HOW LARGE A ROLE SHOULD INDUSTRIAL ENERGY SAVINGS PLAY IN AN ENERGY POLICY BALANCING SAVINGS COSTS WITH RENEWABLE SUPPLY OPTIONS?

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Overview

Energy savings are a key element in reaching ambitious fossil fuel reduction targets and may contribute to increased productivity as well. Fossil fuel reduction may be achieved also by other means as substituting with renewable energy. To compare and balance the effort in these two areas is an important task for policy design. For identification of the most attractive saving options in industry a thorough understanding of end-use demand and industrial processes is necessary to incorporate in the modelling. The paper develops three simulations describing the system wide consequences in Denmark of combined industrial energy savings and renewable supply options.
Industrial energy savings/efficiency options in Denmark exist at various sub-sector and end-use levels even though the average energy intensity of Danish industry is low. This paper investigates savings options modelled in a very detailed setup of hourly demand levels for a range of end-use technologies in Danish industrial sectors.

In the Danish context this is illustrated by the difference between electricity based end-use demands and the natural gas based consumption in industry. The three scenarios analysed are:

- Broad cost efficient energy savings balanced against the cost of supplying each end-use type of energy (base case)
- Energy savings for end-uses with a high fossil fuel share balanced with the cost of supplying instead the energy consumption with renewable sources
- A scenario with heavy focus on electrification options replacing the most expensive fossil fuel energy saving options

Methods

Savings at different hours and particularly with regard to various primary fuels have considerably different interaction with the rest of the energy system. The paper applies existing knowledge about consumption at subsector level and couples it at the detailed end use level with and hourly consumption profile and estimated saving potentials in Denmark. The setup allows examining the system wide effects of promoting savings in specific subsectors and for end-uses. Specifically the effect on the operation of power and heat generation from savings and electrification can be illustrated.
For energy policy purposes the model allows comparing policies to invest in savings that have an economic value higher or equal to cost of producing and supplying the energy product. Within these we compare with a policy that focus entirely on cost of energy savings that reduce fossil consumption balanced against the supply cost of providing only clean energy sources for the end-uses. This will feed into the discussion of directing energy saving policies broadly towards cost efficient energy savings or towards savings reducing primarily fossil fuel consumption..

Results

We evaluate the consequences of the simulations based on their overall energy savings, system wide costs, fossil fuel consumption and differences in effects for energy demand and capacity requirement in the power and heat sector. Furthermore the implications for costs of energy supplied to each industrial subsector are considered and critical effects on individual sectors identified.
Specifically the effects of saving in industrial end-uses with very different time profiles are studied. The aim is to identify if some fossil fuel savings are much cheaper to implement in the system than others if their specific consumption profile has much higher system costs than others.
The electrification options partly relate to low-temperature and medium temperature process heat/steam that has considerable share of natural gas presently. The profiles of electricity demand are affected by such electrification if

the natural gas based processes profiles are fully transformed to the same electricity demand profiles. These demand profiles are largely spread across many working hours and do not have particular peaks and therefore do not impact the power system in any critical way.

Conclusions

Preliminary results show that industrial energy savings profiles do not provide the most savings in particular peak hours in electricity generation and natural gas supply, but that there are both cost-efficient saving potentials and considerable options for electrification in Danish industries. Fossil fuel reductions in industry thus seem able to contribute to Danish fossil reduction ambitions.

Comparing the effects of the scenarios it is possible to make some preliminary recommendations for the effort that should be put into different types of industrial energy savings if the policy is primarily targeting cost efficiency in the system or targeting savings that will reduce fossil fuel consumption in a cost efficient manner.