Energy Savings Versus Energy Supply - Modelling Energy Systems: PhD project description

Author:
Mattia Baldini

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1 Description

The 3-year PhD is part of the SAVE-E project funded by Innovation Fund Denmark. The research project running 2015-2018, will examine what makes Danish households and companies invest in energy-saving solutions. The PhD proposed will contribute specifically on the Work Package 5 (WP5) of SAVE-E project. The thesis will be written in English and will be structured as an article based thesis. It will also include publications in international peer-reviewed journals.

2 Summary of the research

The goal of the project will be to investigate the trade-off between savings and supply, and identify optimal weighting of savings in future renewable energy scenarios. The main objectives of the study are hereby illustrated. A deeper explanation is reported in section 3 where the objectives are grouped in tasks.

2.1 Objectives

The objectives of the project are to:

- Identify and quantify technical, economic and social barriers for potential energy savings,
- Analyse implementation strategies, evaluate incentives schemes and find optimal trade-offs between efficiency improvements and additional renewable energy supply,
- Evaluate macro-economic effects of efficiency improvements and alternative incentive schemes,
- Contribute to development of methods and theory in the intersection of energy systems, behavioural economics, energy economics and stochastic programming areas.

2.2 Outputs

The main outputs related with the PhD project are in line with the aim of the DTU Management department. Indeed the main goal is *"to provides industry, private and public organizations, and the society at large with cutting edge management knowledge and competences for creating solutions to address some of the grand challenges."*[1]

The outcomes of the project are presented according to the scientific and social fields respectively.

The main *anticipated scientific results* are:

- A method for aggregating technical saving potentials and the construction of dynamic cost curves
- Characterization of first movers and quantification of their effect through social networks on second mover adoption of saving investments
- Contribution of real option theory and stochastic programming in explaining how uncertainty is affecting energy saving investments in industry
- An extended energy systems model integrating investments in energy savings
- Analyses of incentives, barriers and policy instruments for energy savings

- Development of a small macro-economic energy model for Denmark describing energy saving investment behaviour in both industry and households

On the other hand, the main *anticipated results for the society* are:

- A decision support tool for implementing energy savings in Denmark
- Assessment of barriers for investments in energy savings, evaluation of policy instruments, evaluation of investments in savings versus increased renewable supply, and for energy savings suppliers improved targeting of end-users likely to implements savings.

3 Tasks

The forementioned objectives are hereby described and explained. These can be assumed to be the main research ideas for the project. The task presented will contribute to the completion of the SAVE-E project's research question :

"...The socio-economic trade-off between energy savings and increased supply from renewable energy will be analysed by extending the energy system model Balmorel [2] to include energy saving investments. Macro-economic effects of investments and savings must be quantified and we do this using a small macro-economic energy model of the Danish economy. The model will be developed based on the tradition of integrating technical energy models into macroeconomic models [3] and coordinated with on-going modelling activities in the Danish Energy Agency..."[1]

The tasks for the PhD are:

1. **Clarify the value of different kind of energy savings:**
   The goal of energy savings is to optimize the use of energy available. This imply the reduction of energy demand, CO2 emissions and the dependency of fossil fuels. The energy savings can be addressed differently, according to the end-user considered. Thus the use of energy from different costumers will be investigated in order to address/propose the correct energy savings.

2. **Tool to compare saving cost curves with supply cost curves:**
   The marginal costs curves are often used in order to find the least cost combination of savings and renewables (RE) while aiming at certain environmental targets. Cost-curves for individual technologies give a static picture of the costs related to savings and supply technologies. Cost curves for heat savings in buildings, savings in process energy, and electricity savings will be created. Furthermore a tool will be built for comparing saving cost curves with supply cost curves to find trade-off between those when reaching certain renewables or energy efficiency targets.

3. **Extend the energy system optimization model Balmorel:**
   The proposed tools will be translated in mathematical terms and implemented in Balmorel. The energy systems optimisation model will be extended in order to consider the new end-use sectors (households, industry, other) and a detailed description of the building mass. Energy-savings investments will be also included.

4. **Analyse different policy scenarios:**
   Once Balmorel will be extended, simulations that considers analysis and policy scenarios will be performed to find an economic optimal mix of savings and supply while meeting GHG reduction targets. The outputs from the simulations aims at giving a guidance on how to optimize energy saving initiatives to exploit peer effects through social networks.

4 Collaborations and contributions

The PhD project will contribute to the Work Package 5 (WP5) in the SAVE-E project. The WP5 is led by Kenneth Karlsson, senior researcher DTU. Peter Meibom, head of department at the Danish Energy Association (adjunct professor at DTU) will contribute with considerable experience in modelling and analyses of the energy system. Nina Juul, senior researcher DTU, will be the main supervisor of the project. Henrik Klinge Jacobsen, professors DTU, will be the co-supervisor. The project will be held in collaboration with WP1 on saving potentials and with WP4 on policies.
DTU will lead the work package and will contribute to the tasks with extensive expertise in the Balmorel model. The Danish Energy Association will contribute to tasks 1, 2 and 3 with modelling and electricity savings expertise. Aalborg University (AAU) will contribute to task 3 with building energy data and expertise. Viegand Maagøe will contribute to task 5 for industrial energy savings.

References

[1] SAVE-E project description *SAVE-E Energy Savings: Closing the Energy Efficiency Gap* 2015: DTU Management Engineering.

[2] Balmorel *www.Balmorel.com* 2012.

[3] Henrik Klinge Jacobsen *Integrating the bottom-up and top-down approach to energy-economic modelling. The case of Denmark.* 1998: Energy Economics 20, 443-461.