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

Sandrine Selosse, Nicolas Garcia, Nadia Maïzi

TOWARD THE FUTURE CLIMATE REGIME : A REGIONAL LONG TERM PERSPECTIVE OF POLITICAL TARGETS AND TECHNOLOGICAL OPTIONS

Sandrine SELOSSE, MINES ParisTech, Centre for Applied Mathematics, +33 493 678 917, sandrine.selosse@mines-paristech.fr
Nicolas GARCIA, MINES ParisTech, Centre for Applied Mathematics, +33 497 157 076, nicolas.garcia@mines-paristech.fr
Nadia MAÏZI, MINES ParisTech, Centre for Applied Mathematics, +33 497 157 079, nadia.maizi@mines-paristech.fr

Overview

The aim of the next negotiations between Parties until the Twenty-first Conference of Parties (COP 21) which will be held in Paris in 2015 is to reach an international agreement involving as many countries as possible, in order to reduce CO_2 emissions sufficiently and stay in line with the ultimate 2°C objective of the UNFCCC. A strong climate policy in line with this 2°C objective requires a global contribution, whether countries are industrialized or developing, or especially fast developing or emerging. However, debates highlights the fact that it is primarily up to industrialized countries to keep their promise of helping countries develop a record of adapting to the impacts of climate change, and nothing is certain as regards the possible level of CO_2 emission reduction that developing countries will be able to attain or, even, accept to reduce. In terms of cost, a larger contribution from developing countries is less expensive than strong emission mitigation in industrialized countries, as expressed by the decision to allow flexible mechanisms under the Kyoto Protocol (i.e. develop GHG emissions mitigation projects where the carbon abatement cost can be lower). But this is not sufficient. Could we reach an ambitious, and necessary, climate target without the participation of developing countries? In the same manner, a key feature of the Copenhagen agreement and of the future accord is the participation of the United States of America and non-Annex I countries, especially China, as they represent a large share of global CO_2 emissions. China and the USA are the largest global emitters of CO_2 and, as concerning developing countries, without their participation in a climate agreement the latter cannot really ensure achieving stabilized CO_2 concentration and global temperatures. Various climate scenarios are implemented in the bottom-up optimization model TIAM-FR and analyzed to explore the effects of a possible international coordination on main environmental and economic indicators. The impacts of different commitment levels under post-Copenhagen and/or global long-term climate policies can thereby be discussed and provide some understanding on the stakes and issues. Particularly, do developing countries have the capacity to implement policies to reduce emissions given that their priority is development and energy supply? What is expected from industrialized countries like Europe? What are the technological possibilities considering the state of development of their energy systems and the evolution of their needs? The main focus is, in a first part, on the ambition of the various climate policies regarding CO2 emissions at global and regional level. In a second part, we discuss the impact of international climate change strategies to the energy system, and particularly on the electricity generation. In this context, discussions investigate long-term solutions, and particularly the development of CCS technologies or renewables, in response to a constraint that influences the energy mix.

Methods

We analyze the environmental and economic impacts of long-term climate commitments by introducing climate pledges in the bottom-up optimization model TIAM-FR. This linear programming model estimates an inter-temporal partial economic equilibrium on energy markets and, in other words, minimizes the total discounted cost of the world energy system over a long time period under environmental, technological and demand constraints. In order to satisfy the energy services demands, the system includes the extraction, transformation, distribution, end-uses, and trade of various energy forms and materials. The structure of the energy system is given as an output, i.e. type and capacity of the energy technologies, energy consumption by fuel, emissions, energy trade flows between regions, transport capacities, a detailed energy system costs, and marginal costs of environmental measures as GHG reduction targets. Emission reduction is brought about by technology and fuel substitutions (leading to efficiency improvements and process changes in all sectors), carbon sequestration (including CO_2 capture at the power plant and hydrogen plant level, sequestration by forests, and storage in oil/gas fields, oceans, aquifers, etc.). TIAM-FR is geographically integrated and offers a representation of the world energy system under a disaggregation in 15 regions. In each region, TIAM-FR describes the entire energy system with the same level of technological disaggregation. Our analyse especially considers 3 groups of countries: Industrialized (IC), Fast developing countries (FDC) and Developing countries (DC).
The various scenarios we investigated include environmental targets for different world regions over the period 2005-2050. We considered the Post-Copenhagen pledges by 2020 and made assumptions on the 2050 targets based on each country's announced political ambitions, expected ambitions or required contributions.We analyze a

combination of these scenarios in order to provide a framework for understanding the climate context of the future regime which is expected to be decided in 2015:

(1) **UNFCCC**: a 50% reduction of the world CO_2 emissions by 2050 by comparison with 2000 (IPCC, AR4):

(2) **Regional Post-Copenhagen pledges scenario by 2020**:

a. **COP+**: optimistic commitment to 2020 of the Copenhagen Accord, without target for DC.

b. **COP-**: pessimistic commitment to 2020 of the Copenhagen Accord, without target for DC.

c. **COP+DEV30**: COP+ with target for DC (30% to 2020 compared to BAU).

d. **COP-DEV15**: COP- with target for DC (15% to 2020 compared to BAU).

(4) **Regional long-term objectives scenario by 2050:**

a. **IND80**: pessimistic target to 2050 for IC (80%), without target for FDC and DC.

b. **IND95**: optimistic target to 2050 for IC (95%), without target for FDC and DC.

c. **IND/FDC80**: pessimistic target to 2050 for IC and FDC (80%), without target for DC.

d. **IND/FDC95**: optimistic target to 2050 for IC and FDC (95%), without target for DC.

e. **IND/FDC80-DEV15**: IND/FDC95 with target for DC (15% to 2050 compared to BAU).

f. **IND/FDC95-DEV30**: IND/FDC95 with target for DC (30% to 2050 compared to BAU).

Results

According to the results analysis, it is interesting to note major facts. For example, the commitments pledged by countries appear too low by comparison with the required level of decrease in order to stay in line with the 2°C target. In strong climate constraint as in **IND/FDC95-DEV30** where developing countries support a lower carbon constraint than in **UNFCCC** (which is determined under the less costly approach), it clearly appears that the CO_2 reduction is particularly supported, in volume, by fast developing countries. However, even if the CO_2 emission reduction from fast developing countries is more important than the one from industrialized countries, it is important to consider the fact that the energy system of the latter has to be completely carbon-free in 2050. Emission reduction is achieved through technology and fuel substitutions and in these cases, CCS development appears particularly determinant.

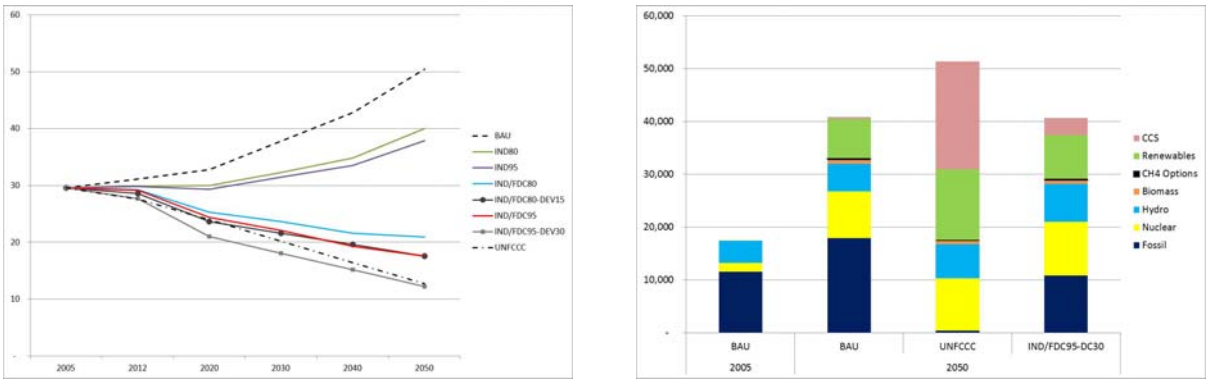

Figure 1: CO2 emissions in regional scenarios (Gt CO2) and Electricity production (PJ) in developing countries

Conclusion

UN climate negotiations therefore continue in order to lead to the signing in 2015 of a new international framework from 2020 with commitments for all countries to better combat global warming. The principle of common but differentiated responsibilities played a major role in negotiating the post-2012 and will remain in structuring the post-2020 negotiations. However, an ambitious emission mitigation objective appears not to be realistically achieved without the contribution of developing countries, especially from the viewpoint of technological challenges. This questions the fair determination of the contribution by developing countries. No country can mitigate climate change on its own. International cooperation is needed to tackle the energy-climate problem. However, not only countries must act, but technological progress must also find an adequate response to countries' ambitions to expand the pool of available (or not) technologies and their mitigation potential. This not only concerns CCS technologies, but also non-fossil energies, like wind, solar, biomass, etc. Thus the question of technological plausibility is also a critical factor for the future international climate regime. The second step of this analyse will be to include cost consideration (marginal cost of carbon and cost of the constrained system).