THE PARIS PLEDGES: GLOBAL IMPLICATIONS FOR ENERGY SYSTEMS AND ECONOMIC IMPACT

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Overview

The United Nations-led international climate change negotiations in Paris in December 2015 (COP21) trigger and enhance climate action across the globe. This paper presents a model-based assessment of the Paris Agreement. In particular, we assess the mitigation policies implied by the Intended Nationally Determined Contributions (INDCs) put forward in the run-up to COP21 by individual member states and a policy that is likely to limit global warming to 2°C above pre-industrial levels.

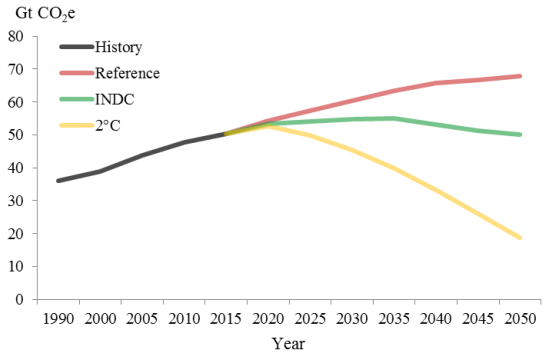

Figure 1: Trajectory of greenhouse gas emissions in the Reference, the INDC scenario and the 2°C scenario

Methods

The assessment of the Paris pledges presented in this paper builds on the combined modelling effort of a detailed, technology-rich energy system model (POLES) and an economy-wide Computable General Equilibrium (CGE) model (GEM-E3). The models are harmonized along a common Reference scenario and are soft-linked to exploit complementarities of a detailed representation of energy production, demand and markets on the one hand, and economy-wide feedback mechanisms including international trade, intermediate input links between industries, and recycling of taxation revenue on the other hand.

The POLES model[1] is a global partial equilibrium simulation model of the energy sector. The model covers 15 fuel supply branches, 30 technologies in power production, 6 in transformation, 15 final demand sectors and corresponding greenhouse gas emissions. Endogenous resource prices, endogenous global technological progress in electricity generation technologies and price-induced lagged adjustments of energy supply and demand are important features of the model.

The GEM-E3 model[2] is a recursive-dynamic CGE model. The model describes the economic behaviour of households and firms, includes (exogenous) government policies, endogenous international trade flows, unemployment, different types of energy use and greenhouse gas emissions.

[1] https://ec.europa.eu/jrc/en/poles
[2] https://ec.europa.eu/jrc/en/gem-e3/

Results

The INDCs have a negligible impact on global oil and natural gas consumption. The demand for solid fuels – coal and lignite – is reduced by more than 15% compared to the Reference. Hence, replacing solid fuels by non-fossil fuels is an important element for climate change mitigation policies.

The INDC scenario leads to strong reductions in hydrofluorocarbons (HFCs) and other fluorinated gases (F-gases), which reveals the fact that the emissions of these gases are relatively inexpensive to abate due to available technological options (European Commission, 2012). The reduction of nitrous oxide (N_2O) emissions is one of the more costly options: a cost-effective implementation of the INDCs leads to N_2O levels that are approximately 7% lower than the levels in the Reference. The emission reduction profiles in the 2°C scenario show stronger reductions for all gases. Interestingly, the emissions of HFCs are reduced at a faster rate than in the INDC scenario up to 2030, but remain stable afterwards. This result indicates that the INDCs exploit nearly the full potential of HFC emission reductions.

The power sector emerges as the main contributor to emission reductions in both INDC and 2°C scenarios. A transformation of the electricity production sector covers more than half of the emission reductions between the Reference and the INDC in 2030. In addition, the power generation sector bridges around 35% of the gap between the INDCs and the 2°C scenario. Higher carbon prices lower the total level of electricity consumption. Both in 2030 and in 2050, the INDC and 2°C scenarios slightly reduce global electricity consumption compared to the Reference. By 2030, the INDCs lead to a transformation of the power sector through a substitution from fossil fuels to zero-carbon technologies. In the Reference, fossil fuels account for around 58% of electricity production. This number reduces to 51% and 42% in the INDC and 2°C scenario, respectively.

The results of the INDC scenario suggest that the Paris pledges have only a limited impact on world aggregate GDP of -0.35%. The 2°C scenario imposes stronger constraints on emissions, leading to more substantial transformations economy-wide. This is reflected in a reduction of global economic output levels of -0.79%. A substantial number of regions undertake significant climate action that leads to relatively small reductions in GDP (less than 1% reduction from the Reference in 2030) compared to the Reference.

Conclusions

The Paris pledges imply a break with historical trends for greenhouse gas emissions, carbon intensity of the economy and pace of improvements in energy efficiency, but are insufficient to reach a 2°C global warming target set by the IPCC.

The results of numerical simulations indicate that the INDCs have little impact on global oil and gas demand. Notable, considerable demand reductions of energy in general (efficiency) and solid fuels in particular, lead to lower greenhouse gas emissions.

A substantial gap remains between the global GHG emissions in the INDCs and the 2°C scenario in 2030, of which around three quarters can be bridged by decarbonising the power sector, reducing emissions from land use, land use change and forestry and lowering energy-related CO2 emissions.

Economic impacts differ widely between regions and sectors. The INDCs imply modest reductions in GDP for most regions (less than 1% compared to the Reference in 2030), whereas some regions increase GDP due to gains in competitiveness driven by relatively unambitious climate policy proposals. Hence, the analysis shows that global action to cut emissions is consistent with robust economic growth. Emerging and lowest-income economies will maintain high rates of economic growth, while fossil-fuel exporting countries face larger impacts.