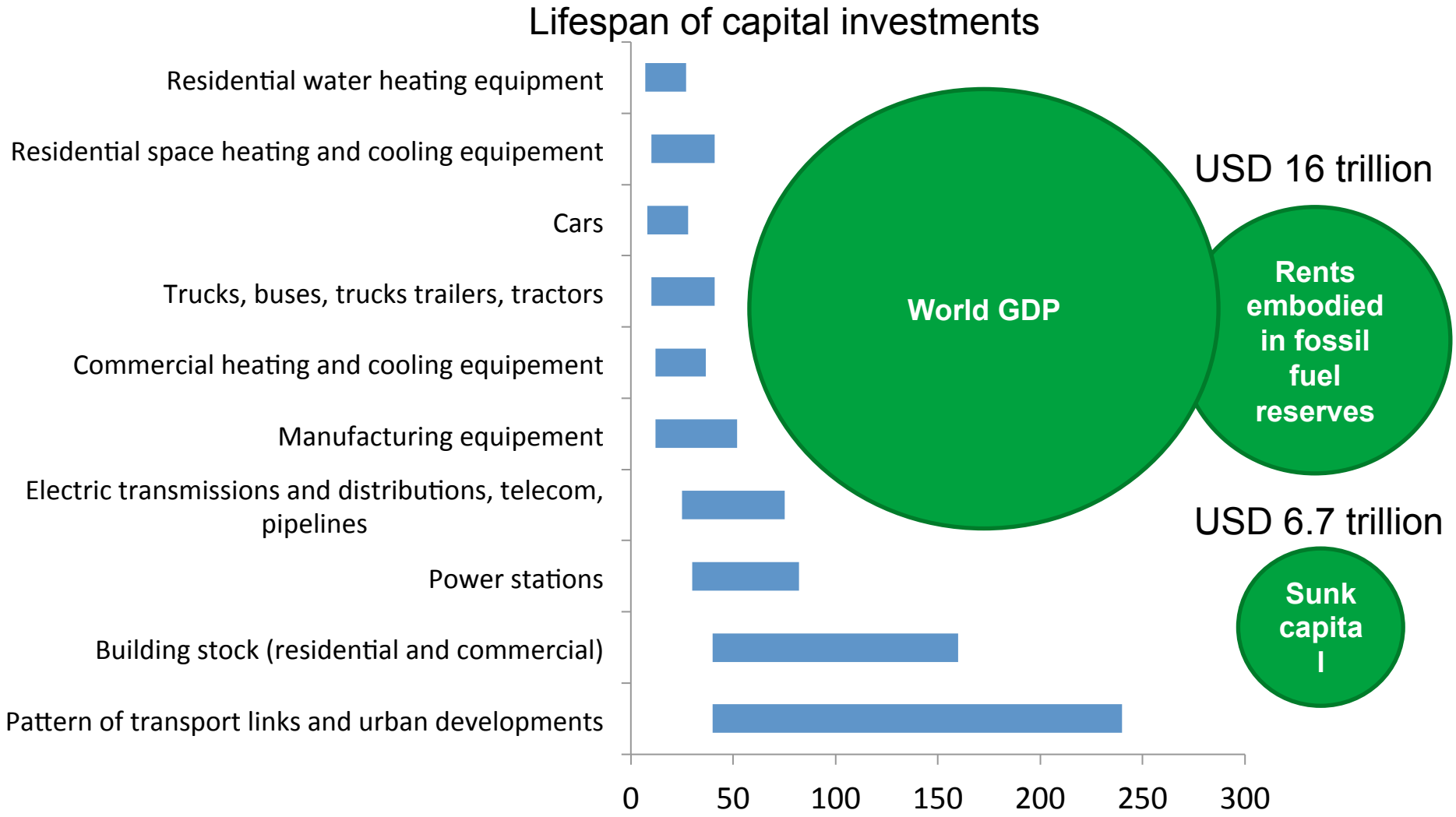
GHG emissions
Climate change

- **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…)

- CO_2-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

ParisTech
INSTITUT DES SCIENCES ET TECHNOLOGIES
PARIS INSTITUTE OF TECHNOLOGY

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

EDF

RENAULT

Schneider Electric

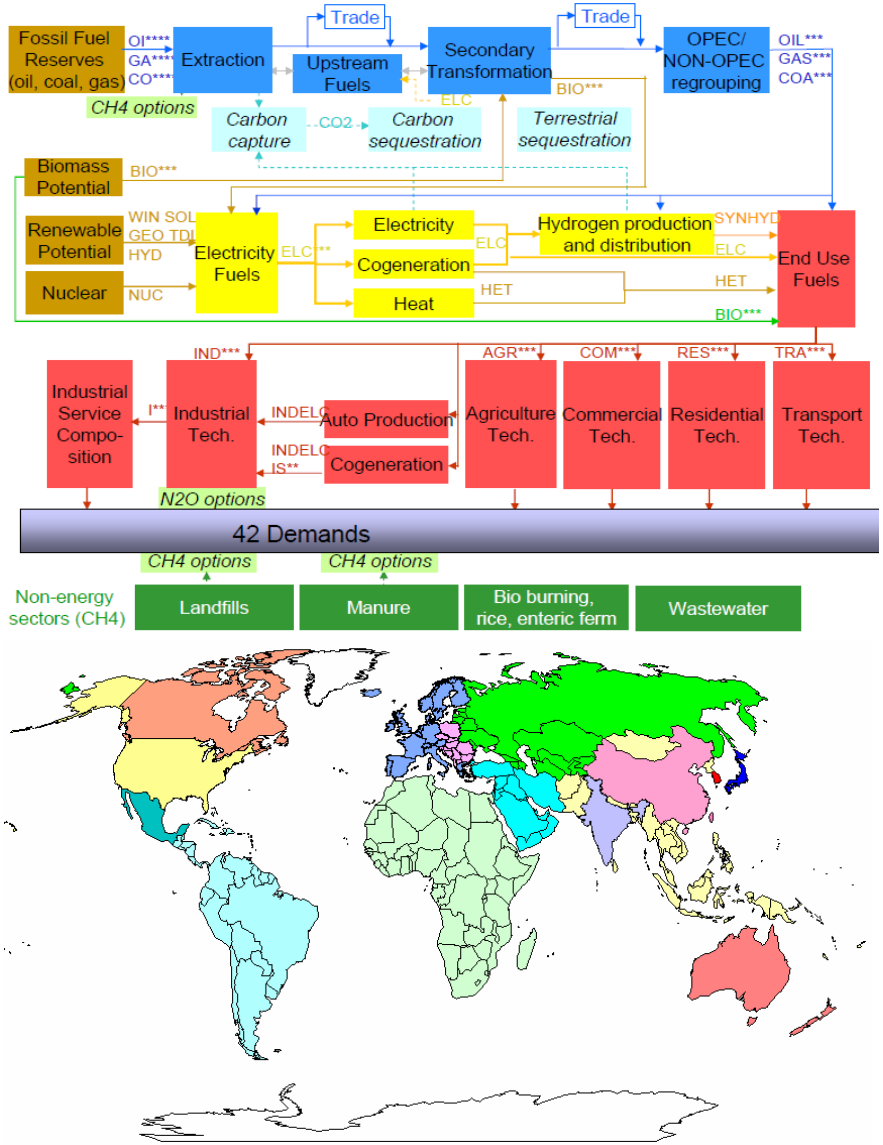
TOTAL

Modeling issues

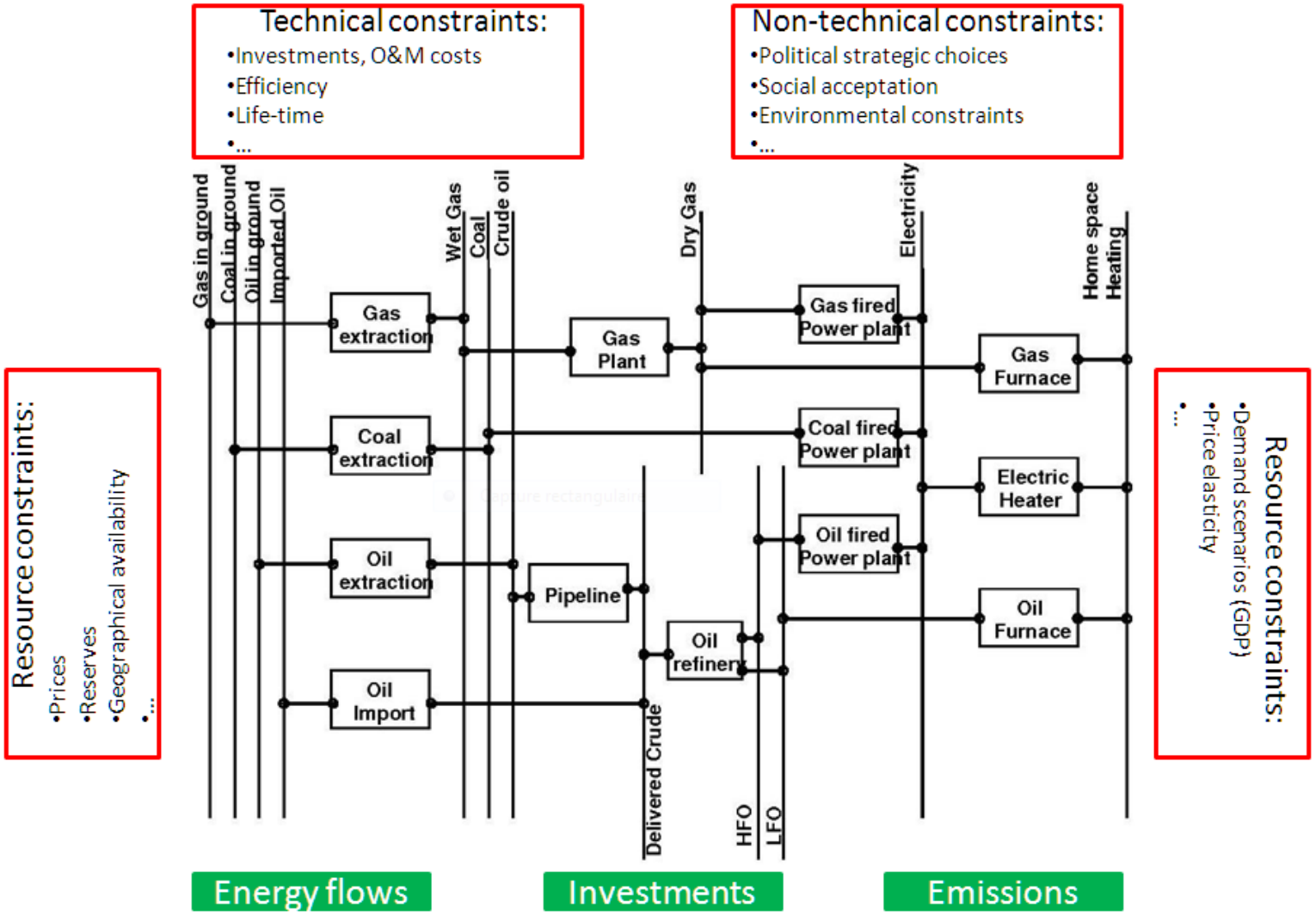
- The TIAM-FR model:

  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

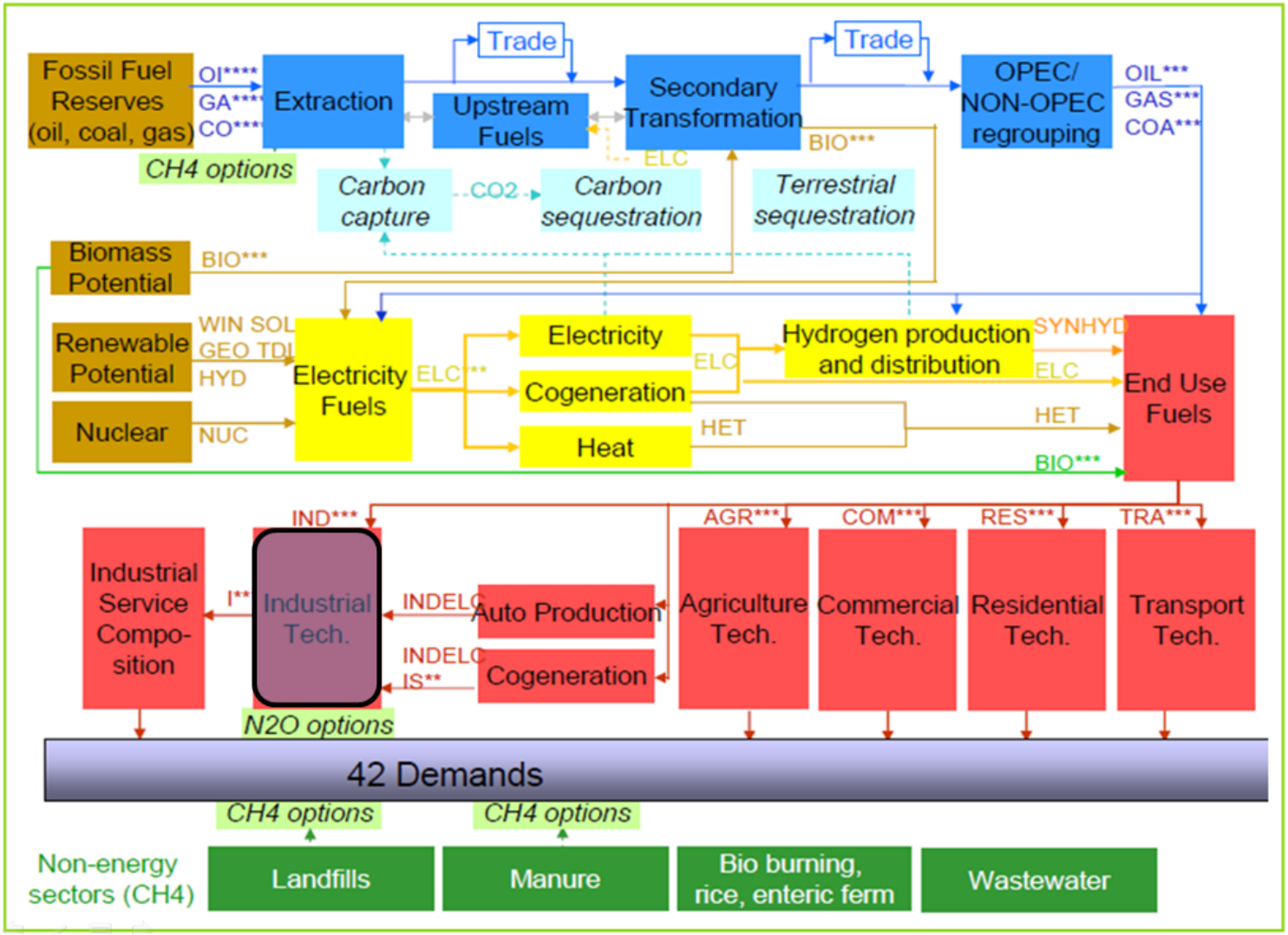


Reference Energy System
within the TIMES formalism

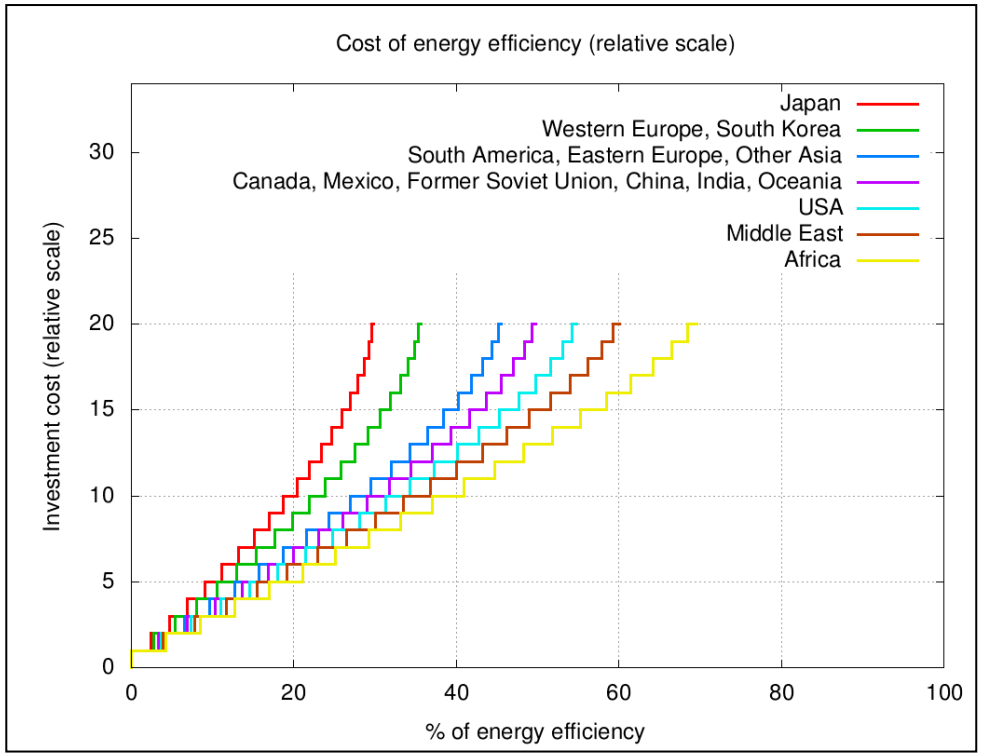


Energy efficiency modeling

Global Reference Energy System:
Industry-sector disagregation



Energy efficiency implementation costs



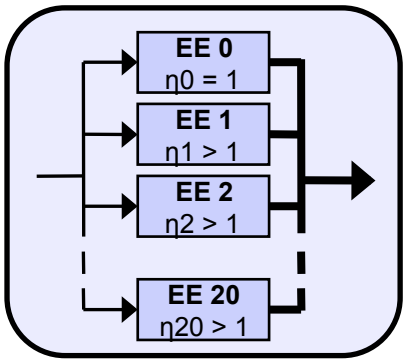
- Model refinement:
  - Provide the cost of the next EE step for an already achieved level (demand side)
- The model selects the rate of EE to implement at the demand side:
  - for each sector and
  - each region

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

For each region and each sector

η1, η2,…, η20
cost1, cost2,…, cost3

DS-EE technologies

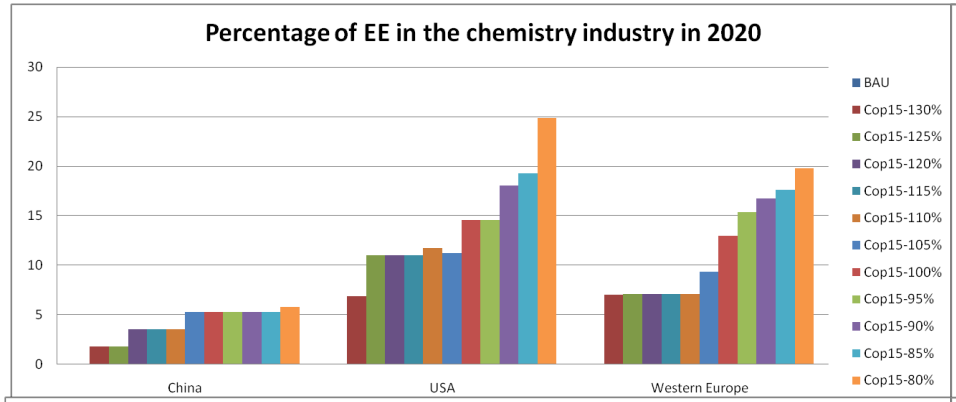


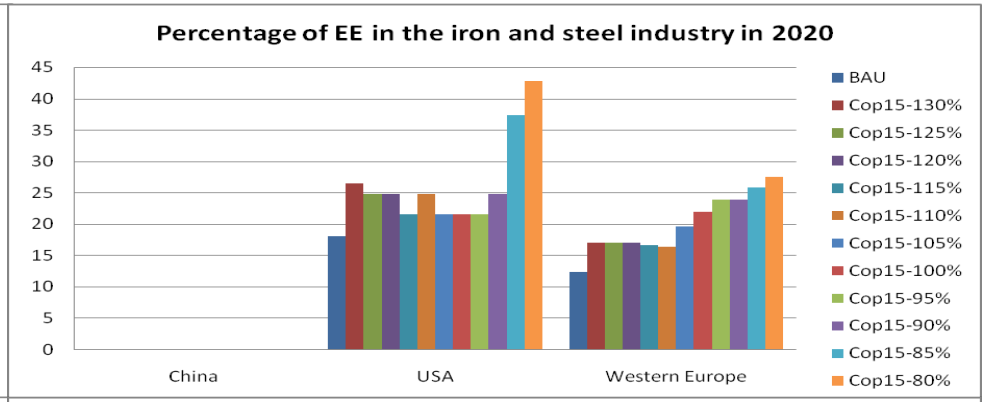
Climate scenarios for 2020

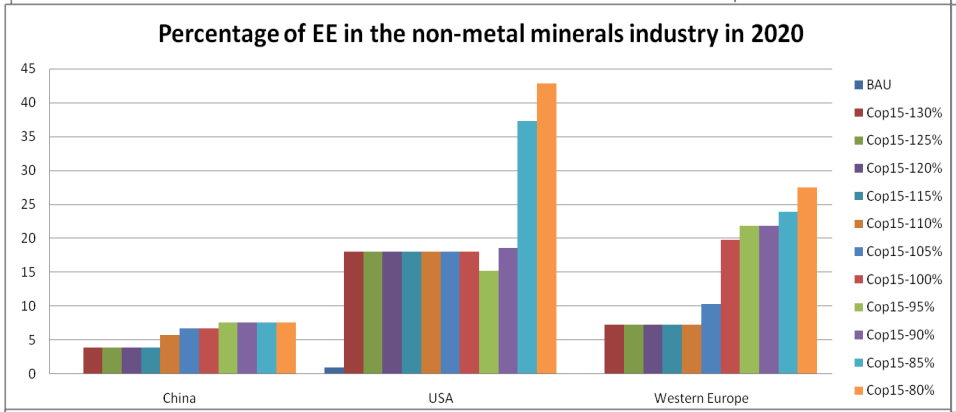
	Europe	USA	China
Business As Usual	No constraint		
COP15 – 80%	20% more constrained than COP15		
COP15 – 85%	15% more constrained than COP15		
COP15 – 90%	10% more constrained than COP15		
COP15 – 95%	5% more constrained than COP15		
COP15	20% on emissions (1990)	17% on emissions (2005)	40% on Carbon 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		

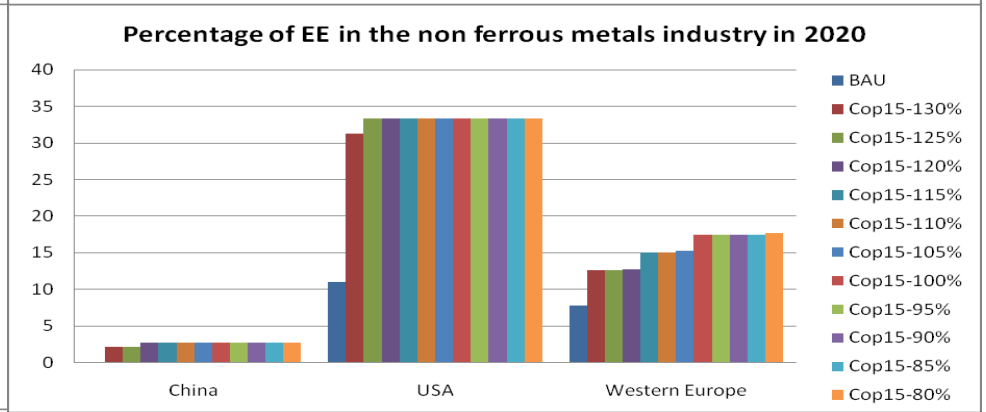
Results

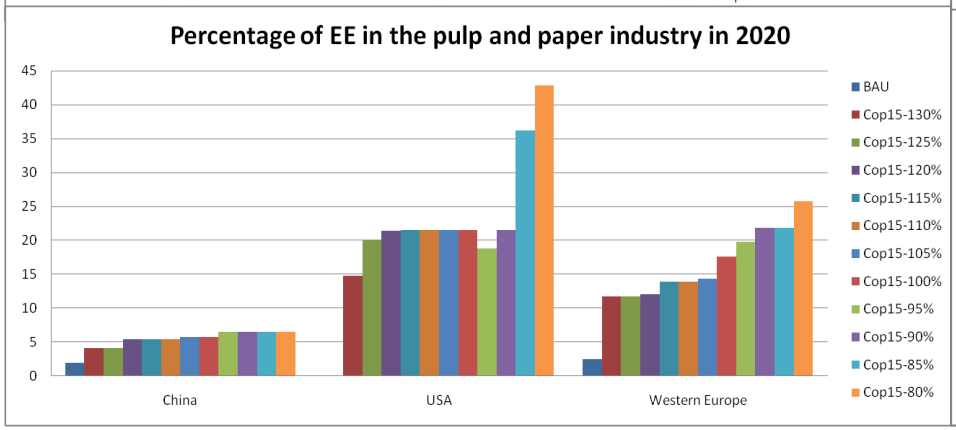
Energy Efficiency implementation in industry

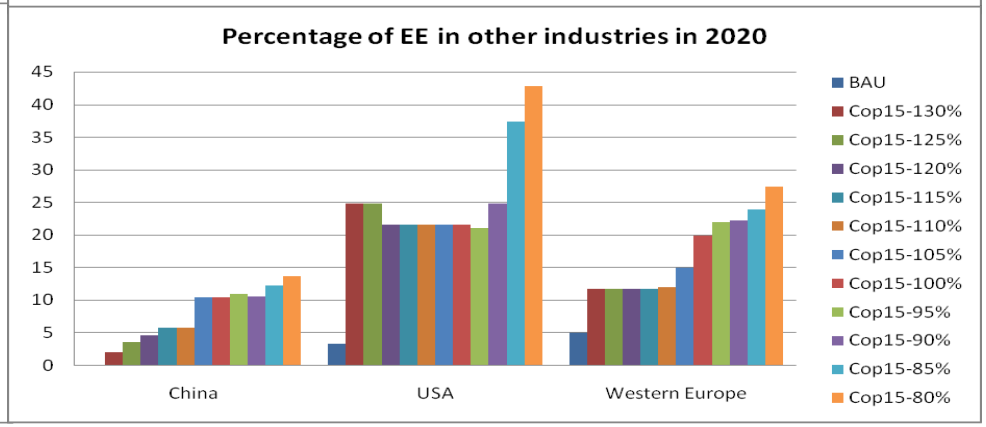




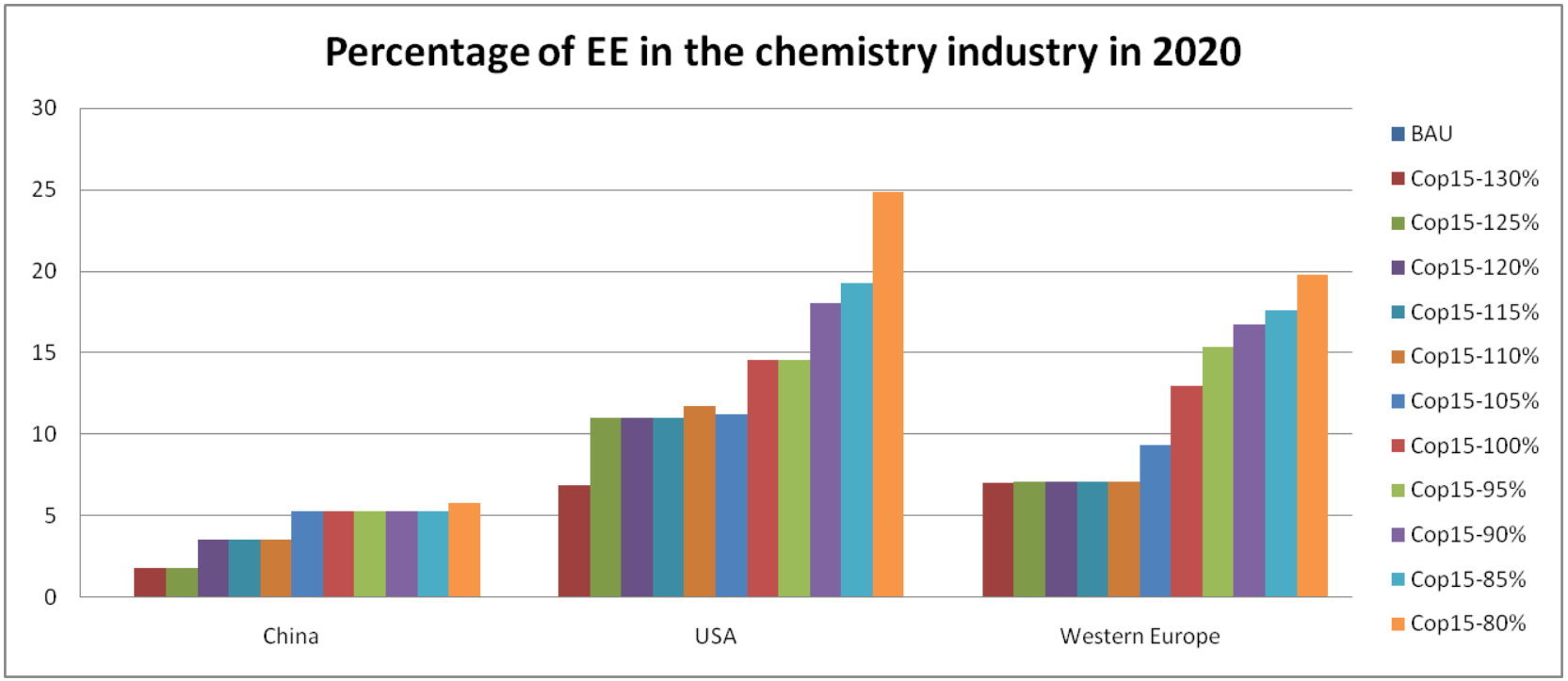








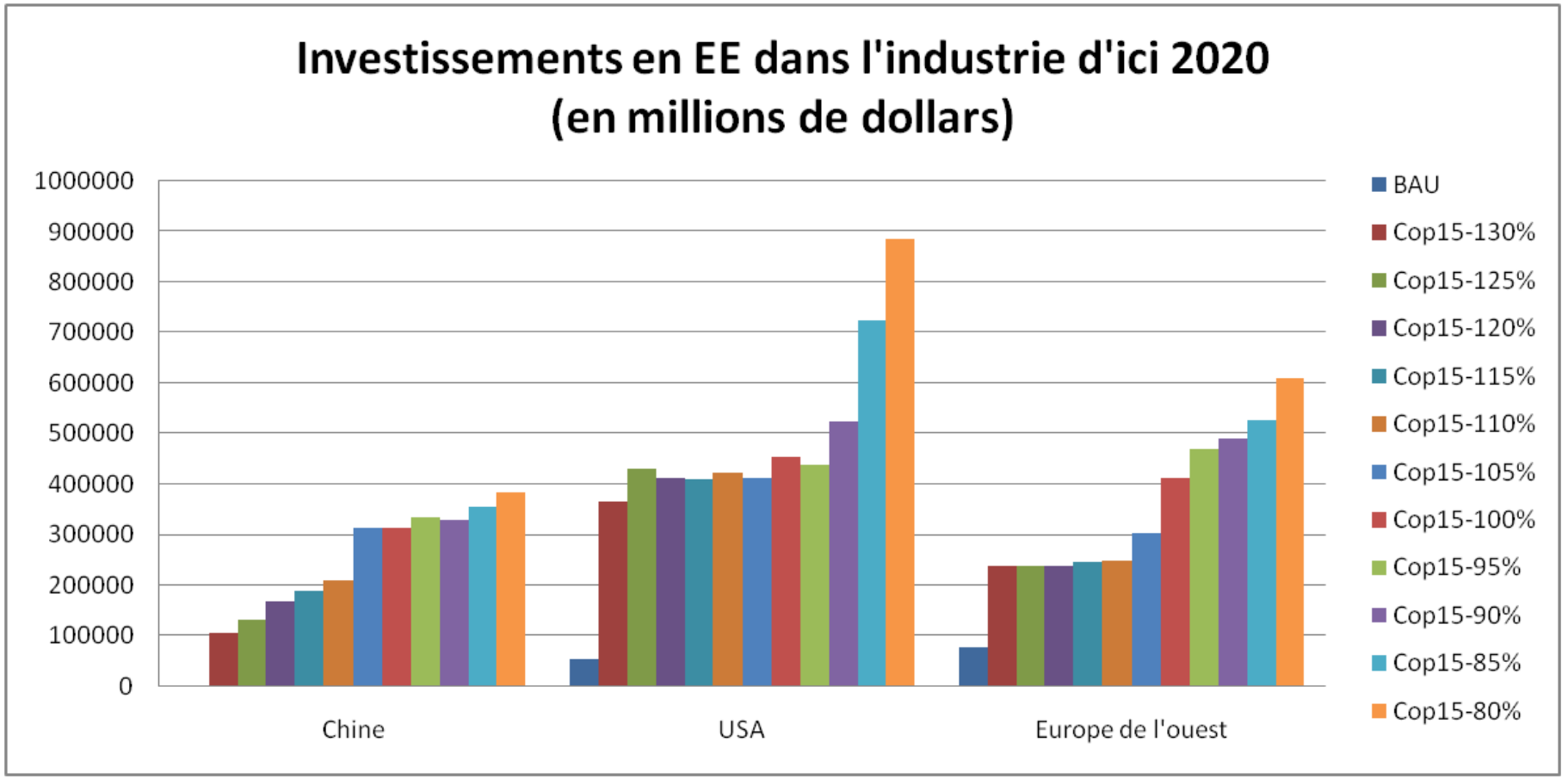
Rate of energy efficiency implemented at the demand side in the industry sector



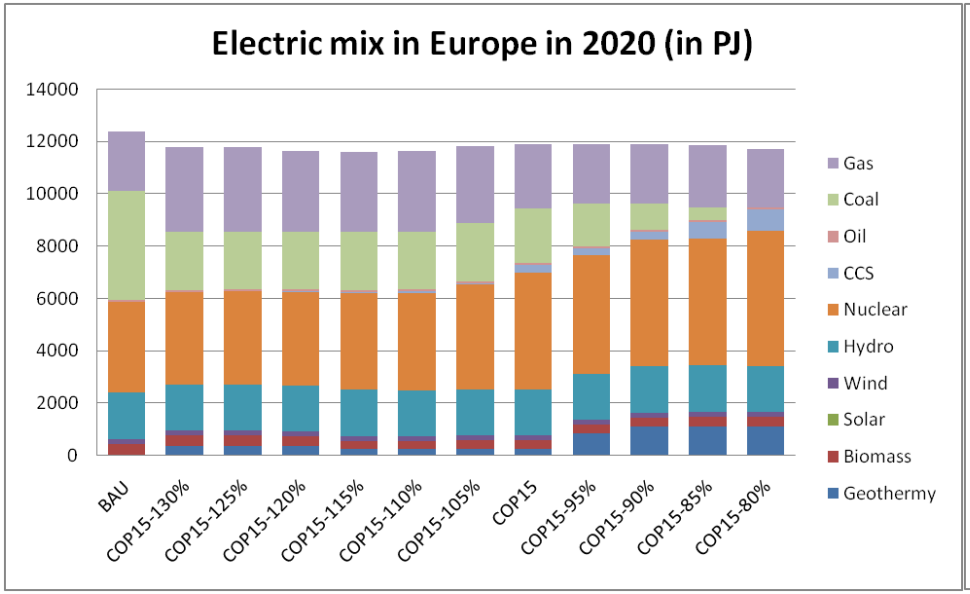
- No implementation for BAU
  - Investments are driven by the climate constraint, not by the economic returns
- The rate grows with the climate constraint
- China has the lower rate of implementation
- Stronger sensitivity for USA and Europe than for China

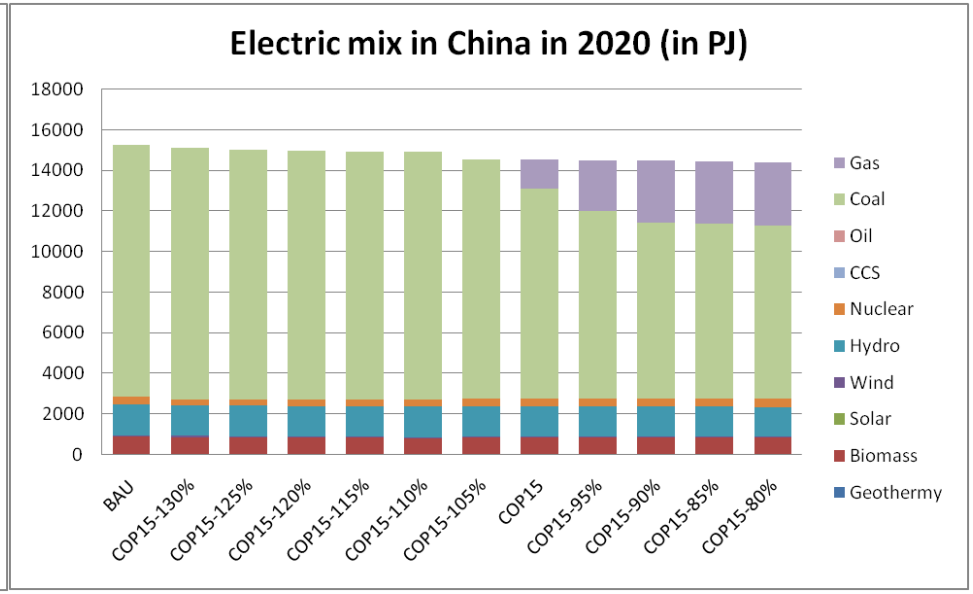
Energy Efficiency market in industry

- No saturation for USA and Europe



Generation Mix sensitivity

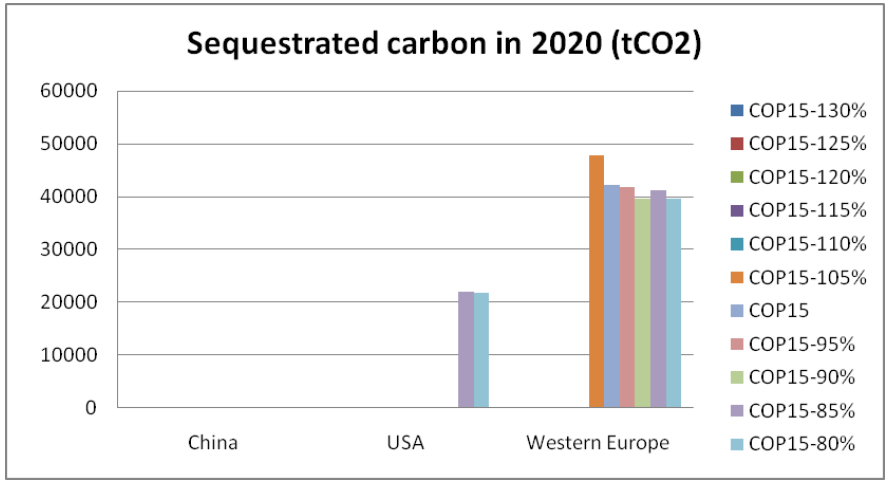


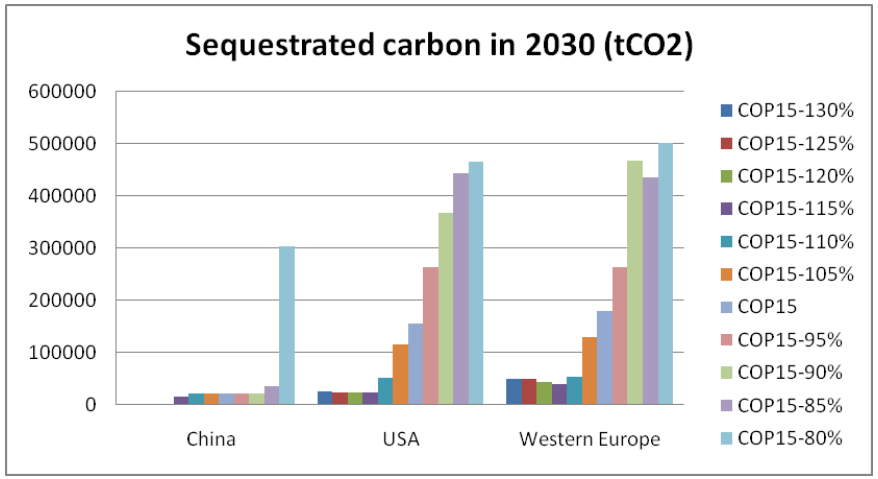


- Low sensitivity to a weaker constraint
- High sensitivity to a stronger constraint
  - Coal substitution by nuclear, gas, geothermy
  - Coal phase-out for Cop15-80% !

- 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)