Dipartimento di Ingegneria e Architettura
Università degli Studi di Trieste
Via Valerio, 10
Tel: +390405583051 Fax: +390405583812
Email: salessandrini@units.it, taccani@units.it, micheli@units.it

PA3.2 Task 5: Test under real conditions of innovative products for the building sector

Performance analysis and collection of experimental data on the micro-cogeneration system based on an internal combustion engine installed in the AREA Science Park campus of Basovizza

EXECUTIVE SUMMARY

Author: Stefano Alessandrini

Scientific supervisor: Rodolfo Taccani

ver. 0.1	Experimental data and software description	SA	RT, DM
Release	**Description**	**Authors**	**Review**

1. INTRODUCTION

The EU climate and energy package "20-20-20" proposes a project to support the social economy of the European market in the next decade by identifying some priority areas. Among these is sustainable growth that requires the promotion and widespread use of high efficiency energy production technologies with low emissions of carbon dioxide. Whereas, according to recent estimates, 40% of primary energy in Europe is consumed by residential building, so it appears fundamental to act in this sector with projects targeted testing of technologies for the efficient and effective use of energy resources. Furthermore, in order to increase energy efficiency in the civil and industrial sector, it appears important to increase the use of distributed energy production systems consisting of medium-small size units connected to the distribution networks of the electrical energy in order to:

- feed electrical loads in the vicinity of the generating unit itself, very frequently in co-tri-generation configuration for the exploitation of the heat;
- optimal exploitation use of local renewable energy sources;
- reduce losses in distribution and transmission of electricity with simultaneous limitation of voltage drops on the lines of the final users.

2. PILOT ACTION DESCRIPTION

The pilot action includes the valorization of ideas and innovative companies in the field of renewable energy and energy conservation through the study of demonstration plants that are also laboratories of technological development and industrial experimentation.

The cogeneration, also indicated with the acronym CHP (Combined Heat and Power), consists in the combined generation of two different forms of energy, mechanical and thermal, by means of a single integrated system. The principle on which CHP is commonly based is to recover the heat released at low temperature by a direct thermodynamic cycle that would otherwise be discharged into the external environment.

The pilot action is aimed to monitor the performance of the cogeneration unit (model Tema100 Energifera) and the development of computational software tool that allows to choose the best plant configuration in order to reduce fuel consumption and emissions in buildings.

2.1 OBJECTIVES

The experimental activity planned by the pilot action is addressed:

- to the evaluation of parameters of operation of the CHP unit and its components;
- to the monitoring the operating variables affecting the performance of the system;
- to compare the performance, for the same environmental conditions, the actual performance and profitability of co-generators based on internal combustion engine fueled by natural gas with those with gas micro-turbines;
- to develop simulation and analysis tools aimed at saving fuel and reducing harmful emissions in buildings (ENPAT).

2.2 PILOT ACTION'S INDUSTRIAL FALLOUT

The cogeneration plant based on the internal combustion engine has been designed to carry out scientific experimentation and for technical dissemination purposes. The use of cogeneration plants of this type, which are characterized by a high overall efficiency, is certainly an excellent source of savings for public or private business realities that require the use of combined heat and power.
The pilot action provides the opportunity for companies in the energy sector, technicians and final users to know in depth the pros and cons of these type of systems. The pilot action also aims to encourage the creation of new companies dedicated to the development of co-generation and tri-generation systems and to enable the companies supplying the installed machines to take advantage of the feedback to improve the product. The knowledge of the real potential of these plants as a single "components" and as a "components" integrated in an energy network is the basic instrument for the development of a smart grid that allows a reduction of fuel consumption and of greenhouse gas emissions and an increase in the overall energy conversion efficiency.

2.3 ENVIRONMENTAL IMPACT

The main environmental benefits of this pilot action (cogeneration) are:

- lower CO_2 emissions;
- lower pollutants (NO_x, CO) emissions;
- lower fuel consumptions.

3. MAIN RESULTS

As for the experimental data on the variable speed micro-cogeneration system, the manufactures specifications have been confirmed. It has been measured that the electrical efficiency continues to be high even at reduced loads. This behavior can be an advantage over conventional fixed speed systems. Nevertheless, the efficiency is approximately the same as in fixed speed systems at medium and design loads.

Using the energy performance analysis tool many different scenarios have been assessed.

In particular, it has been shown that this kind of generation system can extend the grid flexibility when important amount of PV is introduced in the grid. This is because the considered micro-cogeneration system responds quickly to load changes.

4. CONCLUSIONS AND TECHNICAL-ECONOMIC FEASIBILITY

The pilot action has allowed to deepen energy issues that in the recent years have attracted attention. This work presents the main results of an experimental analysis on an innovative micro-cogeneration system confirming the usefulness of monitoring energy systems of this type and highlighting the critical aspects of the management of such facilities. The high-efficiency distributed cogeneration, that offers high values of the Primary Energy Saving Index (PES), is foreseen to be a very promising technology in order to reduce primary fuel consumption. The experimental data collected during the tests have been used also to implement an energy performance analysis software design tool that allows to identify the optimal system configuration and operating strategy in order to minimize fuel consumption, both in the residential building sector and in industrial premises.

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