Improving the resilience of energy systems in the Global South: Energy planning in Ghana as a role model for the world

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What infrastructural requirements are optimal in order to ensure the most secure and sustainable energy supply possible? The MEASURES project has taken a closer look at this question using Accra (Ghana) as a case study. Credit: MEASURES Project

Under the leadership of Empa scientist Mashael Yazdanie, an

international research team is investigating ways to better plan for climate-resilient energy systems in the Global South. Their findings were published in Energy Reports and Energy and Climate Change.

Focusing on the case study of Accra, the capital of Ghana, the multidisciplinary team expanded conventional energy system modeling approaches by incorporating a range of socio-techno-economic challenges, climate change impacts, and resilience metrics into their models. Their approaches are applicable worldwide to support widespread sustainable and resilient energy system transitions.

What criteria should we use to better plan for resilient energy systems? How do socio-economic, technical and climate change related challenges affect sustainable energy systems planning worldwide? What does the situation look like in a region outside the European industrialized perspective?

With these questions in mind, four years ago, the research project Energy Modeling for the Real World Transforming Modeling Approaches for Sustainable and Resilient Energy Planning (MEASURES) embarked on an interdisciplinary study, using Ghana as a case study region.

The aim was to formulate modeling approaches that yield optimal recommendations for climate-resilient energy planning, considering various dimensions—energy demand, infrastructure, climate data, resiliency and robustness of a system and an array of socio-economic factors—that can be applied to cities and countries across the globe.

In their studies, the scientists paid particular attention to issues that are not taken into account in traditional energy models: climate change-induced extreme weather events, climate migration, informal economic systems (i.e., economic activities that are unmonitored and unaccounted

for in official GDP figures), unstable currencies, power system failures and suppressed energy demand (e.g., due to poor infrastructure or financial resources).

Ghana, in particular, faces these challenges, which makes the region an ideal case study. Thus, Mashael Yazdanie, Group Leader of Macro-Energy Systems at Empa's Urban Energy Systems Laboratory, spearheaded the cross-disciplinary, international MEASURES project.

A specific course of action based on regional characteristics

The researchers examined a range of challenges relevant to energy system planning in Accra. What climate change-related environmental changes are to be expected in the coming decades? How will these affect regional migration? What influence does the informal economy and suppressed energy demand have on strategic energy planning? To what extent will currency depreciation thwart energy planning and the development of sustainable energy infrastructure?

Using the open-source modeling framework, OSeMOSYS, they developed an energy system model for Accra and investigated these issues.

The model yielded cost-, carbon- and resilience-optimized energy system capacity and operational planning decisions for Accra, considering its unique local conditions.

For example, concerning the deployment of sustainable energy technologies under the threat of currency depreciation, the researchers find that "investments in photovoltaic and wind energy are most affected by rising depreciation in the case of Accra. If PV systems are part of

larger sustainability commitments in Accra—as prescribed by Accra's current Climate Action Plan—our results indicate that these investments should take place earlier rather than later in the planning horizon to ensure affordable deployment."

According to their study, Accra should additionally focus on efficient waste resource capture and utilization, as well as decarbonization of transportation through fleet electrification for robust and sustainable urban energy system planning.

From local development to global inspiration

The Ghanaian case study is not the only outcome of the MEASURES project; the researchers hope their investigation will catalyze more comprehensive and meaningful approaches for resilient and sustainable energy systems planning worldwide.

In addition to the environmental disturbances that we will face in the coming decades due to climate change, their approach also considers various socio-techno-economic challenges that have received little to no attention in conventional analyses.

For this reason, it was important for the project team to share all methods and results in open-access formats so that researchers and decision-makers worldwide may use them to inform and further develop methodologies, energy decision-making processes, and long-term resilience strategies.

The results and tools of the MEASURES project thus represent an invaluable boost in developing future sustainable energy systems, especially for low- and middle-income countries that are the most vulnerable to climate change.

More information: M. Yazdanie et al, The impacts of the informal economy, climate migration, and rising temperatures on energy system planning, *Energy Reports* (2023). DOI: 10.1016/j.egyr.2023.11.041

M. Yazdanie, Resilient energy system analysis and planning using optimization models, *Energy and Climate Change* (2023). DOI: 10.1016/j.egycc.2023.100097