A Preface to the Special Issue of Optimization and Engineering dedicated to SDEWES 2019 Conference

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Abstract

Global warming and climate change call for urgent minimization of human activities on the environment. Therefore, there is a great need for the improvement of resource efficiencies by integrating various life-supporting systems. The challenge is on the energy, water and environment systems to integrate and become more sustainable. This field of research has received increased attention over the past years with studies across the energy, water and environment systems that optimized different engineering problems. This Special Issue is motivated by the Sustainable Development of Energy, Water and Environment Systems Conference held in October 2019, in Dubrovnik, Croatia. The purpose of this review introduction article is to provide a brief introduction to the field and the articles included in this Special Issue.

Keywords: Optimization; Energy; Water; Environment; Engineering

1. Introduction

From 2002, the beginning of this millennia, the Sustainable Development of Energy, Water and Environment Systems (SDEWES) conference series served to researchers from around the world as a meeting point where they could share, discuss, and develop new ideas in the various areas of engineering. This includes the improvement and dissemination of knowledge in three most important life-supporting systems, namely: Energy, Water, and Environment. The SDEWES 2019 Conference held in Dubrovnik, Croatia during October 1 - 6, 2019, brought together 570 scientists and experts in the area of sustainable development of

energy, water and environment. There were 511 oral presentations, 100 poster presentations, 4 invited lectures and 2 panels with some of the most distinguished experts in the field.

Starting from 2019, and these record numbers in participants and papers presented, the cooperation between SDEWES conference series and the Optimization and Engineering (OPTE) journal, in form of a Special Issue (SI) dedicated to the SDEWES conference was initiated. This SI will serve OPTE's international community interested in the development of novel optimization methods for challenging engineering problems, the innovative application of optimization in engineering, and the opportunities for optimization in various engineering fields. To give the OPTE readers a sense of continuity, this SI introductory article reviews some previous publications that originated from the SDEWES conferences and were published in other journals' SIs that were dedicated to the SDEWES conferences.

2. Background

This section provides the background to the main part of this article, that is the Section 3, where papers included in this SI are shortly reviewed. The content of this section is based on the papers published under other journals' SIs dedicated to SDEWES conference series.

When it comes to the *Energy* system, advanced numerical methods and mathematical modelling techniques have been used, in a significant number of papers, to study various engineering processes and applications. These studies refer to energy engineering problems ranging from optimal heat-exchanger layout for heat recovery steam generators (Čehil et al., 2017), technical and economic performance of a heat exchanger network (Nemet et al., 2013), optimization of an organic Rankine cycle for compact heat exchanger application (Holik et al., 2019), mixed-integer linear programming of heat and power units (Koller and Hofmann, 2018), a multi-objective optimization approach for the selection of working fluids of geothermal facilities (Martinez-Gomez et al., 2017), a multi-objective optimization of a factory model acting as a prosumer on the electricity market (Perković et al., 2018), short-term electricity price and load forecasting in isolated power grids (Heydari et al., 2020), impact of thermal storage capacity on the optimal operation of an industrial energy system (Panuschka and Hofmann, 2019), optimization of a hybrid electric vehicle power-train system (Cuper et al., 2020), etc.

The importance of modelling techniques has been emphasized by several studies analyzing the flexibilization of the future energy systems. These studies examined national, regional and city size power, heating and cooling systems and the utilization of demand

response and Power-to-X systems (Mikulčić et al., 2019). Consequently, there have been studies that analysed optimal design of cogeneration units in the industrial sector (Gambini and Vellini, 2019), coupling of day-ahead electricity market and demand response production (Perković et al., 2017), multi-objective optimization of district heating and cooling systems (Dorotić et al., 2019a) and in a subsequent study the economic, environmental and exergetic multi-objective optimization of district heating systems (Dorotić et al., 2019b), the optimal heat source location of partially heated energy storage process (Dai et al., 2020), optimization of modular district heating solution based on combined heat and power production facility and renewable energy resources (Kazagić et al., 2019), optimization of the future German energy system for power-to-hydrogen applications (Welder et al., 2018), the role of power-to-gas and hydrogen in Italian energy system (Colbertaldo et al., 2018).

The *Water* engineering problems have been addressed and studied by a number of papers, where the water-energy nexus has been most significantly investigated (Urbaniec et al., 2016). The water-energy nexus studies investigated the desalination unit and the heat transfer inside of its preheater system (Hamid et al., 2014), the geometry optimization of oscillating water column for wave energy converters (Ulazia, et al., 2020), optimization of net power density in reverse electrodialysis (Ciofalo et al., 2019), optimization of modular system for power generation from a salinity gradient (Altaee and Cipolina, 2019), optimization of water-energy nexus in shale gas exploration (Oke et al., 2019), optimization of a polygeneration system producing heat, cool and fresh water (Calise et al., 2019), combining of the heat exchanger network and water network (Ahmetović et al., 2014), and in the later study by Ibrić et al. (2016), optimization of hot water production in different climates using solar thermal collectors (Kalogirou et al., 2019), a novel geothermal energy system for wastewater and sludge treatment (Di Fraia et al., 2019).

Optimized local energy supply for efficient and clean *Environment* systems has been the topic of study for a growing number of papers that not only analyse the environmental impact of different technologies, but also analyse the economic viability of such technologies (Mikulčić et al., 2016). Some of these studies include a multi-objective optimization of a syngas powered internal combustion engine to lower nitrogen oxide emissions (Costa et al., 2020), dynamic modelling of the biomass gasification process in a fixed bed reactor (Cerinski et al., 2020), nonlinear modelling of transient operating conditions for a gas turbines (Pires et al., 2018), numerical modelling of a gas cyclone for particle separation (Mikulčić et al., 2014), multi-objective optimization of the municipal solid waste (MSW) management system (Hrabec et al., 2018), optimal ventilation system under outdoor air quality conditions (Nam et

al., 2020), upstream fish migration along rivers (Yoshioka et al., 2018), sustainability of bird population management policy using a stochastic differential equation model (Yaegashi et al., 2018).

The reviewed articles are only a part of the SDEWES papers that highlight successful applications of optimization in engineering disciplines related to energy, water and environment. In conclusion, it should be stressed that further research in the optimal resource supply and demand within the energy, water, and environment sector is needed.

3. Overview of the special issue articles

This inaugural OPTE SI dedicated to the SDEWES 2019 Conference includes seven papers. The manuscripts in this SI address the Energy, Water and Environment types of problems.

Solar power production forecasting is one of the enabling technologies, which can accelerate the transition to sustainable energy environment. Short-term forecast information on the expected power production can assist existing forecasting techniques and enable efficient integration of renewable energy sources through the efficient energy trading, power system control and management of energy storage units. The Jakoplić et al. (2021) paper presents an approach to predict local PV power output based on short-term solar forecasting using ground-based camera and analyses the benefits of such forecast to the power system operation.

Real-time and short-term prediction of river flow is essential for efficient flood management. To obtain accurate flow predictions, a reliable rainfall-runoff model must be used. The article by Jahandideh-Tehrani et al. (2021) proposes the application of two evolutionary algorithms, particle swarm optimization (PSO) and genetic algorithm (GA), to train the artificial neural network (ANN) parameters in order to overcome the ANN drawbacks, such as slow learning speed and frequent trapping at local optimum. These hybrid ANN-PSO and ANN-GA approaches were validated and applied to a case study of Southeast Queensland, Australia.

A study by Pavković et al. (2021) presents a control system design methodology for the drill-string rotary drive and draw-works hoist system aimed at their coordinated control for the purpose of establishing a fully-automated mechatronic system suitable for borehole drilling applications. The functionality of the proposed cross-axis control system has been systematically verified, first by experimental tests of individual rotary/vertical axis control

systems on a downscaled laboratory experimental setup, followed by a thorough simulation study of the overall control system for realistic scenarios encountered in the field.

In order to increase the driving range of battery electric vehicles, while maintaining a high level of thermal comfort inside the passenger cabin, it is necessary to design an energy management system which optimally synthesizes multiple control actions of heating, ventilation and air-conditioning (HVAC) system. To gain an insight into optimal control actions and set a control benchmark, the paper by Cvok et al. (2021) proposes an algorithm of dynamic programming (DP)-based optimisation of HVAC control variables, which minimises the conflicting criteria of passenger thermal comfort and HVAC efficiency.

Motivated by the problem of amount for energy used within buildings for heating, ventilation and air conditioning (HVAC), Mawson and Hughes (2021) propose a novel method of coupling simulation with machine learning to predict indoor workshop conditions and building energy demand, in response to production schedules, outdoor conditions, building behaviour and use. Such predictions can subsequently allow for more efficient management of HVAC systems.

The work by Baleta et al. (2021) presents a multi-objective optimization of an aspirating smoke detection system which uses the pipeline to transport air sample from the sampling points to the analysing module. On the basis of 3D computational fluid dynamics simulation, it has been shown that smoke transport will not always take place in the centre of the pipe and that one-dimensional analysis is not able to determine the layer in which smoke transport will take place.

The article by Savic and Savic Gajic (2021) aims to optimize the extraction of antioxidants from plum seeds (Prunus domestica L.) using ultrasound-assisted extraction. The four extraction parameters, such as the extraction time, ethanol concentration, liquid-to-solid ratio, and extraction temperature were varied to investigate their impact on the content of antioxidants.

4. Conclusions

This paper reviews a selection of recent research articles that investigate the optimization of engineering problems related to Energy, Water and Environment topic. Despite significant progress in the three research areas mentioned, still great challenges exist, especially when it comes to minimizing the impact of human activities on the environment.

The Guest Editors believe that the selected papers and the addressed issues will considerably expand the knowledge body published in the Optimization and Engineering journal and will be of interest to its readers. Furthermore, the Guest Editors believe that this inaugural SI is the beginning of a long-term collaboration between the SDEWES Conference series and the OPTE journal.

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