Advanced visions and problem-solving strategies across energy water and environment systems

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From the Guest editors

ADVANCED VISIONS AND PROBLEM-SOLVING STRATEGIES ACROSS ENERGY WATER AND ENVIRONMENT SYSTEMS

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This editorial provides an overview of twenty scientific articles published in the special issue of Thermal Science. The papers were selected from among 601 contributions presented at the 14th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES 2019), held October 1-6, 2019 in the city of Dubrovnik, Croatia. The topics covered in the special issue include: Energy savings in the building sector; Advanced combustion techniques and fuels; Combined heat and mass transfer of fluid-flow; and Sustainability issues in industrial and power plants: challenges and viable solutions. The editorial also emphasised the papers recently published in the Special Issues of leading scientific journals dedicated to the series of SDEWES Conferences.

Keywords: *combustion, fuels, building sector, heat and mass transfer, energy systems, sustainable development*

Introduction

The Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) [1] is an international scientific conference that gathers scientists and professionals with advanced visions and problem-solving strategies across energy, water and environment systems. Starting from the first Conference in 2002 [2] in the home venue of Dubrovnik, Croatia, the SDEWES research community continuously promoted, motivated and encouraged the holistic and multidisciplinary research directions towards the more sustainable future of the world. Last year, the 14th SDEWES conference [3] reached the record number by bringing together around 570 scientists, researchers, and experts from 55 countries, which provided 17+1 special sessions, four invited lectures, 511/100 of the oral/poster presentations, and two panels with some of the most distinguished experts in the field of sustainable development.

The co-operation between SDEWES Conference and one of the leading SC journal from Serbia *Thermal Science* [4] have been established from the early days in 2002 and continuously expanded by launching the Special Issues [5-10] dedicated to each biannual meeting till today. The present Special Issue of *Thermal Science*, dedicated explicitly to [3], focuses on the four main topics, including Energy savings in the building sector; Advanced combustion techniques and fuels; Combined heat and mass transfer of fluid-flow; and Sustainability issues in industrial and power plants: challenges and viable solutions. The twenty selected papers provide new research contributions in the field of sustainable development, and all of them propose novel approaches or remarkable advances in research studies already explored in past SDEWES Conferences. This editorial also provides an overview of the recently published papers in Special Issues of leading scientific journals dedicated to the series of SDEWES Conferences.

Energy savings in the building sector

In the starting period of the SDEWES Conferences, the energy conservation in buildings and urban areas was marginally investigated [11]. However, due to the growing interest during the last decade, the number of papers on this topic rapidly expanded in the last SDEWES Special Issues. One of the research goals in the studies presented in the last three years was the implementation of retrofit/refurbishment based methods and tools, which enable the significant improvement of the energy efficiency in the different type of buildings: the institutional building in Prague, Czech Republic [12], Brazilian institute of higher education [13], Italian historical buildings [14], Spanish educational building [15], and the apartment buildings in Zagreb, Croatia [16].

Following this trend, Ćuković-Ignjatović *et al.* (p. 3521 in this Special Issue) applied a novel approach to indicate the possibilities for energy efficiency improvement in several building types, which correspond to the typology of kindergartens in Serbia. The current energy performance of the research objects, as well as the estimated performance of the same items, arose as a consequence of three anticipated energy retrofit scenarios (named as improvements in authors' text) were calculated in accordance with the Serbian regulations for Energy Performance Certificate methodology. The calculation results that were obtained by Knauf Term Pro software included: the thermal envelope; heating, ventilation, and air conditioning system; domestic hot water systems; and electrical power and energy systems. In conclusion, the authors pointed out that the large and medium-sized kindergartens, which were built during the 1970's and 1980's, should be in the focus of retrofit/refurbishment activities since these objects account for almost 70% of the total kindergartens' heating area and their real energy demands covered about 76% of aggregate demands in all kindergartens.

The next research direction in this topic covered the specific energy-efficient design of buildings which usually takes into account the thermal analysis of building components. In this group of papers, the authors tried to improve the performances of the buildings by considering: the thermal conductivity of materials in exterior walls and flat roofs in different climate conditions [17], building wall heat capacity [18], the performance of phase change materials embedded in building enclosures [19], and the costs and benefits of roof types, particularly the green roofs [20].

Li *et al.* (p. 3465 in this Special Issue) carried out the numerical simulation to investigate the microclimate inside the Chinese solar greenhouse (CSG). The authors established the 3-D mathematical model to predict the heat transfer details in the CSG and to evaluate the influence of north wall characteristics on the microclimate inside the solar greenhouse. The results of numerical simulation are obtained by using the finite volume method of CFD which was applied on ANSYS FLUENT 19.0 software. The authors reported the reliability of the numerical model and the excellent agreement of computation-based results with the experimental measurements. Comprehensive analysis related to the north wall's thickness, configuration and material property indicated its low impact on the thermal environment inside the CSG. The paper was closed with the authors' observation that their study can be seen as guidance for completing the CSG engineering database and optimal solar energy utilisation for heating purpose.

The integration of RES as the action which will lead to offsetting the conventional use of fossil fuel, both at the district and building level has been actively promoted in SDEWES for long years. The methods which provide the simultaneous implementation of the energy efficiency measures and the increasing utilisation of RES were conducted in the numerous case studies such as: in the hotels on small Mediterranean islands [21], in the small office building located in Southern Italy [22], in the 3-floor office building located in four different Italian weather zones [23], in the ventilated building solar thermal facade built in Ragusa [24], and in the twelve buildings in University Campus of Bari, Italy [25]. Many authors in this research field proposed the use of thermal storage facilities [26] for optimally tackling dynamic characteristics of district heating and cooling in urban energy systems, and to wisely exploit the RES [27], the waste energy [28] and the high-performance technology [29].

Under the aforementioned research objectives, Rosato *et al.* (p. 3555 in this Special Issue) presented the central solar hybrid heating and cooling system [30, 31], integrated with borehole thermal energy storage, aiming to satisfy the thermal, cooling and sanitary water demands of a typical Italian small district. The TRaNsient SYStems (TRNSYS) software has been used for modelling and simulation of the proposed system over five years and with a one-minute resolution time, starting from January 1st. The performance of the system has been assessed from energy, environmental and economic points of view and contrasted with the operation of a typical Italian heating and cooling plant. The authors reported that the new design solution could provide: considerable primary energy savings, decrease of equivalent CO_2 emissions, and reduction of operating costs, in regards to the typical plant. They also estimated its simple payback period of about 20 years.

The performance of seawater source heat pump (SWHP) which could be used only for heating and cooling purposes of buildings in the Old City of Dubrovnik, Croatia [32] was studied by Falkoni *et al*. (p. 3589 in this Special Issue). In the proposed conceptual design, the SWHP utilised the electrical energy either from photovoltaic or/and wind power producing units and the opportunities for energy storage were accomplished by thermal or battery storage systems. The potential of SWHP to utilise the electrical energy from the power-producing plants, was provided for the system based on an hourly and 10 minute time step. The research process contained the analysis of three scenarios that were created by a different combination of SWHP and energy storage systems, while in each of the scenarios the three separate cases, depending on the SWHP's electrical energy source, are defined. The authors disclosed the comprehensive set of results which involved the thermal and economic performances of all scenarios and associated cases and notified the promising design solution for future research.

Doračić *et al.* (p. 3673 in this Special Issue), presented an energy planning study, based on a scenario analysis strategy, for efficient utilisation of industrial excess heat sources [33] into the district heating system. The results of the study are obtained using the data acquired through the CoolHeating project for the city of Ozalj in central Croatia. These data had been processed in the EnergyPRO software for modelling and analysis of complex energy projects with a combined supply of electricity and thermal energy. The model of the district heating system consisted of conventional heat production units, natural gas cogeneration and peak load boilers, and solar thermal collectors, which were combined with a thermal storage system. The primary source of industrial-excess heat in the study was the industrial plant for manufacturing ceramic products, located in the relative vicinity of the city. The authors defined three scenarios named Reference scenario, Scenario 1 and Scenario 2 to analyse the utilisation rate of excess heat and its effect on power-producing units in the system while taking into account the hourly variability of the source. They observed that due to the variable availability of the excess heat source, a significant mismatch with system heat demands could occur in different seasons of the year, and consequently proposed the construction of a designated thermal storage system [34] for the utilisation of excess heat. In a discussion, the authors compared the thermal and economic performance of the proposed scenarios. By that, they provided numerous conclusions related to the more efficient utilisation of industrial excess heat sources into the existing district heating system.

Finally, in last but not least study presented in this topic, Kilkis (p. 3685 in this Special Issue) start the paper with two observations: the first one was that low temperature district energy systems (LTDES) are becoming a focal point in in the global effort and transition to the true sustainability, and second, while moving towards 100% renewable LTDES, the exergy of the district energy may decrease below the pumping exergy requirement, which will eliminate the benefits of using the low-exergy renewables. For that reason, the author proposed an exergy-based holistic model for district energy systems as an optimisation tool for the design and operation of successful 5G districts. This model could improve the value of the overall exergy-based coefficient of performance by primarily focusing on the plant-to-district distance. The research scope covered four TIERS, and each of them is indexed to the optimum plant-to-district distance for maximum exergy-based performance and with minimum CO_2 emissions responsibility. The study also considered the three alternatives for conveying and distributing exergy to the district. The author used the specific algorithm to optimise the thermal insulation thickness in terms of equipment oversizing and temperature-peaking. In conclusion, the author notified that low-exergy district energy systems, when coupled with the lower exergy (LowEx) buildings [35], has a significant potential for decarbonisation, provided that the set of auxiliary recommendations accompanies such attempts.

Advanced combustion techniques and fuels

Combustion accounts for 80% of human GHG emissions and despite the rapid growth in renewable energy generation combustion, still dominates in meeting our insatiable energy demands [36]. Efficient combustion processes is another technology that has attracted increasing interest in SDEWES due to its potential to contribute to relative energy and emission savings in the ongoing energy transition.

Liu *et al*. (p. 3477 in this Special Issue) and Wang *et al*. (p. 3489 in this Special Issue) presented the papers that continued the successful practice of on-going research in MOE Key Laboratory of Thermo-Fluid Science and Engineering School on Xi'an Jiaotong University in China [37-41]. In the first paper (p. 3477 in this Special Issue) they studied the fouling deposits on the blade of the induced draft fan and the surface of the two-stage low temperature economiser (LTE). The research objects were the parts of ultra-supercritical and ultra-low emission coal-fired power plant, located in Shouguang City in China. The study included the elementary analysis of fouling deposits, examination of the reactions of the mineral compositions, and identification of micromorphology. Based on the results, the authors described and illustrated the formation mechanisms of the fouling deposits. In conclusion, they suggested that the thermal design of LTE should be determined to coal and ammonia slip quantity, ash concentration, *etc.* and also elaborated on the problems related to the operational temperature in low-low temperature electrostatic precipitator.

In the second paper (p. 3489 in this Special Issue) the authors used the methodology of CFD computation for analysis of the flue gas-flow and biomass ash particles deposition during the biomass utilisation. The goal of the study was the determination of the sticking characteristic of ash particles and condensation rate of salt vapours on both the windward and the leeward sides of tubes. They provided the 2-D, unsteady-state model and performed the CFD numerical simulation using the code FLUENT combined with some user-defined functions to gain more data on variables. The results of the study unfolded the importance of vapour condensation in the overall deposition rate during the formation stage of initial deposition and signified the more details and basic knowledge related to the problems of particle impaction, rebound, stickiness, and direct condensation of salt vapours on the surfaces of superheater tubes.

Zi *et al*. (p. 3501 in this Special Issue) studied the effects of different parameters combustion conditions on of Shaerhu coal that is utilising in circulating fluidised bed (CFB) boiler located in Xinjiang province, China. Authors provided a comprehensive experimental study to reveal the influence of additives (DH coal cinder, aluminium ash, kaolin, desert sand and washed sand), ash fusion characteristics, mineral transformation and elemental release of Shaerhu coal ash. The final results of the investigation point out a few critical conclusions related to the additive type and ratio to reduce deposits formation on heat transfer surfaces, referred to as slagging and fouling problems of CFB boilers. Other papers published in the previous SDEWES Special Issues in this field studied the ash/emissions-related problems during co-firing low-rank Bosnian coals with different kinds of biomass [42], and ash deposit formation during the combustion of pulverised grape pomace in a drop tube furnace [43].

Qi *et al*. (p. 3511 in this Special Issue) investigated the combustion and fluid-flow coupled with heat transfer of the ladle baking process in the iron and steel industry. The 3-D mathematical model has been proposed a detail analysis of the turbulent combustion and its coupling effects on the heat transfer phenomenon during the ladle baking process. The authors considered the difference between gas radiation in oxygen-enriched combustion and the traditional air-assisted combustion, and they also introduced the modified weighted sum of the grey gases model. Numerical results showed that for the same baking effect, the implementation of pure oxygen combustion can effectively reduce fuel consumption by up to 41.6%. Recently the same group of authors presented a similar numerical study for reheating furnace [44].

Slefarski *et al*. (p. 3625 in this Special Issue) provided the experimental study on the combustion process of methane mixed with ammonia using the flameless combustion technology. In the introduction, the author pointed out that flameless combustion technology has a great potential in the context of increasing the efficiency of energy systems, reducing the emissions of NO_x and high-efficiency utilisation of non-standard low calorific gaseous fuels. The experimental study was conducted in an industrial combustion chamber equipped with the industrial high regenerative system burner. The research goal was to study the influence of physicochemical properties of fuel mixtures and the exploitation parameters of industrial furnaces that are operating in flameless technology. Based on the detailed analysis of the experimental results, the authors concluded that ammonia (as an energy storage agent), when co-fired with methane in the regime of flameless combustion technology, enables the significant increase of sustainability of industrial combustion processes.

The group of authors from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia in last years published several papers related to the numerical and experimental studies of combustion processes in diesel engine [45], spray modelling including the fuel jet disintegration and droplet evaporation processes [46] and behaviour of liquid wall films and its application in many industrial areas [47]. Jurić *et al.*, (p. 3663 in this Special Issue) studied the energy efficiency of combustion systems, and evaluated the impact of radiation on overall heat transfer and consequently, on emission formation. The authors analysed the heat transfer mechanism inside the combustion chamber and the radiative heat transfer in participating media by using the two radiation models: Discrete Transfer Radiative Method (DTRM), and Discrete Ordinates Method (DOM), featuring the finite volume method discretisation technique. In combination with the steady combustion model in AVL FIRE™ CFD code, both models were applied for computation of temperature

distribution in a real oil-fired industrial furnace. The CFD simulation was performed for three steady-state simulations:
(i) the case without radiative heat transfer, where approximately 25% higher temperatures were reached,
(ii) case in which DTRM calculated the radiative heat transfer, and
(iii) case in which DOM calculated the radiative heat transfer.

The computational time in the test cases showed that the CPU execution time of (ii) is approximately four times more time-consuming compared to the (i), and in the case of (iii) and (i) this proportion is around 2:1. The simulation results, for all three cases, were validated against the experimental measurement in the industrial furnace. The authors reported the clear advantage of employing DTRM and DOM radiation models in regards to the case which does not account for radiative heat transfer during the simulation. Furthermore, the results by the DOM model achieved a better agreement with experimental results in the temperature trend near the furnace outlet. In conclusion, they pointed out that the methods with DTRM and DOM models can serve as a solution for a swift investigation of the radiative heat transfer in participating media of real industrial furnaces.

Combined heat and mass transfer of fluid-flow

The problems of heat and mass transfer include a wide variety of engineering disciplines concerning theoretical research, fundamental studies, mathematical modelling, numerical simulations, and experimental investigations. In the previous period, the SDEWES researchers were focused on analytical, numerical and experimental research, with an emphasis on contributions which increase the basic understanding of heat and mass transfer mechanisms: in different types of equipment, such as heat transfer performance of plate heat exchangers [48], the effect of supercritical CO_2 side inlet temperature and pressure on the overall heat transfer performance of a printed circuit heat exchanger [49], the thermo-fluid dynamics characteristics of the industrial ceramic kiln [50]; systems, like the selection of the best overall layout for the experimental Greenwall through the type and the thickness of substrate, plants and air gap [51]; processes, like the cooling effectiveness of the mist/air two-phase flow [52], the selective catalytic reduction based on urea water solution as ammonia precursor [53], and other related objects.

Wang *et al.* (p. 3533 in this Special Issue) upgraded the previously presented research of packed bed [54], a type of process equipment widely used in chemical industries. This time they investigated the relationship between the flow inhomogeneity and the heat transfer characteristics in two types of packed beds: the grille-sphere composite structured packed bed (GSCPB), and the structured packed bed in simple cubic (SC) configuration. The research was performed by the numerical simulation, based on the Renormalization group (RNG) k-ε model used in the CFD code of ANSYS FLUENT software. Both dispersions of the velocity distribution and the residence time distribution are employed to assess the flow maldistribution. The authors elaborated on the results of simulation details and provided three main conclusions related to: uniformity of velocity distribution; flow inhomogeneity; and heat transfer enhancement in GSCPB and SC. The same group of authors recently published the several papers by studying the heat and mass transfer phenomena in the distribution of flow and film cooling effectiveness for improving operational efficiency and reducing the emissions of gas turbines [55-58].

The authors from the Faculty of Mechanical Engineering, the Opole University of Technology in Poland, presented two papers related to the long-standing research process in the laboratory of multi-phase flows. The studies, published in previous SDEWES Special Issues [59, 60], were carried out by parallel using the dynamic image analysis and stochastic processes analysis. In the first paper, Anweiler *et al*. (p. 3577 in this Special Issue) upgrade the body of knowledge presented in [61] and gave an overview of the visualisation techniques of videogrammetry. They described the videogrammetry as a technique that combines visualisation with a simultaneous examination of the momentum, heat, and mass transfer processes along with synchronisation and automation of data acquisition. The authors illustrated the capabilities of this technique for the time domain analysis of changes in selected features and parameters, especially in applications to multi-phase gas-liquid and the solid-gas mixture flows. In conclusion, they addressed that videogrammetry allows the researcher to investigate the mechanics of the flow in multi-phase mixtures, and to optimise the working conditions in many multi-phase flows related types of industrial equipment, with a focus on shell-and-tube heat exchangers and chemical reactors.

Ligus *et al.* (p. 3569 in this Special Issue), evaluated the two different particle image velocimetry (PIV) algorithms, for the prediction of phase flow velocity in industrial devices that operate in the two-phase gas-liquid flow regime. The main idea of the research was the simplification of current calculation procedures in the analysis of the two-phase flow velocity field, which could enable a faster response in the case of automated process control. Experimental measurements were carried out in a rectangular vertical narrow channel using the specific digital PIV measurement system that was controlled by the Dantec Dynamic Studio 2015a environment software. The measurement was organised as the comparative study of flow parameters that secure the occurrence of the four two-phase structures during such flow and dispersed slug for the channel. The analysis of the velocity field was performed using the adaptive correlation (AC) and the adaptive PIV (APIV) algorithms. In conclusion, the authors notified that for some of the flow types, it is possible to replace the time-consuming APIV method and calculate the velocity vectors using AC, because it gives similar results to those obtained by APIV. By them, the extension of the proposed method for selecting an appropriate PIV algorithm, with knowledge of a wider range of two-phase flow hydrodynamics will enable the improvement of the decision-making process related to multi-phase flow industrial systems.

During the last decades, the SDEWES researchers presented a considerable number of experimental and theoretical studies that describe the new class of nanotechnology-based heat transfer fluids with augmented thermal properties – nanofluids. These studies covered the effects of gravity and variable thermal properties on nanofluid convective heat transfer [62], the life-cycle environmental implications linked to the energy efficiency improvement by a nanotechnological aerogel based panel insulation solution [63], the effect of nanoparticle-diesel fuel blends on combustion characteristics, performances and exhaust emissions of a four-stroke single-cylinder Diesel engine [64], the performance, combustion and emission characteristics of a multi-cylinder diesel engine operated with nanoparticles – 100% jatropha biodiesel fuel mixture [65]. Zhen *et al.* (p. 3601 in this Special Issue) studied the thermal performance and flow resistance of nanofluids in the heat exchangers. The experimental investigation was conducted using the one-meter long double tube heat exchanger in which the nanofluid and hot water was flowing in the inner tube and the annular outer part, respectively. The main goal of the study was to determine the influence of Reynolds number and nanoparticle mass concentration on the Nusselt numbers and friction factors. After detail numerical analysis of experimental results, the authors proposed the empirical formulae which can predict the Nusselt number of six nanofluids considering different flow conditions in double tube heat exchangers.

Sustainability issues in industrial and power plants: challenges and viable solutions

The last topic in this editorial contains the four papers of Special Issue that addressed the energy and environmental challenges in different types of complex energy systems, and where the authors proposed viable solutions following the principles and objective of sustainable development.

Charvat *et al.* (p. 3543 in this Special Issue), investigated the feasibility and consequences of replacing nuclear power plants in the Czech Republic with other types of power plants that use different energy sources. In the short overview of the current electricity production, regarding the types of energy sources used in the Czech Republic, the nuclear power plants are identified as the second-largest power producer, which share in the energy mix will soon be increased due to the decommissioning of some coal power plants. The author noticed that those plants could be replaced only by the combination of other power-producer that utilise the different energy sources/technologies such as: RES; coal-fired and combined cycle power plants; small scale cogeneration plants; and waste-to-energy plants; and by the implementation of different measures like import of electricity, energy savings, *etc*. The paper is closed by two conclusions: first, retiring or replacing nuclear power plants would be a political decision, and second, at this moment only the combined cycle power plants running on natural gas are technically and environmentally feasible alternatives for existing nuclear power plants in the Czech Republic. Other papers published in the previous SDEWES Special Issues that uncovered the current trends in the transition to sustainable energy systems investigated: the impact of further integration of variable renewable energy in Germany on the Nordic power market [66]; opportunities and barriers for the energy transition in transport sectors [67]; Mexico's strategy for transitioning from an electricity system highly based on fossil fuels to one based on RES [68]; the urban energy transition of Gruž district in Dubrovnik city, Croatia [69]; and smart energy transition in Danish island of Samso [70].

The concept of power-to-methane that converts electrical into chemical energy was studied by Bareschino *et al.* (p. 3613 in this Special Issue). The authors proposed the innovation conceptual process layout, consisting of the three interrelated units: hydrogen production system, fluidised beds chemical looping system for the combustion of solid fuels, and the methanation reactor. Mathematical modelling and analysis are performed for each of the process units to evaluate the process performances under different parameters of: fuels, coal and three sewage sludge; oxygen carrier; cupric oxide supported on zirconia; hydrogen production via water electrolysis; and methanation catalyst, nickel supported on alumina. The paper is closed by two important conclusions: First, the net power production with reduced or near-zero CO_2 emissions in the process is unfeasible only when very high-moisture/ash-con tent fuels are used, and the second, the proposed process can be utilised as an energy storage system (by assuming only the energy from renewable sources to be used in the process) and in that case, the electric energy storage efficiency is 13% notwithstanding the type of fuel been utilised. The high temperature electrolysis-based power-to-methane process and its integration with oxyfuel combustion to co-generate synthetic methane, heat and power are also presented in [71].

Novak Pintarič *et al.* (p. 3637 in this Special Issue) provided the preliminary design of an industrial plant for the production of high quality concentrated liquid fertilisers and clean water. The authors proposed the two-stage vacuum evaporation process for the conversation of digestate, which had been produced in a biogas plant during the anaerobic digestion of poultry manure and corn silage. The study was performed by combining the laboratory experiments and process systems engineering methods to obtain a feasible and economically viable design solution. The comprehensive economic evaluation of a design solution indicated the positive net present value, a high internal rate of return and short payback time. In conclusion, the authors pointed out that the installation of optimised and heat-integrated two-stage vacuum evaporation process, within the biogas production plants, could result in a circular and economically viable waste management technology. Recently, two Special Issues based on the circular economy track at the SDEWES conference [72, 73], attracted the interest in seeking inspiration and concrete solutions for a sustainable future.

Filkoski *et al.*, (p. 3649 in this Special Issue) continue the system-oriented approach for analysis and energy efficiency improvement of the existing complex energy systems like in the case of lignite-fired steam generator [74] and rotary kiln for dolomite calcination [75]. In this paper, the object of research was the steam-condensate system of the combined heat and power plant, located in Skopje, R. N. Macedonia. The primary energy audit was performed by Energy Steam System Scoping Tool, and it included the analysis of the main processes in the plant, like steam generation, distribution and use; condensate recovery; and combined heat and power generation. Based on the results from an energy audit, two groups of energy losses are identified: in-plant losses, and losses in the heat distribution network, and a set of low-cost measures for energy savings in the plant are proposed. The potential impact of some reliable measures, which were mainly focused on the steam production for the district heating system, are analysed using the Steam System Modeler Tool. In conclusion, the authors reported the significant potential for savings of natural gas, electrical energy, and water, which could lead to the considerable improvement of plant profitability.

Conclusions

This Special Issue of Thermal Science, dedicated to the 14th Sustainable Development of Energy, Water and Environment Systems Conference, held in 2019 in Dubrovnik, Croatia, overview the broad and multidimensional scope of the UNESCO-sponsored SDEWES Conference Series, a leading conference in the field of energy, sustainable development and the environment in the region. The twenty selected papers present recent advances in four scientific topics, and the Gest Editors believe that significant body of work published in this Special Issue will considerably contribute to improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development.

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