sustainability

Editorial

Sustainable Development of Energy, Water and Environment Systems (SDEWES)

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Sustainable development is a highly interdisciplinary concept that involves the interaction of various systems, such as energy, water, and environment, by using waste from one, as a resource in another, and in the exact moment when it is beneficial to all [1]. In 2002, the Sustainable Development of Energy, Water, and Environment Systems (SDEWES) Conferences were established to address this issue. In 2020, four SDEWES conferences were held—due to the COVID 19 pandemic, all of them as online events:

- in February, the 2nd Latin America SDEWES Conference (LA SDEWES 2020) in Buenos Aires, Argentina;
- in April, the 1st Asia Pacific SDEWES Conference (AP SDEWES 2020) in Gold Coast, Australia;
- on 28 June–2 July, the 4th South-East European SDEWES Conference (SEE SDEWES 2020) in Sarajevo, Bosnia, and Herzegovina;
- finally, in September, the 15th SDEWES Conference (SDEWES 2020) in Cologne, Germany.

Overall, SDEWES 2020 conferences created a temporally and spatially distributed forum for researchers worldwide to exchange and discuss their ideas and findings and show the sciences' responsivity to national, regional, and global challenges. The conferences covered diversified research topics, from technical, economic, environmental, and social studies, to the investigations of energy, transport, water, and all kinds of production and environment protection systems and their sustainability.

The tradition of SDEWES conferences is that, after each event, the authors of most valuable papers are invited to publish their research results in special issues of high-ranking journals. From around 700 manuscripts accepted for and presented at 2020 SDEWES Conferences, the present authors selected 15 for this inagural Special Issue of SUSTAINABILITY. The foreground is energy, water, buildings and infrastructure, and waste management and valorization. Before reviewing the selected papers, it seems appropriate to give some background information based on contributions derived from other journals' special issues on previous SDEWES Conferences.

Along with climate changes and developing urbanization, the practices and supply systems of energy, water, and urban management are changing [2]. A comprehensive approach and sustainable development are bases of UN Sustainable Development Goals announced in 2016 and Europe 2020 strategy [3]. With these goals in view, the concept of a green economy is high on the developed countries' agenda [4]. Among all the essential resources from the living need point of view is water. Integrated and sustainable water utilization is an ongoing issue requiring involvement [5]. As energy demand increases and the efficiency of transforming energy forms remains low, primary energy sources' sustainable use is of great importance [6]. This is why the concept of bioenergy in transportation [7] and residential areas [8] is of great interest. The topic of renewable energy sustainability is constantly under discussion [9]. In response to the questions raised [10], suitable analysis tools can help obtain more sustainable energy knowledge [11].

An established trend is to consider urbanized areas as a natural human environment. Considering UN Goals, one can notice that the involvement for work on thermal comfort issues, e.g., urban area overheating [12], increases. The perspective of sustainable urban area planning is essential [13]. It requires analyzing water resources, energy consumption [14] including the use of renewable energy [15], public transport [16], and GHG emissions [17].

From a broad perspective, waste management and utilization of waste materials are crucial parts of the green economy [18]. Within this vast field, researchers' attention is attracted to, among others, the organization and management of waste collection and processing [19] as well as to the tools for optimized waste utilization [20]. Among various types of waste, used oils, their utilization for fuel production, and the resulting environmental impacts are studied [21]. As the research results related to the re-use of hydrocarbons reach high advancement levels, new concepts for using waste in previously unrecognized areas are emerging [22].

Overall, the papers from previous SDEWES conferences clearly show that there is still a need for further research within all of the reviewed topical fields. In line with that conclusion, the programs of SDEWES 2020 events were rich in contributions concerned with energy resources and their sustainable use. Recognizing the primary role agriculture plays in the economy of rural communities of Ghana, Nelson et al. (Contribution 1) investigated possible bioenergy schemes that could increase the use of agricultural crop residues. Using FAO data on crop production and residue-to-product ratios, they estimated the bioenergy potential around 623.84 PJ per year. This figure is equivalent to 19,781 MW—a quadruple of the country's total installed power generation capacity of 4577 MW. Cocoa pod husks—a material currently wasted—were identified as a vital biomass resource for energy generation. Samples of this material were collected in Ghana's six cocoa growing regions and subjected to chemical analyses. As the results showed, due to the low content of nitrogen and sulphur and a high heating value, this material is a valuable fuel for use in the country's rural communities.

Bhandari et al. (Contribution 2) analyzed the need to expand electricity generation and supply infrastructures in Niger—a country where most of the population has no electricity access. Expecting further exploration of fossil fuel in Niger but taking sustainability criteria into account, the authors determined which electricity generation resource/technologies are best suited for future applications. The most accessible energy system for the country was sought using a multi-criteria decision approach, based on 40 indicators that enabled ranking electricity generation options. After considering six evaluation aspects, including availability, risk level, technology, economic advantages, environmental impact, and social impact, eight different options were compiled into a merit list of technology and resources for electricity generation in Niger for use by the country's decision-makers in the future selection and implementation of energy-related projects.

In Nepal, while small hydropower plants can play an important role in covering electricity demand, renewable energy projects' sustainability is sometimes questioned. Butchers et al. (Contribution 3) investigated a representative project cycle of a community-owned and -operated micro-hydropower plant in Nepal and were able to show that a plant's ability to work sustainably depends on specific components of the project cycle. After studying literature, policy and project documents, and interviewing stakeholders, the authors identified factors that negatively affect the hydropower plants' sustainability. Weak specification of civil components during tendering, insufficient quality control during equipment manufacture and construction works, and lack of trained operators are typical problems. Based on study results, recommendations were made for Nepal's micro-hydropower industry regarding specific actions to facilitate the sustainability of community hydro-energy projects.

Dianchi Lake, a significant and economically crucial freshwater resource near Kunming City, China, has been affected by heavy water pollution and eutrophication that became major obstacles to regional sustainable development. Kong et al. (Contribution 4) reported the evaluation of coordination actions intended to support Dianchi Lake basin development planning. The authors considered ten possible development scenarios for the Dianchi Lake basin to balance socio-economic development and environmental protection. A scenario combining high protection and medium development was identified as the most suitable basis for future planning, assuming that economic growth control and non-point pollution source governance could enable the most urgent corrective actions. A simulation study indicated the high protection–medium development scenario would allow reaching the target of acceptable water quality in 2025.

In industrialized countries, the rational use of fuels for transport has attracted much attention. In recent years, off-road vehicles, including those used in forest operations, have been increasingly hybridized by applying additional electrical drives and battery energy storage. Karlušić et al. (Contribution 5) observed that a powertrain's purchase cost and operational efficiency depend on its design and energy management control. Using mathematical models and simulated fuel consumption as an objective function, the authors performed optimization of control parameters of conventional and hybrid cable skidder powertrains operated over a selected forest path. Around 15% fuel efficiency could be achieved in winching and skid trail driving if the hybrid powertrain chosen is applied, leading to a 13-year payback period for the main hybrid drive components.

It is now widely understood that the utilization of volatile renewable energy resources such as wind and solar power necessitates adding flexibility to the future electricity system to ensure a technically and economically efficient network operation. Pfeiffer et al. (Contribution 6) considered the social acceptance and requirements of a participatively developed home energy management system to determine its flexibility potential. Three aspects were investigated: system support optimization, self-consumption and self-sufficiency optimization, and additional comfort functions. Within a small sample area of a three-community cluster, the authors used online household surveying, cluster analysis, and energy-economic optimization. They determined the socially accepted techno-economic potential of households and found that about 30% of the participants are ready to accept the developed system. This would yield a shiftable load of nearly 1.8 MW. However, to ensure households' desirable load behavior, rewarding it through new electricity market mechanisms would be required.

Homes and their energy management systems belong to the products of the building industry which is still seen as an unsustainable activity. As pressure is growing on the involved parties to change this situation, it becomes clear that a project manager responsible for the overall management of a building's different development phases, can significantly contribute to the attainment of sustainability goals. Borg et al. (Contribution 7) presented a pilot study aimed at establishing and identifying a set of key project management processes and relevant supporting practices, and evaluated their significance and possible added value provided. Information was collected using a questionnaire distributed internationally amongst established project managers. It was found that all participants of building development processes are aware about sustainability issues and ways to make a particular project more sustainable. Among project stages defined in the questionnaire, pre-construction (pointed out by 43% of the respondents) and construction (28%) were considered to provide most opportunities for project manager to make decisions that promote sustainability of the whole project. As the main obstacles, the respondents named clients' refusal to commit increased capital (34%), inadequate training of the involved personnel (33%), and the lack of incentives that could stimulate the efforts to increase project sustainability (22%).

As a part of the efforts to make building industry and its products more sustainable, the voluntary adoption is the growing of rating systems for sustainability assessment of built environment projects. Tagliabue et al. (Contribution 7) proposed a framework for shifting from a static sustainability assessment to a dynamic approach employing digital twin and Internet of Things approaches. This is intended to enable real-time evaluation and control, from the user's point of view, of a wide range of sustainability criteria. The framework was tested through some sample applications to a pilot building in the University of Brescia. In this educational building, the daily activities of the engineering students run in parallel to constant monitoring of air quality and thermal comfort as well as the building's energy consumption, along with renewable energy production. The proposed framework for sustainability assessment will become a component of a methodology encompassing the whole building's life cycle. It can enable the use of procedures that employ digital twin in supporting sustainability-related decisions.

Vilčeková et al. (Contribution 8) used the life cycle assessment (LCA) methodology to investigate the environmental impact of wooden houses while also evaluating the indoor environmental quality (IEQ) in these houses. Two existing detached family houses were studied: one with a wooden frame based bearing system complemented by other conventional materials, and the second house built entirely of log wood. Assuming the global warming potential (GWP) indicator is a crucial one for environmental evaluation, the log-wood house equipped with a biomass boiler was found to significantly reduce CO_2 emissions. Based on GWP along with other LCA-related indicators, it is a more suitable alternative than a wooden-frame house. The non-wood materials most significantly contributing to the impact indicators included concrete structures, ceramic roof tiles, and plasterboard. By performing measurements of microclimate parameters in the selected wooden houses under real conditions, the data on IEQ were collected. Considering air temperature and humidity, CO_2 concentration and particulate matter, both wooden houses were free from negative impact on their occupants.

Vujadinović et al. (Contribution 9) discussed the collection of data needed for the status analysis of the Sustainable Urban Mobility Plan (SUMP) for Podgorica, the capital of Montenegro. Basic data for the estimation of the existing condition of the traffic system were collected through desk research followed by several surveys and focus group interviews employing interactions with 5000 Podgorica residents who also provided numerous suggestions for the new traffic planning. University students performed cordon count of motor-vehicle and pedestrian traffic on the city's Bridges. Using quality management tools such as Bicycle Policy Audit (BYPAD) and Parking Policy Audit (ParkPAD), the status of cycling and parking policies was assessed. Some phenomena and trends were identified, including rapidly increasing number of registered vehicles and motorization rate. frequent traffic accidents, and low use of inefficient public transport, walking and cycling. Using the collected data, the main problems of Podgorica traffic system were identified, thus providing the city's decision makers with a list of issues to be resolved when developing the SUMP.

Climate change contributes to the increasing frequency and scale of disasters and infrastructure damage. Therefore, a need arises for more time- and cost-effective approaches to the organization of reconstruction projects. Conventional "build-back-as-before" post-disaster investments may lead to communities' vulnerability to future disaster-induced damage of comparable or greater degree. In their contribution, Chester et al. (Contribution 10) presented how to integrate a "build-back-better" approach in the reconstruction projects, thus facilitating more resilient infrastructure. Based on existing knowledge and practical experience, the aspects of rebound, extensibility, and adaptability were considered to estimate how alternative project delivery methods can improve infrastructure robustness against future hazards, including climate-related ones. Further improvements to project delivery methods are possible by engaging a broader set of stakeholders who can contribute new ideas and insights to the reconstruction projects.

As a consequence of population growth and urbanization, increasing amounts of Construction and Demolition (C&D) waste are available, thus creating pressure on the governments and industrial organizations to re-think and rationalize waste management practices. Waste trading is a measure to avoid waste landfilling and expand the scale of re-using the waste material. In a review paper, Caldera et al. (Contribution 11) examined key factors of importance to creating a global marketplace for waste trading. Taking market-based, operational, and governance factors into account, the authors identified the drivers and obstacles to the development of large-scale C&D waste trading. Other recycled materials draw much attention in parallel to the existing business and trade opportunities for recycled glass and metals. Research is underway on people and technology's roles in online waste trading and developing business opportunities in the emerging C&D waste sector.

The issue of managing C&D waste is a part of the problem area of the growing resource scarcity and the efforts to attain environmental sustainability. In this context, the ideas for sustainable degrowth are under discussion. Hoehn et al. (Contribution 12) investigated the links between circular-economy-orientated food production, food loss, the related waste management systems, and the Sustainable Development Goals. For any food supply chain, a methodology was proposed for estimating the magnitude of degrowth by adopting the life cycle assessment approach to the development scenarios for the period 2020–2040. According to Spanish case study results, Paris Agreement targets could be met if the reduction in GHG emissions was 26.8% in 2020 and 58.9% in 2040. The authors considered various development paths for the Spanish food supply chain, including reduced agrochemicals and the shortening of transport distances. As the most useful path, the reduction in the consumption of meat and fish and seafood was identified, as it could achieve GHG emissions reduced more significantly than the other studied options.

As another potentially important component of the circular economy, biomass waste's efficient use deserves attention, especially in the world's tropical regions where abundant biomass resources are awaiting utilization of their full potential. In this context, Chai et al. (Contribution 13) discussed the prospects of broader applications of supercritical fluid extraction (SFE). This sustainable and cleaner technology has attracted the attention of both researchers and industrialists. The authors critically reviewed SFE technology developments from its inception to commercial application, pointing out its limitations. Undoubtedly, SFE is a tool for use in the approaches to intensifying tropical biomass waste conversion into value-added products such as biopesticides, bio-repellents, phenolics, and lipids for biofuel.

In contemporary agriculture, biomass crops' availability depends on fertilizers' efficient use that enriches the soils in the right doses of the macro and micronutrients. Tesfamariam et al. (Contribution 14) investigated the economics of using municipal sludge as a fertilizer compared to commercial inorganic fertilizer. In addition to the price of commercial fertilizer, the economic feasibility of the sludge replacing or substituting the commercial inorganic fertilizer depends on sludge nutrient concentration, the distance between the wastewater treatment plant and the farm, and the type of agro-ecological zone where the fertilizer is applied. It was found that anaerobically digested paddy dried, municipal sludge containing 3% N, 2% P, and 0.3% K can be economically transported over distances of 20 to 28 km in the arid or semi-arid zones. In potentially more productive agricultural regions (sub-humid, humid, and super-humid zones), the distances of economically feasible sludge transport increase to 51–75 km.

Concluding the overview of papers included in this Special Issue of SUSTAINABILITY, dedicated to the four SDEWES Conferences held in 2020, the present editorial authors hope that the selected papers and addressed issues will be of interest to the readership of SUSTAINABILITY. The papers were chosen to match strategic importance fields of sustainable development: energy, water, buildings and infrastructure, and waste management and valorization. Future SDEWES Conferences will continue the established approach to presenting new research results and practical experience and disseminating new knowledge on how the future can be shaped adhering to sustainability principles. For information on the upcoming SDEWES events, the readers are invited to visit the website of the International Centre for Sustainable Development of Energy, Water, and Environment Systems (SDEWES Centre).

Conflicts of Interest: The authors declare no conflict of interest.

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