Arbitrage between Energy Efficiency and Carbon Management

M. Thiboust, S. Selosse, N. Maïzi, V. Mazauric

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Schneider Electric

The energy dilemma is here to stay

The facts

×2

Energy demand

By 2050

Electricity by 2030

Source: IEA 2007

vs

The need

÷2

CO_2 emissions to avoid dramatic climate changes by 2050

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

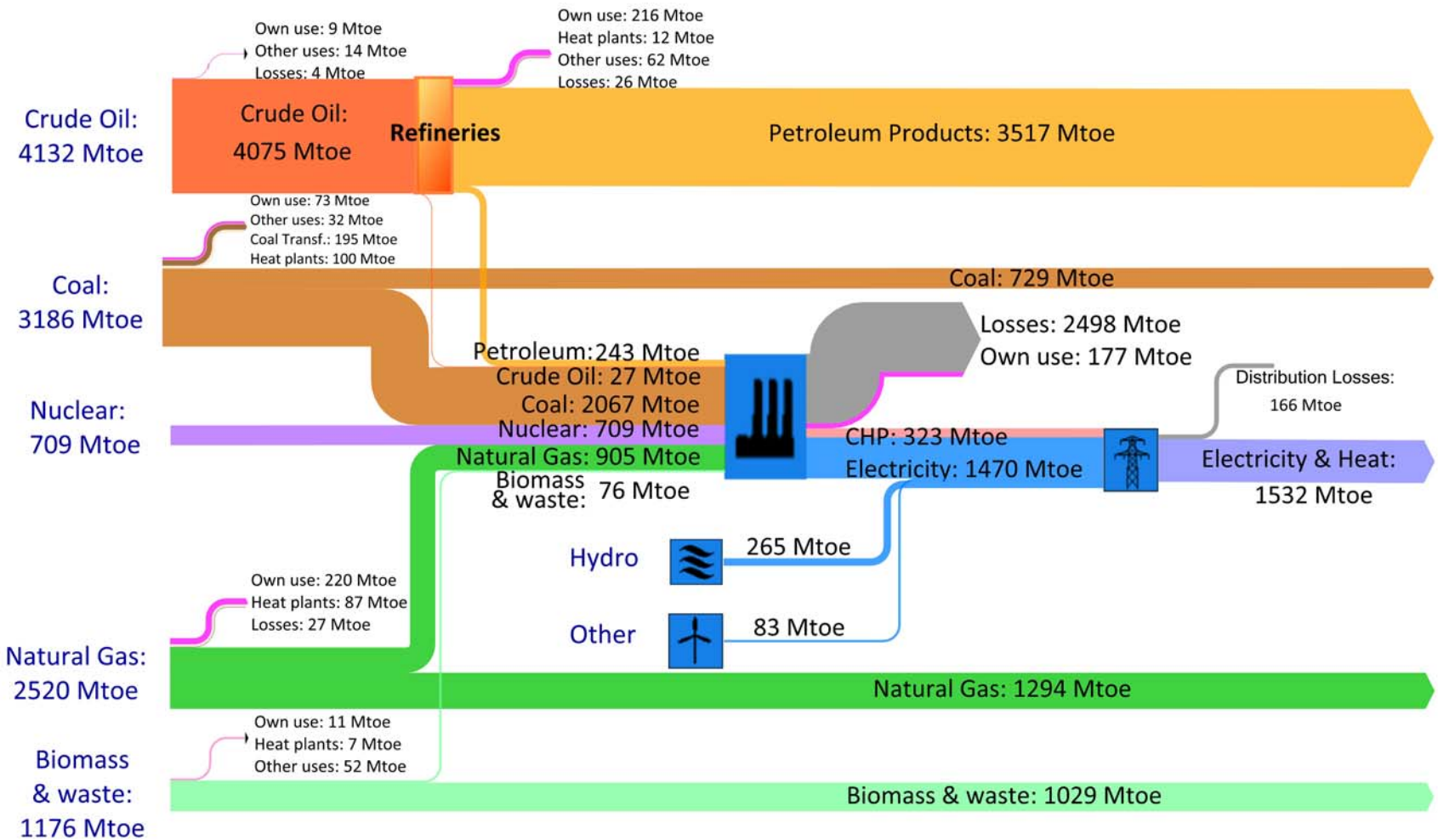
Frequent power outages

Rising energy prices

Climate change

Conflicts for resource access & control

Energy supply Chain (from IEA 2007)



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 CO_2 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

Energy efficiency modeling

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

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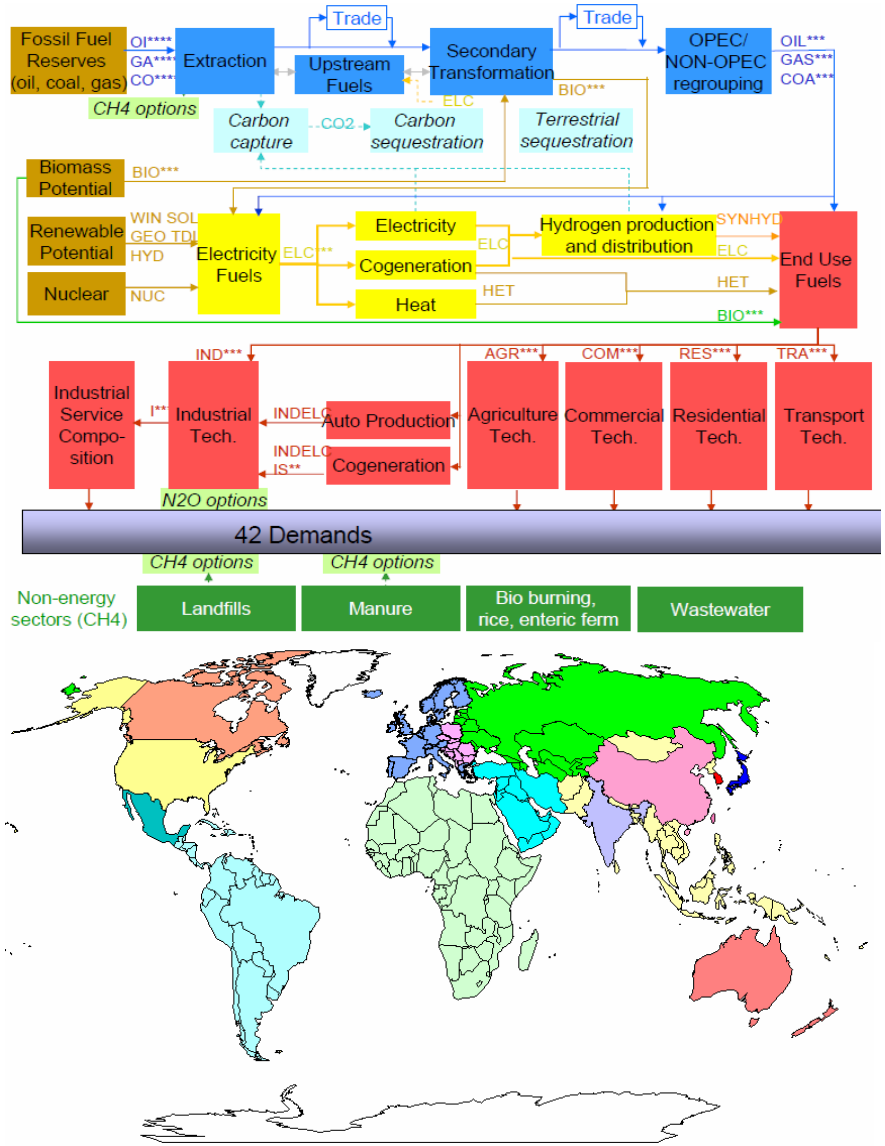
TOTAL

Modeling issues

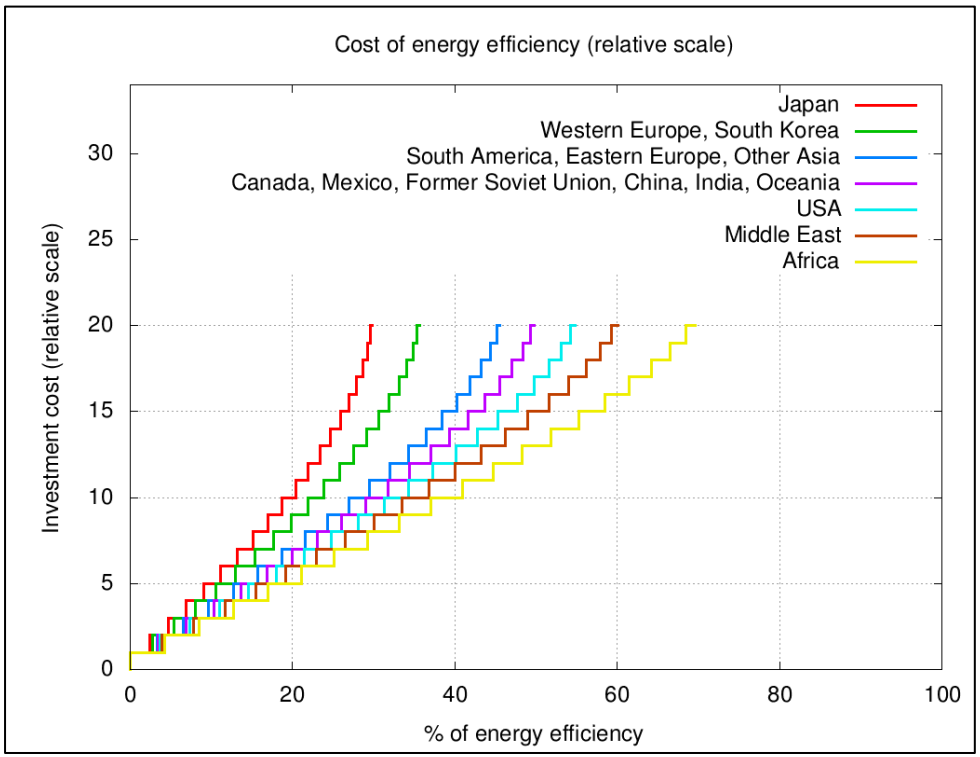
- The TIAM-FR model:

  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



Energy efficiency implementation costs



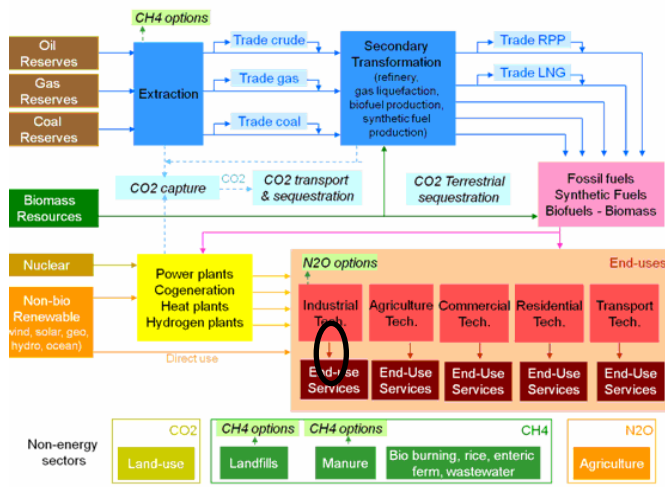
- Model refinement:
  - Provide the cost of the next EE step for an already achieved level (demand side)
- The model selects the rate of EE to implement at the demand side:
  - for each sector and
  - each region

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

For each region and each sector

η1, η2,…, η20
cost1, cost2,…, cost3

DS-EE technologies

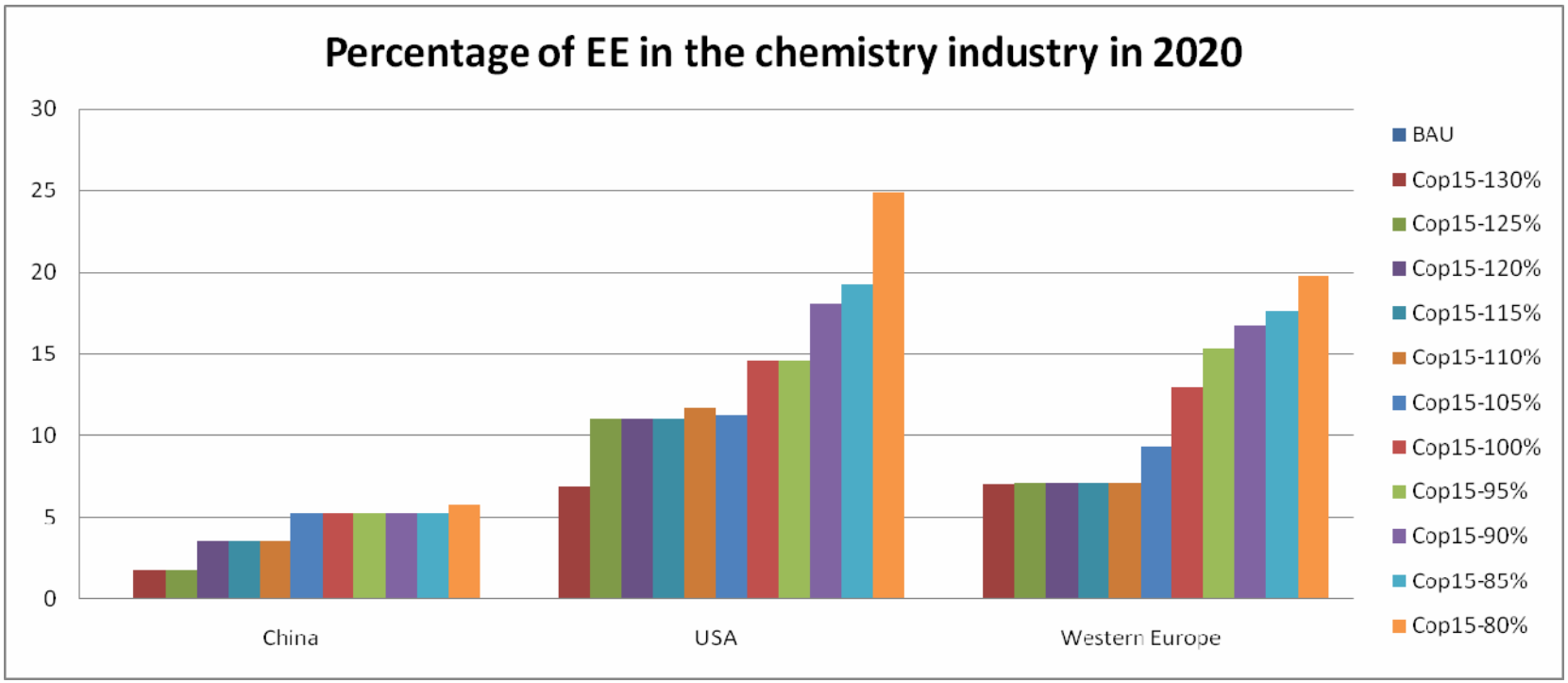


Results

Climate scenarios for 2020

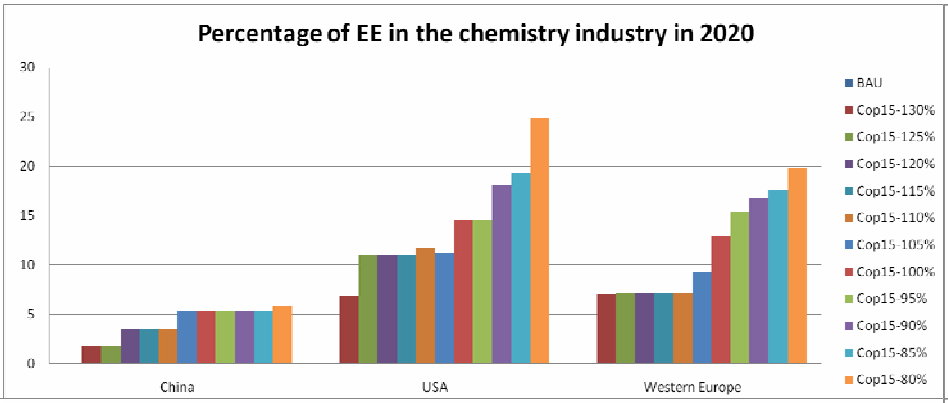
	Europe	USA	China
Business As Usual	No constraint		
COP15 – 80%	20% more constrained than COP15		
COP15 – 85%	15% more constrained than COP15		
COP15 – 90%	10% more constrained than COP15		
COP15 – 95%	5% more constrained than COP15		
COP15	20% on emissions (1990)	17% on emissions (2005)	40% on Carbon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

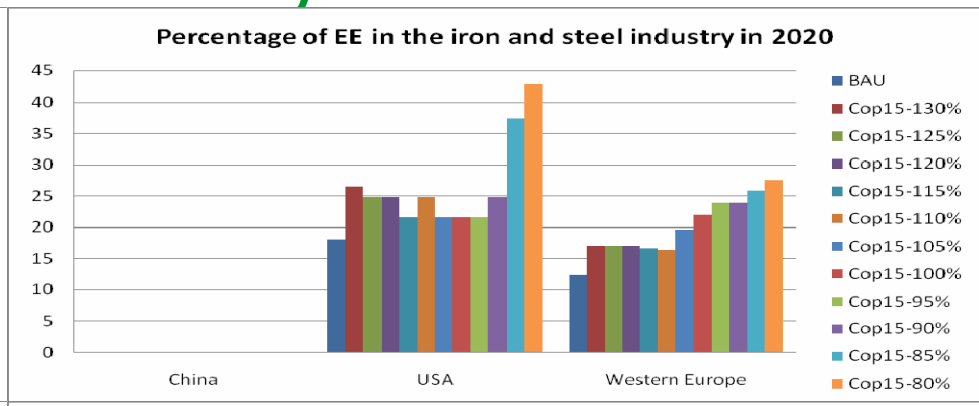
Rate of energy efficiency implemented at the demand side in the industry sector

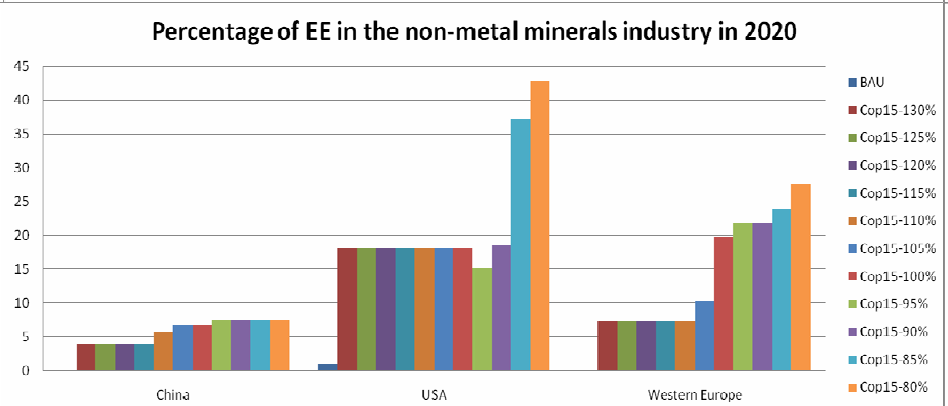


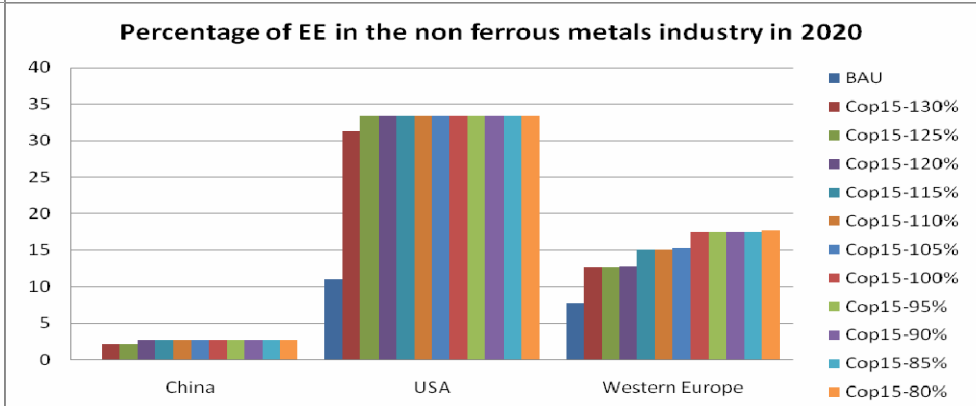
- No implementation for BAU
  - Investments are driven by the climate constraint, not by the economic returns
- The rate grows with the climate constraint
- China has the lower rate of implementation
- Stronger sensitivity for USA and Europe than for China

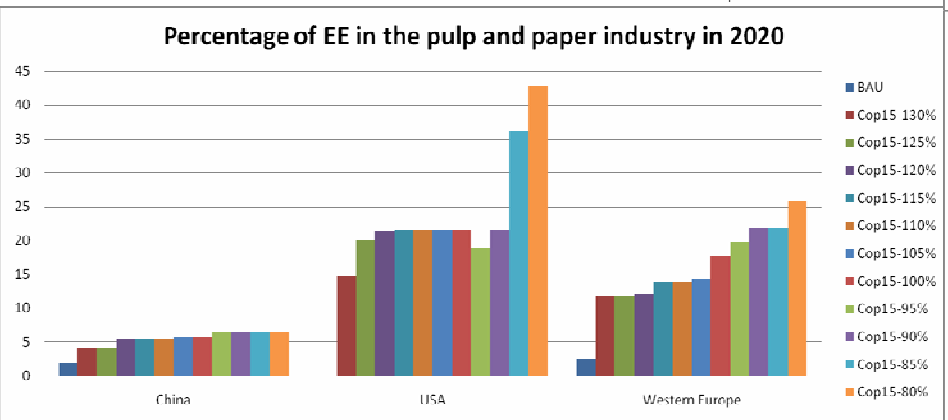
Energy Efficiency implementation at the demand side in industry

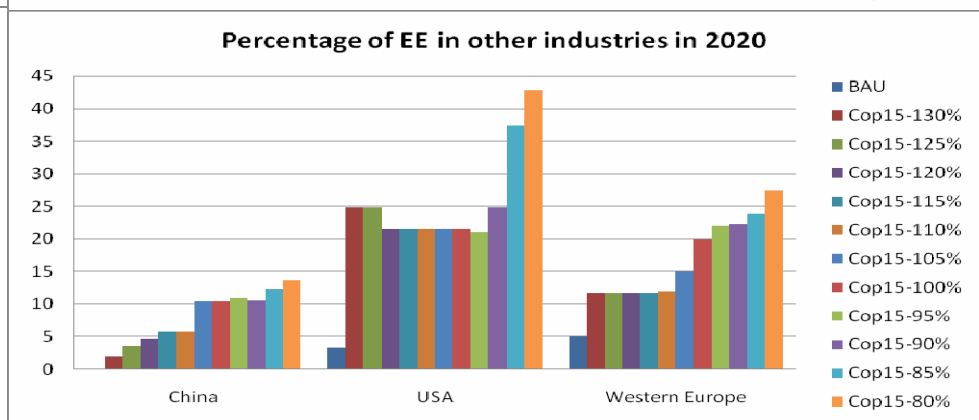






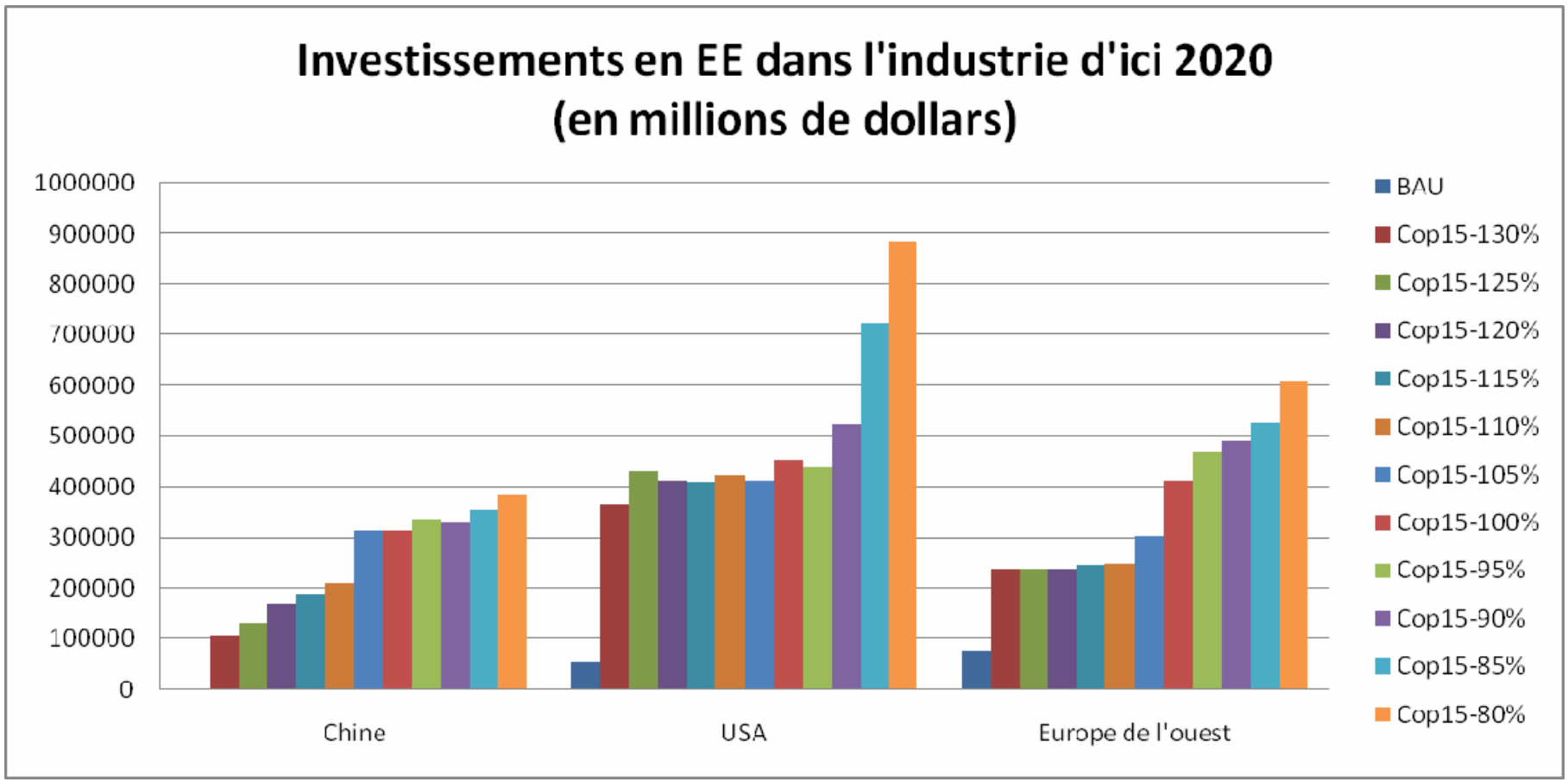




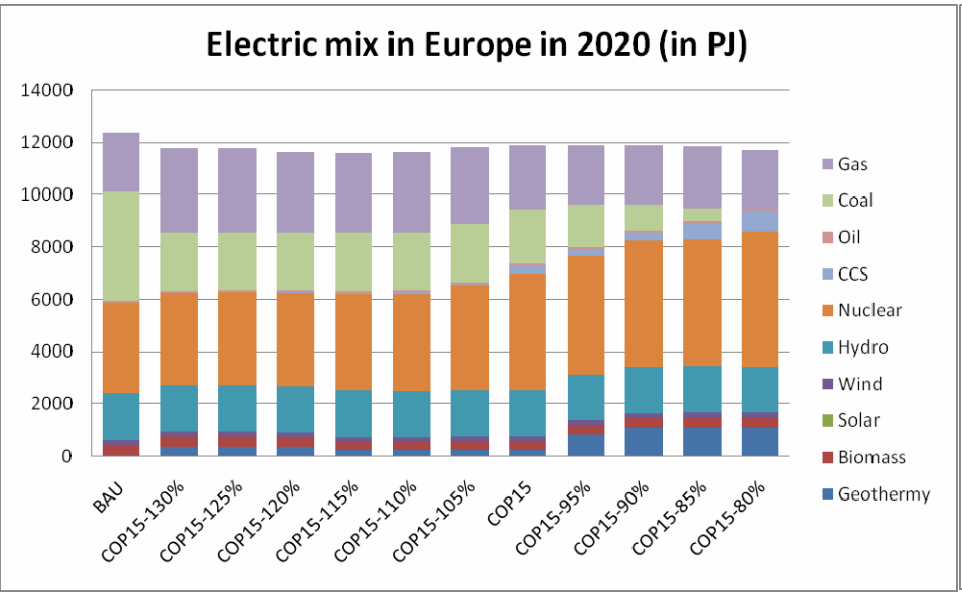


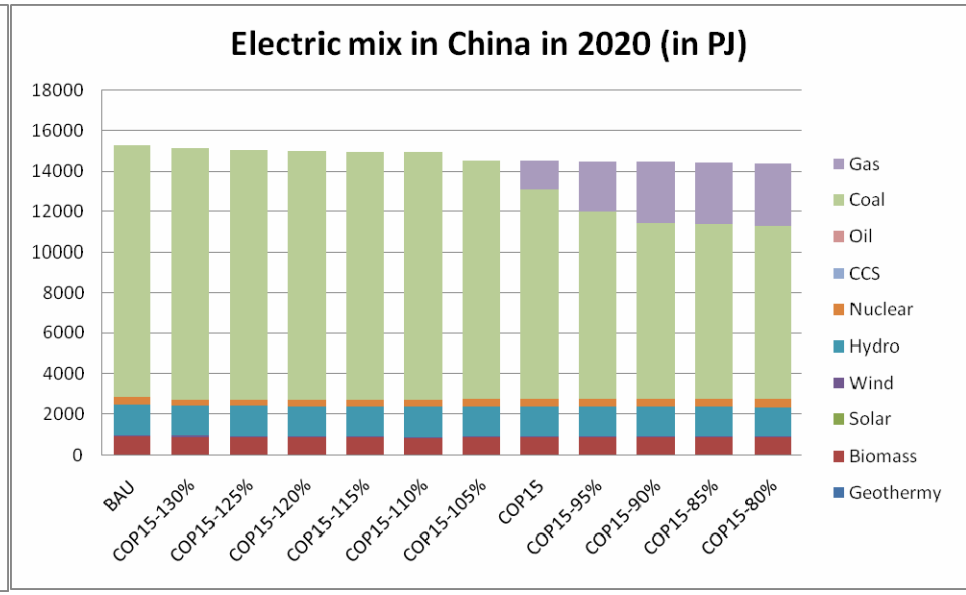
Energy Efficiency market in industry

- No saturation for USA and Europe



Generation Mix sensitivity

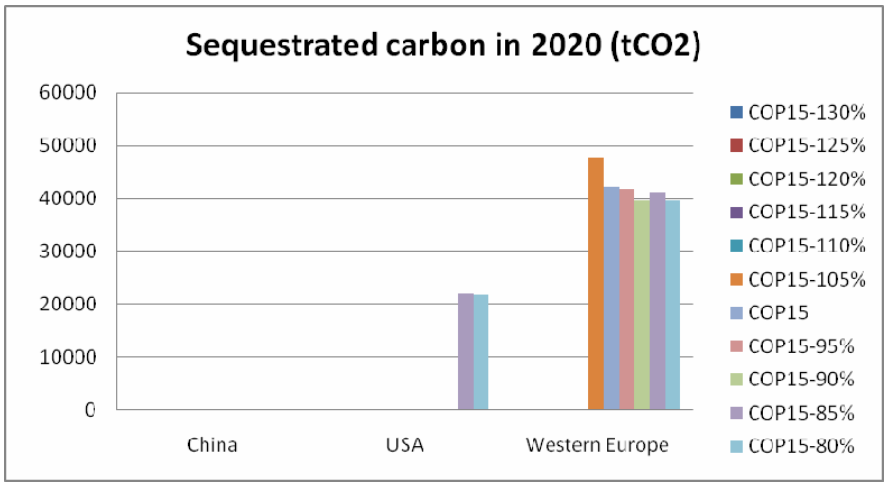


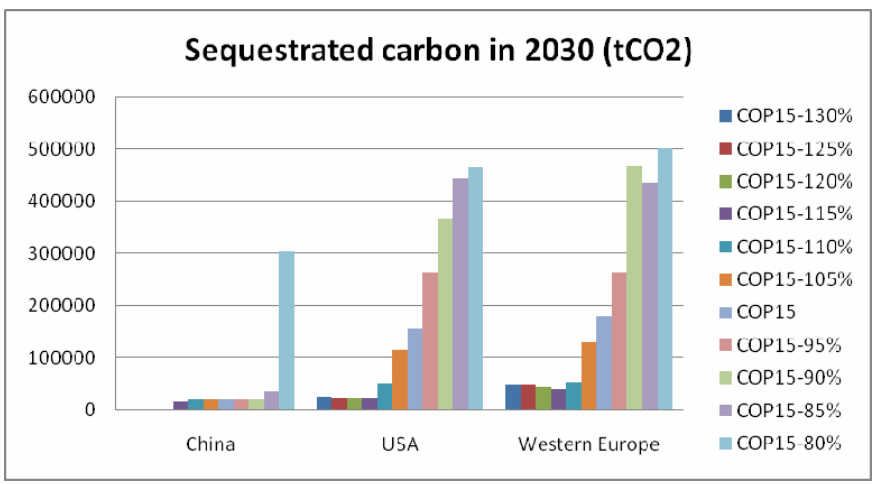


- Low sensitivity to a weaker constraint
- High sensitivity to a stronger constraint
  - Coal substitution by nuclear, gas, geothermy
  - Coal phase-out for Cop15-80% !

- 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