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LIFE CYCLE ASSESSMENT (LCA) OF AN INNOVATIVE SOLAR-BIOMASS ENERGY SYSTEM IN CONTINENTAL CLIMATE

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1 SUMMARY

Hybrid energy systems applied to buildings are an effective solution to increase the share of energy produced by renewable sources to satisfy both thermal end electrical energy demand. In this study, the environmental impact of an innovative energy system based on the use of solar energy and biomass for heating, cooling, DHW, and electricity production was evaluated through life-cycle assessment (LCA) and compared to a reference standard system to be used in a multi-family house building located in a continental climate.

Keywords: hybrid system; solar and biomass energy; life-cycle assesment; environmental impact; energy efficiency;

2 INTRODUCTION

The building sector is well known to be one of the main responsible actors of energy usage accounting for almost 40% of the overall energy consumption and gas emission into the atmosphere (IEA 2019). In this case, the combination of energy efficiency in buildings with the integration of renewable sources is fundamental to achieve deep decarbonisation of the grid. To provide energy for heating, cooling, domestic hot water, and electricity, hybrid energy systems have the potential to increase the share of renewables and provide higher flexibility to energy systems to be adapted in a wider range of climates. In the framework of the EU-funded H2020 project SolBio-Rev, an energy system based on the use of solar energy and biomass was developed to increase the share of renewable sources for different building typologies in different climates. The potential of this proposed system was investigated in (Palomba et al. 2020) and (Palomba et al. 2021) defining the optimal system configuration for each climate to have a perspective of a 100% renewable future scenario for both residential and non-residential sectors. In this study, the environmental impact of the proposed hybrid system was evaluated through life-cycle assessment (LCA) in a residential building located in a continental climate and compared to a reference standard system.

3 METHODOLOGY

The innovative SolBio-Rev system considered in this study is shown in Figure 1. The system configuration was optimized for a continental EU climate and is made of the following components: Solar collectors with integrated thermoelectric generators (TEGs); short-term storage and thermal buffer tank; reversible heat pump/ORC; biomass boiler; and dry cooler. The SolBio-Rev system was compared to a standard reference system based on air-water heat pump (for heating, cooling), a tank with an electric heater (for DHW) and PV panels. The energy consumption and the sizing of the two systems were calculated assuming that the reference building is located in Nuremberg. In this case, a multi-family house from the project iNSPiRe (Dipasquale et al. 2014) was used as a reference for the dimension. The LCA methodology follows the steps defined in UNE-EN ISO 14040:2006 standard (ISO 14040 2006). This study was focused on the system and not the building using as a functional unit 1 kWh of consumed energy with a lifespan of 30 years. For the life cycle inventory (LCI), data were directly provided by the producers of the different types of equipment of the SolBio-Rev systems and from available technical datasheets.

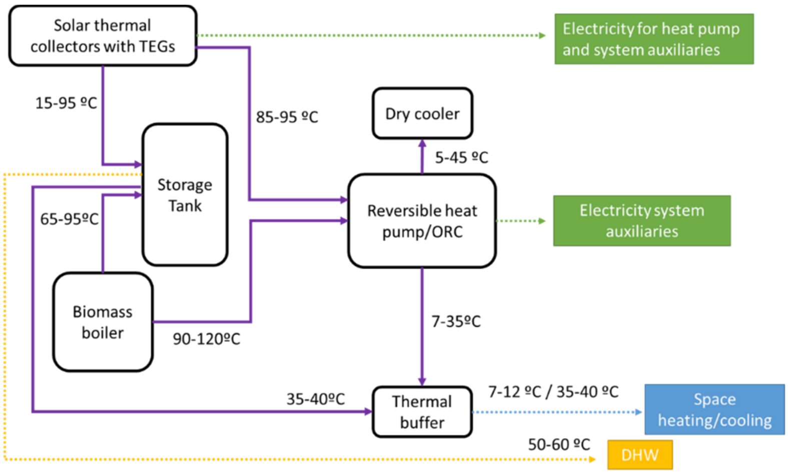

Figure 1. Schematic of the SolBio-Rev system in continental climates

The impact assessment was based using the methods ReCiPe and global warming potential (GWP), taken from the database Ecoinvent (Frischknecht et al. 2005).

4 RESULTS AND CONCLUSIONS

This section will present the results of the LCA for the two systems and the conclusion of this study.

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7 CONFERENCE TOPIC

Renewable Heating and Cooling including high temperature applications; Solutions for Energy Efficiency; Life Cycle Assessment