Sustainable Energy Policy and Strategies for Europe

October 28-31, 2014 in Rome, Italy
LUISS University of Rome

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ABSTRACT SUBMISSION DEADLINE **JUNE 1st, 2014**

The Conference Objectives

As Europe strives to overcome the economic crisis, energy stands out both as a conditioning factor and as an opportunity. The energy situation is evolving in Europe as well as in the rest of the world, where new actors, the emerging economies, are taking the leading role. Political developments in several areas of the globe (North Africa and Middle East, the Caspian region, ASEAN countries) are reshaping the geopolitical situation, generating some worries about the security of supply in the EU countries.

The crisis has somewhat released the pressure on energy demand and allowed to reach objectives in the reduction of greenhouse gas emissions that seemed out of reach, but as the European Energy Roadmap to 2050 makes clear the objectives for 2020 and beyond are likely to require a renewed, powerful effort as soon as the economy is back on the track.

Important steps towards the establishment of a really open and competitive energy market in Europe have been achieved, but much remains to be done. Energy technologies (as evidenced in the SET-Plan) have evolved and contributed new solutions, as in the case of non-conventional hydrocarbon resources, but this has happened more as gradual step-by-step improvements than by real breakthroughs. The evolution of these technologies has been influenced by the instruments adopted by governments to promote new sources or new solutions rather than directly by market demand. The use of "market instruments" to steer the energy choices in the direction of sustainability is the subject of animated discussions, based on the analysis of diverse case studies. The hope of obtaining reductions of energy costs by these means has been often frustrated.

Some sectors show difficulties in moving in the right direction (in terms of economy as well as sustainability): the outstanding example is the transport sector, where, apart from the improvement of the efficiency of vehicles, there is little sign of moving from the present paradigm (with private prevailing over public transport, road over track and waterways,) and sporadic attempts are done to reduce the need of displacements (both of people and of goods). Another sector which is meeting institutional rather than technical difficulties is the building sector, especially as concerns distribution of costs and revenues among the different actors.

The first (dual) plenary session of the Conference will be devoted to the European Energy Road Map to 2050, and to the response to environmental challenges.

The next plenary sessions will deal with the specific energy aspects of transportation, and to the efficiency of energy utilisation in buildings. The last two plenary sessions will be devoted to energy geopolitics and emerging countries, and to the regulation of energy markets.

The 14th IAEE Conference will try to discuss all the issues related to European policy and its new perspectives in 8 plenary and 40 concurrent sessions that will be organized by the **AIEE- Italian Association of Energy Economists and IAEE - The International Association for Energy Economics**, in cooperation with the **Guido Carli Free International University for Social Studies - LUISS**, that will host this conference.

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Evaluating investments for existing District Heating networks depending on the development of buildings' heating demand applying Robust Optimization

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Overview

A main issue of planning the future investments in district heating networks is to anticipate the development of buildings' energy demand. Furthermore, investments in the extension and/or expansion for the existing district heating grid have an impact on heating related decisions (type of heating systems, thermal refurbishment of buildings) of owners of the building or owners associations. In particular, an extension of the existing network leads to lower connection costs and therefore investments in the infrastructure can cause a higher demand for connection. The future energy prices, which face a high uncertainty in their trend, are another essential influencing factor. This is particularly true if the heat production is interconnected with the electricity sector via combined heat and power plant (CHP). The current energy price situation in Europe (low coal and electricity prices and high gas prices) demonstrates this price risk for district heating companies and shows major problems for an economic feasible heat supply for district heating networks whose heat generation is based primarily on combined heat and power generation. The focus in this paper is on developing a methodological framework to answer the following research questions:

1. What are possible and robust network-plans for extension and expansion of the existing district heating grid? How can the interdependencies to the development of residential buildings' energy demand and the uncertainty of the future energy prices be modeled?
2. How does the extension and expansion of the grid influence the customers' decision of changing their heat supply system to district heating?

The methodology is formulated independently from the type of settlement areas. Thus it will be possible to apply the methodology to different settlement types and thereby extend the results on whole cities and regions. In addition, the results for different scenario frameworks regarding policy measures and investment options up to 2030 are going to be compared.

Method

To answer the research questions an integrated approach is used: A robust formulation of a mixed-integer linear optimization model (MILP) is defined to maximize the supplier's profit. This new model formulation considers the costs for heat generation and grid extension/expansion as well as capital, maintenance and reinvestment costs for the existing and future district heating grid whereby a particular focus on the uncertainty of the future fuel prices . Assuming bounded uncertainty of the future fuel costs c_{fuel} ($c^L{}_{fuel} \leq c_{fuel} \leq c^U{}_{fuel}$) an additional restriction for the operation costs c_{op} has to be added to the classic optimization model (1):

$$c_{op} \leq \frac{HL}{\eta} * c^U{}_{fuel} - \delta$$

Depending on the annual Head Load HL of all buildings and the plants efficiency η, the operation costs are constricted with the difference of the upper limit of the fuel costs $c^U{}_{fuel}$ and the infeasibility tolerance δ. This restriction ensures that the solution fits best for a broad range of future energy prices.
Due to the investment decisions and the resulting connection of new buildings, the average connection costs in the area of settlement can be reduced and additional decision makers may consider a change to district heating. An iterative application will ensure the consideration of this feedback mechanism.

To respect the interaction with the buildings' energy demand, the future development is defined with the bottom-up model Invert/EE-Lab (2). The investments in new heating systems and thermal refurbishments are simulated and the applicable costs of heat for the connection to the district heating network are calculated: These costs include the fixed and variable operation costs, the investment for the installation of the heating system and the average connection costs. The average connection costs are calculated on the basis of the average distance to the existing grid and define the upper limit of the consumer's willingness to pay for the supply through district heat. According to this calculation the share of buildings in each building segment (described with age, thermal quality, used heating systems), for which a change to district heating is considered, can be determined.

Results

A methodological framework to generate robust district heating expansion plans is developed. Using the method of robust optimization also uncertainty of the energy prices can be considered. A case study for a representative area in a central European city is performed to illustrate the results of the model. The outcome of this paper should also highlights the impacts for different policy measures or presumptions relating to the general framework. One example for a change in the framework is the composition of the power plant facilities up to 2030.

Conclusions

The methodological framework developed in this paper is suitable to depict the investments in an existing district heating grid considering the development of heat demand and different scenarios from an economic point of view. The classical approach of MILP can't handle the uncertainty in the trend of parameters and can result in wrong decisions. Thus, the robust formulation of the optimization problem reduces the risk of bad investments as the consequences of various input parameters are considered.

Moreover, an analysis of the effects of different scenario assumptions allow to derive conclusions and recommendations about the total costs for the district heating grid, the environmental impacts of an extension/expansion and the key measures to achieve a specified share of district heating.

References

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