Energy 190 (2020) 116432

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Editorial: Sustainable development of energy, Water and Environment Systems

In 2018 the Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) was held in three different locations and periods, so as to offer to the scientific community working in the field several opportunities to share and discuss new ideas and disseminate results of research activities. The 1st Latin American SDEWES Conference was held in Rio de Janeiro (Brasil) in January 28–31 and attracted 180 scientists from 35 countries, with a high number of contributions mainly from Southern American and European academics and professionals, who reciprocally enriched about emerging issues in the field of sustainable development in these continents. Also, the participants ackowledged the inclusion in the programme of 3 invited lectures by eminent scientists and 5 Special Sessions focused on specific major topics. Then, the 3rd South East European Conference on SDEWES was held in Novi Sad (Serbia) from June 30 to July 4, which brought together 190 experts from around 30 countries and whose programme offered 3 invited speechs and 4 Special Sessions. Finally, the traditional Fall Conference on SDEWES was held in Palermo (Italy) from September 30 to October 4, and attracted 400 scientists from around 50 countries with 3 invited speakers and 9 Special Sessions.

The Energy journal has continued its cooperation with SDEWES launching a special issue dedicated to these three SDEWES Conferences. The 34 selected papers cover a wide variety of issues in the fields of energy, water and environment, and all of them propose novel approaches or remarkable advances in well established research lines already explored in past SDEWES Conferences.

Energy planning and sustainable heat supply at district level are among the most investigated topics. In past SDEWES Conferences the concepts of Net-Zero-Exergy-Districts and Net-Zero-compound-CO_2 Emissions-District was proposed by Kılkış as a support to local energy planning [1], which had been successfully applied trough an analytical model, namely *Rational Exergy Management Model*, to the pilot net-zero exergy district of Östra Sala backe in Uppsala Municipality (Sweden) [2]. Filogamo et al. [3] proposed a methodology for the disaggregation of a building stock into typologies of different construction practices, as a support for energy planning at district or regional level. A paper by Novosel et al. [4] introduced an agent based modelling and energy planning instrument, proving its potential for developing efficient local model of the transport sector. In the current SDEWES special issue two papers are specifically devoted to this topic. In the first, Kılkış Ş. and Kılkış B. show that appropriate urbanization options for district density and building characteristics can help in achieving net-zero exergy condition for districts and implemented an urbanization algorithm that can serve as support for local decision-making [5]. In the second paper, Ferrari et al. [6] provide a scientific review of tools for urban energy planning, classifying 17 tools on the basis of their features (analysis type, operation spatial scale, outputs time scale, energy service and licence) and identifying 6 user-friendly instruments that are most viable for widespread use.

A second topic strictly related to the previous one is District Heating (DH), which has been representing one of the hottest research topics among the contributions presented in the last five-year period at SDEWES Conferences. A research line on this topic is aimed at developing solid knowledge about the spatial and temporal distribution of heat demand. Petrovic and Karlsson showed how a Danish heat atlas, developed on a highly detailed database with information on more than 2.5 million buildings in Denmark, can be used for providing inputs to energy system models and optimize expansion of DH networks [7]. Such heat loads estimation at regional basis highly benefits of the availability of simplified approaches to heat load estimation, such as the one proposed by Sholahudin and Han [8] and based on the Taguchi method. Gianniou et al. proposed a method [9], based on the K-means algorithm, to segment the buildings of a district into clusters or groups based on their daily heat consumption and energy intensity and their representative patterns. In the framework of the Heat Roadmap Europe, i.e. the large-scale project aimed at developing low-carbon heating and cooling strategies, Hansen et al. investigated the trade-offs between the costs of heat saving and those of sustainable heat supply [10], demonstrating the economically feasible levels of heat savings for various European countries. The current special issue includes two papers focused on this research line. A study by Möller et al. presents a quantitative method to define local heat supply strategies [11], based on arranging spatial heat demand and supply data and allocating excess heat or renewable heat sources to prospective DH systems. The analysis confirms the large potential existing for de-carbonisation of the heat sector. The second contribution, by Ferrari et al., proposes a literature review on methods for estimating buildings energy demand at district level [12]. Classifications of methods are proposed on the basis of the use of time-aggregated data or detailed energy profiles and of actual or estimated energy demands.

Another research line in the field of district heating is oriented to the optimization of design and the assessment of potential integration with cogeneration systems or the recovery of available waste or excess heat sources. A solid knowledge has been generated in past SDEWES Conferences on these themes, confirmed by several contributions included in special issues of journals. Soltero et al. [13] assessed the potential of natural gas cogeneration for district heating in Spain, quantifying its contribution to the decarbonization of spanish economy, while Falke et al. proposed a multi-objective optimization model for the design of distributed heat

https://doi.org/10.1016/j.energy.2019.116432
0360-5442/

systems integrating Renewable Energy Sources (RES) and district heating and targeted to districts with more than 100 buildings [14]. A study by Liew et al. [15] analysed the capability of Total Site Heat Integration to identify optimal strategies for integration of district cooling systems, supplied via thermally activated chillers such as absorption units, into existing industrial clusters and Locally Integrated Energy Systems (LIES). Li and Svendsen presented an optimization of district heating networks configuration and topology by genetic algorithms [16], pointing out that optimal design is influenced by multiple factors such as the heating loads of each consumer, the distance between the heating plant and the consumers and the physical constraints related to pressure and temperature limitations and heat losses.

In a paper by Lončar and Ridjan various concepts of district and individual heating were compared in terms of energy efficiency and environmental indicators to assess the profitability potential of biomass and natural gas fired district heating in the current Croatian energy market [17]; in the same study the levels of financial support required to achieve projects viability were also discussed. Tańczuk et al. [18] analysed the possibility of recovering the waste energy potential of high temperature slag produced by coal-fired boilers installed in district heating systems, in order to supply high temperature R134a heat pumps. Varga and Palotai proposed a comparison among different methods and technologies for recovery of waste heat at temperature below 150 °C [19]. Smolen and Budnik-Rodz investigated the technical and economical conditions for waste heat utilization in Germany and in Poland, pointing out the role that could be played by heat pumps and transformers and gas motor-driven heat pumps to reduce the energy consumption, identifying a larger potential for application in Germany and Western Europe due to the higher energy prices [20]. Carotenuto et al. performed an energo-economic analysis of a low-temperature district heating and cooling system supplied by solar and geothermal energy [21]; a 1-year simulation in TRNSYS environment was conducted, proving that the system achieves a high primary energy saving but that public funding are needed to make it economically feasible. In the current special issue three papers are specifically devoted to the above topic. A study by Dorotić et al. [22] introduces a multi-objective (i.e. economic and environmental) optimization of a district heating and cooling system, accounting for the detailed operation of the system at hourly basis and aimed at idenfitying optimal supply capacities and thermal storage sizes. A second contribution by Kazagic et al. [23] investigates the potential of renewable district heating system for the Municipality of Visoko, considering the actual operating conditions throughout a year and the current energy prices, also including the effects of taxes and subsidies. The proposed modular DH solution achieves much better economic and environmental results than the existing heating systems. The third contribution by Simeoni et al. discusses the integration of industrial waste heat recovery into sustainable smart energy systems [24], proposing an evolutionary multi-objective model and applying it to a steel casting facility located in Italy. The proposed integration with a DH network at neighbourhood level achieves promising results, being optimized in terms of set of users to be supplied and installed thermal storage capacity. A crucial topic for the effective utilization of sustainable heating technologies is related to the use of heat storage devices, which have been investigated in different studies presented at past SDEWES Conferences. Zhang et al. [25] reviewed the most advanced heat storage techniques, with a particular focus on the use of Phase Change Materials (PCMs) encapsulated in tubular steel structures, with the eventual insert of metallic foams or sponge which was proven to guarantee a higher storage efficiency due to the increased effective thermal conductivity. The growing interest for latent heat storage is confirmed by another study, by Urschitz et al. [26], where the design of the heat exchanger tube is discussed, since this component can represent the limiting factor for the charging and discharging rate of the storage. In particular, the combined use of different materials is studied, i.e. a steel tube and an aluminum one with fins, proving its capability to provide optimal response from both the heat transfer and mechanical resistance perspectives. In the current special issue the potential of a rather novel technology, namely thermochemical storage (TCS), is discussed in a study by Böhm and Lindorfer [27], highlighting the influence of a number of factors such as the configuration of the supplied DH network, the location of the heat sources used for charging the storage and the transfer distance. The use of hydrates and hydroxides results very suitable when waste heat or low cost heat sources are available.

With regard to sustainable heating, another traditional research line such as the analysis of Combined Heat and Power (CHP) systems and heat pumps has continued to stimulate the efforts of scientists attending SDEWES Conferences, in the search for a clear definition of the applicative potential and identification of promising design options. Calise et al. analysed a combined cooling, heating and power system and optimized its operating strategy in a real industrial application, based on a detailed simulation model and accurate cost figures [28]. Hausl et al. investigated the relationship between greenhouse gases emissions and the space heating and cooling application in Austria [29], assessing the potential emission savings deriving from a widespread use of renewable sources and energetically optimized systems. In a paper by Di Fraia et al. [30] a thermoeconomic study was carried out for a combined heat and power system coupled with a wastewater treatment plant; the study proved the feasibility of the integrated lay-out, which achieved substantial economic and energy savings when the system design guarantees the possibility of full exploitation of thermal outputs for drying of sewage sludge. Two studies strictly focused on the assessment of thermal performance of micro- or small-scale cogeneration systems have been proposed by Angrisani et al. [31] and Dutra et al. [32]. In the former study the authors presented a critical analysis of the most common indices used to assess the performance of trigeneration systems, also proposing an interesting reformulation of the so-called “Total Supply Spread”, i.e. a parameter frequently used for profit-oriented optimization of plant operation on hourly basis. In the latter paper, conversely, the technical side of the problem is addressed by analyzing the performance of a micro gas turbine coupled, via a compact cross flow finned tube heat exchanger, with an absorption chiller. The model was validated against experimental data and it represents an excellent instrument to predict the performance of the system under variable load conditions, frequently encountered in buildings applications. The possibility of efficient integration of heat pumps into DH system has been also widely investigated. Østergaard and Andersen proposed an interesting comparison between two alternatives for Domestic Hot Water (DHW) supply [33], (a) the use of conventional DH based on central Heat Pumps (HPs) and heat exchangers and (b) a combination of DH based on central heat pumps and small booster heat pumps using DH water as low-temperature source for DHW production. The second alternative resulted to be the most promising one, since due to the lower DH water temperature it allows for increases in the COP of central heat pumps and for lower distribution heat losses. Blarke and Lund analysed the potential improvements in the coefficient of performance of large-scale HPs deriving by integration with existing CHP plants [34]. The partial use of condensed flue gases as a low-temperature heat source was estimated to lead to 8% cost reduction, also providing benefits in terms of flexibility for the Danish energy system that was assumed as a case study. Verda et al. discussed the optimal integration of ground-source HPs in a DH network, taking into proper account the subsurface thermal degradation caused by heat pump installations and the risk to affect the performance of surrounding installations [35]. A thermo-fluid dynamic model of the soil was used, finally proposing a procedure to select which users in an urban area should be connected with a DH network and which ones should be supplied through an alternative technology. Three papers included in this current special issue are specifically focused on sustainable heating technologies such as CHP systems and heat pumps. In the first paper by Marrasso et al. [36] four different air conditioning systems designed for a building located in Naples are examined, comparing the two traditional scenarios including distributed or centralized boilers and chillers with two more efficient ones, i.e. a trigeneration plant and an electric heat pump. Dynamic simulations allow the authors to assess the energy and environmental performance of the configurations and to identify the trigeneration system as the best performing solution, which maximizes the primary energy saving and minimizes the CO_2 emissions. In a second paper by Gimelli and Muccillo the crucial role of a flexible configuration of the waste heat recovery system for the performance of a polygeneration plant is discussed, based on experimental data obtained for a prototypal 15 kW micro-CHP unit and on a subsequent 1D thermal-fluid dynamic characterization of a double-circuit recovery system [37]. Finally, a third paper by Pieper et al. [38] analyzes the influence of hourly temperature variations throughout the year of three different heat sources, i.e. groundwater, seawater and air, on the seasonal coefficient of performance of HPs when supplying a district heating network. A linear programming algorithm was used to optimize the operation with the aim to minimize annual electricity consumption for the area of Copenhagen, Denmark.

Another extremely hot topic along the 17-years history of SDEWES Conferences is obviously related to Renewable Energy Sources (RES) and the technologies for their exploitation. Contributions in this field may be divided into two main groups, depending on whether they are focused on a systemic level, i.e. they investigate the feasibility and potential of RES-based plants and their integration with the overall energy system, or on a technological level, discussing advances in the state of art with particular regard to novel technologies still characterised by low penetration on the market.

In the former research line, a growing interest has been observed for the role of active participation of consumers in promoting the growth of renewables and favouring the creation of a favourable context. Sousa and Martins proposed an analysis of the Portuguese Electricity Demand-Side Efficiency Promotion Plan [39], a voluntary mechanisms aimed at load management, pointing out the increasing rate of co-funding by participating consumers. In a paper by Bjelić et al. [40] an analysis of the potential role of virtual storage that could be played by the integration of flexible Serbian energy consumers into smart energy systems was proposed; in this study, the HOMER software tool was used to identify load shifts aimed at minimizing the net present cost for the consumers. Grundahl et al. [41] compared the expansion potential of district heating calculated (1) adopting a socio-economic approach, where the socio-economic benefits from expanding the district heating coverage are accounted for, and (2) referring to a consumer-economy, where tax payment is included to properly consider the aspect of economic feasibility for heat consumers. In the current special issue a paper by Hvelplund and Djørup discusses the importance of citizen and consumer ownership models in the transition to100% renewable energy [42], as an alternative to the common policies that mostly focus on building "green incentive" mechanisms. The study confirms that consumer ownership models have positive potential both in terms of maintaining low energy prices and securing low coordination transaction costs in smart energy systems. Among the renewable sources, particular interest has raised for the potential of biomass and biofuels (and, to some extent, to energy valorization of Municipal Solid Waste, MSW), due to the predictable nature of their availability and the consequent role they could play in favoring a high penetration of renewables. Palander and Hietanen presented a fuel procurement planning model for sustainable energy supply in Finland, focusing on renewable forest resources and on peat in particular [43]. The study demonstrated that the current fuel tax regime on peat may require some adjustments in order to achieve the forest fuel procurement targets. Chang et al. investigated the potential of bioenergy production from enhanced production of rice paddies and biomass wastes from the forest sector in Taiwan, calculating the carbon balance for both these scenarios [44]. Projections made up to 2065 allowed to identify a potential for 220–230% increase of the current level of bioenergy supply. Ćosić et al. analysed the potential for energy use of agricultural and forest biomass residual in Croatia [45], based on a methodology that takes into account the transport distance and cost and the size of the power plants to be installed. The average energy potential resulted to be 8.5 PJ for wheat straw, 7.2 PJ for corn stover and 5.9 PJ for forestry residues. A study by Chung and Park [46] assessed the viability of retrofitting biogas-based cogeneration systems to supply three DH networks in Korea. A preliminary estimation of the biogas produced in nearby waste treatment stations was made, and a 1-year simulation was performed to estimate the electricity and heat production and calculate projected simple payback periods, in the range between 2 and 10 years. Tomić et al. assessed the economic viability of using local energy sources such as waste and biomass to supply the district heating plants in Zagreb (Croatia) [47]. Some factors were proven to have a strong influence on the economic viability, and in particular the optimization of plant capacity based on an accurate prognosis of waste generation and the introduction of region wide waste management system. In a paper by Romagnoli et al. [48] the impact of different policy strategies promoting the use of wood fuel for district heating was assessed through a dynamic model. The analysis, conducted assuming the Latvian district heating system as a case study, revealed that national level climate policy measures and Emission Trading Schemes are extremely important for promoting increased utilization of wood fuel. In the current special issue two papers discuss the potential of biomass to contribute to sustainable energy supply. The first paper by Vukasinovic et al. [49] proposes a combined method, based on mathematical optimization and backcasting approach, to achieve long-term sustainable utilization of biomass, considering the relevant techno-economic parameters of the forest biomass supply chain. The method, applied to one municipality in Serbia, allows to identify the drivers and key uncertainties to achieve the desired future utilization of wood biomass. The second paper by Caputo et al. [50] proposes a survey of operational conditions of large biomass district heating plants in Italy. These plants are mostly fuelled by wooden chips and have stimulated the development of a local energy supply chain based on forest by-products. The integration of other renewable sources, the cascade use of heat and the use of cogeneration resulted to be the main drivers to promote biomass use in smart district heating networks.

The second research line regarding renewables and efficient integration of novel technologies and approaches is aimed at developing new technological solutions or proposing advances in existing ones characterized by moderate market penetration or still at a demonstration level. Bevacqua et al. proposed a Reverse Electrodialysis Heat Engine (RED HE) operating with "thermolytic" ammonium hydrogen-carbonate (NH_4HCO_3) aqueous solution as a working fluid [51]. A sensitivity analysis allowed the authors to identify the optimal operating conditions, achieving a power density of 9 W/m^2 of cell pair and an exergy efficiency approximately equal to 22%. Giacalone et al. [52] carried out an exergy analysis of a reverse electodialysis unit, based on a 1-D model and accounting for all the main factors of non-ideality such as the permselectivity of non-ideal membranes, the ohmic losses and the uncontrolled mixing phenomena deriving from salt and water diffusive fluxes across membranes. The effects of flow arrangement, load condition and concentration of solutions were also investigated. A closed-loop reverse electrodialysis heat engine was investigated by Ortega et al. [53], identifying it as a promising technology for the exploitation of very low-grade heat from renewables or waste heat from industrial processes. Multi-effect distillation unit was adopted for regeneration of concentrate and dilute solutions for the RED section, resulting as the main source of irreversibility in the whole closed-loop system. Other articles focused on the connection between rivers and anthropic activities, some focusing on the impact of the latter on the ecosystemic equilibrium and conservation of the former, some others looking at the possibility to exploit rivers for energy production. Uche et al. analysed different water demand management options to face demand deficits in the Ebro River region (Spain), applying the Physical Hydronomics methodology and accounting for the physical and chemical exergy of the river water flow [54]. Samaras and Koutitas developed an one-line shorelined change model, namely "PELNCON" elaborating the field and wave characteristics at the breaker line and a "source" term for the sediment supply rate, in order to study the evolution of the coastal morphology close to rivers [55]. Other studies focused on a promising technology like solar PhotoVoltaic-Thermal (PVT) collectors. In a paper by Buonomano et al. [56] the low-temperature heat recovered from a building-integrated PVT collector is assumed to be supplied to an adsorption chiller for space cooling purposes; a dynamic simulation model in TRNSYS is used to assess annual performance and the viability to supply a 3-floors office building located in Italy. Slimani et al. modelled a hybrid PVT solar corrector embedded in an indirect solar dryer, with the aim to assess its energy performance [57]; the system was proven to reach a suitable air temperature for drying agricultural products, while achieving an overall 90% energy efficiency. With a focus on the Water-Energy Nexus, two studies by Schlör et al. [58] and by Chinese et al. [59] addressed different aspects of this key topic in the process towards sustainable development. The former study proposed a four-phases approach based on the Ridder method to analyse the food-energy-water nexus in Germany, while the latter proposed a sectoral analysis focused on electric steelmaking industry in Europe, evaluating feasible interventions to reduce primary energy and water consumption. In the current special issue some articles are specifically devoted to present advances in renewable technologies or novel approaches for efficient use of resources. Giacalone et al. [60] propose a techno-economic assessment for applications of reverse electrodialysis exploiting the salinity gradients available in different sites, based on a rigorous assessment of energy harvesting potential in each scenario. Results are presented in terms of Levelized Cost of Energy (LCOE) and suggest that cost competitiveness can be achieved in some of the examined scenarios. A study by Ciofalo et al. investigates the boundary conditions that maximise the net power density in Reverse Electrodialysis [61], focusing on the inlet concentrations of concentrate and dilute solutions, the thickness of the channels where the solutions pass and their velocities. A third paper, by Salamanca et al. [62], discusses the potential of an osmotic power plant exploiting the controlled mix of two flows with different salinities (river water and seawater) at the Magdalena River mouth in Colombia. The potential for a 6 MW net power production is demonstrated, also proposing possible solutions for further reduction in energetic losses through improvement of pretreatment process and membrane permeability. Barone et al. propose an innovative low-cost water based prototype for a PVT collector, assessing its performance via dynamic simulation and experimental analysis [63]. Different design criteria are proposed for the system, integrated with a stratified hot water storage tank, for supplying domestic hot water to a single family house, dependin on its location (Freiburg, Naples and Almeria). In a paper by Oke et al. [64] a mathematical framework is proposed for the optimization of the use of water and energy along the whole chain of shale gas, focusing on the different steps of production, processing, distribution, usage in power production and power transmission. The water-energy nexus concept allows for the identification of margins for 23.2% reduction in freshwater utilization and 42.7% reduction in energy consumption of the regenerator.

Another technology that has attracted increasing interest due to its potential to contribute to the ongoing energy transition, and in particular to the decarbonization of the transport sector, is represented by Electric Vehicles (EVs). Several studies have been presented on this topic in past SDEWES Conferences. Briggs et al. [65] reviewed the challenging aspects of simulating non-automotive and off-highway vehicles, comparing the cases of an inner-city diesel-electric hybrid bus and a forklift truck equipped with an internal combustion engine. A paper by Cipek et al. proposed a control-oriented simulation model of a power-split hybrid EV [66], which applies the bond graph methodology to model the dominant dynamic effects of the mechanical transmission. An electric generator speed control loop is also designed, including a proportional-integral controller, and an off-line control optimization algorithm. Dayeni and Soleymani [67] presented an approach for intelligent control of fuel cell vehicles based on traffic condition recognition, using an extensive real driving pattern database including six representative traffic conditions for the city of Tehran (Iran). A fuzzy logic controller is employed, and the simulation results proved the proposed intelligent controller to success in different traffic conditions, achieving fuel savings between 9 and 17%. Hofer et al. [68] compared the effects of weight reduction, induced by the use of lightweight materials, on the energy use and cost of conventional and electric passengers vehicles. The results show a strong potential for weight and cost reduction in battery electric vehicles, although the conventional ones resulted to be more sensitive to mass reduction in terms of energy use. Two papers included in this current special issue address the topic of pattern modelling, which play a crucial role for reliable assessment of potential applications of EVs. Yavasoglu et al. propose a real time range estimation method without destination knowledge for battery EVs, based on an implementation of machine learning [69]. A very efficient decision tree method is used to classify road types, and the estimation method reveals very efficient as proven by comparison with real life measurements collected by a driving test. In the other study by Cipek et al. [70] the conversion of a conventional 1.6 MW heavy haul diesel-electric locomotive into a hybrid one is considered, based on the incorporation of a battery energy storage system in parallel to the generator. Once resized the powertrain components to meet comparable traction force, the performance of the conventional and the hybridized locomotives are compared for a mountainous railway route driving scenario with realistic slope and speed limitations, quantifying the fuel and CO_2 emissions savings.

Several of the concepts discussed above, in particular the goal of achieving high penetration of renewables and the perspectives opened by smart design and management of energy systems and by demand management strategies find a particular interest for isolated areas, such as small islands. In past SDEWES Conferences a large number of papers have been specifically targeted at planning and designing sustainable energy solutions for islands, and some special thematic sessions on this topic have also been organized by eminent scientists in the field. Segurado et al. [71] analysed the energy and water supply system in S. Vicente island, Cape Verde, assessing a couple of promising solutions: (a) the use of excess wind power to drive desalination units and face the fresh water scarcity, (b) the use the desalinated water in a pumped hydro system to store a part of the remaining excess wind power. The adoption of these measures was proven to allow for a 36% electricity production from renewable sources, at meantime lowering by 7% the costs. In a paper by Beccali et al. the potential for CHP retrofit of the existing diesel engines installed in small Italian islands was estimated [72], assessing the costs for the installation of small district heating network to supply the recovered heat. At the current economic conditions, the proposed retrofit only resulted feasible in two islands characterized by higher number of inhabitants. A study by Ocon and Bertheau proposed an accurate techno-economic assessment for the transition from a diesel-based to a solar PV-Battery-Diesel hybrid system-based grid in the islands of Philippines [73], showing that even in absence of subsidies, such a transition can lead to a 20% reduction of the levelized cost of electricity. Although not strictly focused on islands, a paper by Jin et al. [74] investigated a topic of great interest for isolated electric systems, i.e. the frequency regulation control by installation of large battery energy storage systems; in this paper, however, the analysis is conducted at a very large territorial scale (i.e. the whole Korean system), proving that the output power and frequency control of the battery performed efficiently. Stoppato et al. proposed a model for the optimal management of small PV pump hydro energy storage, particularly suitable for remote areas with no grid connection [75]; such a system was supposed to be installed in an isolated small village in Nigeria and used for pumping ground water for irrigation and other water needs. A thermoeconomic analysis of a hybrid renewable polygeneration system was proposed by Calise et al. [76], under the assumption to install a complex plant (including a parabolic through collector field, an Organic Rankine Cycle unit and a Multi-Effect Desalination system) in the island of Pantelleria. Based on a dynamic optimization and an optimized control strategy, the system achieved a simple payback in the order of 8.5 years at the current price conditions. Three papers included in this special issue are focused on different topics related to sustainable energy use in remote areas. A first study by Fuentes-Cortes et al. [77] proposes a multi-objective strategy to define the relationships between design and utility prices in water and energy off-grid systems, such as a rural isolated community in Mexico. Levelized cost of electricity is used as a common metric to analyse the off-grid systems, and a particular scenario based on a number of natural gas- and biogas-fuelled CHP units is examined. Marczinkowski and Østergaard compare the options based on electricity storage and on electricity-to-heat with Thermal Energy Storage (TES), as alternative energy planning strategies in the islands of Samsø and Orkney [78]. The TES approach results in overall reduced energy system costs, while the system with battery energy storage reveals a stronger effect on the exchange of electricity. Another study by Meschede investigated the demand shifting potential of desalination plants in remote areas like islands, using a mixed-integer linear programming method to simulate the optimal dispatch [79]. The case study demonstrated a limited demand shifting potential if only existing plants are used, while this potential significantly increases in case of utilization of additional micro pumped hydro storage.

Some other contributions presented at past SDEWES Conferences have been focused on the evolution of power systems, considered at a national or sovranational scale. Komušanac et al. analysed the impact of wind and solar PV generation on the national power system load in Croatia [80], proposing a number of simulations conducted by EnergyPLAN and obtaining a Pareto front that identifies optimal scenarios for power generation from renewables. Bogdan et al. proposed a power system optimization model [81] based on hierarchic activation of run-of-river hydro plants, cogeneration plants, nuclear and thermal power plants, also accounting for the contribution of storage hydro plants for covering peak loads and the cross-border power purchase in case of shortage of installed capacity. The model was aimed at forecasting the amounts of fuel gas to supply the power plants. Another study by Gómez et al. [82] analysed the possible consequences for the Spain electricity sector of different strategies aimed at achieving the 20% target of final energy consumtpiong from renewable energies at 2020. Several scenarios were created, based on estimation of the technical potential of renewables, the residual lifetime of conventional power generation installations and the fossil fuel prices. A paper by Gerse [83] critically discussed the adequacy of the Hungarian power system for a future scenario based on increased share of renewable energy sources. The author proposed an analytical country-specific adequacy assessment model, based on a probabilistic modelling of production from wind power plants and on original adequacy indicators, also accounting for the expected plant availability and forecasted hourly energy demand. Kozioł and Mendecka assessed the economic, energetic, environmental and sociological effects of replacing conventional plants, fuelled by fossil resources, with renewable technologies [84]. The proposed method, which represents a generalization of existing approaches based on the “Economic Efficiency of Energy Substitution” indicators, was applied to a case study and proven efficient in providing a comprehensive view of all the effects induced by substitution. In this current Special Issue two papers are focused on this topic. A study by Langarita et al. [85] investigates the economic and environmental effects of three future scenarios for the electricity sector in Spain, respectively targeted at different European Union (EU) objectives: (a) increasing the trade with the rest of Europe and the integration with the European network, (b) enhancing the environmental sustainability by increased use of renewable energy sources and (c) increasing the competitiveness of the Spanish electricity sector. A complex equilibrium model, which accounts separately for the different activities in the power sector, allowed to identify the potential improvements in production and trade and reductions on CO_2 emissions. The second paper, by Kabayo et al. [86], presents a life-cycle sustainability assessment of the electricity generation system in Portugal, proposing a comparison between the different impacts of coal, natural gas, large and small hydro, wind and PV systems. It is observed that coal has the highest environmental impacts in most of the examined impact categories, while a greater variability is observed for socioeconomic impacts. By identifying trade-offs amongst technologies and sustainability indicators, the work provides an informed basis for future energy policy in Portugal.

Another topic widely investigated by contributors at SDEWES Conferences is the energy performance of buildings and the analysis of energy saving strategies in this sector. Some papers have been focused in particular on studying building envelope, passive strategies to reduce energy loads and solutions for renovation of historical buildings. Chen et al. [87] proposed a simulation-based approach to optimize passive solutions aimed at improving the energy performance of buildings in hot and humid climates. Charde et al. compared the thermal performance of static sunshade and brick cavity wall, carrying out an experimental campaign in realistic test rooms and analysing the hourly inner temperature profiles in summer and winter periods [88]. The combined effects of the building elements allowed to improve the building energy performance in both these periods, revealing efficient in lowering space heating and cooling loads. A critical overview on the feasibility of energy retrofit actions in historical buildings was presented by Galatioto et al. [89], focusing on the Italian residential building heritage and discussing comprehensively the different effects of the most common retrofit measures, pointing out their advantages and drawbacks. Singh et al. [90] investigated the relationship between several interventions of building renovation and the occupants' thermal perception of their indoor environment. The questionnaire based comfort survey revealed that change of glazing had negligible or adverse effects on the environment, while increases in the transparent/opaque surface ratio in the envelope produced higher indoor temperature fluctuations and discomfort. Beysens et al. studied the performance of passive radiative cooling systems for dew condensation [91], collecting historical data of operation of systems installed in different sizes and carrying out chemical and biological analyses of the dew, which resulted to be qualified as drinkable water in most of the cases. Three papers included in this current Special Issue are focused on the above topic. Krstić-Furundžić et al. [92] propose a comparative assessment of energy performance for different shading concepts and façade designs. The analysis is performed by simulation for an office building located in Belgrade (Serbia), and it allows to identify the shading solutions that most contribute to reduce heating and cooling loads, offering useful insights for renovation in similar office buildings. Bottino-Leone et al. [93] present a holistic approach for the evaluation of natural-based internal insulation as a solution to reduce energy demand in historic buildings without affecting the integrity of their façades. Dynamic hygrothermal simulation and energy assessment are performed and complemented by a life-cycle assessment to calculate the environmental impacts of intervention. The third paper by Blázquez et al. [94] is aimed at assessing the potential improvement of comfort conditions and energy efficiency in Mediterranean heritage residential buildings through incorporation of passive strategies, such as thermal isolation of air cavities of walls and retrofit of window frames and glazing. The results testify that the benefits in terms of energy load reductions are higher than the potential improvement in comfort conditions.

Other studies have been focused on the relevance of building modelling for the identification of efficient solutions and design of more sustainable buildings. Chong and Wang proposed an interesting review of Building Information Modeling (BIM) applications for sustainable development in the built environment [95], focusing on certain areas of sustainability and on the phases of project development, design and construction. Horvat and Dović proposed a rigorous dynamic model, based on differential equations, to calculate buildings energy requirements and heat losses in the DHW production and the space heating system [96]. The proposed application to a family house was used to compare the results with those obtainable by EN ISO 13790 and standard EN 15316, showing that significant differences exist between these approaches, in terms of calculated annual energy consumption. In a paper by Annunziata et al. [97] a detailed overview of the current national regulatory framework in 27 EU Member States was presented, with a focus on (a) the integration of energy efficiency and renewable energy requirements, (b) the translation of investments in energy savings into economic benefits, (c) the commitment towards "nearly zero energy" target. The analysis revealed large differences among the examined states. Another study by Kočí et al. investigated the influence of the adopted weather data in the assessment of building energy loads by dinamic simulation [98], comparing the results achieved for a building in Prague (Czech Republic) adopting eight different weather data sets. The results showed that the calculated energy load are very sentitive to the weather data set adopted, with discrepancies between annual loads up to 20%. Beccali et al. reviewed a number of models evaluating thermohygrometric comfort in natural ventilated buildings, based on adaptive approaches [99], focusing on hot-humid climates and considering the Mozambican building traditions as a case study. Turhan and Gokcen Akkurt analysed the perceived thermal sensation of occupants in office buildings located in sites with Mediterranean climate [100]. A multiple linear regression model was used to derive analytical relationships between the measured objective and subjective parameters, with the aim to identify margins for reduction in energy consumption without affecting the thermal comfort of occupants. Two papers included in the current Special Issue are focused on building energy performance modelling and on the relevance of occupants behaviour for its assessment. The first study, conducted by Marzullo et al. [101], develops a systematic toolchain for the automatic extraction of Reduced-Order Models from Computational Fluid Dynamic simulations, with the aim to support the design and operation of Near-Zero Energy Buildings (NZEB). Assuming as input parameters the inlet temperatures and mass flow rates at the zone-zone interfaces, the results show that the absolute error can be very low, while the computational cost for solving the model can be significantly lower. The second contribution by Piselli and Pisello [102] discusses the influence of occupants' behaviour long-term monitoring integrated to prediction models on the building energy performance, assuming an office building as a case study. The use of data derived from two-years monitoring and the integration with neural response tests performed on selected occupants allows the authors to recognize the relevant role of personal non-physical factors in the reaction to thermal stimuli. Another recently emerging research line consists in the thermoeconomic analysis or optimization of buildings energy systems. Due to its peculiar nature, thermoeconomics has been traditionally devoted to the analysis of energy conversion systems in stationary or quasi-stationary operation, as can be observed in the paper by Kostowski and Usón [103] where a thermoeconomic cost-accounting was carried out for a natural gas expansion system integrated with a cogeneration unit. Similarly Rokni proposed a thermoeconomic analysis of a complex system, including biomass gasification, a solid oxide fuel cell and a Stirling engine, considering it in stationary operation and thus calculating cost rates for each material stream and energy flow [104]. From this viewpoint, the paper by Pikon et al. [105] certainly introduced some methodological novelty, discussing some elements of thermoecologic cost accounting for the home heating sector. However, in this cited paper the analysis was carried out following a life cycle perspective and the critical aspects of thermoeconomic applciations in systems with unsteady operation did not emerge. In this current special issue a paper by Picallo-Perez et al. proposes a novel approach for thermoeconomic analysis under dynamic operating conditions targeted at space heating and cooling systems in buildings [106]. The method operates on "averaged energy flows" calculated by dynamic simulation on an arbitrary time basis and adopts a flexible super-structure to account for the different operating modes of HVAC systems throughout the year.

Finally, several papers presented at SDEWES Conference are aimed at developing models for representation of global phenomena or at analysing the availability of resources at global scale and their international trades. A study by Akashi et al. [107] presented a projection for global CO_2 emissions from the industrial sector up to 2030, considering future scenarios concerning the changes both in technologies and industrial activities. Assuming no changes in technology, a dramatic increase of emissions in 2030 was estimated (15 $GtCO_2$), due to growth in industrial production, while technological options for emissions reduction (with an estimated cost of 100 US$/$tCO_2$) resulted to provide a reduction potential of 5.3 $GtCO_2$. Pleβmann and Blechinger proposed an outlook on South-East European power systems until 2050 [108], attempting to identify the most cost-effective decarbonization pathway to reach the EU mitigation targets. The developed multi-regional power system model led the authors to estimate the need for an additional 120.7 GW capacity from PV systems and 92.4 GW from wind power. A paper by Đozić and Urošević included in this special issue proposes an innovative use of Artificial Neural Network (ANN) for testing long-term energy policy targets [109]. The analysis focuses on the prediction of CO_2 emissions at EU level until 2050 and it examines several ANN structures to select the one best performing for modelling large energy systems, namely the *Cascade Forward Back Propagation* structure. With regard to studies focused on the security and economics of supply of fossil energy resources, Taliotis et al. analysed the prospects of Cyprus and Israel focusing the attention on natural gas [110]. This study highlighted that due to the rapid increase in the annual consumption, large efforts have been made in these countries in the search for and the exploitation of offshore reserves, eventually resulting in a relevant potential for export of electricity, liquefied natural gas and gas-to-liquid products. The last paper included in this special issue, written by Guo and Hawkes [111], analyses the impact of gas demand uncertainties and of geopolitical issues, such as the tariff strategies between China and United States on the gas produced in the latter country, on global gas trade. The study reveals that even if global demand decreased by 2030, the revenue of North American gas trade would be only marginally affected by an additional tariff imposed by China on US natural gas.

1. Conclusions and acknowledgements

This Special issue, dedicated to the 1st Latin American SDEWES Conference, the 3rd South East European Conference on SDEWES and the traditional Fall Conference SDEWES 2018, provides an overview of great diversity of topics related to sustainable development. The Guest editors believe that the selected papers and the addressed issues will considerably contribute to extend the knowledge body published in Energy journal and will be of interest to its readers.The Guest editors would like to thank all the reviewers who have made most valuable and highly appreciated contributions by reviewing, commenting and advising the authors. Special thanks should go to the administrative staff of the Energy journal for their excellent support.

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Available online 31 October 2019