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SDEWES 2014 – Sustainable Development of Energy, Water and Environment Systems

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ABSTRACT

One of the main issues of the coming decades is to improve resource efficiencies by integrating various life supporting systems, using waste from one, as resource in other, and in exact moment when it is beneficial to all. The challenge is on the electricity, heating, cooling, transport, water, buildings, industry, forestry and agriculture systems to integrate and become more sustainable. Since the sustainable development depends more and more on the holistic approach on the integration of energy, water and environment systems, from the beginning of the 21st century, a series of Sustainable Development of Energy, Water and Environment Systems (SDEWES) Conferences has been founded to cover these issues. The background of this Special Section of the Journal of Cleaner Production is therefore the Sustainable Development of Energy, Water and Environment Systems dedicated to both SDEWES 2014 Conferences – 1st South East European SDEWES Conference and 9th SDEWES Conference. The Special Section focuses on scientists, researchers, policy makers, educators, general public and practitioners in various branches of industry including the energy and water & wastewater sectors and environmental services. The purpose of this Special Section is to increase public awareness of key issues of sustainable development and to stimulate exchange of research results, practical experience and novel ideas among actors involved in investigating, planning and implementing sustainable development. The Special Section is focused upon four main fields that are of strategic importance to the sustainable development: Energy issues; Water issues; Environmental engineering and management; Sustainability approaches and promotion of sustainability concepts. The division of selected papers according to the named research fields has been established by the previous Journal of Cleaner Production Special Sections and Volumes dedicated to the SDEWES 2013 Conference. Hence, this Special Section is an extension of the previously generated SDEWES knowledge base in these four main research areas. As sustainable development is improving piecewise, so although it is necessary to see the big picture, actual technological improvement is one aspect of the technology systems. It has been shown that the sustainability can be improved by improving certain systems taking care of holistic sustainability criteria or integrating various systems in a way to improve the efficiency or resource efficiency of the combined system.

1. Introduction

The two SDEWES 2014 Conferences – 1st South East European SDEWES Conference and 9th SDEWES Conference, are dedicated to the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from natural resources and replacing them with knowledge based economy, taking into account its economic, environmental, and social pillars; as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water, environment and food production systems and their many combinations. Sustainability is also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the SDEWES Conference series have at the beginning of the 21st century become a significant venue for researchers in those areas to meet, and originate, discuss, share, and

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disseminate new ideas. The papers included in this Special Section (SS) are based on contributions presented at the Sustainable Development of Energy, Water and Environment Systems (SDEWES) Conferences in 2014. That year for two times, the SDEWES Conference served as a venue for scientists and practitioners interested in various issues of sustainable development from all over the world, to meet, discuss, share, and disseminate new ideas. First time, beginning of July, it was the South East European SDEWES Conference (SDEWES SEE 2014) in the Macedonian pearl-Ohrid, as the first from the biannual regional series, and the second time, it was 9th SDEWES Conference (SDEWES, 2014), held last week of September at the sea, sailing from Venice to Istanbul and back. Both conferences, SDEWES SEE 2014 with 119 participants from 33 countries and SDEWES 2014 with 226 participants from 50 countries, mobilized a range of resources which are essential for deepening the knowledge body and scientific understanding and for ensuring that the sciences are responsive to the emerging international, European, regional and national challenges.

As sustainability is a highly interdisciplinary topic, it often involves interaction of different systems (Afgan and Carvalho, 2000). The two conferences covered a variety of topics, from the economic, environmental and social studies, to the studies which assessed and measured the sustainability of energy, transport, water, environment and food production systems and their many combinations. The Journal of Cleaner Production, which has previously published two reports on the contents of the SDEWES 2009 and 2011 (Urbaniec, 2010; Duic and Urbaniec, 2012), several papers from the SDEWES 2011 and 2012 conferences, and a review of the SDEWES 2013 (Duic et al., 2015), has continued its cooperation with SDEWES launching a SS dedicated to both 2014 Conferences. From among 400 contributions presented at both SDEWES 2014 Conferences 25 papers were selected for this JCLP SS. The papers for the present SS SDEWES 2014 can be roughly divided into four research fields that have been established by the previous JCLP Special Volume dedicated to the SDEWES 2013 Conference: Energy issues including biomass use for energy and chemicals (6 papers); Water issues (7 papers); Environmental engineering and management (5 papers); Sustainability approaches and promotion of sustainability concepts (6 papers). Hence, the previously generated SDEWES knowledge base in these four main research areas is extended by this SS.

2. Background

This Section provides the background to the papers reviewed under the Section 3 of this article. It is structured in a way, that the background for the four research fields (Energy issues including biomass use for energy and chemicals, Water issues, Environmental engineering and management, and Sustainability approaches and promotion of sustainability concepts) under which the selected papers are classified, is given in more detail.

From the beginning of the 21st century, when the SDEWES conference series was initiated, papers published under this and other journal's Special Sections or Volumes dedicated to the SDEWES conference significantly contributed to the knowledge increase in these particular research fields. As some of the papers have been notably cited, the quality and knowledge that they provide to the scientific community has become of significant importance. In order to give the readers a sense of continuity a review on some of previously published papers is given here.

Regarding the Energy issues, over the past 5 years the published papers illustrated the complexity of the issues of sustainable energy systems on single residential house, small isolated community, county, city, island, national, and regional level (Kettl et al., 2014; Gerse, 2015; Weissenbacher, 2015).

The consumption of non-renewable primary energy resources results in their depletion, which is becoming absolutely crucial for the sustainable development of humankind. Furthermore, the production of power based on burning fossil fuels involves harmful emissions. Therefore, there have been studies that analyse the improvement in the power production from fossil fuels like coal (Mikulandrić et al., 2013; Stanek et al., 2015). However, the research on the generation of power from renewable energy sources (RES) and their efficient utilization is one of the most prominent areas of energy research. Importance and interaction between intermittent renewable energy and the electricity, heating and transport sectors have been recognized in numerus publications.

Photovoltaic energy conversion systems (PECS) have recently undergone impressive growth and substantial cost decreases, while deployment for concentrating solar power (CSP) has been much slower. As the share of PECS rises, the challenge of system integration will increase. This favours CSP, which can be combined with thermal storage and co-firing to reduce variability. It is thus an open question how important solar power will be for achieving climate mitigation targets, and which solar technology will be dominant in the long-term (Pietzcker et al., 2014). There are also limitations that need to be considered when PV installations are considered, and these are land scarcity and energy goals. Azzopardi and Gabriel-Buenaventura (2014) performed a feasibility assessment for high penetration of distributed photovoltaics based on net demand planning. The study showed that contrary to what is commonly believed, high penetration of PVs in a development area is feasible and may even reduce grid infrastructure costs.

Biomass as a renewable fuel that is considered CO_2 neutral has attracted a remarkable part of research (Mikulčić et al., 2014). Over past 5 years, different types of biomass utilization have been investigated. Biomass gasification has been studied by Mikulandrić et al. (2014), in another study by the same authors Mikulandrić et al. (2015), and in a newer study by Sriwannawit et al. (2016). Forbes et al. (2014) investigated the physical, chemical, thermogravimetric and combustion properties of eight different biomass fuels in a small scale multi-fuel boiler. Zhang et al. (2012) in their study analysed the bio-ethanol production from non-grain feedstock. Following that study, Souza and Seabra (2014) investigated the integrated production of sugarcane ethanol and soybean biodiesel, and Yang et al. (2014) studied the potential of bioethanol production from Taiwanese chenopods.

Energy storage has an important role in bridging the gap between intermittent renewable energy sources (RES) nature and the demand side. It is also important in the recovery of waste heat from industrial processes and therefore different types of energy storages for different purposes have been studied. Zhang et al. (2014) studied the latent heat storage with tubular-encapsulated phase change materials (PCMs), whereas Barzin et al. (2015) analysed price-based control system in conjunction with energy storage using phase change materials and peak load shifting. Both studies highlighted that the problem of the integration of RES in the current energy system is related to the intermittent nature and uncontrollable occurrence of RES. The studies showed the trends in the research on energy storages and their efficient use.

The transportation sector is one of the major energy consumers in most energy systems and a large portion of the energy demand is linked to road transport and personal vehicles. In 2010, according to the IEA (2010), it accounted for 22% of global CO_2 emissions, making it the second most CO_2 emitting sector, right after the electricity and heat generation sector. While all other sectors had significant renewable energy penetrations, transport is still heavily dependent on oil displaying rapid growth in the last decades. There is no easy renewable solution to meet transport sector demand due to the wide variety of modes and needs in the sector. Biofuels along with