Policy Brief

PLANETS

Probabilistic Long-term Assessment of New Energy Technology Scenarios

SEVENTH FRAMEWORK PROGRAMME

Probabilistic Long-term Assessment of New Energy Technology Scenarios

The research project "PLANETS - Probabilistic Long-Term Assessment of New Energy Technology Scenarios" (2008-2010) is sponsored by the European Commission under the Seventh Framework Programme (Project No. 211859).

Contents

This policy brief describes the results and recommendations of the PLANETS research project (www.feem-project.net/planets), funded by the European Commission under the Seventh Framework Programme with the scope of devising robust scenarios for the evolution of low carbon energy technologies over the next few decades. A suite of six energy-economy-climate modelling groups (DEMETER, ETSAP-TIAM, GEMINI-E3, PEM/TEAMS, TIAM-ECN, WITCH) analysed the implications of several climate policies under a wide set of assumptions about national commitments and the use of international carbon offsets. The work under the PLANETS project focused in particular on uncertainties, regarding both the future evolution of climate policies and the prospects of key carbon mitigation technologies. The modelling efforts were complemented with techno-economic assessments of a number of specific mitigation options, in particular Carbon dioxide Capture and Storage (CCS) and bio-energy.

Interim emission targets matter for the economics of long-term climate stabilisation

A shift towards climate stabilisation can occur along different pathways. The PLANETS project analysed ten possible climate control scenarios with six different integrated assessment models. These scenarios combined long-term climate stabilisation targets of 500 and 530 ppm-equivalent (ppm-e) – consistent with long-term equilibrium temperature increases of 2.3 and 2.5°C respectively, under a central value for the climate sensitivity – with different strategies regarding how to achieve these targets. Immediate and fully cooperative action starting from 2012 was compared with "second-best" scenarios characterised by different regional emission quotas.

Results indicate that emission reduction targets for 2050 are relevant for the economics of long-term climate stabilisation. Models find that several scenarios with a 500 ppm-e climate target are unreachable, in particular those in which some regions aim at initially mild reductions followed by more drastic reductions after 2050. Postponing abatement makes it impossible, or at least considerably more costly, to achieve climate stabilisation.

While the global costs of climate policy are manageable, they are also very sensitive to the related temperature target and to the speed of action

The table below shows that the global cost of achieving a climate target of 530 ppm-e is not negligible. On average, however, this cost stays below 1-2% of Gross World Product, with wide variations across models. The 500 ppm-e target is much more difficult to attain. In most cases it is achievable, but at a significantly higher cost than with the laxer target and on the condition that abatement actions start at full speed from 2012. This target becomes infeasible, even with early action, if high economic growth materialises. When second best quota systems are assumed, the target is reachable only in the case of optimistic evolution of technology. The global cost associated with these scenarios is much higher than for the laxer target, especially after 2050.

Greenhouse Gas Concentration Target	Temperature Increase*	Global Macro-economic Costs	
		2030	2050
530 ppm-e	2.5 °C	0.3%÷2.6%	0.7%÷6%
500 ppm-e	2.3 °C	1%÷3%	2%÷>8%

Global costs across models for two climate stabilisation targets under a first best assumption of immediate participation.

**Equilibrium temperature increase above pre-industrial level*

This result indicates that even for climate policy less ambitious than a 2°C target, the rapid creation of a global coalition is a prerequisite for success. In other words, a course of deep global emission reductions needs to be initiated as early as possible, since initially mild emission reductions followed by more drastic mitigation after 2050 could make climate stabilisation infeasible or exceedingly costly. A relatively small extra temperature reduction of 0.2°C implies significant additional global costs, or even potential infeasibility, due to the high non-linearity of abatement costs.

The design of an effective and engaging climate deal should consider heterogeneities of regional mitigation costs

As an alternative to immediate and global participation, the PLANETS project considered two different second best quota systems. In both these quota scenarios the developed world (i.e. OECD) takes immediate stringent emission reduction action, while the developing world postpones its abatement effort by at least several decades. Both quota systems imply an overall global reduction of greenhouse gas emissions in 2050 of about 28% with respect to emissions in 2005. One of the core differences between the two quota systems is that in one case the OECD reduces its emissions down to a level of 20%, while in the other it decreases these emissions to a deeper floor of 10% with respect to 2005 emissions. These different mitigation levels balance out with differences in emission reductions achieved by the three other groups of countries considered: energy-exporting nations, developing Asia and the rest of the world.

The two quota systems generate significantly different results, especially in terms of regional costs. The OECD and developing Asia see their costs more than double when switching from one quota system to the other. The costs per GDP for the EU are lower than those for the OECD as a whole. This means that the EU is better positioned to achieve emission reductions than other regions in the OECD.

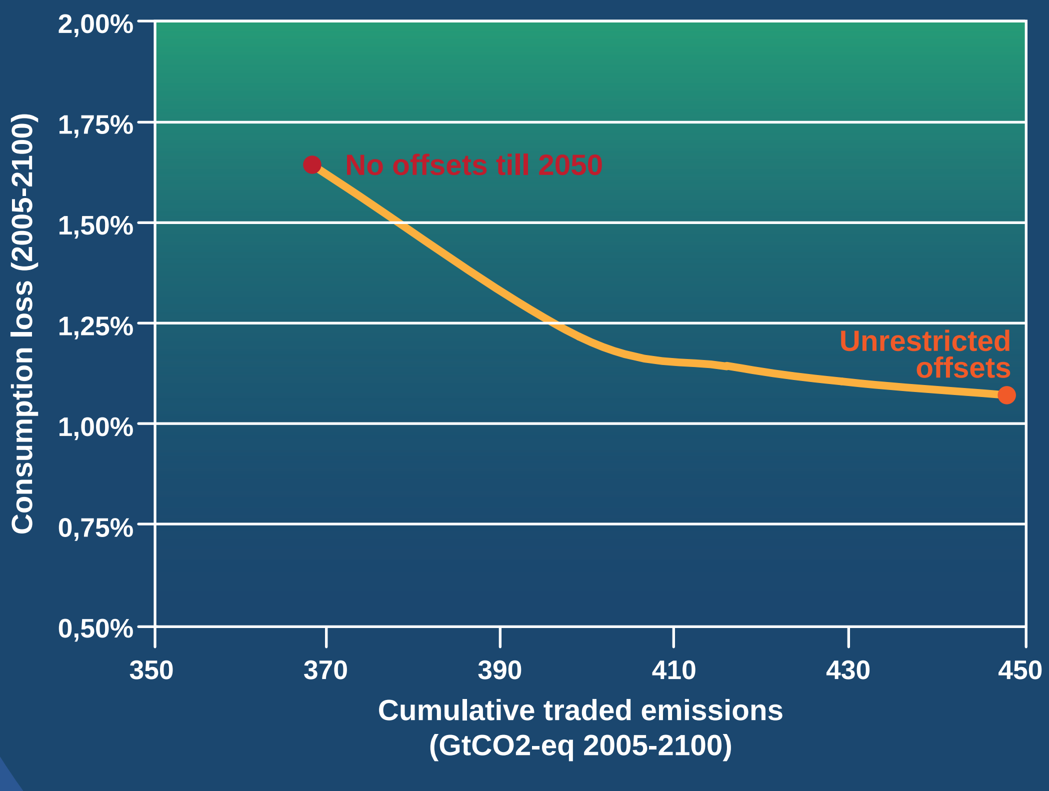
Other regions also show varying costs depending on the quota allocation implemented. The revenues resulting from permit trading typically have a large impact on both macro-economic and regional costs. Developing countries (except those in the category of energy-exporting nations) usually play the role of permit sellers in all scenarios. They can therefore gain large benefits from an international carbon market, especially in more stringent climate scenarios characterised by rapidly increasing carbon price.

Energy-exporting countries experience large costs as a result of high expected baseline emissions and reduced revenues from the oil market. This factor is likely to affect to some extent the success of, and the costs associated with, global climate policy. The price of oil and the behaviour of OPEC may affect the possibility of ensuring climate stabilisation, though it is not expected to be among the main determinants.

Moderate restrictions on the use of international carbon trading are likely to induce modest economic penalties on a global scale

The unrestricted access to emission credits from third countries (that is, international offsets) maximises economic efficiency, but it may reduce domestic abatement efforts and adversely affect the stimulation of innovation in low carbon energy technology. For this and other reasons, some countries consider restricting the purchase of emission credits from third countries. Most of the findings of the PLANETS project indicate that the global costs of emission control are only modestly affected by a moderate limit on emissions trading, as demonstrated in the figure aside.

The adoption of a global trading limit, however, can have quite a significant impact on the abatement costs incurred in individual regions. When trade is restricted, permit-buying regions undertake more emission reductions domestically, which calls for a more pervasive economic effort. On the other hand, trade restrictions induce more innovation in low carbon technologies, with beneficial international spill-overs of knowledge and positive repercussions on energy security.



Global costs for various levels of restrictions on the use of international offsets (based on results from the WITCH model).

The achievement of climate stabilisation targets requires a dynamic portfolio of mitigation options which initially favours technologies that are ready to be integrated within the existing system

The policy scenarios analysed under the PLANETS project indicate that, to minimise overall climate compliance costs, the most cost-efficient solution exploits a broad set of different mitigation options. This set accounts for the different time scales associated with the deployment of different energy technologies. Based on economic considerations and environmental concerns for climate change, our models suggest that this set relies consistently on a combination of nuclear power, renewables, and CCS applied to fossil fuels and biomass. Energy saving has also proven to be an important strategy, both in the supply sector and in the end-use sector, especially when the scope for technological substitution is limited.

Technologies that can be integrated in existing energy systems, and do not require drastic changes in consumer behaviour, generally have a clear advantage. For example, given the growing capacity of coal-based power, co-firing biomass with coal is an important near-term mitigation option. When not only economic arguments but also social and environmental aspects are considered, renewables (predominantly solar, wind and hydroelectric power) are among the top-ranking greenhouse gas emission reduction technologies. Nuclear energy is penalised by certain economic features as well as aspects of social acceptability, but it becomes a particularly valuable option when a carbon price internalises the environmental externality of climate change. Nuclear power is thus an important mitigation option for stringent climate policy.

Carbon Capture and Storage could be an important mitigation technology in the transition toward a low-carbon economy...

The results of the PLANETS project confirm that Carbon Capture and Storage (CCS) has the potential to materialise large emission reductions, especially in the mid-term. All PLANETS models consider CCS – either in combination with the combustion of fossil fuels or biomass – an effective and efficient mitigation technology, especially in the mid-term until 2050. As such, CCS is found to be a bridging technology. Indeed, CCS could be an appropriate mitigation alternative until the next generation of carbon-free technologies becomes competitive, because it fits the current energy system without the necessity for major infrastructure changes. In the long term after 2050, CCS is expected to become less important in reducing greenhouse gas emissions, since it is not an entirely carbon free energy technology, whereas renewable and nuclear power plants in essence are.

The PLANETS models vary significantly in projecting the nature of the future role of CCS. Models that foresee a large role for energy savings suggest a relatively small deployment of CCS in the power sector (11%-38% of total emission reductions). Models that determine large increases in the use of electricity, however, employ such increases as a means to implement CCS on a large scale (43%-75% of total emission reductions).

...but its large scale deployment requires a balanced mixture of policy instruments

The application of CCS to power plants is still in an early demonstration phase, and various technical and economic implications remain uncertain. The timing of CCS implementation is strictly linked to the possibility of ramping up the entire chain of capture, transport and storage of CO_2 in a coordinated way. Scaling challenges may constitute a sizeable obstacle to the widespread diffusion of CCS technology. The ability of society to establish large transportation networks and orchestrate storage activity internationally will depend on many factors, including institutional and political ones. Surmounting the corresponding hurdles may not prove straightforward, even while from a technical point of view CCS today appears a proven technology.

Climate policy is shown to be a key determinant of the market share that CCS may obtain. Policy stability proves to be fundamental in determining the choice of investments in CCS projects. Modelling results of the PLANETS project suggest that CCS is more sensitive to climate policy uncertainty than to technology cost uncertainty, because CCS is competitive only if the climate externality is internalised with a credible and stable carbon price.

A mix of policy instruments could contribute to reducing both policy and technology uncertainty for CCS. Emission performance standards could shield the deployment of CCS from policy uncertainty. However, CCS technology should not be fully exempted from carbon taxes, not only because it is not a fully carbon-free technology, but also because the risk of CO_2 leaking from the underground cannot be excluded, even though it would occur in a far distant future.

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The PLANETS project

PLANETS is a research project funded by the European Commission under the Seventh Framework Programme with the scope of devising robust scenarios for the evolution of low carbon energy technologies in the next 50 years. The project has brought together eight partners with strong analytical tools, designed to foresee the best economic and technological response to future climate and energy policies.

A portfolio of integrated assessment models has analysed the implications of climate policies under a wide set of assumptions about national commitments and the use of international carbon offsets. This assessment has been expanded to account for the uncertainties regarding the future evolution of climate policies and the prospects of key carbon mitigation technologies. The modelling evaluation has been complemented with technological and economic assessments of key mitigation options such as Carbon Capture and Storage (CCS) and bio-energy.

The project output has comprised several publications in the form of reports, working papers and articles in journals. A special issue in a peer reviewed journal is under way. The research has been disseminated widely through a range of international-focused activities, such as seminars and conferences, and events in cooperation with the International Energy Workshop. Three online polls have provided external insights on the role of policy and technology. For further information, please visit the PLANETS website www.feem-project.net/planets.

Project website: www.feem-project.net/planets

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