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Sustainable Energy Planning and Management with Energy Scenario Modelling, GIS Tools and Demand Projection

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ABSTRACT

This 42nd volume of the International Journal of Sustainable Energy Planning and Management includes two articles from the 2023 Sustainable Development of Energy, Water and Environmental Systems (SDEWES) conference series as well as two ordinary articles. The two first articles establish links between the energy systems analysis model EnergyPLAN and respectively the Quintel Energy Transition Model (ETM) and urban building energy modelling to form more comprehensive modelling environments. Third, an article addresses energy systems modelling from a more spatial perspective, with the presentation of the ODHeatMap tool to model the spatial characteristics of heat demand particularly in areas where optimal energy planning data may not be available. Lastly, Vietnam's economy and energy demand is increasing rapidly, and, in this issue, analyses are presented regarding how measures in renewable energy utilization and energy efficiency improvements have to be under different scenarios, for Vietnam to reach its carbon dioxide emission reduction goal.

Keywords

Energy systems analyses;
EnergyPLAN;
ETM;
Heatmapping and GIS;
Demand projections;

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1. SDEWES 2023 Special Issue

The opening section of this 42nd volume of the International Journal of Sustainable Energy includes two articles originally presented at the SDEWES conference. In the first, Cameron and coauthors [1] integrate the widely used EnergyPLAN [2,3] energy systems model with the Quintel Energy Transition Model (ETM) [4] (described and characterised further in [5–8]). The special focus point of the work presented is a perceived shortcoming in the handling of costs on the ETM model, prompting a soft-linking to EnergyPLAN though the *epnlink* Python library. Outputs from the ETM model are in this way extracted for EnergyPLAN input. The authors use the combined models to model net zero carbon scenarios for Northern Ireland.

Borelli and coauthors [9] also combine two models in their work, focusing on renewable energy communities taking Santa Chiara district in Trento, Italy as a case. They combine EnergyPLAN with urban building energy modelling (*umi)*. They found that change in climate has large impacts on future need for cooling, while also showing the prospects of solar thermal panels, photo voltaics and heat pumps. They also stress the importance of a multi-faceted modelling approach like the one presented.

EnergyPLAN has previously been applied in SDEWES work by Bačeković on integrated vs non-integrated energy systems [10], Østergaard on business vs socioeconomic optimisation [11] and a Frederikshavn, Denmark case study [12], Marcinkowski with island case studies [13], Thellufsen regarding renewable energy-based cities in country contexts [14], Hansen on a

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heat roadmap for Europe [15], Grundahl on socioeconomic vs user economic optimisation [16], and Askeland on the potential role of Norway as a battery for Europe [17]. Connolly presented work on how Ireland should initiate a transition [18], Liu investigated transition prospects for China [19], and Mathiesen focused on links between energy transition, economic growth and employment in Ref [20] as well as the limits imposed by biomass constraints [21]. As the developer of EnergyPLAN, Lund has several works using the model in the SDEWES context, with [22] focusing on a smart energy Denmark scenario, general renewable energy development paths in [23], comparison with alternative models [24], scenarios for Denmark in 2030 and 2050 [25] and finally [26] focusing on the impacts of transition choices on needs for storage and transmission capacity.

2. Regular Articles

The IJSEPM has a solid track-record within the of GIS mapping for district heating starting with Möller and Nielsen's [27] notable work on mapping of heat demand from 2014. Later work includes Dochev and coauthors work on graph theory in heat demand mapping [28], Kuriyan and Shah's [29] model for planning district heating systems from both a spatial and technological perspective, and Urquizo and coauthors [30] using thermal imagery for heat demand concentration assessment in Newcastle. Büchele and coauthors [31] used the Invert/EE-Lab model combined with spatial analyses to establish development potential for district heating in Austria. Others have focused on the locational aspects of sources – notably Jürgens [32] assessing the locational aspects of waste heat from data centres in Germany for district heating and Pieper and coauthors [33] addressing heat sources for district heating and cooling. Yet another branch of the district heating and spatial analyses field is within the layout of district heating grids. Thus, Dénarié and coauthors [34] as well as Fallahnejad, Kranzl & Hummel [35] focus more closely on the piping layout of district heating systems. Outside this journal, there has also been a strong focus on waste heat sources [36], on overall transition studies incorporating energy systems and spatial analyses [37], distribution costs [38], mapping of heat sources [39] and e.g. the concept of effective width [40,41].

For this issues, Moreno and coauthors [42] take a starting point in lack of detailed building information for making heat atlases in some regions. Thus, they develop ODHeatMap – an open data-based workflow for establishing heat atlases based on e.g. buildings footprints. Ulaanbaatar (previously anglicized as Ulan Bator) in Mongolia is a city of large heating demands, severe air pollution from coal combustion – yet modest district heating as well as modest energy planning data availability. This city is therefore taken as a case for demonstration ODHeatMap. Moreno has previously addressed the issues of heat demand mapping under restricted data availability in [43], where the tool MUSEPLAN was presented.

In Ref. [44], Hoang addresses another Asian country with a different context. In Vietnam, economic growth is spurring energy demand increases. Analysing historical data as well as a series of demand projections for the 2030 and 2050 the authors establish that emission scenarios meet 2030 targets, this is not the case for the longer term 2050 scenarios. To meet the long-term 2050 objectives, significant increases in renewable energy exploitation as well as energy efficiency improvements in the residential and industrial sectors are strongly needed.

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