ENERGY TECHNOLOGY AND ENERGY ECONOMICS: ENERGY POLICY ANALYSIS IN TWO DIFFERENT MODEL TRADITIONS

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Overview

Models are useful and widespread tools in energy and climate policy analyses. Two main families of models have been developed over the decades. One is the energy system models, based on optimization of technology choices in production, distribution and consumption of energy. The other is economic computable general equilibrium models, based on optimizing economic agents whose interaction in markets (including energy markets) determines equilibrium prices and quantities. Over time, the two traditions have adopted features from each other and included more of the real-world complexities (such as behavioural and market barriers). The purpose of our analysis is to study the similarities and differences between the two modelling approaches in the context of energy efficiency policies.

We have analysed the same policy – energy efficiency targets in households – using two models of different modelling traditions. The models generate fairly different results, particularly in the electricity market.

Methods

We study energy efficiency policies in households in an energy system model, TIMES-Norway (Lind and Rosenberg, 2013) and in a computable general equilibrium (CGE) model for Norwegian economy, SNOW-NO (Bye et al., 2015).

First, we create baseline scenarios up to the year 2030 (see Rosenberg and Espegren (2014) and Bye et al. (2015) for details). Then we examine the outcomes of a policy aimed at reducing household energy consumption for heating purposes by 27% by 2030 (based on energy efficiency policies suggested in EU (2012) and EU (2014)). We implement the energy efficiency policies in households by introducing a cap on energy use for heating in Norwegian homes in SNOW-NO. In TIMES-Norway, the policy is implemented by restricting the use of purchased energy for heating.

TIMES-Norway's principal strength is the rich array of technological measures that can be implemented as a response to policies. However, total demand for energy services is fixed and does not respond to price changes. The model determines how the total energy demand is met by different choices of technologies and energy products.

In SNOW-NO, technology options are fewer and less detailed, but, contrary to TIMES-Norway, households can change both the level and the composition of their consumption. When energy consumption is restricted, households' utility maximisation will normally influence demand for all other consumer goods and services. This will in turn influence prices, and hence supply and demand by other market agents in the whole economy. Even though SNOW-NO does not model technologies in detail, we have refined our modelling of energy efficiency investments based on data from TIMES-Norway.

Results

Our analysis illustrates that the two different approaches may yield fairly different results.

In the energy system model TIMES-Norway households' *electricity* consumption remains roughly the same, even with the relatively strict reduction requirements for *energy* consumption. In TIMES-Norway, purchased energy can be replaced by energy production directly in the dwelling (for example by solar energy or heat pumps). Investing in heat pumps turns out to be the key response to the cap on purchased energy. Heat pumps require substantial amount of electricity. The reduction in household energy consumption takes place through reduction in the use of other kinds of energy (firewood and district heating).

In contrast, the same energy efficiency policy in the CGE model SNOW-NO leads to a substantial decline in household electricity consumption. Heating technologies are not modelled in detail in SNOW-NO, so heat pumps are not available as an option (substitution between technologies that use the same energy carrier, like electricity, is not modelled). The energy use cap triggers investments that make dwellings more energy efficient. In addition, the demand for heating falls significantly in order to adapt to the cap. In other words, part of the households' response is to avoid heating of all rooms or to move to smaller dwellings – options that do not exist in TIMES-Norway.

Moreover, the general equilibrium approach emphasizes the wider economic context surrounding the energy system. In addition to technological adjustments that improve energy efficiency, SNOW-NO suggests a significant substitution from heating and housing services towards consumption of other goods and services in households. As electricity is the main energy carrier in Norwegian households, this reduction in energy and electricity use in households results in a substantial decline in electricity prices. Lower electricity prices lead to increased demand for electricity in other sectors of the economy. Especially electricity-intensive process industries benefit from lower electricity prices and expand.

Conclusions

Model analyses provide useful information about the effects of policy measures and expected market developments. Our analysis reveals the need to examine energy policy and market developments from several angles when important decisions are to be taken.

The divergent results stem from fundamental differences between the two modelling approaches, particularly regarding assumptions about behaviour. Different models focus on different characteristics and illustrate different aspects of energy markets.

References

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