

Article

Fostering Energy Resilience in the Rural Thai Power System—A Case Study in Nakhon Phanom

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Abstract: With rising electricity demand, heavy reliance on imports, and recent economic downturns due to the negative impact of the COVID-19 pandemic, supply chain bottlenecks, and the Russian invasion of Ukraine, Thailand is suffering severely from energy resilience risks. The government has therefore set a goal of decentralizing energy production through small-scale distributed renewable energy systems. To support their design and the planning process, we simulate multiple scenarios with wind turbines, photovoltaic systems, and battery storage for a model community in rural Nakhon Phanom, Thailand. Using the software NESSI4D, we evaluate and discuss their impact on energy resilience by considering environmental sustainability, economic attractiveness, and independence from the central power grid. To fill the gap of missing data on energy demand, we synthesize high-resolution load profiles from the Thailand Vietnam Socio-Economic Panel. We conclude that distributed photovoltaic systems with additional battery storage are only suitable to promote energy resilience if the government provides appropriate financial incentives. Considering temporal variations and local conditions, as well as a participatory decision-making process, are crucial for the long-term success of energy projects. Our advice to decision-makers is to design policies and regulatory support that are aligned with the preferences and needs of target communities.

Keywords: energy system simulation; energy resilience; distributed renewable energy; case study; sustainable development; energy policy



Citation: Hart, M.C.G.; Breitner, M.H. Fostering Energy Resilience in the Rural Thai Power System—A Case Study in Nakhon Phanom. *Energies* **2022**, *15*, 7374. <https://doi.org/10.3390/en15197374>

Academic Editors: Ruijin Du and Minggang Wang

Received: 22 September 2022

Accepted: 4 October 2022

Published: 7 October 2022

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1. Introduction

In the past decades, Thailand has experienced impressive social and economic development which has allowed its economy to become the second-largest in Southeast Asia. With its sustained growth and successful poverty reduction, the population's energy demand is increasing as well [1]. In the past 10 years, annual residential electricity consumption has risen by 54% to 38.500 GWh in the provinces [2]. This trend was further amplified by COVID-19 when it rose extraordinarily by 6% to 9% on a year-on-year basis between 2018 and 2021 [2]; see Figure A1 in Appendix A. These increasing demands are mostly satisfied by higher fossil fuel production and imports, of which the latter has risen tenfold since 2009; see Figure A2 in Appendix A [3]. As a result, carbon emissions increase, which negatively affects the environment and people's health [1]. Apart from an ecological perspective, these strong dependencies on other countries, political market risks, and the above-mentioned rising demand threaten Thailand's energy security and resilience [3,4]. Specifically in the past two years, the interlocking disruptions in global supply chains, Russia's invasion of Ukraine, increasing global fuel and LNG prices, and the adverse effects of the COVID-19 pandemic demonstrate that such energy market dependencies can severely jeopardize a country's economy and its people's overall well-being. Driven by these risks and further motivated by international agreements such as Paris 21 and the Sustainable Development Goals, the Thai government has set its focus on increasing the energy system's resilience with locally produced, clean energy [5]. One of its tactics is to support communities to become electricity prosumers by producing and utilizing small-scale renewable energy