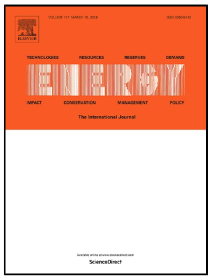
Accepted Manuscript



Allocation of economic costs in trigeneration systems at variable load conditions including renewable energy sources and thermal energy storage

Eduardo A. Pina, Miguel A. Lozano, Luis M. Serra

PII:	S0360-5442(18)30492-4
DOI:	10.1016/j.energy.2018.03.083
Reference:	EGY 12541
To appear in:	*Energy*
Received Date:	30 November 2017
Revised Date:	15 March 2018
Accepted Date:	16 March 2018

Please cite this article as: Eduardo A. Pina, Miguel A. Lozano, Luis M. Serra, Allocation of economic costs in trigeneration systems at variable load conditions including renewable energy sources and thermal energy storage, *Energy* (2018), doi: 10.1016/j.energy.2018.03.083

Allocation of economic costs in trigeneration systems at variable load conditions including renewable energy sources and thermal energy storage

Eduardo A. Pina, Miguel A. Lozano, Luis M. Serra

GITSE – Aragon Institute of Engineering Research (I3A), Department of Mechanical Engineering, Universidad de Zaragoza, Calle María de Luna 3, 50018, Zaragoza, Spain
epina@unizar.es

Abstract

As energy systems become more and more complex, the issue of the appropriate way to allocate the cost of the resources consumed increases because the way in which allocation is made directly affects the prices of the products obtained and, thus, the consumers' behavior. Thermoeconomics has been used to explain the cost formation process in complex energy systems. The thermoeconomic analysis of a trigeneration system including renewable energy sources (RES) and thermal energy storage (TES) was developed to determine the energy, capital, and total unit costs of the internal flows and final products. This work addresses issues not yet deeply studied in thermoeconomics, namely the joint production of energy services in dynamic energy systems and the incorporation of TES, RES (photovoltaic panels) and a component with different products for each operation mode (heat pump producing heat in heating mode and cooling in cooling mode). The interconnection between charging and discharging periods through the TES units was explored, allowing the discharged flow to be traced back to its production period. The trigeneration system resulted more profitable than the reference system, with total cost savings of 9,942 €/yr, which was translated into the lower annual total unit costs of the final products.

Keywords

Cost allocation, energy systems, renewable energy, thermal storage, thermoeconomics, trigeneration.

1. Introduction

Motivated by the increasing concern about global warming caused by greenhouse gas emissions and depletion of fossil fuel resources, the transition to alternative energy systems is currently underway. In trigeneration systems, electricity (and/or mechanical energy), heating, and cooling are produced from the same primary energy source by combining cogeneration with a thermally activated technology (TAT), such as an absorption chiller. In this way, the thermal coverage can be extended to meet refrigeration demands. Nevertheless, many alternative devices may be incorporated in various existing configuration modes [1–4]. Trigeneration systems benefit from the energy integration of the processes in their equipment, achieving higher energy efficiency, lower primary energy consumption, lower unit cost of the final products, and lower environmental burdens relative to conventional energy systems [5–8].

The optimal design of trigeneration systems must address two fundamental issues [9,10]: the synthesis of the plant configuration (installed technologies and capacities, etc.) and the operational planning (strategy concerning the operational state of the equipment, energy flow rates,