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# Energy price spread as a driving force for combined generation investments: A view on Europe

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ABSTRACT

Combined generation of heat, cooling and power has a large potential to increase its share in distributed generation of energy. Such investments are driven by energy savings which result to operational profits. These profits are very sensitive to the prices of the competitive energy products: electricity and gas. In this work a theoretical indicator is developed between energy prices, the technical characteristics of cogeneration and conventional generation equipment and the investment viability. Through this indicator, the operational profitability of cogeneration equipment is mapped and discussed. Empirical rules are extracted which can give a clear view of the sensitivity of energy prices on energy efficiency investments. The European cogeneration status quo is analyzed in terms of energy prices and market share. The developed indicator is also used, to analyze market related barriers and highlight the importance of energy pricing policy as a tool to minimize the risk exposure of energy efficiency investments.



## 1. Introduction

Combined generation of electricity, heat (CHP) and in many cases cooling utilizes the primary energy of a fuel even more efficiently, economically, reliably and with less harm to the environment than separate production means [1]. It is recognized by the EU as one of the most efficient ways to produce end-use energy from fossil fuels [2]. CHP systems are touching all five dimensions (energy efficiency, secure supplies, energy market, emission reduction, research and innovation) of the newly announced EU's Energy Union.

Two big categories of such systems can be identified: a) centralized power plants which extend their primary activity of electricity production to heat production and distribute it via other network to the end consumers (main producers), and b) distributed generation plants which benefit from the increased efficiency generating electricity and heat wholly or partly for their own use as an activity which supports their primary activity (autoproducers). Fig. 1 shows the share of electricity generation from CHP technologies for 2012 sorted by the CHP autoproduction share. This work focuses on the latter category as the energy prices and their spread which is examined in this work is one of the strongest drivers of such investments.

Autoproducers mainly exist in the industrial and the tertiary sector (medium scale CHP) and to a smaller extent to the residential sector (micro-CHP). Electricity is usually distributed to office applications and cooling devices. Thermal energy is used for space heating and other processes, such as equipment sterilization, laundry, and kitchen, etc. The most important factor that affects the feasibility of such investments is occupation and activity frequency as expressed by the capacity factor. Buildings like hospitals, hotels, schools can be the perfect candidate of such technologies since they have demanding thermal and cooling loads due to HVAC (heating, ventilating and air conditioning) systems. The evolution of the installed capacity of CHP technologies, along with the CHP share of different commercial consumers for 2014, is shown in Fig. 2. The dominance of gas driven technologies in this sector is prevalent. From the sigmoid curve it can be noticed that the market has passed the phase of the exponential growth and that it has reached its maturity.

However, there is still potential to be realized if certain barriers are lifted. In general, the barriers of distributed generation technologies fall into one of the following categories [5]:

- High initial costs
- Market risks for new technologies;
- Imperfect information;
- Uncertainty (technical, regulatory, policy, etc.).

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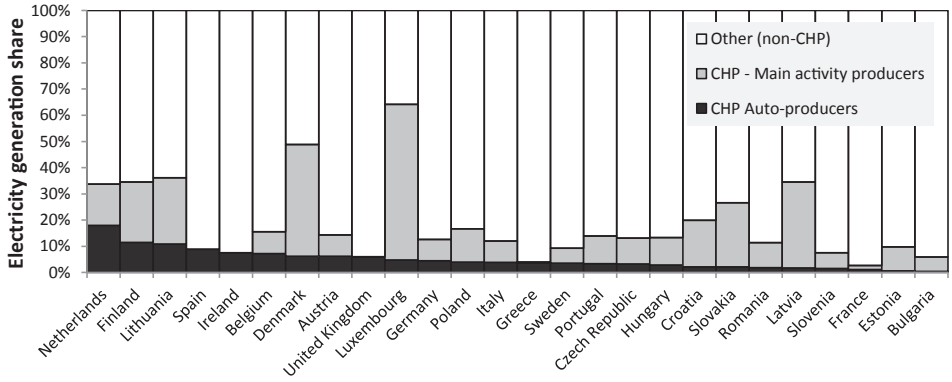


**Fig. 1.** Share of electricity generation of CHP autoproducers and main producers. Data source: [3].

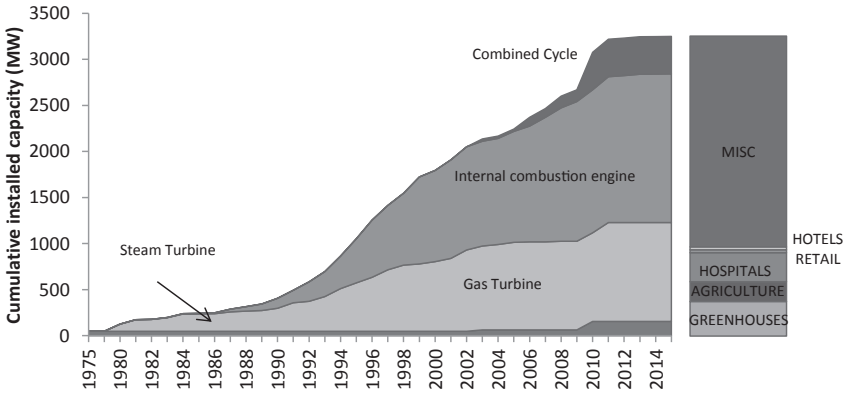


**Fig. 2.** Installed capacity in 2012 of CHP autoproducers per technology for tertiary sector. Data source: [4].

According to Baer et al. [6], the economic challenges of CHP investments are the greatest barriers to viability. Although CHP promises long-term energy-bill savings, companies often feel a greater financial risk because CHP installations have high upfront costs and long payback periods compared to traditional equipment. The recent economic crisis and the difficulties in securing financing have caused companies to become increasingly conservative, with even greater aversion to investments with longer payback periods.

EU Member States have recently reported the barriers of realization of the national potential of high efficiency cogeneration. The most important barrier – with 17 Member States reporting it – was the fuel prices and their volatility [7]. Other barriers in order of significance are: heating demand, law complexity, no support schemes, limited financial resources, regulatory framework uncertainties etc. A more recent study by Colmenar-Santos et al. [8] highlights this fact: price volatility and the regulatory framework are the most important barriers and without proper risk mitigation, these projects cannot be easily materialized. Investment opportunities of CHP scheme are difficult to evaluate due to the high complexity and multiple sources of risk [9]. CHP operators in EU have a particular uncertainty because low wholesale electricity prices have coincided with relatively high gas prices which is causing many plants to operate partially or not at all [10,11].

In order to better understand the barriers, it is necessary to examine the investment initiative of auto producers and how it differs to that of main producers. The investment dilemma of autoproducers consists of the decision whether cogeneration is more economical than conventional outsourced separate generation production means. The driving force of CHP investments is the energy savings, and the profits related to those savings are linked mainly to the prices of the competing fuels which are usually gas and electricity. It is evident that the more efficient the substituted equipment, the less attractive an energy efficiency investment is going to be. Another driver for distributed generation is the displacement of high-priced grid power with lower cost electricity generated onsite. Project economics are based on many project specific factors — size of system, total installed cost of the project, and local construction and labor rates. Production of energy is not the core business of the autoproducers, so a stable and risk-free environment is needed. In other words, these consumers (especially from the commercial and residential sectors) give advantage to systems that are simpler and not as price inelastic as cogeneration systems [12]. Hence, the viability of such installations is dependent on the substitution of the current equipment, market conditions, and the stability that is provided by the regulatory framework.

According to the above, it makes sense to study the theoretical relation between the viability of combined generation technologies and the market conditions and conventional equipment efficiency. In literature, there are some attempts for the use of such indicator. ‘Spark spread’, which refers to either the difference or the ratio of the competitive fuels i.e. natural gas and electricity, is the most common one. In an ‘energy market’ context it is usually the difference between electricity prices and gas prices multiplied by the heat rate which reflects the gross operation margin of a power plant [9,13]. Based on this difference, many financial products, such as options, have been used to hedge [14] and to estimate the value of such investments [13,15].

Dispatch decisions between competing technologies (e.g. cogeneration vs heat pumps) have also been based on this

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