

# Renewable Energy Systems 2020

Maria Vicidomini

Department of Industrial Engineering, University of Naples Federico II, 80125 Naples, Italy;  
maria.vicidomini@unina.it

In the last few years, several states have experienced a significant growth of the global energy demand. The simultaneous increase of greenhouse gas emissions is also associated with an increase in meteorological catastrophic events in numerous areas of the world. In this framework, several countries have agreed to develop a novel sustainable energy pattern and to accomplish it with all the actions required to limit the rise of the average temperature of the Earth. This goal can be achieved through different strategies: developing novel efficient energy conversion systems, promoting energy efficiency and a more conscious use of energy, and promoting the use of novel and innovative renewable energy technologies. This effort has led to a number of positive effects, such as energy diversification, reduction of pollutant emissions, and the development of local green economies. On the other hand, the large non-programmable amount of renewable energy delivered to electric grids poses severe issues in terms of the management of excess energy and balance between demand and supply. This phenomenon is determining an increasing cost of the management of electric grids, which is typically transferred to the final consumer. In this context, the Special Issue “Renewable Energy Systems 2020” aims at collecting the most significant and recent studies dealing with the integration of renewable technologies into new or existing water, electricity, heating, and cooling networks. In this editorial, the collected papers analyzing the possible utilization of renewables for multiple purposes (power production, heating, cooling, water management, transport), aiming at increasing the diffusion of such sources, are summarized.



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## 1. Introduction

In recent years, the future availability of non-renewable fuels (such as natural gas, coal, oil) and drinkable water scarcity, particularly in coastal/island and semi-arid areas, are becoming severe issues [1]. Therefore, sustainable energy plants, based on renewable energy technologies, such as geothermal, wind, solar, biomass, etc., should be taken into account, in order to achieve eco-friendly development. In this framework, EU (European Union) nations plan to cover by 2030 at least 32% of the total energy consumption by renewable energy sources and to reduce greenhouse gas emissions by 80–95%, when compared to 1990 levels, by means of a 100% renewable electric energy system [2].

Considering this background, the studies collected in this Special Issue cover the following topics: (i) the analysis of plants based on photovoltaic (PV) panels and battery energy storages, investigating the use of electric vehicles [3], the coupling of these systems with a single hydropower plant for renewable energy communities [4], the assessment of the impacts of these plants on the effectiveness of electric distribution grids [5], their economic evaluation in residential applications for islands not electrically connected to the mainland [6], and the development of novel control strategies to address voltage disturbance in transmission systems connected with PV systems [7]; (ii) the economic analysis of a novel floating offshore wind structure, built with concrete [8]; (iii) the power to synthetic natural gas (PtSNG) plants to store intermittent renewable sources [9]; (iv) a low-cost secured distributed Internet of Things (IoT) system for monitoring and controlling appliances/devices connected in a polygeneration microgrid supplied by renewable technologies [10] as well as the optimization of both independent energy systems, ensured by

the integration of the thermal/electric energy systems and renewable energy systems [11], and of building energy consumption by means load forecasting methodologies [12].

## 2. Research Topics Represented in This Special Issue

A total of 10 papers were selected for this Special Issue. The main ideas of these papers are briefly reviewed in the following subparagraph in order to summarize the main outcomes of the presented researchers.

### 2.1. Plants Based on Photovoltaic (PV) Panels and Battery Energy Storages

Petrusic and Aleksandar Janjic [3] proposed a solution to eliminate the adverse effects of uncontrolled electric vehicle charging, for hybrid electric vehicle charging stations coupled with the small-scale PV fields and battery energy storages. Their method, allowing one to perform a detailed calculation of renewable energy share coming from energy stored in the battery, is based on a multicriterion optimization of the charging/discharging schedule of the battery and electric vehicle charging level. They aim at reducing the charging costs and battery degradation, and at maximizing the solar renewable energy source. Adapting their method for a suitable case study, the results show that in the case of maximizing only the electric vehicle charging energy originating from renewable sources, the solar plant produces 86.7% of the required energy. Moncecchi et al. [4] developed a mathematical model to find the optimal portfolio for an energy community, considering the energy demand and the local source availability. The solution of the optimization problem, the Shapley value, was used, as a known method able to allocate costs and profits of shared infrastructures as well as to distribute benefits among community members. The model was applied to a real case study, related to the low-voltage grid of Chiou, part of the village of Porossan in the municipality of Aosta. The resulting optimal energy community configuration is based on two PV power plants and one hydroelectric plant, including 14.4 kWp of PV generators and 20 kW of hydroelectric generators, respectively. This configuration was economically viable from the point of view of the investors, with a profitability index of 1.36, and, at the same time, it is aligned with the social purposes of the renewable energy community. Mancini et al. [5] assessed the impact of electric vehicles on the design and effectiveness of electric distribution grids with distributed generation. The aim of the work is the analysis of the technical limitations of the current networks and how transformers and lines will be able to address the increasing use of electric vehicles. The critical issues were observed, with special attention paid to urban networks rather than rural ones. Thus, future significant investments are required to achieve the full availability of high-powered charging stations. The authors state that the increasing power demand from electric vehicles represents a critical issue for the grid, mainly because their highest demand occurs during the typical consumption peaks of residential customers. Electric demand-side management strategies, considering a change in the behavior and use of electricity of customers, were proposed. Pereira et al. [6] presented an economic assessment of solar-powered residential battery energy storage systems on Madeira to understand if energy storage devices under the current legislation and energy tariffs are profitable. In this work, the data of one year-long solar PV production and electricity demand measurements, considering two different battery control strategies, are used. The obtained results confirm the current highlights of other similar studies, i.e., that the storages for self-consumption only are not profitable until the average price of energy storage devices becomes lower than 256 €/kWh (including the inverter price). Kim et al. [7] propose a novel droop control strategy for setting a dead band value that varies with time in order to address the voltage problem against disturbance in a transmission system connected with a utility-scale PV system. Simulation results showed that an adaptative dead band, rather than a fixed one, is able to perform a flexible system operation against disturbance.

## 2.2. Novel Floating Offshore Wind Structures

Baita-Saavedra et al. [8] performed an economic analysis of a novel floating offshore wind structure, consisted of concrete, that the authors considered as the path towards the future of floating offshore renewable energy technologies. The proposed technique, explaining in detail the cost to build the platform, is applied to a possible farm of 500 MW located in Portugal. Four economic scenarios taking into account different electric tariffs and capital costs are combined. The results show that economic feasibility is obtained for a farm with an electric tariff of 150 €/MWh and 6% of capital cost and an electric tariff of 150 €/MWh and 8% of capital cost, resulting in values equal to EUR 1657 M and EUR 1365 M, respectively.

## 2.3. Power to Synthetic Natural Gas (PtSNG) Plants

Perna et al. [9] investigated the technology of power to synthetic natural gas (PtSNG) plants as method to deal with the surplus of renewable sources on the electric grid. The aim of their study is to analyze the energy storage potential and the technical feasibility of the PtSNG concept considering different plant sizes (1, 3, and 6 MW). They also analyzed the ratio between the renewable electric energy supplied to the plant and the total electric energy generated by the renewable plant, based on a 12 MW wind farm. The analysis was carried out by a dynamic model and a thermochemical and electrochemical model, allowing one to predict the plant performance in steady state. The resulting annual overall efficiencies are in the range of 42–44%. The plant load factor, i.e., the ratio between the annual chemical energy of the produced SNG and the plant capacity, is equal to 60.0%, 46.5%, and 35.4% for 1, 3, and 6 MW PtSNG sizes, respectively.

## 2.4. Other Topics

Other topics regard the following works. Martínez-Martínez [10] presented a low-cost secured distributed Internet of Things (IoT) mechanism for monitoring and controlling devices in microgrids including renewable energy sources. The proposed mechanism provides real-time access to each device connected to the system for monitoring and control purposes, allowing the user to visualize real-time power consumption/generation data with a graphical user interface. Here, two renewable energy sources are considered: a micro-wind turbine and a PV array, both with their respective charge controller. This application was clearly considered useful mainly for security purposes, alerting the user when a device reaches a defined threshold power consumption. Stevanato et al. [11] showed that an open-source multi-energy system optimization tool effectively allows one to obtain the lowest-cost optimal solutions for the generation and comparison of multiple integrated thermal and electric energy system configurations for off-grid contexts. Their tool was applied to the Chilean village of Toconao, proposing a configuration in which thermal loads and electrical loads can be satisfied by a completely integrated system, consisting of PV panels, an electric storage system, a back-up diesel generator, solar thermal collectors, a hot-water storage tank, and back-up LPG (Liquefied Petroleum Gas) boilers. In this configuration, a levelized cost of energy of 0.090 USD/kWh and a renewable penetration of 93.7% are reached. Moradzadeh et al. [12] proposed two methods to predict the cooling and heating load of a residential building. In particular, multilayer perceptron (MLP) and support vector regression (SVR) are the proposed applications based on artificial neural networks and machine learning, respectively. Generally, these methods are used to produce a linear mapping between input and output variables, that were applied to the investigated issue, i.e., the energy consumption of the residential buildings, and are represented by the technical parameters of the building and the related heating and cooling loads, respectively. The results show that the MLP and SVR methods predict the heating and cooling loads with a maximum of R equal to 0.9993 and 0.9878, respectively.

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