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A COMPARISON OF METHODOLOGIES INCORPORATING UNCERTAINTIES INTO POWER PLANT INVESTMENT EVALUATIONS

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Motivation

With the liberalisation in the electricity market intensive discussions have been aroused in terms of the changing environment for investments in electricity markets. One of the most noticeable points is the incorporation of uncertainties into power plant investment evaluations.

In contrast to the regulated electricity market, where almost all the risks could be transferred to the end consumers due to the existing monopolies, investors are nowadays exposed to diverse uncertainties at a (more or less) competitive market and have to take them into account at making their investment decisions. Hence, how to appropriately handle such uncertainties becomes the greatest concern during the decision process and furthermore, a crucial precondition of assuring sufficient investment in generating capacities.

Based on a comprehensive survey of diverse approaches for the power system expansion planning over the past two to three decades, this paper offers a comparison of techniques proposed to deal with uncertainties. Advantages and shortcomings of selected techniques will be illustrated through a case study. With focus on current contributions to the literature, this paper draws conclusions on the development potentialities of new methodologies able to meet the requirements of power plant investment evaluations in the coming years.

Methodology

This paper begins with a brief introduction of significant changes the electricity industry has experienced during the deregulation, in particular, relating to uncertainties. Uncertain factors are differentiated between the ones which all along exist but did not really play an important role in the planning until the deregulation took place, e.g. demand growth, fuel prices, regulatory environment, and the ones which have emerged under the new framework, e.g. electricity prices, behaviour of other participants, cf. [1, 2].

In the subsequent part of this paper different solution approaches to the power system expansion planning under uncertainty are introduced. The approaches previous to the deregulation usually address the problem with a common objective to provide an adequate supply of electricity at minimum costs. Uncertainties mentioned above were involved in the decision process through several techniques. In the articles surveyed three methodological categories can be identified: (i) stochastic optimisation, (ii) robustness analysis and (iii) option value methods, cf. [3, 4, 5].

In the contributions dealing with investment in generating capacities under deregulated conditions the problem is normally solved by maximizing the expected profit. Responding to the increased uncertainty arising from other factors as shown before, traditional techniques from the regulated time are adjusted to the new challenges. Additionally, methods from other areas are also introduced to be combined with the conventional ones for a better description of current electricity market. In this context, we underline the real options theory, an approach whose application traces back to the real asset evaluation on the financial market. Moreover, a discussion on different opinions about its adaptation in the power system provides a more extensive view on this method, cf. [6, 7].

The final part of this paper consists of a case study to evaluate a power plant investment project. Three selected techniques dealing with uncertainties will be respectively implemented in the evaluation model. Modelling results sequentially provide a basis for the demonstration of differences of these techniques. In addition, their advantages and drawbacks will be assessed in consideration of varying strategic objectives of the evaluation, which can e.g. be the system adequacy.

Results and Conclusions

Through the comparison of diverse techniques along the developing process in the power system, the change in the meaning of dealing with uncertainties for the investment decision making is outlined. Within this paper is shown, that incorporating uncertainties into investment evaluations can influence investment decisions to a great extent, regarding choosing technology, determining investment timing and defining investment scale.

According to the analysis carried out in this paper, the real options theory can be regarded as the most interesting approach among the studied techniques for the further research on power plant investment under uncertainty. However, its application relies on a quantitative description of uncertainties for a robust decision. Hence, precise modelling of uncertainties with usage of quantifying tools will be required. However, this leads to stochastic programming approaches that may dramatically complicate the decision problem. Therefore, a reduction of the problem's complexity by developing concepts to identify the significant uncertainties turns out to be another challenge.

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