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AESMT '21

Proceedings of short papers

Volume 3

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MAIN TOPICS

ALTERNATIVE ENERGY SOURCES
• Solar and Hybrid Thermal Systems
• Solar Photovoltaic Systems
• Solar Radiation Measurement and Sun-tracking
• Geothermal Energy Applications
• Phase Change Materials (PCM) Applications
• Wind Energy
• Biotechnologies
• Hydrogen Energy
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F O R E W O R D

The Fourth International Scientific Conference "Alternative Energy Sources, Materials & Technologies AESMT'21" was held between 14th and 15th June 2021 in Ruse, Bulgaria. Representatives of 34 countries (Austria, Bulgaria, Chile, China, Cyprus, Egypt, France, Germany, Greece, Hungary, India, Iran, Iraq, Israel, Italy, Kazakhstan, Kosovo, Kuwait, Latvia, Lebanon, Lithuania, Macedonia, Nigeria, Norway, Portugal, Romania, Russia, Serbia, Spain, Tajikistan, Turkey, United Kingdom, and Yemen) sent their works to the conference. Selected reports (69 works) have been published as short papers in the proceeding of the conference.

It is my pleasure to be an editor of the presented short papers, which focus on new international scientific results in the field of Alternative Energy Sources, Materials and Technologies (Solar and Hybrid Thermal Systems, Solar Photovoltaic Systems, Solar Radiation Measurement and Sun-tracking, Geothermal Energy Applications, Phase Change Materials (PCM) Applications, Wind Energy, Biotechnologies, Hydrogen Energy, Ocean/ Tidal Energy, Energy Materials Science, Mechanical Engineering and Technologies, Electrical Engineering, Low-Carbon Technologies, Energy Efficiency).

Prof. Aleksandar Georgiev, PhD (European Polytechnic University, Pernik, Bulgaria)

Chair of the AESMT'21 conference

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ELECTRICAL ENGINEERING

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ENERGY EFFICIENCY

Alternative Energy Sources, Materials & Technologies (AESMT'21), Volume 3, (pp. 13-14) 2021
ALTERNATIVE ENERGY SOURCES, Solar and Hybrid Thermal Systems

Influence of different parameters of solar systems on building exergy optimization

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Exergy can be used for the optimization of energy losses in different energy system. Exergy is also used for design and performance evaluation of energy systems. In this paper it is investigated the residential building, located in Serbia, with solar systems (photovoltaics and solar collectors) and different space heating. Exergy optimization was performed with the aim to determine the maximum value of the generated electricity. Also, environmental analysis of applied solar systems was performed. The residential buildings with different parameters of photovoltaics and domestic hot water (DHW) system are investigated. The buildings were simulated in EnergyPlus software.

Keywords: Exergy, photovoltaic, solar collector, building, optimization

INTRODUCTION

Performances of energy-related engineering systems are evaluated primarily by using the energy balance. In recent years, the exergy concept has gained considerable interest in the thermodynamic analysis of thermal processes [1]. The exergy analysis is a method based on the Second law of thermodynamics and it quantifies the loss of efficiency in a process that is due to the losses in energy quality.

At the other side, due to increasing demand for energy and rising cost of fossil fuels, solar energy is considered an attractive source of renewable energy that can be used for electricity generation and domestic water heating in residential buildings. Photovoltaic (PV) technology is an attractive option for clean and renewable electricity generation because it represents the direct conversion of solar radiation into electricity. Electrical energy can be treated as totally convertible to work, so the electricity is pure exergy. Also, heating water consumes nearly 20% of total energy consumption for an average family [2]. So, solar water heating systems are the cheapest and most easily affordable clean energy available to homeowners that may provide most of hot water required by a family. Using PVs and solar collectors together, represent a great opportunity for reducing the consumption of primary energy in residential buildings.

Many scientists are investigated different exergy calculation during the past 20 years [3-6].

This paper reports investigations of the exergy optimization, with the major aim to determine the optimal size of PV panels and solar collectors on the roof, in order to achieve the maximum amount of exergy. On that way, it can be obtain the maximum value of exergy efficiency for installed solar systems, and primary energy consumption will be minimized. The residential building with variable PV cell efficiency, variable hot water consumption and variable temperature in domestic hot water system is analyzed.

The investigated building was located in Kragujevac, Serbia. The building is designed with PV panels and solar collectors installed on the roof. Generated heat energy is used for domestic hot water (DHW) heating. Electricity generated by the PV may be used for space heating, cooling, lighting, and electric equipment. Building is analyzed for three different space heating system – electric, gas and district heating.In this paper, the EnergyPlus, Open Studio plug-in in Google SketchUp, Hooke-Jeeves algorithm and Genopt were used for simulation and optimization [7].

RESULTS AND DISCUSIONS

In the first part of investigations, hot water temperature is varried. The first case was the hot water temperature 50 ^{o}C, the second case was the hot

water temperature 60ºC and the third case was the hot water temperature of 70 ºC, respectively. Results obtained by exergetic optimization shows that with the increasing of hot water temperature, there is increase in exergy efficiency (Fig.1).

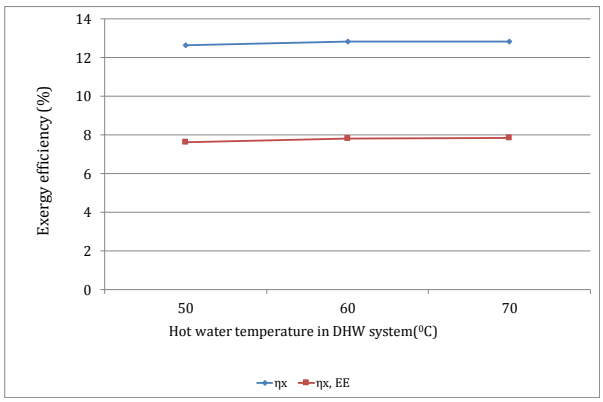

Fig.1. Exergy efficiency in building with different hot water temperature

Area of installed PV panels was the same for all different heating systems, i.e. 79.6 m^2 of PV panels and 1 m^2 of solar collector. On this way, building generates 169.3 GJ of primary energy, and building with gas heating system is positive net energy building.

Second part of investigations referred to variable cell efficiency of installed PV panel, i.e. the analyzed cases was 12%, 14% and 16%. Area of installed PV panels was the same as previous - 79.6 m^2 of PV panels and 1 m^2 of solar collector. This value is optimal value for energy generating by solar systems. With the increasing of PV cell efficiency, there is a significant increase in exergy efficiency (Fig.2).

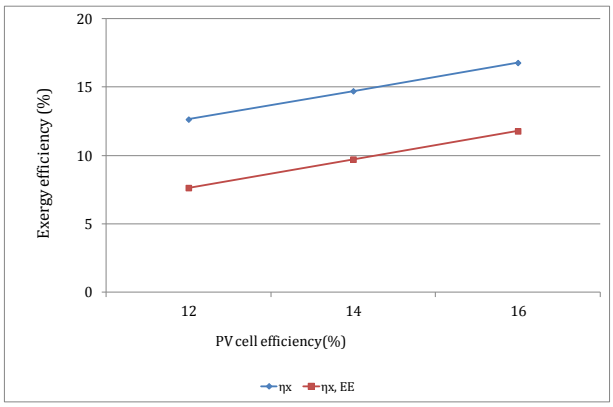

Fig.2. Exergy efficiency for building with defferent cell efficiency

In the buildings with gas heating system, concept of PNEB can be achieved.

Third part of investigation referred to variable hot water consumption. Area of installed solar systems was the same as in previous cases, and exergy efficiency increased with increased hot water consumption. Building with gas heating system, was positive-net energy buildings (PNEB).

CONCLUSIONS

In this paper, an exergy optimization of Serbian buildings is present, with the aim to determine the optimal area of installed solar systems.

It can be concluded that installed systems can generate a large amount of energy, and on that way,it can be achieved a significant values of exergy efficiency. Concept of positive-net energy building may be achieved in the buildings with gas heating system.

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