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Analysis of electric and thermal seasonal performances of a residential microCHP unit

Guglielmo Magri*, Costanzo Di Perna, Giorgio Serenelli

Dipartimento di Energetica, Università Politecnica delle Marche, Italy

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ABSTRACT

One of the most recent innovation of thermo technique industry is the development of wall hung cogenerative gas boilers that adopt Stirling engines in combination with condensing heat exchangers. Such machines are suitable for installation in single houses since the electric power is around 1 kW.

However in order to justify the investments on the electric grids and to urge the simplification in laws, that makes now very difficult the installation, it is important to be able to quantify the primary energy savings achievable with such technologies; moreover because of the higher cost for the user it is also necessary to quantify the savings of money.

For those reasons the aim of this work is the calculation of the energetic and economic performances of a Stirling engine microCHP installed in a detached house, built in 70's in Milan in comparison with a condensing gas boiler as reference case. The simulations carried out using TRNSYS software show that the use of the Stirling microCHP gives advantages both in energetic and in economic terms, but they shown also that those advantages are higher with some schedules of the heating.

1. introduction

The need for efficient conversion technologies such as combined heat and power (CHP) production is undeniable nowadays [8] and one way to apply such technologies is to develop small units suitable for apartments and single-family houses (microCHP units). In terms of the hydraulics, these units are installed just like any conventional boiler and they offer the opportunity to generate electrical energy too while heat is produced and supplied to the home.

Such machines could increase the diffusion of distributed generation systems, but this depends heavily on the conformation of the power grids. Since the latter were not designed for this purpose, major conversions are needed to make them suitable for distributed generation, and that is why a strong political will is needed to move in this direction and invest in the necessary changes. The same political determination is also needed to simplify the rules and regulations for authorizing the installation of these microCHP units, since it is currently very difficult to do so, especially in Italy, because the same apply as for major CHP generating stations.

It is also very important for users to be able to quantify the money savings in order to calculate the payback time, given the considerable investment needed to install these units. Studies have already been conducted on the situation in some countries, e.g. The Netherlands [6], Germany [4,11], and the UK [2,9], but the research available for Italy [5] is rather old and fails to take into account the latest Stirling microCHP appliances.

On the other hand, given the high market potential and the difficulties encountered in obtaining authorization to install these systems, it is very important to perform these monetary assessments for Italy – especially for the case of existing buildings – because of the enormous potential value of such an additional method for the energy refurbishment of the country's large building stock.

The aim of this work was thus to build a model of an installation with a Stirling microCHP unit in a typical home suitable for such a solution and to perform numerical simulations to establish the amount of primary energy consumed and the electrical energy generated, and then to assess the related energetic and economic advantages by comparison with a gas condensing boiler installed in the same conditions.

2. Building details and loads

This study was conducted on a detached family house built at the end of the 1970's in the suburbs of Milan. According to directory of buildings components in [12] [9] the building consists of two

* Corresponding author
E-mail address: guglielmo.magri@alice.it (G. Magri).

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