Demand response and on site biomass CHP strategies: a case study in the Italian agro-industrial sector

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Summary
The implementation of the energy utility strategies designed to influence customer use of electricity in ways to produce desired changes in the utility's load shape and provide ancillary regulation services to the grid was carried out since vertically integrated electric industries. In particular, the Demand Response (DR) became a significant part of utilities' strategies to meet current and future energy end-users needs. The goal is to avoid construction of generation facilities that would be operated for relatively few hours per year and/or costly power purchases, by strategic shifting of customer loads. In this study, a methodology is proposed to select the optimal load management strategy, including on site cogeneration of heat and power by means of local biomass fuel and natural gas, and applied to the case study of a wood processing firm in the Italian energy scenario.

Key words: energy management, biomass, CHP, load management

Introduction

Energy management measures falling under the umbrella of the demand side include not only demand response techniques, but also energy saving measures, storage systems and on site generation, all with an emphasis on reducing both the consumption of thermal/electrical energy and the centralized generation capacity. To obtain an optimal load shape, utilities have implemented curtailable services, time of use electricity tariffs (TOU) and real time or spot pricing, which constitute value-added products.

The deregulation of electricity markets increases the interest in the likely relationship between suppliers and consumers. On the supply side, utilities have to make investments and pricing decisions taking into account competitors and the new possibilities available to customers. On the demand side, customers will be increasingly aware of saving opportunities arising from the new flexibility in supply. Indeed, freedom in supplier choice will make consumers look for the deal that best fits their specific energy needs. Therefore the load management (LM) becomes a customer concern and LM programs use a variety of different means to reduce the electric energy costs such as peak clipping, valley filling, load shifting, or energy efficiency measures, which may include fuel substitution, energy storage, cogeneration of heat and power (CHP) , based on both fossil and renewable sources.

Materials and Methods

In this paper, an industrial LM methodology is proposed and applied to a wood frames production firm in the Italian energy scenario to lower the energy costs and the greenhouse gas (GHG) emissions. The following input data are used to inform the model: (i) the hourly energy consumption pattern, (ii) the TOU cost of thermal and electrical energy, (iii) the typology of load management strategies adopted by the customer, (iv) the further options of on site CHP generation by means of biomass fuel available as a by-product of the production process. Starting from the collection of energy consumption data for the end-user, standard curves for load demand and energy price are obtained and the most appropriate load management/on site CHP generation options are selected. For each of them, the economic indices to evaluate the profitability of the investment and the global energy balances and environmental benefits are evaluated, in order to recognize the best strategy under the Italian energy framework and subsidies available. A flowchart of the proposed methodology is reported in Figure 1.

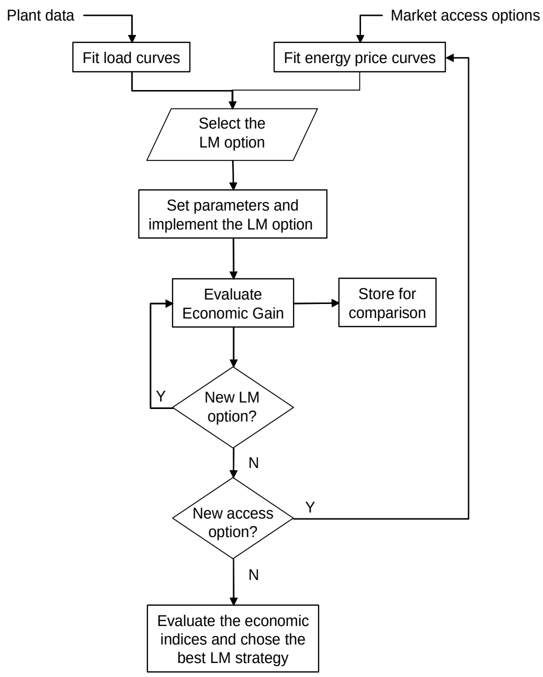

Figure 1. Flow-chart of the proposed approach to select the best LM strategy.

Results and discussion

The long term study to assess the best LM strategy is carried out on a planning horizon of 20 years, and considering a discount rate of 4%. The profitability index (PI) for the various LM strategies and including the installation of CHP systems is reported in Figure 2. The two case studies of a natural gas fired 500 kWe internal combustion engine (ICE) for CHP (case CHP-A) or a lignocellulosic biomass fired gasifier coupled to ICE (case CHP-B) have been compared. In particular, in case of biomass fuels, the two options of electricity fed into the grid with income from feed in tariffs available for renewable energy in the Italian legislative framework (B1) or on site consumption to match the electricity demand of the firm (B2) have been considered.

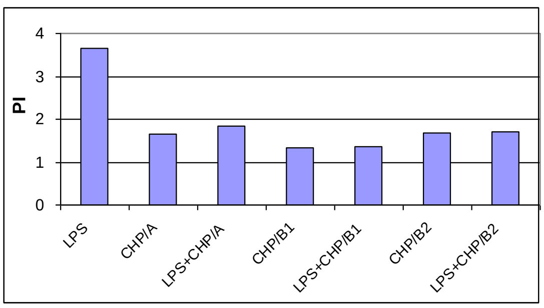

Figure 2 - The PI of the different LM options over the planning horizon for the case A-natural gas fuel and the case B-biomass fuel (B1 electricity fed to the grid; B2 on site electricity consumption).

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