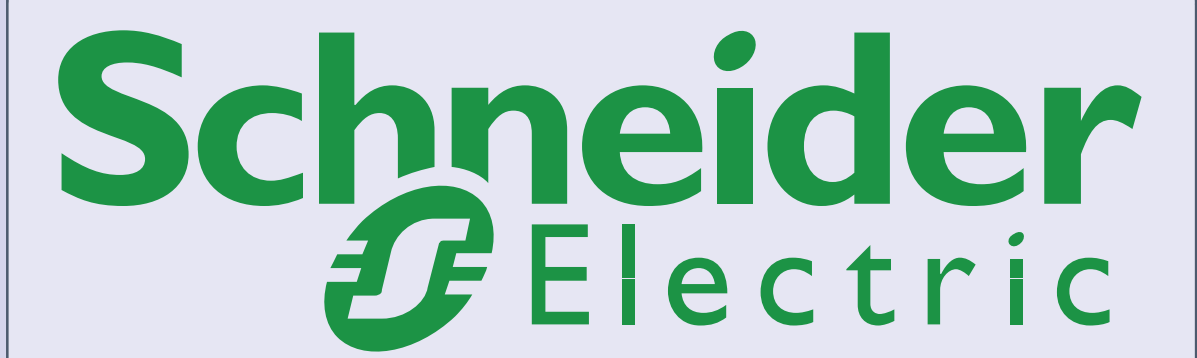


# CARBON AND ENERGY EFFICIENCY PROSPECTIVE



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## Energy efficiency modeling for carbon prospective

Following the Copenhagen climate conference in 2009, some countries have adopted **carbon abatement pledges**. As energy savings are a source of indirect carbon reduction, those pledges will impact the development of **energy efficiency solutions**. We wanted to quantify those impacts and determine their sensitivity to COP15 pledges.

### Different ways to reduce carbon emissions:

- Renewable energies
- Nuclear energy
- Substitution of coal power plants by gas power plants
- Carbon Capture and Sequestration (CCS)
- **Energy efficiency (EE)**
- Others

What is the arbitrage between those solutions ?

### EE modeling

Implementation of the concept of EE in the TIAM-FR energy model.

### Sensitivity of EE levels to COP15 pledges

Determination of the optimal EE allocation for COP15 and COP15-variant pledges

## Energy efficiency modeling in TIAM-FR

Generally, the percentage of energy efficiency (EE) is an input in energy models (used for assessing the impact of EE on the energy and climate system).

However, if we want to see the arbitrage between EE and the other carbon abatement solutions, we need to obtain the **optimal EE percentage as an output of the model**.

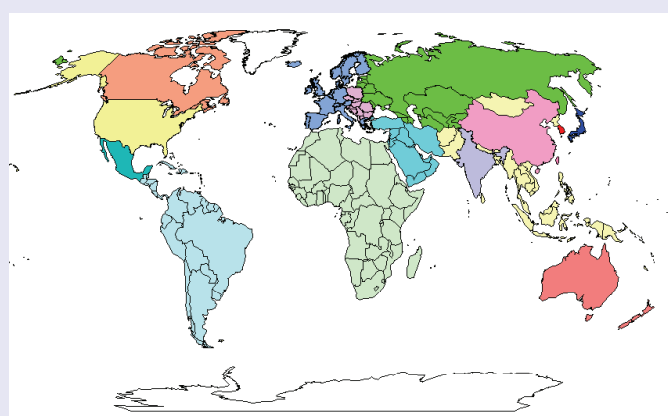
### The TIAM-FR Energy Model

#### TIMES Integrated Assessment Model

- Developed by the ETSAP under the aegis of the IEA

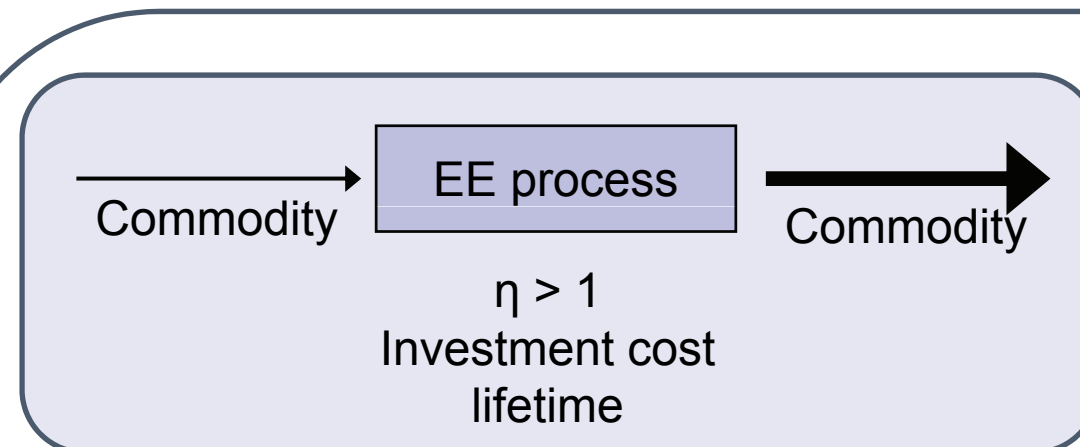
#### A MARKAL/TIMES model:

- Optimization model
  - Linear programming
  - Minimization of the total discounted system cost
- Bottom-up model
- Driven by the demand



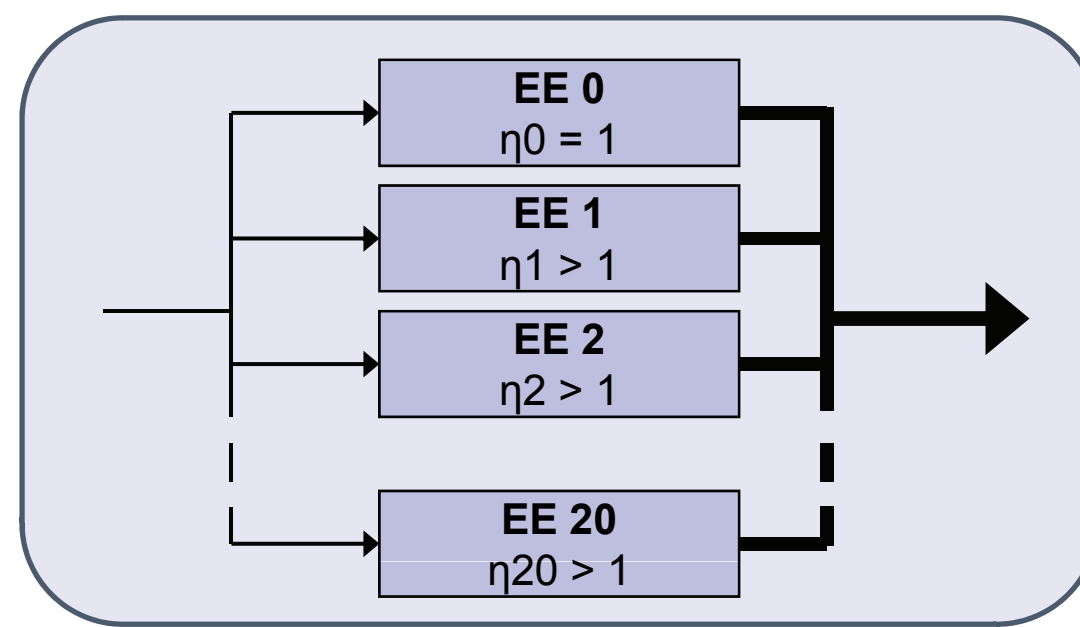
#### TIAM-FR characteristics:

- Detailed representation of the energy system
  - Thousands of processes
  - Hundreds of commodities
- 15 world regions
- Time horizon from 2000 to 2100
- Integrated climate module

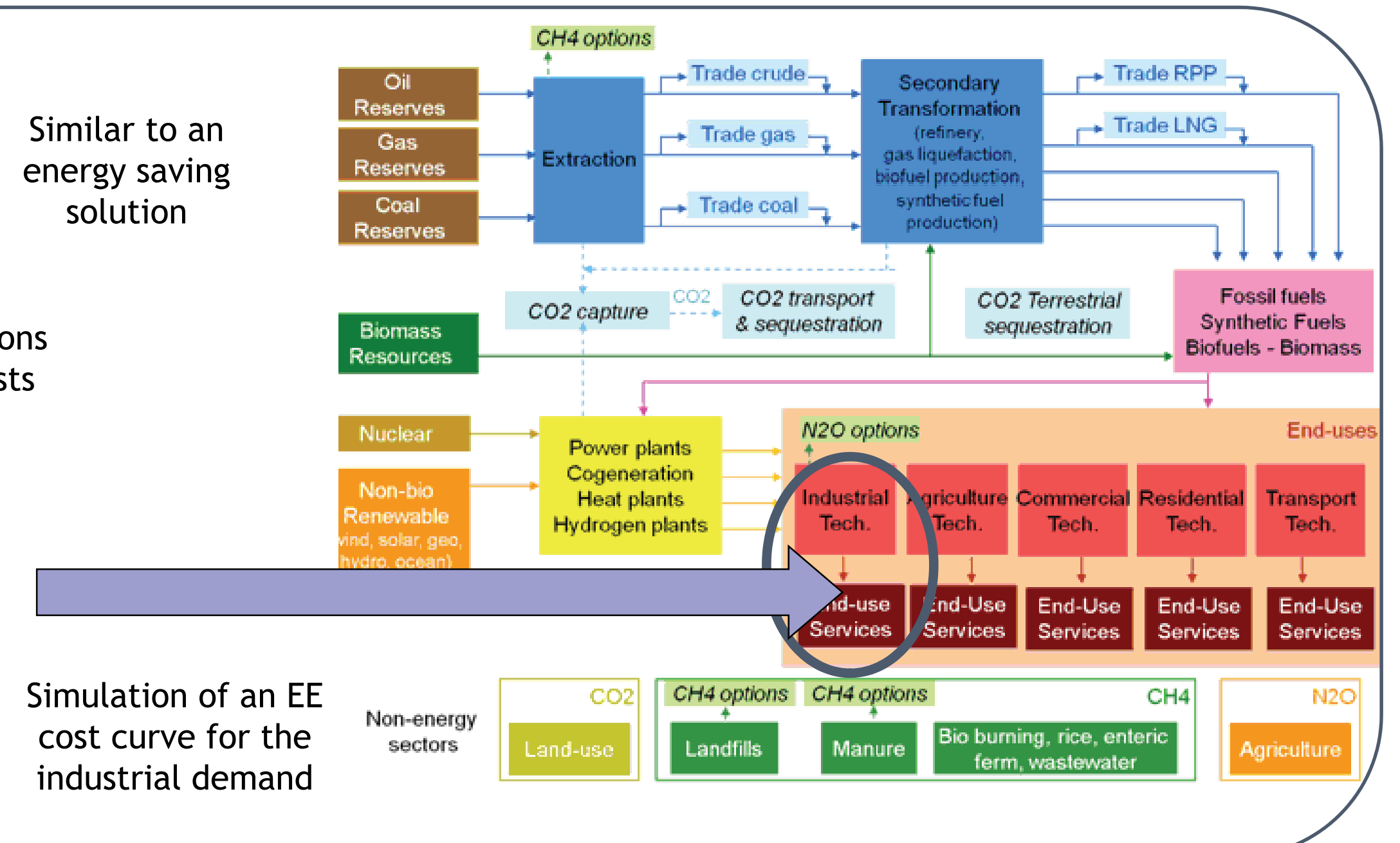


Similar to an energy saving solution

Different EE solutions have different costs



Simulation of an EE cost curve for the industrial demand



Cost of energy efficiency (relative scale)

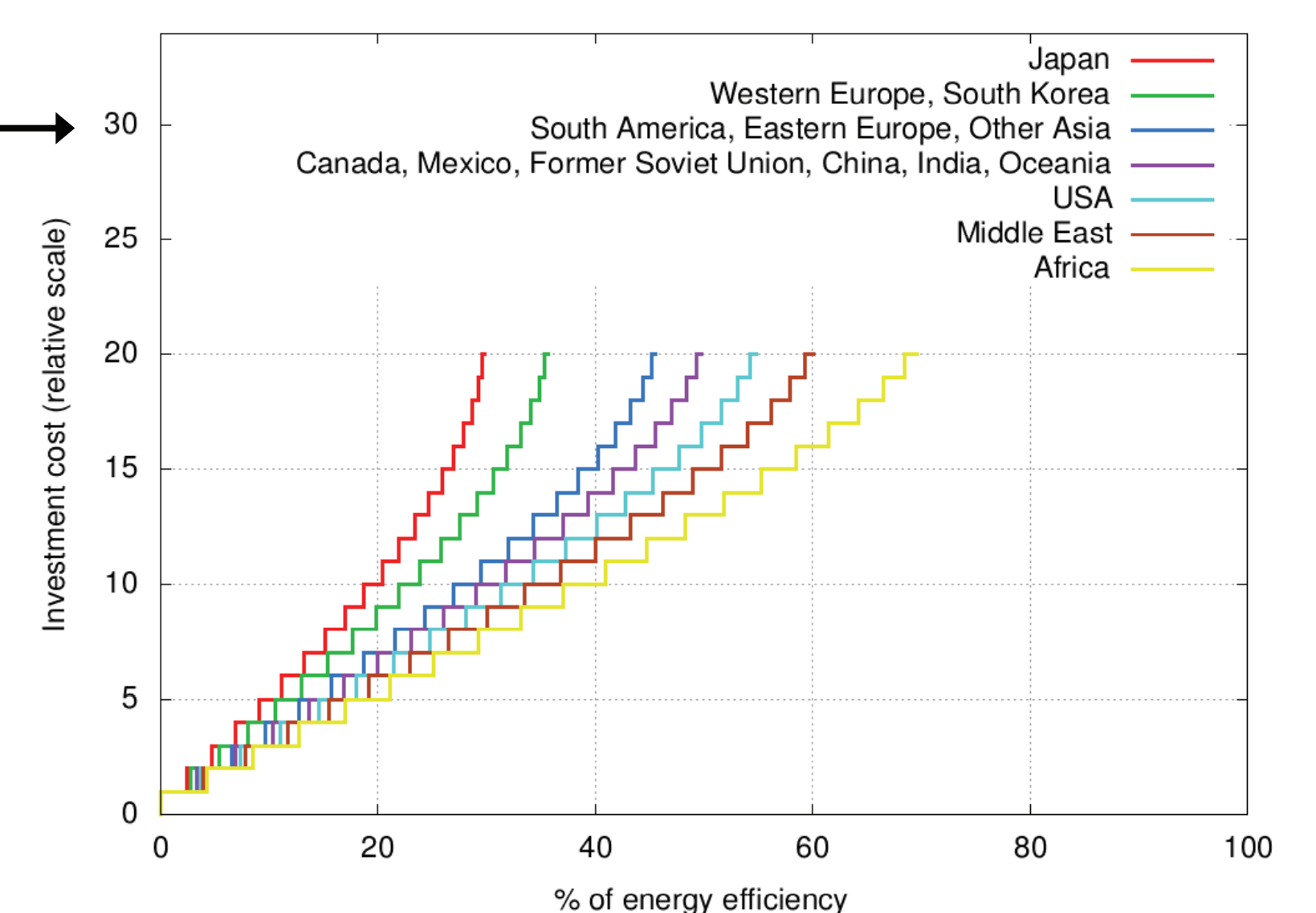
EE processes have to be calibrated:

- The EE cost curves are assumptions that give the cost and potential for each world region

Investment decisions are driven by:

- Investment cost
- Financial savings due to energy savings

With this **aggregated implementation of EE**, the model has the possibility to determine the most cost-effective allocation of EE processes (i.e. the optimal EE percentage for a given region, a given sector and a given year)



## Sensitivity of energy efficiency levels to COP15 pledges

Those results represent the **percentage of EE in 2020 in different industry sectors** for different climate scenarios.

EE is increasingly used as carbon emissions becomes more constrained.

The development of EE solutions seem to be more sensitive to carbon abatement pledges in the USA and Europe than in China.\*

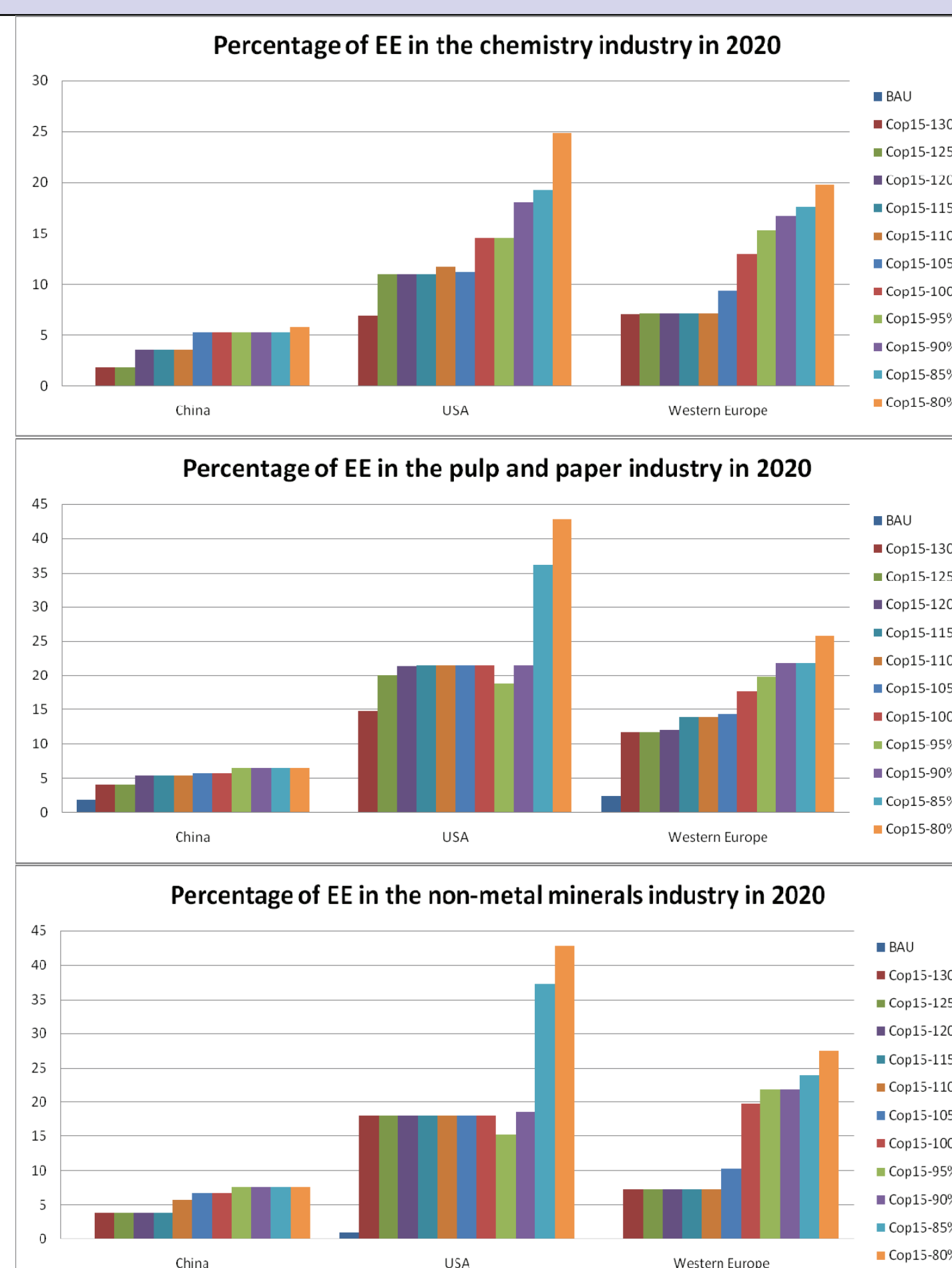
### Climatic scenarios for 2020

Reduction pledges (with reference year)	Europe	USA	China
Business As Usual	/	/	/
COP15	20% of emissions (1990)	17% of emissions (2005)	40% of carbon intensity (2005)

The COP15-variant scenarios allow to determine the sensitivity to COP15 pledges:

- COP15-110% is less constrained by 10% than the COP15 scenario
- COP15-90% is more constrained by 10% than the COP15 scenario

\* As the model is not well-calibrated yet, those results are just a "proof-of-concept"



## Conclusion and perspectives

Our implementation of the EE concept in the TIAM-FR energy model makes it possible to determine the optimal EE allocation for each region, each industrial sector and each year. To our knowledge, it is the first time an aggregated approach of EE is deployed like this in an optimization energy model.

Because EE plays an important role in the fight against climate change, this promising approach is of key importance when studying the arbitrage between carbon abatement solutions.

In order to improve the relevance and the reliability of our model, further calibration work is still necessary and we need to deploy our approach of EE in other sectors like transport, residential, commercial, agriculture, oil & gas and electricity.