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A decision support model for combined heat and power economic evaluation

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ABSTRACT

Many European states support Combined Heat and Power (CHP) investments and provide better selling tariffs for the electricity produced. In this paper, a model was developed that can help energy planning and decision-making for CHP investments in an unstable energy market. The model uses as variables state subsidies, natural gas and electricity selling price. Five different scenarios from Greek economic reality had been used in order to evaluate their economic viability and the investment risk. Finally, a sensitivity analysis was carried out, having as variables the natural gas price and the State subsidy. The sensitivity analysis of the natural gas price showed that although profits decrease as natural gas price increases, the investment remains viable for almost twice the current natural gas price. This means that small fluctuations of natural gas price do not affect the investment to a crucial degree.

1. Introduction

Combined Heat and Power (CHP) is a tool to help towards energy conservation. In addition, many countries subsidize CHP units that can make them attractive. For CHP applications, natural gas has dynamically entered the market and has become a more profitable fuel compared to oil. Often, due to unpredictable economic and political factors, it is quite difficult to take optimal investment decisions for CHP systems or to determine economic parameters such as the payback period.

The two main sources of the Greek energy production system are lignite (60%) with decreasing trend and natural gas (25%) with increasing trend. Lignite is offered to the main Greek power production company (PPC) at relatively low prices keeping the electricity prices per kW low. On the other hand, natural gas price is depending on international oil prices and is subject to severe fluctuations. A rising major issue the last decade is the CO_2 emission penalty, which gives the power production using natural gas a clear advantage. In order to develop the national CHP sector, the state should subsidize the capital cost and the electricity selling price of private small scale investments. Thus the CHP units will contribute to the stability of the national grid system, decrease CO_2 penalties and secure the country in the future keeping strategic lignite reserves for the following generations.

Other authors have also carried out evaluation of CHP units. Giaccone and Canova [1] presented a methodology for the feasibility study and the economical analysis of the investment is presented under the Italian legislative framework. The methodology is applied to an actual case. Kosugi et al. [2] developed a model to optimize the installation capacity of the CHP under constraints on electricity-and-heat supply and demand balances, etc. Energy cost and emissions of CO_2 and SOx were also calculated with the model, while parametric surveys were carried out for natural gas and CHP capital prices. Streckienev et al. [3] the optimal size of a CHP-plant with thermal store under German spot market conditions is analysed and the sensitivity analysis which followed, showed to what extent the optimal solution would vary by changing the key economic assumptions. Muller and Lund [4] used a spatially explicit economic model, to calculate the potentials and costs of connection to expanded district heating networks by supply technology and a comprehensive energy systems analysis is carried out to model how the new district heat can be supplied from an energy system with higher shares of renewable energy. Ren et al. [5] developed a multi-objective optimization model for identifying the operational characteristics of a distributed energy system, in order to meet the energy demands of a local area while considering both economic and environmental objectives. The compromise programming method has been implemented in order to select the final operating strategy from the set of possibly optimal solutions. Remer et al. [6] reported on the technical and economic evaluation with a gas-fuelled 4 kW prototype cogeneration package. They described the experimental setup used to test this cogenerator and measured power output, electrical voltage and frequency, thermal output, natural gas consumption, noise levels, reliability and economics. They noted that in most cases, a small business or homeowner would receive a low rate of return and payback period that exceeds the life of the cogenerator unless the total thermal efficiency can be

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