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A SHORT REVIEW REGARDING RENEWABLE RESOURCES EXPLOITATION IN TODAY'S EUROPEAN BUILDINGS CONSTRUCTION

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Abstract

Renewable resources are important sources of energy with increasing interest recently, given that the current activities of the population, but also the expansion of industries, are irreversibly affecting exhaustible energy. Currently renewable resources are not sufficiently exploited, hence they are still of great interest to researchers, engineers and builders.
This paper aims to provide an overview of the technologies based on renewable resources in nowadays construction. Given the impossibility of recovering consumed energy, the innovative solution for reducing energy use and its storage is the development of novel solutions of integration and involvement of renewable resources in construction. This should be performed from the design stage, construction using renewable materials, recycled or with minimal energy consumption, and up at the stage of building entirely green houses. Among the technologies based on the use of renewable energy resources used in construction, solar water heating systems, photovoltaic systems, heat pumps or heat recovery systems are frequently used.
By involving these renewable resources in construction, the aim is to reduce energy consumption by stimulating primarily energy production and improving the following main sectors: economic, ecological, medical and last but not least the considerable improvement of personal comfort, thus respecting the rules imposed by the European Union in 2020 on operational energy conservation.

Key words*: buildings, renewable energy, renewable resources.*

INTRODUCTION

Nowadays, buildings have a high environmental impact on the society not only in terms of land occupation, but also of water, electric and thermal energy and materials consumption in Europe. This is the main reason why the builders and engineers have started to develop the green buildings, which are using renewable energy including solar energy, wind energy, biomass and geothermal energy. Choosing green buildings aims to reduce the emission and pollution in order to create sustainable buildings or even zero energy buildings.
However, the possibility of applying renewable energy in buildings construction varies significantly, depending on the renewable energy types, energy quantification strategy, geographical area, climates differences or/and building characteristics. Renewable energy systems have started to be used for improving electric and thermal performance in sustainable buildings, replacing energy obtained from fossil fuels and nuclear energy. Most frequently used renewable energy systems are photovoltaic, evaporative cooling, wind turbines and solar heating systems (Albatayneh et al., 2018).
The aim of this paper is a short review regarding the use of renewable resources in buildings construction.

MATERIALS AND METHODS

The present paper represents a scientific literature review from public domain. The relevant websites consulted were: Science direct, PubMed, Mendeley, Google Scholar, Research Gate, NCBI (The National Center for Biotechnology Information). In this study, only the research articles from the last few years, starting with 2018 were selected. For this short-review were consulted more than 50 papers, the most relevant to the subject being selected.

RESULTS AND DISCUSSIONS

The use of renewable energy resources in buildings is a large domain with various applications as will be presented further.

Solar energy systems in buildings

Solar energy in buildings could be used as passive or active solar systems. The passive solar systems use the solar energy for daylighting, heating, cooling, distillation for drinking water, water pumping. More examples of passive solar heating systems and passive solar cooling systems were presented by Chel and Kaushik (Chel and Kaushik, 2018).

A positive influence of different variants of photovoltaic systems on the energy performance indicators as primary energy indicator, delivered energy indicator, and the CO2 emissions was demonstrated by Marchwinski (Marchwinski and Kurtz-Orecka, 2020) in the case of a nursery building from Warsaw. More, from the economic point of view, integrated photovoltaic systems used as building envelope material for the whole buildings facades with various direction or orientation and flat roofs, is a favourable option due to the fact that it could reimburse the investment costs and could be seen as a source of income for the building (Gholami and Røstvik, 2020). Moreover, the integration on a prefabricated low-energy house of photovoltaic/thermal roof systems coupled with a water-to-water heat pump has a positive effect on the annual electrical and thermal performance (Rounis et al., 2018). Also, positive effects and high energetic performance were demonstrated in the energy renovation of an existing building from Cyprus, using building integrated photovoltaic/thermal systems and a corridor type double façade system (Theokli et al., 2021).

A solar cooling system application in cooling and domestic hot water production was examined in summer Mediterranean climate for residential buildings. The optimization process of this kind of cooling system showed the possibility to work up to 83% renewable energy (Bilardo et al., 2020).

Many design options for building integrated photovoltaic systems on roofs and facades showed the positive impact on the German energy system (Kuhn et al., 2021).

Studies show that, in the last period, in Germany, Denmark, Sweden the interest even in seasonal thermal energy storage increased, and in this direction were developed and installed seasonal thermal energy storage systems in solar district heating, in order to offer a balance between summer-winter temperature variations (Ochs et al., 2020). Of great interest is the possibility of a building to obtain positive energy, becoming a positive energy building which could sustain house operation and activities and even to sustain charging electrical vehicles, which are more and more commune.

Wind energy systems in buildings

Wind energy in buildings could be used also as passive systems (passive cooling) or active systems (wind turbines), the latest being able to be integrated into the buildings, also. Several researchers and engineers have started to develop many hybrid renewable energy systems. In one example was studied the potential of photovoltaic and battery systems with additional micro-generation wind turbines (10.5 kW) in two countries from Central Europe (Germany and Czech Republic) to supply electricity of residential users (Camargo et al., 2019).

In a study conducted by Calise and colleagues, in 2020, a hybrid renewable system was developed, consisting of building integrated photovoltaic panels coupled with small size wind turbines (20 kW) and double-stage heat pumps, for a hotel building from Italy. This hybrid system offers the possibility to enhance the stability of the renewable energy production (Calise et al., 2020).

Geothermal energy systems in buildings

Geothermal energy is a renewable resource energy involved in heating and/or cooling of houses (even greenhouses). Geothermal energy systems could be applied as heat pumps, heat pipes and in-well heat exchangers, but the most found in buildings is as heat pipes. The soil temperature transferred by water or air could also be used for cooling in the summer and heating in the winter (Yüksek and Karadağ, 2021).

A geothermal system containing two ground-coupled heat pumps was developed for an office building in Hamburg, as a heat source, heat sink or for cooling the building (Duus and Schmitz, 2021). Also, geothermal energy was used as a heat source for a neighborhood of existing

residential buildings from Netherlands, (Pinto and Carrilho da Graça, 2018).
A hybrid renewable energy system, based on geothermal and solar energy, in a building from Portugal, was implemented by Palmero-Marrero and colleagues to diminish energy consumption and increase the building energy efficiency (Palmero-Marrero et al., 2020).

Hydrogen energy systems in buildings

Hydrogen energy could be exploited as well as the renewable resources discussed above for heating buildings, but also for cooking or generating electricity. Hydrogen energy is a renewable resource produced from solar, wind or geothermal resources. So, in this manner many hybrid systems were developed.
The energy efficiency of an office building located in Greece was increased by adopting a hybrid system to cover the electrical needs of the building functionality, for heating and cooling. Primarily, the energy is collected from solar panels and wind generators. So, this hybrid system converts the excess energy (the unconsumed energy by office buildings) to gaseous hydrogen which could be used as an energy storage system (Peppas et al., 2021).
In a study conducted by Lokar and Virtič was studied the possibility of hydrogen integration with photovoltaic and battery storage systems in order to cover the energy needs in residential buildings (Lokar and Virtič, 2020).

Biomass energy systems in buildings

Biomass, also, is a renewable resource, produced from organic matter and biological mass as wood, oilseeds plants, fiber plants, carbohydrate plants, animal and urban wastes. The biomass energy systems are used to produce electricity and as biofuels.
In this direction, for renovated and non-renovated residential buildings and multi-family houses a hybrid system (solar-biomass system) was implemented by Palomba and colleagues in 2020, for heating, cooling and electricity in various European areas and climates as Madrid, Berlin and Helsinki (Palomba et al., 2020).
The vegetable fibers as barley straw and olive tree waste mixed with sodium silicate solution were studied to create panels for buildings thermal insulation in two different climatic areas as Bari and Bilbao (Liuzzi et al., 2020).
Recently, more and more renewable multi-energy systems have been adopted, due to the possibility of their efficient implementation in buildings and their help in the fight against decarbonisation.
As could be remarked, solar energy is more often used in buildings, both residential and institutional buildings, than other renewable energy resources.

CONCLUSIONS

This review on European research studies indicated that buildings are responsible for a high percentage of global carbon dioxide emissions, therefore adoption of renewable energy and materials in buildings construction or restoration (even historical and heritage buildings), converts construction industry into a sustainable domain.
In the last years, many possibilities of using renewable energy resources in buildings were developed with remarkable results as presented. Nowadays, construction engineers and architects are interested in designing buildings integrating renewable resources with lower costs and higher quality.

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