



ParisTech's Chair Modeling for sustainable development



Insights on the Chinese climate agenda : Technical challenges

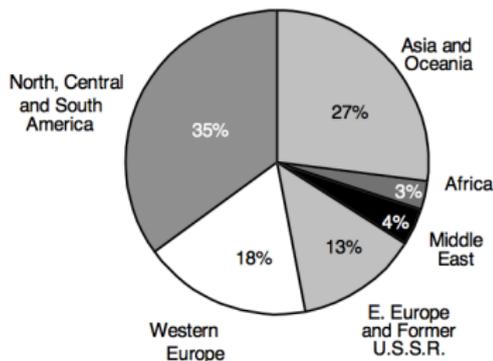
N. Forsell, S. Selosse, N. Maïzi

MINES ParisTech, Center for Applied Mathematics

IEW – Stanford, 6-9th July

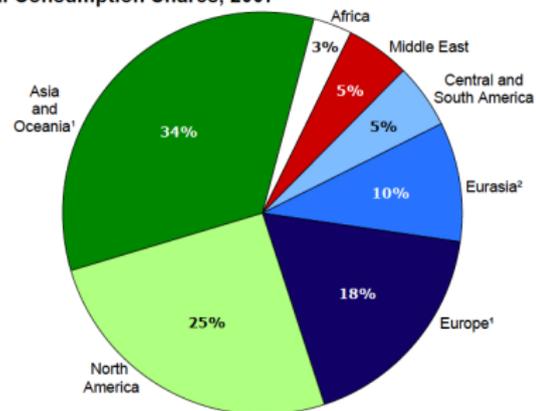
Evolution of primary energy consumption

Regional Consumption Shares, 2000



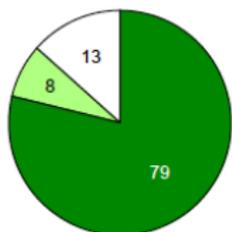
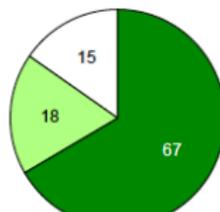
Source: AER 2000.

Regional Consumption Shares, 2007

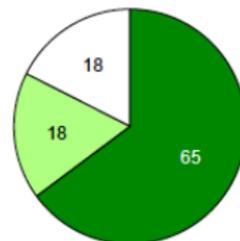
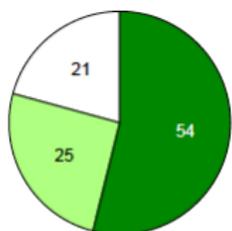
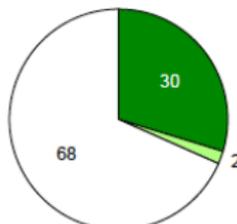


Source: AER 2009.

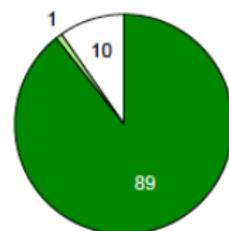
Regional electricity production mix (2007)

Asia and Oceania²

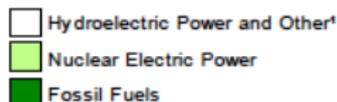
North America

Eurasia²Europe²

Central and South America



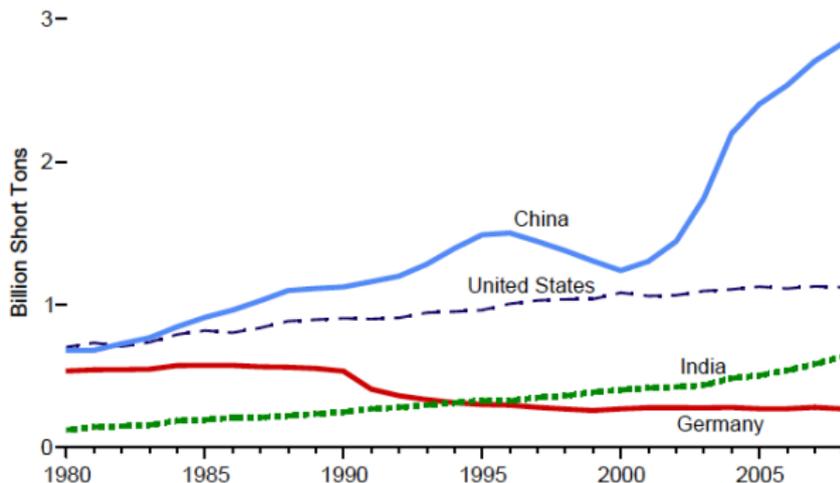
Middle East and Africa



Source: AER 2009.

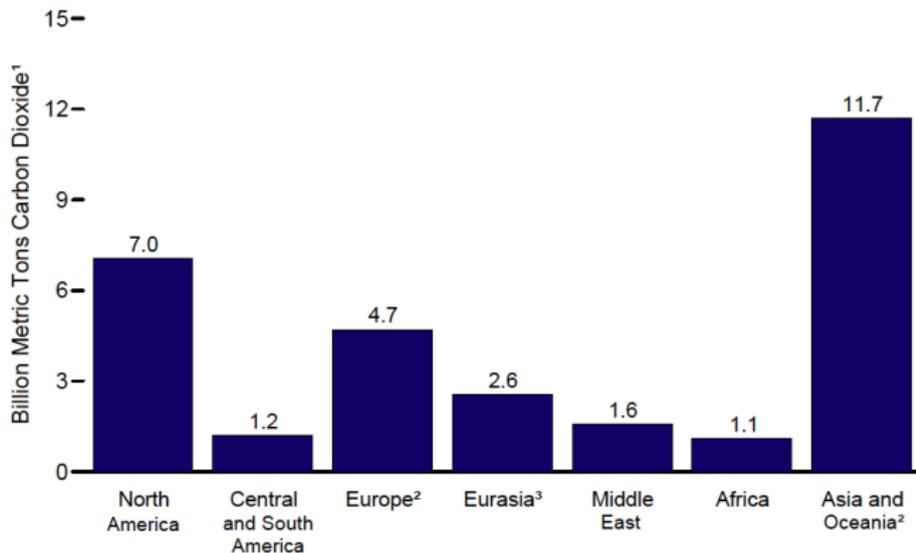
Coal consumption for top consuming countries

Selected Countries, 1980-2008



Source: AER 2009.

Carbon dioxide emissions from energy consumptions (2007)



Source: AER 2009.

Model and climate targets

Energy system analysis with MARKAL-TIMES models

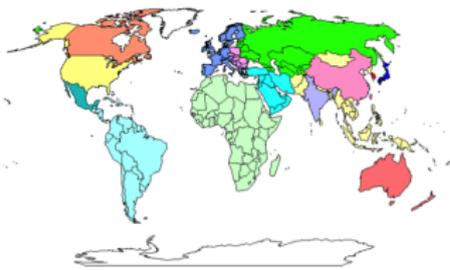


Figure: Regional aggregation in world TIAM-FR model.

TIAM-FR prospective model

- General model framework created by ETSAP (Energy Technology Systems Analysis Programme)
- Linear programming approach
- Time horizon from 2000 to 2100
- A geographical aggregation with 15 regions
- An integrated climate model

Consideration of climate targets (CO₂ emissions)

- No emission constraints

No constraint

BAU scenario

- Regional targets according to Copenhagen commitments:

High commitments

Optimistic scenario

Base commitments

Pessimistic scenario

- Global target according to a 2° C temperature increase:

Global carbon constraint

2.5 W/m² scenario

Copenhagen agreements for 2020

Regions	Reference year	Level of commitment	Reduction	Type of reduction
Western+Eastern Europe (WEU)	1990	$\frac{Low}{Up}$	$\frac{20\%}{30\%}$	Emissions
Japan (JPN)	1990	<i>Fix</i>	25 %	Emissions
Australia+New-Zealand (AUS)	2000	$\frac{Low}{Up}$	$\frac{5\%}{25\%}$	Emissions
United States* (USA)	2005	<i>Fix</i>	17 %	Emissions
Canada* (CAN)	2005	<i>Fix</i>	17 %	Emissions
China (CHI)	2005	$\frac{Low}{Up}$	$\frac{40\%}{45\%}$	CO ₂ intensity
India (IND)	2005	$\frac{Low}{Up}$	$\frac{20\%}{25\%}$	CO ₂ intensity

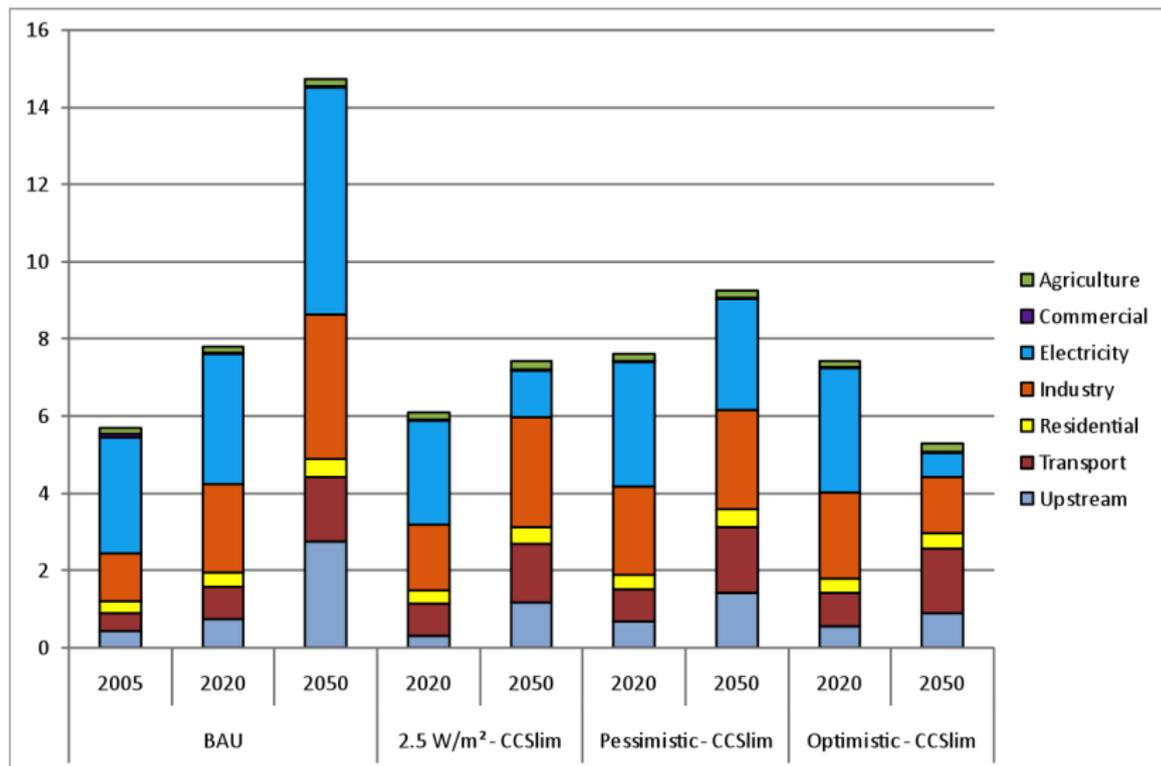
CMA prolonged assumptions for 2050

Regions	Reference year	Level of commitment	Reduction	Type of reduction
WEU, EEU and JPN	1990	$\frac{Low}{Up}$	$\frac{60\%}{80\%}$	Emissions
AUS	2000	$\frac{Low}{Up}$	$\frac{60\%}{80\%}$	Emissions
CHI	2005	$\frac{Low}{Up}$	$\frac{90\%}{10\%}$	$\frac{CO_2\ intensity}{Emissions}$
IND	2005	$\frac{Low}{Up}$	$\frac{60\%}{10\%}$	$\frac{CO_2\ intensity}{Emissions}$

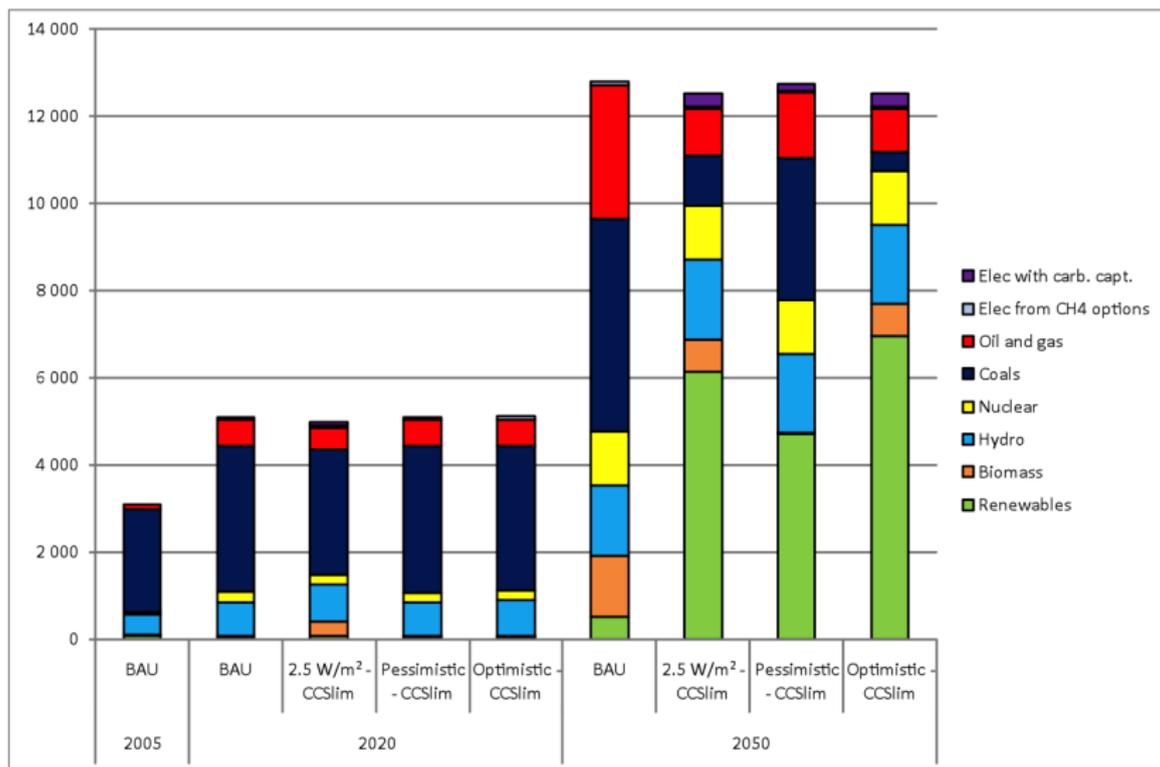
*  USA/CAN intermediate emission commitments:
30% by 2025, 42% by 2030, and 83% by 2050

Regional, global, and sectorial consequences of commitments

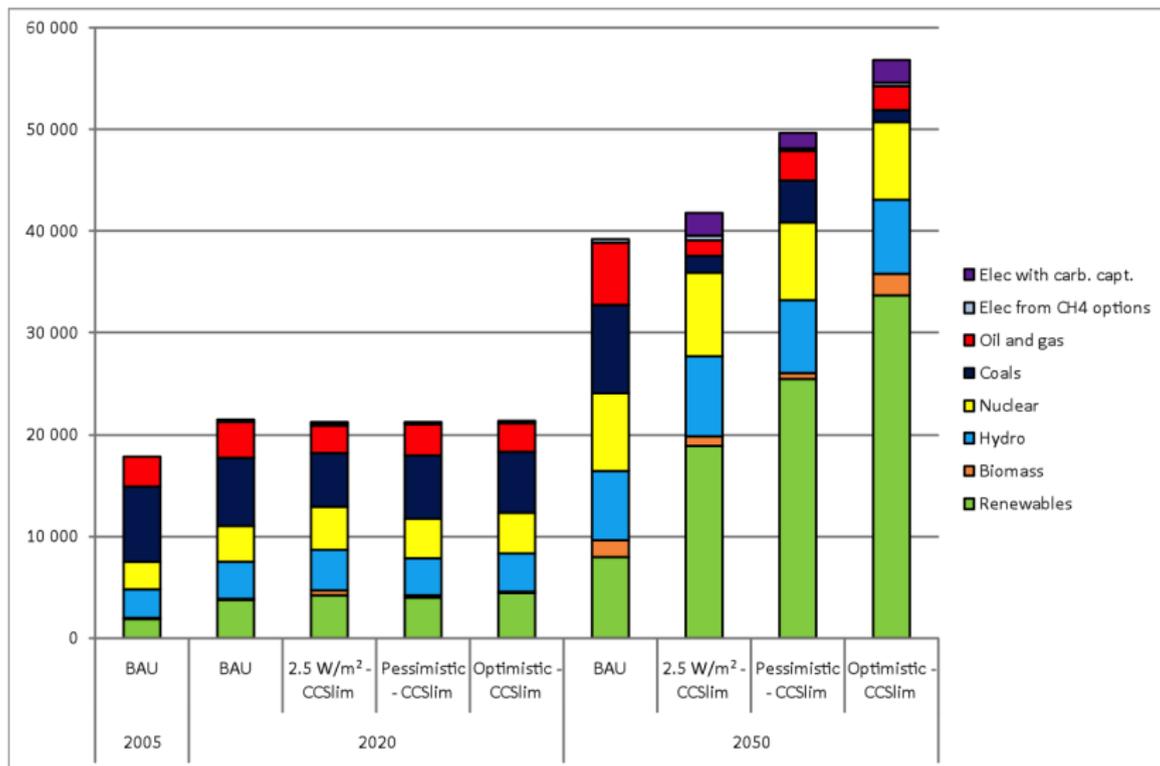
CO₂ emission from energy consumption (CHI+IND) in Gt



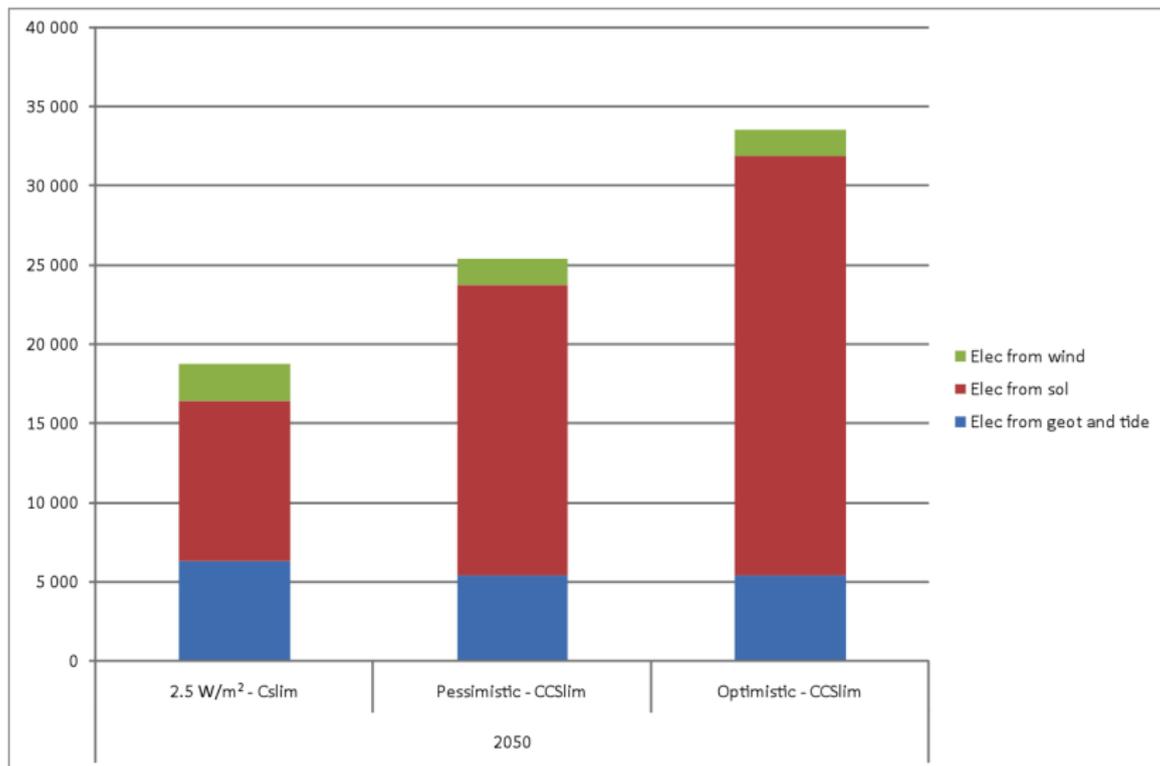
Electricity production mix (CHI+IND) in TWh



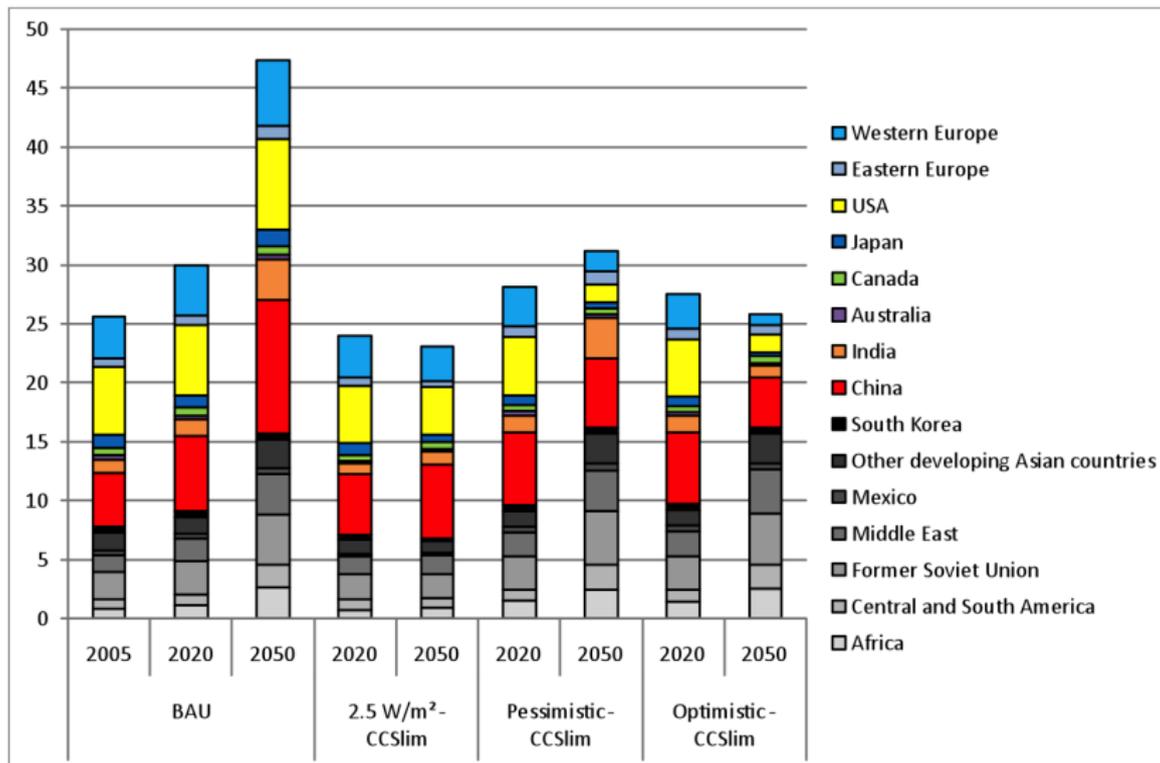
Electricity production mix (Global) in TWh



Electricity production from renewables (2050) in TWh



Global CO₂ emission in Gt



Conclusions

High share of electricity production from renewables

Challenges:

- Fluctuations in electricity production
- Implementation cost
- Scaling up production