EDITORIAL for the Special Issue of Journal Cleaner Production dedicated to BIWAES 2017

Cleaner Production for Human and Environmental Well-being

1. Introduction

Global challenges, such as climate change, natural resources depletion and environmental pollution, are often considered as an unavoidable consequence of intense economic activities that consume natural resources around the world to meet human needs. The concept of sustainable development was introduced to refer to "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs", thus calling for improving present human wellbeing while at the same time preventing natural resource depletion in favor of future generations (Brundtland Report, WCED, 1987). In the last decades, sustainable development has become the target of different actions by policymakers, academicians, industry representatives and researchers in several disciplines, focusing on the three pillars of economic development, social inclusion and environmental protection (UN, 2017). The common perception is that the transition towards sustainability requires a deeply transformative action, involving long-term approaches and interactions at all levels of society, throughout tools spanning from technological innovation to policy reforms up to integrative and multidisciplinary approaches (Zou et al., 2017). The implementation of cleaner production and consumption patterns in urban, agricultural and industrial activities, based on re-shaping of the dynamic interaction between environmental and economic systems, becomes a crucial step in achieving the goal of sustainability, at local and global time and spatial scales. According to the United Nations Environmental Program (UN, 1992), cleaner production is defined as the continuous application of an integrated preventive environmental strategy to processes, products and services in order to increase efficiency and reduce risks to humans and the environment. Over about 20 years, several definitions of cleaner production have been formulated, highlighting sometimes the social dimension of sustainability, in terms of supporting the development of people and communities, sometimes the economic dimension, with special focus on environmental issues and resource efficiency aspects (Hens et al., 2018). In recent years, resource efficiency has come higher on the political agenda: in Europe, for instance, the issues related to natural resources have been addressed in the Flagship Initiative Resource Efficient Europe, in which resource efficiency is considered as a means of preventing resource scarcity and achieving climate goals as well as an opportunity to improve economic competitiveness. A better management of energy and material flows, towards increased energy and material efficiency and optimized resource use, are widely recognized to generate environmental benefits and decreased loads on human wellbeing. Nevertheless, the concept of efficiency may be controversial, advocating the same results (products, services) be achieved with lower resource investment (material, energy, labor), or, vice versa, better results (more products, more services) be achieved based on the same resource effort in terms of materials, energy, labor. According to Huysman et al. (2015), efficiency can be defined as the ratio between the useful output (benefit) and the inventoried flows as well as the ratio between the intended effect (benefits) and the environmental impact. Increasing efficiency does not always mean resource savings (Jevon paradox and rebound effect) and implies not only the amount of input or output flows be taken into proper account, but also (or mainly) their environmental quality be carefully assessed (impacts of resource use coupled to resource generation cost). As a consequence, resource efficiency can be improved by either reducing the amount needed to produce the output or by reducing the environmental impacts associated with the output itself (Bundgaard et al., 2017). The turning point towards the desired transition to a more sustainable model is therefore optimization, rather than maximization: any process or system has to be made functional and effective, within its specific constraints.

The Biennial International Workshop Advances in Energy Studies "Energy Futures, Environment and Wellbeing" (BIWAES 2017), held in Naples from 25th to 28th September 2017, was designed to facilitate the generation of knowledge and promote critical discussion about how to optimize products, processes and services throughout efficiency increase in resource use, including human capital, and, at the same time, about the prevention of waste and emissions and their impact on the environment and human wellbeing.

2. Energy Futures, Environment and Wellbeing.

This Special Issue (SI) of the Journal of Cleaner Production (JCLEPRO) stems from the need to find answers to questions about advanced energy, resource and waste management in a multifaceted perspective covering technical, environmental, socio-economic and policy aspects linking energy futures, environment and wellbeing together. The transdisciplinary feature of the proposed issue includes both technological innovations for cleaner production pathways and non-technological drivers to promote the transition to sustainability, including the following points and the related questions. Contributed papers were grouped accordingly.

1) Energy and cleaner production. Innovative designs and technologies.

To what extent will future technologies be able to combine energy demand increase, transition from fossil fuels to renewables and GHGs emissions decrease? To what extent are they designed to prolong the economic competitiveness of fossil fuels use? What are expected to be the technologies for the future of energy production, and what those for a transition regime? Are cleaner production and energy efficiency compatible with the mantra of economic growth? How are innovative technologies considered in the mainstream narrative of sustainability and sustainable development?

1.1 *Xu et al. (2019)* evaluate the environmental and economic performances of three rice production modes, namely rice monoculture, conventional rice-crab and optimized rice-crab modes, in Panjin City surrounding Liaohe River Basin in Northeast China, in terms of economic and environmental (emergy) benefits. Moderate industrial integration and large-scale operation modes, efficient utilization of local resources, whereas reducing external inputs are suggested to make the investigated agricultural model considerably cleaner and more sustainable.

1.2 *Skaf et al. (2019)* show the results of an extensive field study on natural and human-driven flows, supporting different agricultural production systems in different Lebanese regions. By jointly applying environmental accounting methods, such as gross energy requirement, material flow accounting, emergy accounting, and emissions accounting as well as contribution to impact categories, a set of biophysical and socio-economic indicators is proposed to integrate the environmental accounting and a socio-economic perspective on food security and sustainable agriculture.

1.3 *Gonella et al. (2019)* report a discussion developed by one of the thematic working groups at BIWAES 2017, about the role of technology in the energy transition. In particular, some conceptual weaknesses are highlighted in the current debate on technology and global environmental issues, framed in global policies that appear unsuitable to obtain tangible results.

2) Energy and material efficiency and their interplay.

Are energy and material efficiencies always coupled to environmental benefits? Since there is embodied energy in manufactured materials, are reuse and recycling of materials real opportunities for energy saving? By implementing circular economy patterns, where full or partial recycling of matter is linked to less energy use, less environmental degradation and less mineral mining and processing, can economic growth be finally disconnected from the use of primary resources and the generation of environmental impacts?

2.1 *Corcelli et al (2018).* investigate the interplay between energy and material efficiency in the pulp and paper manufacturing sector; the Authors show that the partial fulfilment of energy requirements by means of a circular use of residues within the system, such as for example the generation of renewable energy *in situ* from black liquor and residual biomass, leads to a noteworthy reduction of impacts (more than 70% in global warming and fossil depletion potentials).

2.2 *Santagata et al. (2019)* investigate energy and resource recovery from animal by-products, in order to exploit them effectively in a biorefinery perspective with the aim of overcoming resource shortages and decreasing environmental impacts. The Emergy Accounting approach is used to evaluate benefits and environmental load of the process, by comparing the advantages achieved and the demand for ecosystem services and natural capital depletion to make the process possible.

2.3 *Boccia et al. (2019)* explore the potentiality of a tomato-wastes biorefinery with particular regard to the Italian scenario. The possible re-use strategies and the available examples of tomato wastes conversion into marketable products are reviewed, highlighting that the upscaling of such processes at an industrial level still remains to be assessed in order to pave the way to new markets for the valorization of tomato wastes.

3) Renewable and nonrenewable energies between growth and de-growth patterns.

Are the philosophy and impacts of economic growth still consistent with an innovative systemic and environmental perspective capable to shift the focus from one human generation (30 years) time-frame to long-term production and consumption patterns that are less impacting, socially equitable and financially feasible? To what extent are renewable and non-renewable energy systems capable to support societal needs, under growth and de-growth perspectives?

3.1 *Uche et al. (2019)* illustrate experimental tests of a hybrid trigeneration pilot unit, that provides electricity by coupling four photovoltaic/thermal collectors and a micro-wind turbine, fresh water by means of hybrid desalination (membrane distillation, and reverse osmosis), and sanitary hot water. The environmental assessment of the pilot unit shows very low impacts with respect to the conventional supply of energy and water.

3.2 *Fierro et al. (2019)* propose an integrated evaluation of the actual benefits expected from bioethanol in the transport sector, by applying the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) to the prospective realization of a local biorefinery system in Campania Region (Southern Italy).

3.3 *Di Donato et al. (2019)* review the role of thermophilic microorganisms and their enzymes involved in the biotechnological production processes of second generation bioethanol, relying on residual biomass feedstock, with the aim of a more sustainable energy generation without compromising food security and environment.

4) Implementing energy efficiency, barriers and solutions. From theory to practice.

If it is true that energy efficiency is the least expensive way for businesses to reduce energy demand and emissions, also translating into added benefits of reduced operational costs and risks, how is it possible to fill the large gap still existing between the available energy efficiency options and actual implementation by companies, public administrations and households? How can benefits and costs of energy efficiency as well as the existence and importance of implementation barriers be properly addressed, measured and monitored?

4.1 *Raugei and Winfield (2019)* present a prospective Life Cycle Assessment of the production and end-of-life recycling of a new, high-energy type of cobalt-containing lithium ion battery pack for electric vehicles, using a lithium cobalt phosphate cathode. The assessment also includes a newly-developed hydrometallurgical battery recycling process which enables the recovery not only of valuable metals, but also of the graphite component, with promising results in terms of cumulative energy demand and greenhouse gas emissions.

4.2 *Nastro et al. (2019)* preliminarily prove the high potentialities of microbial fuel cells for the degradation of the polycyclic aromatic hydrocarbons in marine sediments taken in front of the brownfield steelwork facility of Bagnoli (South Western Italy). The advantages that such a technology can provide to the restoration of the marine environment are undiscussed because of the low environmental disturbance and of the energy recovery that can be attained.

4.3 *Florio et al (2019).* combine the utilization of microbial fuel cells (MFC) with anaerobic digestion (AD) and dark fermentation in a two-steps process for the treatment of the organic fraction of municipal waste. The results show that MFC technology is a valuable pretreatment of solid substrates to improve the yields of the AD in terms of biohydrogen production and COD removal.

5) Stakeholders and energy planning.

Which is the common ground to approach the "stakeholder" concept and what are the practices of energy planning consistent with stakeholders interests and perspectives? To what extent participatory approaches are likely to promote sustainable energy planning practices? Who are the stakeholders to be involved for sustainable and effective energy planning? Which benefits, challenges and opportunities arise from stakeholder involvement?

5.1 *Mokhtar et al. (2019)* provide an empirical investigation into the relationship between supply chain leadership and reverse supply chain performance, considering the mediating role of governance mechanisms as well as the importance of stakeholders in optimising the adoption of reverse supply chains practices.

5.2 *Casazza et al. (2019)* assess the state-of-the-art on port air pollution monitoring and modelling, designing a framework structure for stakeholders involved in operative planning to support the development of appropriate actions, integrated urban policies and transition toward cleaner production and consumption processes in port areas.

5.3 *Pasichnyi et al. (2019)* present a novel data-driven approach, based on urban building energy modelling, for strategic planning of building energy retrofitting. The application to the case of Stockholm demonstrates the potential of rich urban energy datasets and data science techniques for better decision-making and strategic planning.

6) Socio-economic variables in designing local energy policies.

How can socio-economic variables be linked to the local management of energy and material resources demand and supply (integrating distant heat and electricity provision through grids as well as local energy purchase or self-production), as well as to food and other services supply through participatory networks, infrastructures, financial systems and policy making all involving stakeholders?

6.1 *Ji et al. (2019)* design models, such as the model of Infinitely Repeated Game with Trigger Strategy or the cost-benefit analysis model, to explore the feasibility of an “urban-rural sustainable cooperation” pattern. Targeted policy proposals are put forward for relieving the severe imbalance between urban and rural development and realizing “green poverty reduction” in rural areas.

6.2 *Cristiano and Gonella (2019)* apply systems thinking and emergy accounting to transport studies in order to assess the socioecological convenience of a civil infrastructure. The need to support ecologically and strategically sustainable societal decision making in the transportation sector is framed in wider thoughts on economic planning and resource allocation.

6.3 *Liu et al. (2019)* put forward policy recommendations for the sustainability of Beijing domestic water supply according to the analysis of environmental data related to urban water metabolic system, modeled on the basis of the ecosystem cumulative energy availability (emergy accounting).

6.4 *Mäkivierikko et al. (2019)* use a mixed methods approach to examine the connection between the need to belong to a group and a context for energy feedback, finding out that implementing a local social network could lead to both persistently engaging energy feedback and also improving human well-being.

6.5 *Nawab et al. (2019)* construct an urban energy-water nexus framework, considering both domestic and international trade, based on the environmentally extended multi-scale input-output (EE-MSIO) model. A higher coordination, together with a rearrangement of the regional trade structure, results the key leverages for an effective management of resources and environment.

1. Conclusions

The main outcome from the BIWAES 2017 gathering is a widespread awareness that a systemic approach is needed when dealing with global sustainability problems. Increased efficiency in resource use, including human capital, as well as prevention of waste and emissions, and their impact on environment and human wellbeing, need to be evaluated through an effective integration of different quantitative perspectives and different scales of analysis. The guest editors hope to contribute, by means of this special issue, to a deeper understanding of technical, environmental, socio-economic and policy aspects of energy, resource and waste management towards more sustainable energy futures, environment and wellbeing.

Acknowledgement

We would like to thank all the reviewers for their time and effort. Without their dedicated work this special issue would not have been possible.

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