Robust Policies for a Low Carbon Future

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Aims

There is a strong need to design robust policy packages for emission reductions against a background of significant uncertainties on energy scenarios (including fuel prices), technology costs and availability and regulatory framework (specially the nature and ambition of any new international agreement on climate change). The inherent features of power generation investments and the electricity market like interdependencies, lack of efficient electricity storage and transmission monopoly add to the complexity of the problem.

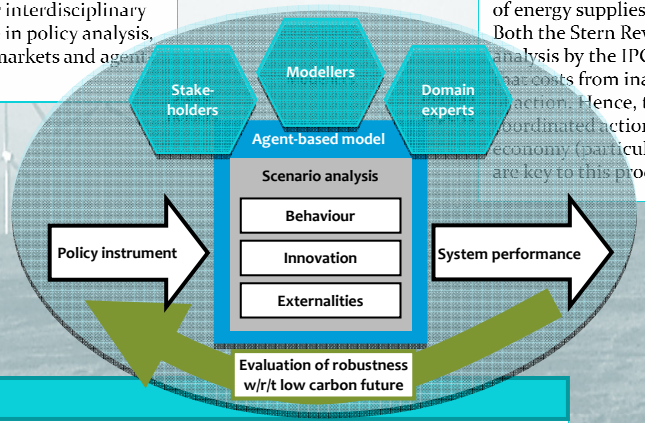
In a situation like this modelling and simulation has proven very useful. Models not only allow to explore the effects of different scenarios but also to assess the sustainable development of possible pathways towards an aspired end state -- in this case, a low carbon future.

We propose to develop an agent based model of the UK electricity system to analyze and explore how policy interventions affect the behaviour of organisations in the total supply chain of the electricity sector. Our interdisciplinary team combines expertise in policy analysis, electricity and financial markets and agent based modelling.

Policy Context and Rationale

Long-term targets for the reduction of carbon emissions have been central to the UK policy debate on climate change for a number of years. Following RCEP's (2000) recommendations, the UK government adopted 60% CO_2 reduction target by 2050 from 1990 levels in the Energy White Paper (EWP 2003). The EWP 2003 also outlined terms of references in reaching these targets, namely the need to maintain the competitiveness of the economy, reliability of energy supplies and fuel affordability. Both the Stern Review (2006) and the analysis by the IPCC (2007) emphasized that costs from inaction outweigh the costs of action. Hence, they imply a long term, coordinated action and restructuring of the economy (particularly of the energy system) are key to this process.

The need for long term planning of energy policy has been resonated in a new Energy White Paper (EWP May 2007). The analysis for the EWP included using a long term energy system model to explore endemic uncertainties and different energy system pathways that might emerge under different scenarios and the economic implications of transition to a low carbon economy. With the Climate Change Bill, which was introduced to Parliament on November 14, 2007 with the aim of receiving Royal Assent by spring or early summer 2008, the UK will strengthen the institutional framework to deliver its carbon reduction commitments via a system of legally binding carbon budgets and clear and regular accountability to the UK, Parliament and devolved legislatures.



Methodology

Agent-based modelling is the preferred methodology for two reasons.

1. Agent-based modelling allows for explicit consideration of strategic behaviour of individual organisations and customers and the subsequent effects on the performance and evolution of the electricity sector in the UK.
2. The explicit consideration of organisational and customer behaviour within the models allows for assessing the nonlinear and complex interrelationship between policy interventions, market forces and customer preferences in the electricity sector.

Only recently, agent-based models have received attention as a potential tool for use in the **electricity sector**. In general, these models have specifically focused on wholesale power markets exploring the consequences of strategic behaviour of electricity generators to the quantity and price of electricity in the context of specific market rules and network infrastructures.

The focus of the agent-based model in this interdisciplinary research project is different from previous models developed, because it explicitly takes into consideration the complexities involved in large-scale transitions in infrastructures. Instead of only focusing on short-term operational behaviour of generators or network operators, the model will take into account those organisational decisions and/or shifts in customer preferences that have a high impact on the transition of the current electricity infrastructure towards one aligned with a low carbon future.

The role of **uncertainty** and **innovation** are two key aspects within this agent-based model. High-stake investment decisions are irregular and involve high levels of uncertainty. By means of the ABM approach, we will be able to model adaptive investment behaviours in a realistic way, to account for the heterogeneity among agents, and to explore the systemic effects of different strategies toward uncertainty in different scenarios. Secondly, the focus on a long-term transition requires explicit analysis of the role of innovation, both in terms of incremental learning as well as the introduction of disruptive technologies, in the electricity market. Explicit consideration will be given to the role of innovation in the transition towards a low carbon future.

Expected Outputs

The methodology developed within this highly interdisciplinary research project will make several unique contributions to the development of policy instruments for the UK electricity sector:

1.Broad platform to explore and develop robust policy interventions for a low carbon future in the UK.
2.Explicit consideration of the role of uncertainty and innovation in the long-term planning of the electricity sector.
3.An alternative approach to scenario modelling used in the Energy White Paper 2007.