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Climate change mitigation by means of sustainable development of energy, water and environment systems

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ABSTRACT

Integrated approaches in energy, water and environmental systems can improve the climate change reduction process. New scientific developments and advancements have provided numerous opportunities in the comprehensive human progress direction. In this regard, we have reviewed the 16th Conference on Sustainable Development of Energy, Water and Environment Systems presented in this editorial. Examining recent scientific developments, eight research articles on this special issue are related to eight main topics. The solar energy technology and storage section reviewed the first four articles. These articles include topics such as: 1) advanced technologies to form a new TT PS-TIM window system for adaptive daylight control and advanced thermal insulation combination, 2) using experimental data for field testing located in an area with Mediterranean climate conditions, of newly installed FPVS in these areas, 3) possibilities described in short rotation of willow type and energy crop Miscanthus cultivation dedicated to former coal mining areas, 4) using solar and geothermal energy with boiling water purification and reverse osmosis. Furthermore, the following four articles are reviewed in the energy management systems section. These articles include topics such as, 5) deep analysis of facial expression and eye tracking using samples of non-expert participants to determine emotions caused by electricity consumption graphs in different time scales, 6) studying the electric vehicles (EVs) main life cycle activities using an exploratory survey and their potential inequities, 7) the biodiesel fuel production from waste sardine fish oil using methanol, ethanol or isopropanol and a solid heterogeneous catalyst prepared using eggshell and copper oxide [CaCu(OCH3)2] is analyzed. Finally, 8) biotechnology microalgae have been studied in 70-litre vertical photobioreactors that use unsupplemented secondary brewery wastewater as growth media using two collecting cells mechanically methods under hydrothermal (autohydrolysis) and dilute acid hydrolysis.

The 2021 SDEWES conferences special issue editorial introduction

Today, we are witnessing integration in the sustainable development and coordination sectors and scales perspective in scenarios that aim to avoid increasing global warming. Addressing these existing gaps to achieve this goal can ensure a safer world in terms of climate and reduce about 10 tons of carbon per year through using new energy with renewable energy solutions. In this regard, net zero goals are increasing every day in all countries of the world, and local and regional actors and national policies play a vital role in renewable energy establishment and integration [1]. On the other hand, considering the interactions network between the Sustainable Development Goals (SDGs) and the global climate, urgent and deliberate action is required to use more renewable energy.

The leading years can be crucial for the renewable energies progress orientation and acceleration in a sustainable future. In this regard, the researchers formed a research community from the Sustainable Development of Energy, Water and Environmental Systems (SDEWES) conferences to continue to provide critical scientific guidance in the desired direction by sharing this vision from the 21st-century beginning. The SDEWES research community extensively investigates the most pressing issues, improving the energy systems' efficiency by integrating all the possible opportunities to use the surplus of a resource at the right moment. Such perspectives are critical to sustainable development advancement and lead to the research guidelines formation for electricity, heating, cooling, transportation, water, waste, sewage, buildings, industry, forestry, and agriculture systems. In recent years, research advances have strengthened the scientific knowledge base while advancing sustainable solutions, including those related to renewable energy islands [2,3] and energy systems [4].

The first Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) was held in Dubrovnik in 2002. The SDEWES conference series has provided a forum for worldwide scientists and those interested in sustainability to share the art state, future directions and priorities. One of the coming decades' main issues is to improve efficiencies by integrating various energy systems, using excess from one as a resource in another and at the right moment. Integrating electricity [5], heating [6], cooling [7], transport [8], water [9], buildings [10], waste [11], wastewater [12], industry [13], wood [14] and agriculture [15] systems will be pivotal towards sustainable development. SDEWES has maintained high publishing standards, with

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more than 2100 research articles published in leading journals. In 2021, the 16th SDEWES Conference, held during October 10–15 in Dubrovnik, Croatia, will deliver 700 contributions and more than ten special sessions devoted to various sustainability topics. Energy Conversion and Management has continued cooperating with SDEWES, launching a special issue dedicated to the 2021 Conference. A total of 8 research articles have been published in Energy Conversion and Management-X journal. Research articles prior to this new special issue have been published in previous editorials in the SDEWES research database [16–23]. Such initial contributions will be very constructive in the European Union (EU) strategy policy direction for energy system integration, which is based on a central focus on energy system integration. In addition, research findings from the SDEWES research community have been published in a collection that supports SDG7 on clean energy. This special issue presents the latest SDEWES community research contributions that use the energy, water and environmental systems integration to realize opportunities for a more sustainable future.

Renewable energy for climate neutral islands

The national energy systems transformation towards decarbonization concerning renewable energies can be considered the most urgent worldwide. In this regard, a climate law that requires extensive measures across the continent and islands can promise a binding legal goal of climate neutrality [2]. Therefore, the SDEWES research community is dedicated to guiding researchers to pursue renewable energy futures for island energy systems to achieve synergies based on an integrated approach across energy, water and environmental systems. In this case, it can be said that related solutions for island energy systems have been intensively analysed [24], including integrate smart charging [25], grid interconnection [26], district cooling [27] and hydrogen energy [28].

In this case, Bertheau [29] has used a geographical analysis using clustering and modelling of energy systems and their combination as a solution for the 100 % renewable energy use in the Philippine Islands. Mimika et al [30], used a new demand response model to find the benefits for all stakeholders in the electricity market on lead days by considering the revenues of demand response service providers while reducing operating costs in Algeria as used in Croatia. In another study, Meschede [31] used the energy and water sectors to increase the renewable energy sources use based on demand change and micropump hydraulic storage analysis. Further, the geothermal energy sources integration to convert energy use for wastewater treatment and sludge treatment processes in island systems have been investigated by Di Freya et al [32].

Electrification solutions for island energy systems

Intentionally, the climate neutrality goals in the studied islands are formed based on the opportunities for electrification and their flexibility options that can support the electrification process to these islands. Therefore, researchers in the SDEWES community have focused on specific solutions that can increase electrification opportunities in the various islands' energy systems. In this case, Nastasi et al [33] tested hydrogen and battery storage options that have been compared for hourly electricity storage from PV modules in the five buildings context in an island-based energy system. In addition, Ferrara et al [34], developed a machine learning-based approach with deep residual learning to optimize the nearly zero-energy buildings' energy performance in studying the island-based building. This approach is investigated to analyze a design space with nearly 300,000 alternatives for a multi-family apartment building on Sardinia island. In addition, Lemmens et al [35], examined the renewable energy and health intersection by analyzing a 25.4 kW grid-connected solar system for a rural health centre in the Philippines that reduced electricity costs by about 35 %.

Solar energy technologies and storage

Developing countries mainly generate electricity for their communities by burning coal; on the other hand, energy transmission is a significant challenge. In this regard, energy-generating products can be a promising raw material for producing biofuel and its further use for producing electricity and heat. Thermotropic (TT) materials can be used for the solar energy dynamic regulation and daylight, saving building energy and improving the indoor environment. In addition, transparent insulating materials of parallel slats (PS-TIM) can be used when integrated into a double-glazed window cavity to increase the window system's thermal resistance, which can significantly reduce the building heating energy consumption. Ming et al [36], have conducted a study using advanced technologies to form a new TT PS-TIM window system for adaptive daylight control and enhanced thermal insulation combined. They have proposed thermotropic hydrogels such as hydroxypropyl cellulose (HPC) and poly (*N*-isopropyl acrylamide) (PNIPAm) for incorporation into polymethyl methacrylate (PMMA) laths between double glasses to achieve this goal. Their research optical investigation results will guide the system's further development.

Maraj et al [37], using experimental data from a field test located in a region with Mediterranean climate conditions, uses a newly installed FPVS with an installed capacity of 0.5 MW/s DC. This unit can be considered the largest unit in the world according to its installed capacity and diameter. Their research results include energy efficiency, final efficiency, performance ratio, capacity factor and system efficiency. Furthermore, they indicate a daily period on sunny and cloudy days and provide a clear view of system performance. Merzic et al [38], explained the possibilities and elaborated on the short rotation coppice type willow and energy crop Miscanthus cultivation sustainability dedicated to former areas of coal mines belonging to the largest power utility in Bosnia and Herzegovina, namely JP Elektroprivreda BiH d.d. in Sarajevo. The paper focuses on economic, environmental and social indicator groups used to perform the aggregated economic analysis and the multi-criteria analysis.

Bitew Shumiye et al [39], their research combined a study using solar and geothermal energy with boiling water treatment and reverse osmosis. Their study objectives can be electricity production, advanced boiling and water purification with improved energy efficiency, reduction of wasted heat and cost-effectiveness. In this study, they produce a daily cycle of electricity and charge thermal energy storage with an exergy efficiency of 51.64 %. Furthermore, their results show that the night cycle, boiling water treatment with electricity generation and waste heat output, works with an exergy efficiency of 49.25 %.

Energy Management systems

Today, it can be said that due to the climate change situation, smart home energy management systems [6] help by providing an overview of a household's electricity consumption at the device level using time scaling visualizations [40,41]. In this regard, the electricity consumption charts are visually appealing to release the potential for positive energy transfer participation. Pfeiffer et al [42], have done deep analysis of facial expression and eye tracking with samples of 48 non-expert participants with the determining emotions triggered aim by electricity consumption graphs at different time scales. In this device-level study, participants were randomly divided into one of three groups with power consumption graphs at different time scales at the device level.

Dall-Orsoletta et al [43], identifies the electric vehicles (EVs) main life cycle activities using an exploratory survey, where they occur and the associated potential injustices. They extend the energy principles justice to EV technology through a whole systems approach and show how it may not fully utilize low-carbon energy transport. Their results provide insights into how electric vehicles can be implemented through smart grids and vehicle-to-grid developments, global justice as a

consequence of greenhouse gas (GHG) emissions and global resource depletion, and restorative justice through laws and standards that require environmental restoration is helping. Sharma et al [44], produced biodiesel fuel from waste sardine fish oil using methanol, ethanol or isopropanol are analyzed using a solid heterogeneous catalyst using eggshell and copper oxide [CaCu(OCH3)2]. They perform the esterification of fish oil before the transesterification process to reduce the fish oil acid value. Three samples of biodiesel were produced and they can be considered as fish oil methyl ester (FOME), fish oil ethyl ester (FOEE) and fish oil propyl ester (FOPE). The research results help develop strategies to improve the unsaturated fish oils used for biodiesel production.

Martins et al [45], biotechnology microalgae have been studied in 70-litre vertical photobioreactors that use unsupplemented secondary brewery wastewater as growth media using two collecting cells mechanically methods under hydrothermal (autohydrolysis) and dilute acid hydrolysis. They state that both processes enable high recovery of soluble sugars (about 50 %), mainly in oligomeric form with added value (92 % and 90.5 % for dilute acid hydrolysis and dilute acid hydrolysis, respectively) will be present. Their research shows that compared to the promotion strategies based on total microalgae biomass, these mild processes are auspicious because they enable the oligosaccharides and value-added protein co-production in the future.

The maritime sector decarbonization

One sector that needs decarbonization with effective strategies can be considered the maritime sector, especially transportation. In this regard, the SDEWES research community studies for modelling the energy system including the marine part towards the carbon neutrality goal by 2050 have been done of Sardinia island, Italy. In this case, options are presented for related energy and water systems on cruise ships, including waste heat for absorption chillers and thermally activated desalination. In this regard, it is possible to save up to 1.9 kg of fuel per year for ships sailing along the Mediterranean Sea and the Caribbean Sea [46].

Di Micco et al [47], developed a targeted approach to compare the diesel propulsion complete replacement with hydrogen propulsion in marine vessels. Among the ships that contribute the most to CO_2 emissions, a chemical tanker, a category responsible for about 45 per cent of ocean-going ships' CO_2 emissions, is a case study when it calls into the Los Angeles and Long Beach ports. The requirements include matching the load profile factors of an 8.3 MW diesel engine under identical passenger conditions to the operational performance of a proton exchange membrane fuel cell. Hydrogen consumption is estimated at 47–52 tons, which, considering the safety fuel margin of 10 %, avoids 786 tons of CO_2 instead of 250 tons of diesel. Storage options for compressed gaseous hydrogen, liquid hydrogen and metal hydrides are compared. There are gains in the engine room compared to a diesel engine despite the same mass and volume on board. The fuel chamber is increased due to lower weight and volume density. As a net effect on the ship, 0.1 % of the total cargo mass capacity is estimated to be replaced in the liquid hydrogen option, while up to 9 % is replaced by metal hydrides, which are lighter materials necessary for the storage tank. Further economic comparison shows that a zero-emission solution is easily feasible when there is an incentive to avoid CO_2 emissions at $112 per ton. This approach, which can be used to target specific ships in categories with the highest CO_2 emissions, could be a promising solution for the maritime sector and port ecosystem roadmaps and related organizations to steer the industry towards a zero-emission future. In addition, telecommuting can reduce energy and greenhouse gas emissions from conventional transportation while shifting energy consumption from offices to residential buildings as a pervasive practice. For example, the increase in household energy consumption during the pandemic was about 4.2 % in the Kobe city in Japan [48]. Zhang et al [49] have studied an analytical approach to determine the equivalent fuel-saving ratio, including the different components and the influencing factors energy-saving contribution rate in hybrid hybrids. This approach has been applied to optimize the design and control of more efficient hybrid electric bulldozers representing significant differences from on-road hybrid propulsion.

New frontiers in renewable energy technologies

Advances in renewable energy technologies continue to push new frontiers for energy transmission, enabling more people to benefit from bright sunshine and abundant, powerful winds. Recent advances made by the SDEWES research community include developing efficient energy technologies using solar, wind, wave, geothermal, hydropower, and bioenergy. Altguer et al [50], describe how a cooling system for PV panels with different atomizing nozzles increases electrical efficiency by 8.7 % and reduces water consumption to 0.891 L/h for each per cent increase in efficiency, providing more opportunities. In addition, it provides the combination form with agricultural applications. Hamed and Alshar [51] reviewed solar PV, concentrating solar energy with wet and dry cooling, and wind energy technologies to guide the large-scale solar and wind farms planning with prevented or minimized environmental impacts, including facilities. In a study, Tariq et al [52], compared a triple-generation system with a parabolic solar collector and an organic Rankine cycle and prioritized the scenarios based on multiple criteria for exergy efficiency, cost and operational reliability. Barron et al [53], investigated the concentrated PV panels energy performance with thermal or evacuated glass that resulted in energy savings in the 48 % and 90 % range compared to reference systems; when used in buildings in 14 water zones, they may have taken action.

Innovations for more comprehensive and higher-performance solar energy technologies can increase the energy transmission benefits. In a study, Ocłoń et al [54], experimentally investigated a model for optimizing solar PV panels with tracking and cooling capability, which increased the electrical conversion efficiency by about 1 % due to cooling and heat extraction. A low temperature can lead to domestic use. El-Alani et al [55], describe the aerosol particles impact on experimental sites based on direct average radiation in Morocco under clear sky conditions. Alahmer and Ajib [56] have studied opportunities to improve control and operation strategies to increase COP values and specific cooling power. Al-Foas et al [57], have developed a new dynamic numerical model to describe the solar PVT power plants performance, including their electrical and thermal energy efficiency. This new model was validated by an experimental investigation based on a PVT plant in Catania, Italy, with a total efficiency of 37.22 %. Cheng et al [58], developed and investigated a federated learning-based model to detect ice on wind turbine blades with high accuracy, especially in wind farms located at high latitudes.

Advances in accurate forecasting of marine energy

Marine research is included in the SDEWES Community Research Partnerships activities including offshore wind energy. Ciappi et al [59], in a study of modelled oscillating water column devices with chamber and optimized turbomachines, focused on a system off the coast of Tuscany, Italy, that can generate up to 42 MWh per year with a power conversion efficiency of up to 8.7 % from waves to wire. Penalba et al [60], have developed a data-driven approach for more accurate prediction of ocean weather conditions. Using an original data set from the Bay of Biscay, their approach examines the increase in sea surface temperature due to ocean warming with long-term wave height and wave power changes. Offshore wind and wave energy should be considered renewable energy sources (RESs) with high new energy potential that can be installed in marine areas in the coming decades [61]. Wind energy produced in wind farms is continuously increasing, using new technologies and reducing economic costs. The data extracted from the satellite technology can be effectively used in near and offshore areas

for wind speed mapping and long-term and short-term analyzes of the studied wind regimes. Satellites can be appropriately used to obtain global wind distribution over oceans and seas. Although this stage can be considered the offshore wind farms (OWFs) development initial stage, it is necessary to focus on the offshore wind (OW) potential assessment and mapping to highlight the best areas for installing turbine generators [3].

In this case, Rusu [62] investigates the wave power dynamics in the North Atlantic Ocean under a climate scenario with a radiative power level of 4.5 W/m^2 modellings. The wave characteristics results, the significant wave height can be reduced by 10 to 20 % in the area near the Iberian Peninsula coast. Majidi Nezhad et al [63], designed a new methodology to estimate the wind's speed potential using Sentinel-1 images of the Sentinel Application Platform (SNAP) software to extrapolate wind speed data for each cell pixel size. The GIS (Geographic Information System) software is used to map wind data and find the best pixel location by comparing these data with in-situ data. Obtained results proved an improvement of the OW assessment accuracy using multiple satellite observations, demonstrating that SAR wind maps can support OW speed site assessment by introducing observations in different phases of an OW farm project.

Conclusions

The SDEWES research scientific contributions community address key areas that contain promising opportunities for achieving climate neutrality and beyond, as summarized in this editorial. It is increasingly critical to translate these research contributions into impact in the urgent policies context that are being considered to address climate change. The eight articles in this special section that form the basis of this editorial contribute to a coherent whole for the sustainable development of energy, water and environmental systems that the SDEWES research community has consistently supported over the years.

In the first paper, the authors conducted a study using advanced technologies to form a new TT PS-TIM window system for adaptive daylight control and advanced thermal insulation combination. They have proposed thermotropic hydrogels such as hydroxypropyl cellulose (HPC) and poly (*N*-isopropyl acrylamide) (PNIPAm) for incorporation into polymethyl methacrylate (PMMA) sheets between glass layers to achieve this goal [36]. In the second paper, a newly installed FPVS with an installed capacity of 0.5 MW/s DC is used using experimental data from a field test located in an area with Mediterranean climate conditions. The research results include energy efficiency, final efficiency, performance ratio, capacity factor and system efficiency. In addition, they show a daily cycle on sunny and cloudy days, providing a clear view of system performance [37]. In the third article, the sustainability possibilities analyzed of willow cultivation and short-period miscanthus energy crop assigned to the former coal mining areas belonging to the largest electricity company in Bosnia and Herzegovina, i.e. JP Elektroprivreda BiH d.d. This article focuses on economic, environmental and social indicator groups used to perform mass economic analysis and multi-criteria analysis [38]. Also, in the fourth paper, the authors combined solar and geothermal energy with boiling water purification and reverse osmosis. The objectives of their study include electricity generation, advanced boiling and water purification by improving energy efficiency, reducing wasted heat and making them affordable. In this study, they generate a daily cycle of electricity and charge thermal energy storage with an exergy efficiency of 51.64 %. In addition, their results show that the night cycle, boiling water treatment with electricity generation and waste heat output, works with an exergy efficiency of 49.25 % [39].

In the fifth article, the authors have done an in-depth analysis of facial expression and eye tracking with samples obtained from non-expert participants to determine the emotions caused by electricity consumption graphs in different time scales. In this study at the device level, participants were randomly divided into one of three groups with energy consumption graphs at different time scales at the device level [42]. In the sixth study, researchers have addressed the electric vehicles (EVs) main life cycle activities using an exploratory survey, where they occur and the associated potential injustices. Their studies provide insights into implementing electric vehicles through smart grid and vehicle-to-grid developments, global justice as a result of greenhouse gas (GHG) emissions and global resource depletion, and restorative justice through laws and standards requiring environmental restoration [43]. In the seventh article, sardine fish oil waste and a solid heterogeneous catalyst using eggshell and copper oxide [CaCu(OCH3)2] have produced different biodiesel fuels. Three samples of biodiesel were produced in this study, which can be considered fish oil methyl ester (FOME), fish oil ethyl ester (FOEE) and fish oil propyl ester (FOPE). The research results will help to develop strategies to improve the unsaturated fish oil used for biodiesel production [44]. Finally, in article number eight [45], their research shows that compared to the promotion strategies based on total microalgae biomass, these mild processes are auspicious because they enable the oligosaccharides and value-added protein co-production in the future.

The guest editors see considerable potential in the research articles included in this special issue. Guest editors believe these contributions will greatly interest Energy Conversion and Management readers. The ability to accelerate the addressing climate change process in an urgent and timely manner through an integrated approach is of high priority for a sustainable future. Similarly, the translation of these scientific advances into environmental impacts will be of considerable importance.

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Davide Astiaso Garcia[a,*], Giannakopoulos Dionysis[b], Predrag Raskovic[c], Neven Duić[d], Moh'd Ahmad Al-Nimr[e]
[a] *Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Roma, Italy*
[b] *Centre for Research & Technology Hellas, Chemical Process & Energy Resources Institute, Ptolemais, Greece*
[c] *Faculty of Technology, University of Niš, Leskovac, Serbia*
[d] *Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Ivana Lučića 5, 10000 Zagreb, Croatia*
[e] *Mechanical Engineering Department, Jordan University of Science and Technology, Ar Ramtha, Irbid, Jordan*

[*] Corresponding author.
E-mail address: davide.astiasogarcia@uniroma1.it (D. Astiaso Garcia).