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# Optimized Gas Pricing Policy to Have Maximally Peak Shaving

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**Abstract.** Today pricing policy in the electricity network is an effective way to oblige users to change their consumption during peak hours. At the same time by increasing distributed energy resources like Combined Heat and Power (CHP) and also gas network penetration level in huge areas it will be more attractive to use gas price as another motivated factor to alter electricity consumption curve. In this article, based on energy hub concept, an optimization approach related to the power dispatch through an energy hub is simulated and consequently an effective pricing policy of natural gas, to have a maximally electricity load shaving, is determined.

## Key Words

peak shaving, natural gas pricing policy, energy hub, optimal operation, Combined Heat and Power (CHP)

## 1. Introduction

Today, small-scale microturbines and other distributed generation plants are used increasingly [1, 2]. Microturbines are providing electricity and thermal energy at the same time, thus using natural gas with a higher overall efficiency compared with single gas turbines or hot water gas boilers. As gas-fired power stations establish a connection between the electrical and chemical network, certain interchangeability as well as a certain redundancy are being introduced into the system [3, 4]. During peak hours it might be financially attractive to generate electricity from gas instead of consuming directly from the electrical network [5]. Therefore it is expected that peaks from the electrical network will be moved to the gas network, resulting in a more intensively and differently used gas network. When considering hot water boilers or combined heat and power (CHP) similar relations and dependencies can be found between thermal network and electrical or chemical networks.

Hence, On the contrary In the past that efforts focused on the operational optimization of systems employing only one form of energy [6, 7, 8] recent research effort is addressing the integrated control of combined electricity and natural gas systems[9, 10, 11, 12]. Different approaches have been developed and used for various purposes.

While approximated flow models are used for instance in [13] for optimizing the flows through an energy supply chain, [14] and others employ detailed steady state power flow equations for natural gas and electricity appropriate for dispatching a real system.

Based on the concept of energy hubs [15] it enables simple analysis of couplings and interactions between the natural gas and electricity infrastructures [16]. The approach presented in this paper aims at a general modeling and optimization framework for energy systems including multiple energy carriers, e.g. gas and electricity, and also their environmental effects. By means of this model and represent an appropriate objective function the paper proposed an effective way to reduce consume of electricity supply in the peak time duration to have a maximally flat load curve by determining a policy for natural gas pricing.

This paper is organized in six sections. After this introduction, the energy hub concept is presented in Section II. Based on this concept, the mathematical model of the considered two carrier system is given in Section III. Exciting electricity and natural gas pricing policy is mentioned in section IV. Main problem, objective function and a proposed pricing policy are then investigated in Section V. Finally, Section VI summarizes and concludes this paper.

## 2. Energy Hub Modelling

Some conceptual approaches for an integrated view of transmission and distribution systems with distributed generation have been published. Besides "energy-services supply systems"[17], "basic units"[18], and "micro grids"[19], so-called "hybrid energy hubs", are suggested, where the term "hybrid" represent the use of multiple energy carriers[5,10,11]. An energy hub is considered a unit where different energy carriers can be converted, conditioned, and maybe stored. It represents an interface between different energy infrastructures and/or loads. Energy hubs consume power at their input ports which is connected to, e.g. electricity and natural gas infrastructures, and prepare certain required energy services such as electricity, heating, cooling, and compressed air at their output ports [10].

Energy hubs include two basic elements: direct connections and converters. Direct connections are used to deliver an input power to the output without converting. Converter elements are used to change carriers into other forms or qualities. Some of these convertors to mention are gas turbines, combustion engines and fuel cells. Figure 1 demonstrates an example of an energy hub.