# Accepted Manuscript


An innovative trigeneration system using the biogas as renewable energy

Grazia Leonzio

PII: S1004-9541(17)30823-6
DOI: doi:10.1016/j.cjche.2017.11.006
Reference: CJCHE 968

To appear in:

Received date: 2 July 2017
Revised date: 23 September 2017
Accepted date: 6 November 2017

Please cite this article as: Grazia Leonzio , An innovative trigeneration system using the biogas as renewable energy. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Cjche(2017), doi:10.1016/j.cjche.2017.11.006

Energy, Resources and Environmental Technology

# An innovative trigeneration system using the biogas as renewable energy

Corresponding author: Grazia Leonzio[1]

[1]Department of Industrial and Information Engineering and Economics, University of L'Aquila, Via Giovanni Gronchi 18, 67100 L'Aquila, Italy

email: grazia.leonzio@graduate.univaq.it; grazia.leonzio@virgilio.it

telephone number: +39 340 1537804

**Abstract**

One of the way to decrease the global primary energy consumption and the corresponding greenhouse gas emissions is the application of the combined cooling, heating and power generation technologies, known as trigeneration system.

In this research an innovative trigeneration system, composed by an absorption heat pump, a mechanical compression heat pump, a steam plant, a heat recovery plant is developed. The low temperature heat produced by the absorption chiller is sent to a mechanical compression heat pump, that receives the process water at low temperature from the heat recovery plant and bring it to higher temperatures. The trigeneration system is feed by biogas, a renewable energy. A design and a simulation of the system is developed by ChemCad 6.3® software. The plant produces 925 kW of electrical energy, 2523 kW of thermal energy and 473 kW of cooling energy, by the combustion of 3280 kW of the biogas. The P.E.R. is equal 1.04 and a sensitivity analysis is carried out to evaluate the effect of the cooling capacity, the produced electrical energy and the process water temperature. The first has a negative effect, while other parameters have a positive effect on P.E.R. Compared to a cogeneration system, the trigeneration plant produces the 28% higher of power and the 40% lower of carbon dioxide emissions. An economic analysis shows that the plant is economically feasible only considering the economic incentives obtained by the use of heat pumps and steam plant at high efficiency. Saving 6431 $t \cdot a^{-1}$ corresponding to 658000 euro/year of incentives, the plant has N.P.V. and P.B.P. respectively equal to 371000 EUR and 4 year. Future works should optimize the process considering the cost and the energetic efficiency as the two objective functions.

**Keywords:** Trigeneration system, Biogas, Energy efficiency, Process simulation, Heat pumps, Environmental analysis.