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INTRODUCTION

Energy and environmental challenges: bringing together economics and engineering (ICEE'17)

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This special issue includes extended and reviewed versions of high-quality papers submitted to the 2017 International Conference on Energy and Environment (ICEE 2017) organized by the School of Economics and Management, University of Porto (FEP), the Economics and Finance Research Centre, University of Porto (CEF.UP) and the ALGORITMI Research Centre, University of Minho, which took place at FEP on 29–30 June 2017. Twenty papers were selected, and the authors invited to submit an extended version for regular journal review, in order to be included into this special issue. After the journal's review process, 13 papers were accepted for publication.

This special issue of Environment, Development and Sustainability draws together a wide range of contributions which show that a multidisciplinary research agenda is essential to understand both the energy and environment nexus and challenges. As in the previous edition (Ferreira et al. 2016), the topics are vast but a common trend towards some main issues can be highlighted. Specifically, three main areas are covered in this special issue: the research on clean mobility technologies, problems related to sustainability evaluation and pathways and policies to guide the transition of the energy markets. Although important advancements have been achieved during the last 2 years, the dynamic nature of the energy markets and the quick development of technological and non-technological innovations increasingly offer more complex challenges and provide a fertile field for research.

The transportation system has been the focus of different studies and projects, with the electric vehicle assuming a crucial option for the sector decarbonization process. The topic is debated in this special issue in Ajanovic and Haas (2019) and Neves et al. (2019), using different approaches but common concerns.

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The former Ajanovic and Haas (2019) discussed the major barriers and the future challenges for electric vehicles addressing, in particular, their potential to reduce greenhouse gas emissions. The authors analyse the major properties of different types of rechargeable batteries and discuss challenges related to the availability of materials needed for battery production and recycling needs. The study highlights important research priorities related to battery development and the carbon intensity of the electricity generation. The latter Neves et al. (2019) also emphasized the environmental benefits associated with the electricity use on the transportation sector while assuming that that positive impact will only be reached if the electricity is generated from renewable sources. The authors demonstrate, using a panel vector autoregressive model, how electricity use on transportation has enlarged the economic growth while consumption of renewable fuels hampered it. However, the study could not identify a statistically significant relationship between the electricity use on transportation and the CO_2 emissions for the time-span and counties comprised in the study.

Indicators are frequently used for sustainability evaluation of different sectors, as debated and demonstrated for real case studies in Alves et al. (2019), de Camargo et al. (2019), García-Álvarez and Soares (2019) and Mussi et al. (2019). Different and complementary approaches should be considered under this topic, including the life cycle analysis [as debated by Martins et al. (2019)] and economic models which allow to estimate the willingness to pay for cleaner options (Botelho et al. 2019). Alves et al. (2019) addressed the case of the mining industry in Brazil. A Model for Sustainability Assessment of Mining (SAoM—Model) is developed to obtain a Mining Sustainable Robustness Index which can be used as a proxy to evaluate sustainability of each company and to benchmark different companies of the sector. The research identifies some main challenges to sustainable mining, namely the lack of community engagement and of local stakeholders' involvement and the disregard for actions to mitigate environmental and social impacts. These problems are particularly evident among small or artisanal companies and cooperatives.

The topic of sustainability indicators is also addressed by de Camargo et al. (2019) for the case of the swine industry in the Brazilian State of Santa Catarina. The authors propose a Sustainability Indicators System (SIS) which can be used to diagnose and compare the efficiency of the industry from a broader perspective. The SIS model classified the pig farms of the Western Santa Catarina area at the level "in search of sustainability" for the different dimensions, excepting for the social one according to which all types of farms were classified as "unsustainable".

García-Álvarez and Soares (2019) deal with sustainable energy production and consumption and their influence on the development of sustainable energy markets. The paper introduces a set of indicators of sustainable energy markets and develops the Sustainable Energy Market Aggregated Index in the EU-28. The results allow to identify countries with the highest scores which developed suitable policies on sustainable energy consumption and/or in sustainable energy production. Reinforcing actions in sustainable consumption and production are proposed for member states with the lowest results.

Mussi et al. (2019) treated the evaluation of sustainability using both quantitative and qualitative indicators. The authors address sustainability programs in Brazil and used the case of Itaipu Hydroelectric Plant's strategic sustainability plan to show the importance of going beyond traditional quantitative indicators for the evaluation of these programs. These qualitative aspects include concerns for ecosystem and biodiversity, and involvement and empowerment of local population.

Martins et al. (2019) presented the LCA4Power tool, which is implemented on MS Excel™ and based on life cycle thinking (LCT) methodology. The authors review

instruments proposed in the literature or freely available in the internet to assess the environmental impacts of electricity production and concluded that these are not easy to use and most have a limited scope. The use of the LCA4Power tool is demonstrated evaluating the potential environmental impacts of the endogenous electricity production in mainland Portugal. The results indicate that this tool is adequate to assess the equivalent carbon emissions resulting from electricity production and further developments are proposed in particular to deal with the social and economic impacts.

Botelho et al. (2019) compared the welfare impacts of renewable energy sources controlling the type of renewable and the specific environmental impact by source. They consider the three main renewable options (wind, hydropower and solar photovoltaic) and use discrete choice experiments to elicit the corresponding economic value from a random sample of national residents in mainland Portugal. The authors conclude that electricity production from renewables implies statistically significant welfare losses from the point of view of national residents and the respondents are willing to pay more to use some sources than others.

The design of pathways and effective policies to guide the transition of energy markets requires modelling to understand the contribution of different factors to the overall clean energy objectives, as discussed by Cunha et al. (2019) and Madaleno and Moutinho (2019) and for power generation planning Martinez-Fernandez et al. (2019). The companies' strategies to deal with these energy transitions are analysed by Guerra-Mota et al. (2019) and Pereira et al. (2019). Their study allows linking energy policies and the future perspectives of the electricity industry.

Cunha et al. (2019) applied the multiplicative Log Mean Divisia Index (LMDI) decomposition method for countries with a different socioeconomic background and energy mix, to identify the main factors explaining changes in energy efficiency. The results of the study indicate that energy efficiency trends show different patterns among the countries analysed and within each country from a sectoral perspective. The authors outline policy implications of the research including the need to promote technological development, to raise awareness of end-users and to develop instruments to reduce the costs of implementing energy efficiency measures.

Madaleno and Moutinho (2019) use a decomposition method to separate the carbon emissions of a country into its possible contributing factors for 15 European Union (EU) economies. The results indicate that economic growth and population growth imply higher emissions for the EU-15, which substantiates the need to implement cleaner energy and develop more environmental sound techniques to reach both economic growth and emission reductions.

The proposal of Martinez-Fernandez et al. (2019) is to adapt and apply the Modern Portfolio Theory (MPT) and the Capital Assets Pricing Model (CAPM) financial tools to a portfolio of CO_2 emitting generation technologies under diverse scenarios. To demonstrate the applicability of this technique in emission reduction policies, an example is discussed. The results highlight the importance of the carbon capture and storage technology (CCS) to achieve a less risky generation mix, with less emissions and allowing a higher diversification due to the presence of cleaner fossil fuel technologies.

The energy transition is debated also by Guerra-Mota et al. (2019), calling attention for the multiple changes at the political, economic, social and environmental context which pose important challenges to the European Electricity Utilities. The analysis of the seven largest European energy utilities suggests that companies tend to deal with these challenges through innovation in technology and business and those social aspects related to employment, training and new business structures are increasingly relevant.

Pereira et al. (2019) addressed the European Union's (EU) electricity distribution industry, traditionally organized as network monopolies. The authors analyse the challenges brought by the new market design associated with the growth of distributed generation and new smart grid capabilities. The results of the proposed Policy Delphi method reveal the importance of the development of research and development support policies, innovative regulatory frameworks, and concerted actions at the EU and Member States level, to support the electricity distribution industry transition.

The papers resulting from the conference allowed then to consolidate ICEE conference as a major instrument to debate the energy and environmental future, creating room to debate problems from different perspectives and opening directions for future research. In particular, the following aspects emerged as fundamental topics for further studies:

- Electric vehicles will play a major role on the future transportations systems but research is still required on battery development and on electricity generation, transmission and distribution planning to ensure their genuine contribution for the decarbonization of the energy system.
- Different approaches have been used for sustainability evaluation, but concerns on social goals, locals' empowerment and the inclusion of point of view of residents, show that the social dimension is still lagging behind environmental and economic aspects. New approaches are needed not only for the assessment of these social impacts but also for its effective integration in traditional models and tools.
- Energy transition towards a more sustainable energy system requires additional studies not only on technology selection and development, such as CCS, but also on the proposal of innovate policies. Research on the companies' strategies to deal with the multiple market changes and its inherent challenges is required both on the design of these strategies and on the assessment of its impacts at social and economic level.

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