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Editorial

Energy Industry Transition Transformation in the Wake of COVID-19

George Xydis [1,*] and Evanthia Nanaki [1,2]

[1] Department of Business Development & Technology, Aarhus University, Birk Centerpark 15, 7400 Herning, Denmark; evananaki@gmail.com
[2] HelleniQ Energy, New Technologies & Alternative Energy Sources, Chimarras 8A, 15125 Athens, Greece
* Correspondence: gxydis@btech.au.dk

1. Introduction

The COVID-19 pandemic has caused significant shifts in energy demand and generation patterns, going beyond geographical boundaries and demanding creative responses from the energy industry as a whole. The COVID-19 pandemic has not only disrupted daily life but has also brought about a new period of uncertainty across the world. Lockdowns and social distancing measures affected nearly 54% of the world's population, significantly altering energy demand patterns in ways that the world had never experienced before [1]. The aim of this Special Issue is to identify and assess the adverse effects of the COVID-19 pandemic, highlighting the need for coherent energy policies and synergies across all sectors at the country, city, and industry levels.

2. Energy Demand and Challenges

This Special Issue includes the work of researchers worldwide who share a common interest in applying energy system engineering techniques to enhance energy system designs and carefully assess environmental, social, policy-related, and health-related impacts. Historically, the field has been centered on the development of process design, synthesis, integration, and optimization methods to achieve savings in energy and environmental conservation. However, the emergence of the COVID-19 pandemic has ushered in an unparalleled global health and economic crisis [2]. While the pandemic's impact has been felt in numerous sectors, it has significantly disrupted energy markets, affecting coal, gas, and renewables alike [3]. This crisis has underscored the vital importance of robust healthcare and electricity infrastructures. As governments and policymakers grappled with these intertwined challenges, they tried to remain committed to addressing a paramount issue of our era: the transition to clean energy. In light of these considerations, this Special Issue is dedicated to shedding light on the multifaceted impacts of COVID-19 through enhanced scientific and interdisciplinary insights.

The initial lockdowns, enforced in response to the pandemic, led to significant shifts in residential energy consumption as people adjusted to remote work and altered daily routines. South Africa faced unique energy challenges due to its wealth disparities and ongoing blackouts. A case study in George, South Africa, underlined these challenges, revealing that the strictest lockdown stage prompted affluent communities to increase their energy consumption by 5%, while less privileged communities saw a 2.5% rise [1]. This emphasizes the significance of local data for tailored decision making in future pandemics or disasters.

On the other hand, China's approach to COVID-19, characterized by short-lived city lockdowns, raised questions about its effect on electricity consumption. A novel clustering-based method was employed, focusing on the industrial-driven electricity consumption patterns in various regions in China. The results highlighted both short-term and long-term effects, showing that some regions only experienced temporary shifts in consumption

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patterns, while others underwent permanent changes. This research revealed the dynamic impact of the pandemic on energy usage [4].

The adoption of virtual education during the pandemic also caused unanticipated savings in energy. A case study involving 13 state universities in Michoacán, Mexico, emphasized significant reductions in electricity consumption, resulting in monthly savings averaging 76.24 MWh. These savings translated into an annual reduction of approximately 497 TnCO2e emissions and cost savings of USD 8882.25 per month. This study underscores the potential for educational institutions to embrace energy-efficient and sustainable practices as virtual and hybrid education continues to evolve [5].

However, the impact on buildings' demand and residential energy use was huge. The pandemic and associated lockdowns, in a way, served as a social experiment, revealing changes in residential electricity usage patterns during the pandemic, including increased energy consumption by those working and studying from home, potentially fostering digital competence and new energy consumption approaches [6]. This has also had a long-term impact on the mindset of homeowners, as different design settings appeared which were considering the new electricity demand patterns [7]. In the future, adapting office buildings into residential spaces to meet the almost zero energy demand requirements is a feasible solution, despite the challenges of returning back to office spaces, driven by the global oversupply of office areas and increased demand for apartments due to remote work and the COVID-19 pandemic [8]. As remote work becomes more prevalent, the repurposing of office buildings into multi-family residential units gains relevance. An energy analysis demonstrates that such conversions are feasible with minimal financial and technical investments, opening doors to sustainable energy consumption and building utilization. Furthermore, the pandemic's impact on global power systems and prices was profound. Germany, Great Britain, and France witnessed fluctuations in power demand and prices. An econometric analysis connected the number of active COVID-19 cases and lockdown periods to load reductions. The study also scrutinized the pandemic's effect on power prices, revealing reductions ranging from EUR 3 to 6 per MWh. However, the implications for carbon emissions were relatively minor, with Germany experiencing the most significant reduction [9]. In addition, in a very interesting analysis, the cold storage demand and the high electricity consumption of different vaccines were simulated, and it was proven that in terms of real warming impact, the environmental impact of the Oxford–AstraZeneca, Janssen COVID-19, and CoronaVac vaccines in Brazil was 35 times lower compared to that of the Pfizer vaccine; hence, the Pfizer vaccine was the worst in terms of its ecological footprint [10].

3. The Pandemic's Effects on the Electricity Systems and Grids

The COVID-19 pandemic transcends being merely a health crisis; it heralds a new era for the energy sector. One paper in this Special Issue reviewed the existing literature on the pandemic's long-term impacts and analyzed measured data to uncover the challenges posed to power system operation, planning, and renewable energy integration. The findings underscore the need for ongoing research to address the multitude of questions raised by the pandemic. Lessons learned during this crisis will undoubtedly inform the trajectory of energy consumption, production, and environmental responsibility in the post-pandemic era [11]. In another study, the methodology developed was applied to the European power system, providing a comparative assessment of lockdown's consequences in the European context. This approach can help stakeholders better understand the pandemic's impact on the power sector and make informed decisions for future resilience and planning [12]. Lastly, another study examined the profound effects of the ongoing COVID-19 pandemic in Italy, encompassing economic sectors, daily life, and the power industry, highlighting unprecedented behavior in terms of both energy consumption and volume as a result of restrictions and lockdown measures [13].

4. Impact in Other Sectors: Transport and Tourism

Directly linked to the issues discussed above, the pandemic created new challenges for public transport organizers and operators, necessitating innovative protection measures to prevent epidemic outbreaks within the transportation infrastructure. A study in this Special Issue offered a proactive set of actions, tailored to various epidemic scenarios, supporting local authorities and transport operators in ensuring passenger safety and minimizing the financial impacts on urban public transport companies [14,15].

The COVID-19 pandemic also disrupted the tourism sector, leading to a notable reduction in greenhouse gas emissions across Central and Eastern European (CEE) countries. A multiple regression analysis demonstrated that the pandemic resulted in reduced emissions caused by tourism in the CEE region. A study in this Special Issue offers valuable insights into the pandemic's environmental implications for the tourism sector, in general [16].

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