

 $\frac{1}{\alpha)^{n(t-1)}} \sum_{i \in TCH} invcost_i(t) \cdot I_i(t) + \sum_{t \in T} \frac{1}{(1+t)^{n(t-1)}} \sum_{t \in TCH} \frac{1}{(1+t)^{n(t-1)}} \sum_{t \in TCH}$ 

 $varom_i(t)$ .

 $fixom_i(t).C_i(t) +$ 

 $price_{ELG,s}(t)$ 



## Toward the future climate regime: a regional long-term perspective of political targets and technological options

Sandrine SELOSSE and Nadia Maïzi

MINES ParisTech, PSL Research University, Centre for Applied Mathematics, Sophia Antipolis, France Chair Modeling for sustainable development

October 28-31, 2014

14th IAEE European conference LUISS University of Rome

## The way to win the Climate Fight (?)

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#### Climate context: Post-cop 15

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 $ixom_i(t)$ 

 $(1+\alpha)^{n(t-1)}$ 

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- Laid the foundations of a post-2012 climate agreement
- Failed to reach a global agreement on post-Kyoto greenhouse gas emission reductions
- → In late January 2010, some countries pledged their commitment to the UNFCCC as part of the Copenhagen Agreement to mitigate GHG emissions by 2020

#### What will happen after 2020 ?

- The Parties affirmed their will to conclude this new climate agreement in 2015, with entry into force planned for 2020
- Challenge of global climate change requires a high level of international cooperation
- → COP 21 in Paris December 2015 will mark a decisive stage in negotiations on the future international agreement on a post-2020 regime
- What could be the future climate regime?

## **Modelling approach : TIAM-FR**

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- French version of the TIMES Integrated Assessment Model (ETSAP/IEA)
- Optimization, linear programming, bottom-up, multiregional
- Long-term possible futures of the energy system

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ixom<sub>i</sub>(t)

 $(1 + \alpha)^{n(t-1)}$ 

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## Scenarios for the future climate regime

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Long-term UNFCCC ultimate 2°C objective

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 $(1+\alpha)^{n(t-1)}$ 

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- UNFCCC scenario: 50% CO<sub>2</sub> emissions reduction by 2050 /2000 (IPCC)
- Copenhagen Accord with commitments by 2020
  - Post-COP15 commitments by 2020
- International cooperation / agreement by 2050 : Regional long-term objectives according to international convergence and expressed ambitions between



## **Climate scenarios - Implementation**

5	5/17 INTERNATIONAL ASSOCIATION for ENERGY ECONOMICS	14th IAEE European Energy Conference – LUISS University of Rome – October 28-31 , 2014					
$\frac{1}{1+\alpha)^{n(t-1)}} \sum_{i \in TCH} in$	Scenarios	Description					
$\times \left( \sum_{i \in T \in U} fixom_i(t) \right)$	BAU	World reference scenario without any explicit policy measures on CO <sub>2</sub>					
$+\sum_{i\in ELA}\sum_{z\in Z}\sum_{y\in Y}varc$	UNFCCC	50% reduction of the world $\rm CO_2$ emissions by 2050 by comparison with 2000					
$+\sum_{k\in ENC}\sum_{cost}cost_{ks}($	Regional Post-Copenhagen pledges scenario by 2020						
$+\sum_{s}\sum_{z\in Z}\sum_{j\in V}$	COP+	Copenhagen Accord : - higher CO <sub>2</sub> emission reduction targets by 2020 - excluding developing countries					
	COP-	Copenhagen Accord : - lower CO <sub>2</sub> emission reduction targets by 2020 - excluding developing countries					
	COP+DEV30	Copenhagen Accord : - higher CO <sub>2</sub> emission reduction targets by 2020 - developing countries : 30% of CO <sub>2</sub> emission reduction by 2020 compared to BAU					
	COP-DEV15	Copenhagen Accord : - lower CO <sub>2</sub> emission reduction targets by 2020 - developing countries : 15% of CO <sub>2</sub> emission reduction by 2020 compared to BAU					
Mary mary							

 $(1+\alpha)^{\gamma}$ 

## Post-COP15 commitments by 2020 (Copenhagen Accord)

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 $(1+\alpha)^{n(t-1)}$ 

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Region	Reduction by 2020	Reference year	Target	Evolution 2005-2020					
Group 1: Industrialized countries									
AUS	5% - 25%	2000	Emission reduction	-13% / -32%	-19% /-23%				
CAN	17%	2005		-17%					
JPN	25%	1990		-33%					
USA	17%	2005		-17%					
WEU+EEU	20% - 30%	1990		-18% / -29%					
Group 2: Fast developing countries									
CHI	40% - 45%	GDP 2020		+76% / +61%	+92% / +77%				
IND	20% - 25%	GDP 2020	Carbon Intensity	+155% / +138%					
Group 3: developing countries									
FSU	15% - 25%	1990	Emission reduction	+41% / +24%	+13% / +5%				
CSA (BR)	36.1% - 38.9%	2020 BAU		-5%					
MEX	30%	2020 BAU		-28%					
SKO	30%	2020 BAU		-22%					

# CO<sub>2</sub> mitigation targets by 2050

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 $(1+\alpha)^{n(t-1)} \sum_{i \in TCH}$ 

fixom<sub>i</sub>(t)

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vari	Scenarios	Description			
r De Des (	Regional long-term objectives scenario by 2050				
	IND80	Pessimistic target by 2050 for IC (80% / 2000), without target for FDC and DC			
2	IND95	Optimistic target by 2050 for IC (95% / 2000), without target for FDC and DC			
	IND/FDC80	Pessimistic target by 2050 for IC $$ and FDC (80% / 2000), without target for DC			
6	IND/FDC95	Optimistic target by 2050 for IC and FDC (95% / 2000), without target for DC			
Million	IND/FDC80-DEV15	IND/FDC80, with target for developing countries (15% to 2050 compared to BAU)			
a la	IND/FDC95-DEV30	IND/FDC95, with target for developing countries (30% to 2050 compared to BAU)			



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## Is this in line with the 2°C objective?

## **Short-term CO2 emissions pathways**

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## Long-term CO<sub>2</sub> emissions pathways

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 $\frac{1}{(1+\alpha)^{n(t-1)}} \sum_{i \in TCH}$ 

fixom<sub>i</sub>(t)

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# Is this in line with the principles of equity and common but differentiated responsibilities?

## **Regional contribution to the mitigation effort**



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 $\frac{1}{(1+\alpha)^{n(t-1)}} \sum_{i \in TCH} in$ 

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fixom<sub>i</sub>(t)

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## **Technological reading to the mitigation effort**

# **Regional** electricity production in 2005 and 2050 in BAU, UNFCCC and IND/FDC95-DEV30 scenarios (PJ) – Industrialized countries

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# **Regional** electricity production in 2005 and 2050 in BAU, UNFCCC and IND/FDC95-DEV30 scenarios (PJ) – Fast developing countries

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 $ixom_i(t)$ 

 $\overline{(1+\alpha)^{n(t-1)}}$ 

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### **Regional** electricity production in 2005 and 2050 in BAU, UNFCCC and IND/FDC95-DEV30 scenarios (PJ) – Developing countries

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ixom<sub>i</sub>(t`

 $(1+\alpha)^{n(t-1)}$ 

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## **Concluding remarks**

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# $(1 + \alpha)^{n(t-1)}$ $ixom_i(t)$

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## Essential **global** contribution

- Contribution from DC
- Fair level of mitigation?



• 15% (/BAU2050)? 30% (/BAU2050)? Or 84% (/BAU2050) in UNFCCC

## Ambitious target from IC but also FDC

- Historical vs future(/present) responsibles
- Realistic target : availability of technological solutions
  - To the scale of the challenge: CCS, biomass, storage
  - The CCS technologies can constitute a key carbon reduction option
    - Uncertainties regarding incentives, social acceptability, costs

% CCS	IC	FDC	DC
UNFCCC	24	75	40
IND/FDC95-DC30	46	47	8





# Thank you for your attention!

## *World* electricity production in 2005 and 2050 in BAU, UNFCCC and IND/FDC95-DEV30 scenarios (PJ)

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