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Review

Addressing the main challenges of energy security in the twenty-first century – Contributions of the conferences on Sustainable Development of Energy, Water and Environment Systems

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ABSTRACT

Climate change and fossil fuel reserve depletion both pose challenges for energy security and for well-being in general. The top ten among them include: Decarbonising the world economy; Enhancing the energy efficiency and energy savings in buildings; Advancing the energy technologies; Moving towards energy systems based on variable renewables; Electrifying the transport and some industrial processes; Liberalizing and extending the energy markets; Integrating energy sectors to Smart Energy Systems; Making the cities and communities smart; Diversifying the energy sources; and Building more bio-refineries. Presenting the contributions of selected conference papers published in the special issues of leading scientific journals (including all the papers from the current Energy special issue), this review demonstrates the capacity of the Conferences on Sustainable Development of Energy, Water and Environment Systems for generation of knowledge which could serve as the centrepiece of a pertinent response to those challenges.

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1. Introduction

At the Paris climate conference (COP21), in December 2015, the world united to fight climate change adopting the first-ever universal, legally binding global climate deal. The Paris Agreement sets the ambitious goal of limiting global warming to well below 2 °C above preindustrial levels, which requires decarbonisation of the world economy – more or less the entire world to get off fossil fuels this century while still ensuring energy security. This calls for a triple approach of combining efficiency, sufficiency and renewable energy.

To start with the massive energy efficiency in buildings, for example through improved building designs that dramatically reduce the need for energy to fuel heating, cooling and ventilation. In the nearly zero buildings, however, this approach can prove rather costly. Having low energy demand urban districts enables sharing on-site or local heat sources and combining this with a feasible level of energy savings in new, as well as in existing buildings.

Furthermore, an adequate response to the challenges of energy security requires high efficiency energy conversion facilities and systems which will enable efficient uptake of the variable renewables.

Once the shift to low carbon electricity is on the upswing, the electrification of transport, buildings and some industrial processes, powered by the low carbon electricity should become among the main pillars of the abovementioned triple approach of efficiency-sufficiency-renewables.

The energy security of the twenty-first century is inconceivable without a re-design of the energy markets, which allows energy efficiency and energy savings, renewable energy to continue to expand and to integrate the heat and transport sector with the electricity sector.

Making the energy smart by integrating energy sectors towards Smart Energy Systems is another challenge related to energy security, as the most effective and least-cost solutions for energy systems based on variable renewables are to be found when the electricity sector is combined with the heating sector and/or the transport sector in a smart energy system [1]. That is the way how to address effectively the issue of sustainable energy and transportation systems, i.e. energy generation for vehicles and the relation to the stationary supply of electricity and heating [2].

In difference to the smart grid, which is focused solely on the electricity sector and uses grid extension, electricity storage and demand side management as the primary means to deal with the integration of fluctuating renewable sources, the smart energy system approach offers more gainful solutions with storages in heat, gas or liquids, as well as batteries in electric vehicles [3].

All of these technologies, approaches and strategies should ensure supply of accessible, available and acceptable energy for smart cities and communities. That means more efficient and cleaner ways to heat and lighting in buildings, smarter urban transport networks and, outside of the energy system, upgraded water supply and waste disposal facilities, as well as more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population.

Furthermore, ensuring future energy security equally requires

diversification of energy sources and routes which, along with continued investment in energy projects (demand reduction and alternative technologies including renewable sources), remains critically important for preventing economically destabilizing price spikes.

And last but not least, an immense potential for ensuring energy security lies with the biorefineries which integrate biomass conversion processes and equipment to produce fuels, power, heat, and value-added chemicals from biomass.

Summing up, the top ten challenges of energy security of the twenty-first century can be defined as follows:

- Decarbonising the world economy
- Enhancing the energy efficiency and energy savings in buildings
- Advancing the energy technologies
- Moving towards energy systems based on variable renewables
- Electrifying the transport and some industrial processes
- Liberalizing and extending the energy markets
- Making the energy smart
- Making the cities and communities smart
- Diversifying the energy sources
- Building more biorefineries

Certainly, the best available scientific knowledge is needed in order to come to grips with these challenges.

A generator of such knowledge can be seen in the series of conferences on Sustainable Development of Energy, Water and Environment Systems (SDEWES) which provides a forum for world-wide scientists and those interested in learning about the sustainability of development, to present research progress and to discuss the state of the art, the future directions and priorities in the various areas of sustainable development. This includes the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water, food production and environment systems and their many combinations. SDEWES maintains high publishing standard as more than 800 SDEWES papers are published in special issues of “Energy – The International Journal” and of other leading scientific journals – “Journal of Sustainable and Renewable Energy Reviews”, “Applied Energy”, “Journal of Cleaner Production”, “Energy Conversion and Management”, “International Journal of Hydrogen Energy”, “Clean Technologies and Environmental Policies”, “Waste Management & Research”, “Thermal Science”, and others. The last main SDEWES conference (Dubrovnik, 2015) delivered total 541 contributions – 5 invited lectures, 3 panels, 49 regular sessions, 17 special sessions and 5 poster sessions. Worth noting by their success are the special sessions “Measuring sustainable development bottom-up and top-down – theory and practice” and “Cogeneration and trigeneration systems for applications in buildings and industry: methodologies, current perspectives and challenges”. The dedicated Energy special issue includes 24 papers.

The main goal of this review is to prove the above stated role of knowledge generator by analysing selected SDEWES contributions published in the special issues of leading scientific journals

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