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Sustainable Energy Planning and Management – SDEWES 2024 Special Issue on transition from coal and modelling approaches

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ABSTRACT

This 45th volume of the International Journal of Sustainable Energy Planning and Management includes papers from the *Sustainable Development of Energy, Water and Environmental Systems* (SDEWES) conference series held in 2024. A focus area of this special issue is conversion of coal-reliant energy systems in Columbia, Indonesia and Poland. Another focus area is on modelling approaches and the inclusion of decision makers and stakeholders in the process.

Keywords

Energy system transition;
District heating;
Stakeholders;
Energy system modelling

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1. Special issues contents

This SDEWES special issues follows in the footsteps of a series of previous SDEWES special issues of the journal since its inauguration in 2014 [1–7]. In this special issue, five articles present newest research within energy system transition studies with a focus on particularly the transition of energy systems in areas or countries dominated by a prevalence for coal.

Colombia is a country of coal resources but also a country of biomass resources, where the latter have a potential to reduce greenhouse gas emissions. In [8], Infante Cuan and coauthors present a mixed integer linear programming model to optimize a supply chain for bioethanol, electricity, and bagasse pellets from Colombian sugarcane. Bioethanol meets national petrol demand, while bagasse pellets from 17 biorefineries across 13 regions can replace coal in thermoelectric plants. Avoided emissions represent close to one quarter of Colombia's target. Key challenges include price volatility in biomass, bioethanol, and carbon credits, affecting long-term viability. Land use sustainability must be assessed to avoid conflicts with food and ecosystems. Sensitivity analysis shows, however, that sugarcane and bioethanol prices significantly impact the payback period.

The IJSEPM has traditionally had a certain focus on Columbia, though not so much on the biomass side. Mican [9] analysed the risk of renewable energy projects more broadly, Gelves [10] presented work on the assessment of solar projects, Bastidas-Salamanca & Bayona [11] addressed wind power project assessment and in [12], Velasquez investigated the energy matrix of Columbia, finding amongst others an efficiency improvement over time.

Irsyad and coauthors [13] refine participatory backcasting by integrating existing visions with stakeholder engagement and road-mapping, applied to South Kalimantan, Indonesia—a region economically reliant on coal mining. In their work, a roadmap was co-created toward a Net Zero Emission future. Key proposals include expanding wind power, PV and battery storage, transitioning coal-based industries to bioenergy, improving data on renewable potential and grid flexibility, and promoting energy-saving behaviour and electrification. The study advances backcasting methodology by leveraging pre-existing visions rather than generating new ones.

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Fitriani [14] previously addressed power generation transition scenarios for Indonesia, Sani [15] dynamic modelling of Indonesia, and in [16], Siregar ranked different renewable energy sources in the same setting. Al Hasibi [17] focused on transition analyses of Bali whereas other studies like Gunawan [18] (PV), Damayanti [19] (electrification of cooking) and Putranto [20] (hydropower), Setiartiti [21] and Al Hasibi & Hadi [22] (transportation) have focused on particular technologies in the energy system.

Coal-based second-generation district heating systems remain widespread and inefficient in Central and Eastern Europe. The study by Tańczuk and colleagues [23] assesses the technical and economic feasibility of integrating geothermal energy into a Polish district heating system. The study evaluates three retrofit scenarios: 1: a geothermal doublet with direct heat exchange; 2: addition of an absorption heat pump powered by a gas boiler; and 3: inclusion of a second geothermal doublet. Hourly thermal simulations show geothermal heat contributions rising from 35% (Scenario 1) to nearly 70% (Scenario 3). Economic analysis however reveals that Scenario 1 with the lowest geothermal contribution as most viable. Geothermal retrofitting, especially via direct exchange, offers a cost-effective path to district heating decarbonization.

Energy system complexity poses challenges for policymakers, requiring simulation tools that support systems thinking and informed decision-making. In [24], Blumberga and coauthors explore the design of a national energy and climate policy simulation tool tailored for policymakers and stakeholders. Twenty-two participants—including policymakers, climate practitioners, and others—developed strategies under two roles: dark greens and bright greens. Results revealed that most failed to meet task objectives, indicating that policymaker status alone does not ensure successful outcomes. Success depended on understanding the link between scenarios and results. For comparative analysis, findings were evaluated against prior research involving master students. The study underscores the need for simulation interfaces that enhance learning and feedback to improve strategic energy policy development.

Effective energy system modelling requires robust stakeholder engagement, solid data collection, and the integration of local specificities. Matak's study [25] study focuses on Africa's energy challenges—limited electricity access, unreliable supply, and dependence on traditional biomass—through case studies in Morocco, Mozambique, and Mali's Niger River basin. A mixed-methods approach, combining surveys, interviews, and focus groups, was used to capture diverse stakeholder perspectives. The Quadruple Helix framework guided stakeholder inclusion, encompassing academia, civil society, policymakers, and investors. Research objectives included identifying national energy needs and priorities, evaluating current modelling practices, fostering stakeholder collaboration, and informing the development of context-sensitive energy models. Findings underscore the importance of inclusive, localized approaches to energy modelling in addressing Africa's complex energy landscape.

Modelling approaches is a firm component in this journal's DNA, with Dall-Orsoletta and coauthors [26] exploring the inclusion of social aspects on energy systems models. Volkova [27] presented an app for improving user experience and engagement in district heating systems when transforming to 4th generation district heating. Similarly, Krog and coauthors [28] explorer the actual engagement of consumers on 4^{th} generation district heating. Both refer to the nomenclature of district heating as established in [29–31], where 4^{th} generation applies lower temperature levels – but also encompasses changes in the organisation of district heating.

Kuriyan and Shah [32] presented a model for the planning of district heating networks, combining such networks' spatial dimension with energy systems model and Gupta and Ahlgren [33] reviewed the use of models for the study of urban energy systems.

Prina and coauthors [34] presented their EPLANopt model in this journal. This model draws on the widely used EnergyPLAN model [35,36] but whereas the basic EnergyPLAN is intended for simulation only, EPLANOpt embeds EnergyPLAN in an optimisation routine for endogenous energy system scenario optimisation (see [37] for an in-depth discussion of simulation and optimisation models).

In [38], Østergaard, Andersen, and Kwon established a framework for combining long-term demand forecasting and forecasting of temporal variation with EnergyPLAN to improve modelling accuracy when the composition of the electricity demand changes. Zugno, Morales, and Madsen [39] addressed models from a more operational perspective, focusing on dispatch decisions for power producers and traders.

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