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ECONOMIC AND ENERGETIC ANALYSIS OF A DISTRIBUTED MICRO-GENERATION SYSTEM IN THE SAVONA UNIVERSITY CAMPUS

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Overview

The energetic systems development of the countries characterized by mature market economies has determined a main division of the electricity and heat production systems: in fact nowadays there are many large power plants, characterized by high efficiency and power rate, such as combined cycle power plants, steam cycle power stations, nuclear units, … and, on the other hand, distributed generation systems, based on a set of different micro-generation power plants, are regarded as advanced energy production technologies. The electricity and heat distributed generation determines a lot of advantages, among which it's important to remember the reduction of high environmental impact sources in limited areas, the utilization of the heat produced as a waste product during the generation process and the reduction of the electrical load on power grids. Then it's necessary to emphasize the importance of having the heat and power production unit close to the end users, because heat can't be carried very far without large losses.

Methods

The present article describes an important outstanding project at the Savona University Campus: the research team has planned and designed the installation of a distributed micro-generation plant which consists of a set of micro-cogeneration gas turbines and a solar system composed by thermal solar panels and photovoltaic modules. The heat and the electricity produced by this system can be utilized by different users that are present in the Campus: the university offices, classrooms and laboratories, the canteen and some firms of the tertiary sector. At first the cogeneration plant will integrate the pre-existent boiler units while in the future it will probably take their place. The excess of the heat produced by the cogeneration plant will be sold to some firms, located outside the Campus, that utilize heat in order to produce process steam, while the excess of the electricity will be yielded to the external electric grid. It will be also possible to acquire the most important operating parameters of the plant through a data acquisition instrumentation.

Results

In particular, the present paper deals with the energetic and economic analysis of the cogeneration system that is going to be installed in the Savona University Campus. About the energetic analysis, the heat and electricity consumptions of the Campus have been evaluated, in terms of kWh consumed, in order to establish how many micro-turbine, solar thermal panels and photovoltaic modules will have to be installed; by the way, different scenarios have been analyzed, considering that the Campus hourly thermal and electric load profiles are very variable, and a market analysis has been done in order to choose the best and most suitable technology as occasion may require. The environmental impact of the new installation is an other important aspect that has been considered in order to estimate the avoided CO2 tons, in accordance with the limits defined by the Kyoto Protocol, by utilizing the solar technology and the cogeneration system in place of the pre-existent traditional boiler. From the economic point of view, the article reports the investment

analysis in order to evaluate the payback period and the net present value; the analysis considers both the fixed (initial investment) and variable (operating and maintenance) costs.

Conclusions

In conclusion, it's important to remember that the projected generation plant can be considered as an excellent example of energy saving in buildings; then, it represents an advanced case study and an interesting pilot laboratory to be considered as a reference application in the cogeneration field: in the next years other similar applications could be realized in order to promote energy saving projects, that have to be optimized from the energetic and economic point of view.

References

M. Reini, M. Casisi, (2006), "Energy Production through Distributed Urban Cogeneration Systems: preliminary definition lay-out, units size and operation", ASME ATI 2006 Conference on Energy: production, distribution and conservation, Milan, Vol. 1, pp. 249-261

M. Di Veroli, F. Fraticelli, L. Rubini, (2006), "Impianto ibrido termico-fotovoltaico per la Facoltà di Architettura Valle Giulia nel Progetto di Solarizzazione de La Sapienza", 61st ATI Annual Congress, Perugia, Vol. 1, pp. 3-7

A. Calabria, M. Di Veroli, L. Rubini, (2006), "Software per la scelta ottimale di collettori solari termici a bassa temperatura", 61 st ATI Annual Congress, Perugia, Vol. 1, pp. 23-27

- A. Croci, S. Mariani, B. Suatoni, (2006), "Impianti solari termici a circolazione naturale per produzione di acqua calda sanitari", *61st ATI Annual Congress*, Perugia, Vol. 1, pp. 35-41
- C. M. Bartolini, C. Brandoni, F. Caresana, L. Pelagalli, (2006), "Valutazioni tecnico-economiche di sistemi di cogenerazione con microturbine a gas", *61st ATI Annual Congress*, Perugia, Vol. 2, pp. 639-644
- D. Di Santo, (2005), "Lo stato della generazione distribuita in Italia", *Ecomondo 2005*, Rimini, Vol. 2, pp. 639-645
- S. Campanari, (2005), "Evoluzione delle tecnologie cogenerative", *Ecomondo 2005*, Rimini, Vol. 2, pp. 646-654
- P. G. Charalambous, G. G. Maidment, S. A. Kalogirou, K. Yiakoumetti, (2006), "Photovoltaic Thermal PV/T Collectors: A Review", *Applied Thermal Engineering Journal 27 (2007)*, Elsevier, pp. 275-286
- H. I. Onovwiona, V. I. Ugursal, (2004), "Residential cogeneration systems: review of the current technology", *Renewable and Sustainable Energy Reviews 10 (2006)*, Elsevier, pp. 389-431
- L. Colombo, F. Armanasco, O. Perego, (2006), "Experimentation on a cogenerative system based on a microturbine", *Applied Thermal Engineering Journal 27 (2007)*, Elsevier, pp. 705-711