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SINTEF

Linking Global and Regional Energy Strategies (LinkS)

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Conference abstract

In the research project "*Linking Global and Regional Energy Strategies (LinkS)*" funded by the Research Council of Norway and Hydro, we have studied the linkages between global and regional energy and climate policies and their implementation on regional level. Through the use of large scale energy system models we have examined how regions can contribute to global climate mitigation targets by utilizing regional-specific policy structures and technical characteristics. We have also studied how regional policies may support a sustainable development of the regional energy system based on regional differences in technology, economy, governance and resources.

Partners in the project are The Joint Global Change Research Institute, US, University of Maryland, US, Tsinghua University, China, NTNU and SINTEF Energy Research.

To explore the long-term, global implications for human energy, economic and land systems of limiting human climate forcing, **The Joint Global Change Research Institute** (JGCRI) has considered the interactions between the world's regions on decade to century time scales with their Global Change Assessment Model (GCAM). First, a counterfactual reference baseline is established for the evolution of the Earth's energy, economic and land systems as they might develop over the remainder of the 21st century in the absence of new policies whose primary purpose is limiting climate change. Through a set of structured sensitivity exercises the effects of climate policy stringency, technology availability and policy architecture on technology choice, technology deployment timing, and economic cost of limiting human climate forcing is explored. Two different policy stringency levels are examined to investigate the effects of limiting the deployment of different technologies, and analyze the implications of applying the European 20-20-20 policy architecture globally. The resulting "*Global 20-20-20*" scenario is found to be potentially very powerful in limiting climate forcing, if extended spatially to other, global regions, and intensity over time. This hypothetical "*Global 20-20-20"* scenario comes with higher social costs than idealized policy instruments that achieve the same environmental outcome such as the carbon tax, but there may be other, non-climate benefits accruing to such a linked policy package.

Several research teams have looked at the regional implications of different climate policies in the EU, China and US. For the EU, energy security is also a major policy concern as one of the three main "pillars" for its energy and climate policy - reducing greenhouse gas emissions, improving the security of supply and increasing the region's competitiveness. Due to environmental consideration and nuclear phase-out policy, the demand for natural gas in Europe is expected to increase while the estimated domestic supply of natural gas in Europe is declining. The **University of Maryland** has performed a study to investigate the European security of natural gas supplies as a result of the completion of the several European pipeline projects that involve Europe and/or Russia and US LNG exports. The Nord Stream, South Stream, and Southern Corridor Projects have been incorporated into the World Gas Model (WGM). The WGM allows new pipelines to be built and expanded as a function of the pipeline operator's investment decision in an endogenous manner. The pipeline operator considers expanding a particular pipeline if it is profitable. The WGM considers the cost of pipeline expansion in terms of the length and type of pipelines (on-shore or off-shore) and distinguishes between the cost for new construction and expansion. This analysis largely focuses on the flows from Russia to Europe given new pipeline capacity and the pipeline investment decisions.

For a given policy scenario GCAM computes a projected electricity mix for Europe, however, the results only include annual figures for two large regions, Eastern Europe and Western Europe. A new stochastic optimization model for capacity expansion, EMPIRE (*European Model for Power system Investment with Renewable Energy*), is developed in a PhD study at **NTNU**. EMPIRE is used to analyze cost optimal implementation of a GCAM scenario. Results like annual demand for electricity in Western Europe and Eastern Europe is broken down to national levels and used to generate hourly load series for each country. Fuel prices from GCAM are used to determine the cost of generating electricity using different technologies. The EMPIRE model then computes optimal investments in generation and transmission capacity required to reach the energy mix suggested by GCAM. The model also considers a large number of operating conditions at an hourly level for the European power system, thereby addressing the issue of short-term variability, which is hidden when only looking at annual figures. This is especially important in system with a high share of intermittent renewable power generation. Results from the three GCAM scenarios will be presented.

The EMPS model of **SINTEF Energy Research** is an energy marked model that can handle uncertainties in input parameters such as wind, solar and hydro energy. In this study, a new iterative approach is used to forecast the long term development of infrastructure in the European power system. The results of the iterative approach are compared with the more formalized investment model EMPIRE using the same input based on the results from 450 ppm scenario GCAM simulations. The two models identify similar main corridors for new electricity infrastructure, though there are difference in sizes and timing of investments. This is expected as the EMPIRE has a higher complexity in the modeling of future investment while the EMPS only considers a single year, with higher resolution and complexity, when making the investments. The detailed results from the EMPS simulations are used to explain the differences in investments, where the important factors are hourly variations in price differences as well as timing of the investments. Large hourly variations in price differences between regions throughout the year will cause transmission investments in the EMPS model which are not captured by EMPIRE as the mean value might be small. On the other hand the EMPS does not consider future developments when making an investment, which might lead to a suboptimal solution for the total period. The objective of the work is to highlight and explain the differences of the two complementary methods/tools.

As one of the top emitters in the world, China is facing more and more pressures from both international and domestic communities. **Tsinghua University** will briefly introduce the trend of energy production and consumption in China in the latest years to give a background on the following talk. To confront the energy, climate and environmental challenges, the government of China issued its 12th Five Year Plan in year 2011 with a view to transit to a low carbon development path in the coming decades. One important shift in Chinese climate policy is the shift from a traditional command and control policy to market based policy such as emission trading schemes and carbon tax. Six cities and provinces have started pilot schemes with a view to start a national ETS in 2015. Tsinghua will introduce the most recent progress in China's climate policy, including an overview of climate policy before and after Copenhagen, the shift of policy paradigm, the new policy package in 12th Five Year Plan, the progress of ETS pilots in selected cities and provinces and its interaction with frozen reform of electricity sector.

Climate goals need to be pursued together with other priorities in social and development agenda. Thus, a significant more carbon-efficient pathway at national and local level must be in line with and contribute to sustainable development goals. The key to link international agenda with national and local priorities is the range of benefit can be achieved through such linking. A scenario and co-benefit study in electricity and cement sectors will be used to illustrate how international climate agenda can be aligned with national and local priorities.

In their second talk, **University of Maryland** first gives a brief overview of both US Federal and US State energy-related initiatives in regards to climate policy. Some comparison with the European programs is made. Then, in the second part of the talk the focus is on the issue of shale gas and the confluence of local, state, and federal drilling and other policies and their impacts on the ultimately recoverable amount of gas from the Marcellus shale gas basin.

In addition to the techno-economic modelling, analyses of the climate and energy policies of the EU, USA and China have been led by the policy team at **SINTEF Energy Research**. Focus has been on regional entities like China, the US and the EU, which all demonstrate different approaches to climate-policy formulation and implementation, in addition to being the world's three main emitters of greenhouse gases. These countries and their different approaches is a key to enable a more robust global climate-change policy regime.

Three analytical dimensions have been employed, related to: (1) *level of climate policy anchorage* - from which policy level do the climate policy initiatives stem? (2) *'issue-linkage'* – to what extent are climate policy initiatives linked to other relevant policy fields? and (3) *interdependencies* – patterns of economic and political interaction and mutual dependency. The three regions are characterized by multiple ways of interaction between the levels of policy anchorage. Hence, top-down and bottom-up patterns of policy anchorage are in no way mutually exclusive. By adding the impact of issue-linkage, and by focusing more closely on the specific case of energy policy, the importance of such dynamics stands out even more clearly. This insight implies that stronger, common global action should be based on experiences from the regional dynamics – in order to achieve more sustainable and realistic outcomes at the global level.

Secondly, we have combined these insights with insights from numerical analyses of future global climate policy scenarios. How can future climate-change mitigation efforts be designed in order to achieve a more coherent, harmonized policy approach? This question is discussed as a complementary, qualitative analysis to the numerical study of the possible outcomes of a transfer of the EU 20-20-20 targets to the global level.

The EU has been considered to be a front-runner in the international cooperation on climate-change mitigation. The 20-20-20 targets also represent an example of broader and more sector-encompassing approach to climate-change ('issue-linkage'), than alternative strategies elsewhere. When considering the numerical and qualitative factors in combination we find that costs and benefits associated with a *Global 20-20-20* strategy are providing a viable outcome (technologically, economically and by reduced GHG), but that processes of policy implementation related to specific policy sectors must be addressed in order to actually prepare and implement such a 'transfer' in practice. In the absence of a global climate policy authority, issue linkages and patterns of interdependence should be taken more into account.