ENERGY SECURITY THROUGH SUSTAINABLE ENERGY AND CLIMATE TARGETS IN SMALL ISLAND DEVELOPING STATES

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Overview

Energy is a strategic commodity for small island developing states (SIDS), considering its importance for socio-economic activities. Moreover, the energy challenges faced by these small island nations are manifold: increased dependence on fossil fuel imports, relatively concentrated primary energy and electricity mixes, and high energy bills that further burden their national budgets. All these challenges jeopardize their energy security. In this context, the energy transition could improve island energy security. This study explores the power systems of two islands in the Republic of Mauritius (RoM): mainland Mauritius and Rodrigues Island. We investigate the sustainable and low-carbon pathways in the RoM and the likelihood of achieving energy security by modelling energy and climate mitigation targets over the period 2019-2050.

Methods

Mainland Mauritius and Rodrigues Island were modelled separately to account for specific power system dynamics. For this purpose, we developed a TIMES bottom-up model for the Republic of Mauritius (RoM-TIMES) based on a cost-optimisation approach. The latter is a multi-regional model with two internal regions. Regional discounted costs aggregated into a single total cost constitute the objective function minimised by the model in its equilibrium computation. Figure 1 illustrates the exogenous inputs and the expected outputs of the RoM-TIMES model, calibrated for the reference year 2019 based on data collected from Statistics Mauritius and the local network operator, the Central Electricity Board. We investigated three scenarios: (i) a BAU scenario which serves as the reference scenario; (ii) a 35RE scenario where both island power systems are expected to deliver at least 35% renewable energy penetration by 2025 and 40% by 2030; and (iii) a 30GHG scenario where a 30% reduction target is set for both regions.

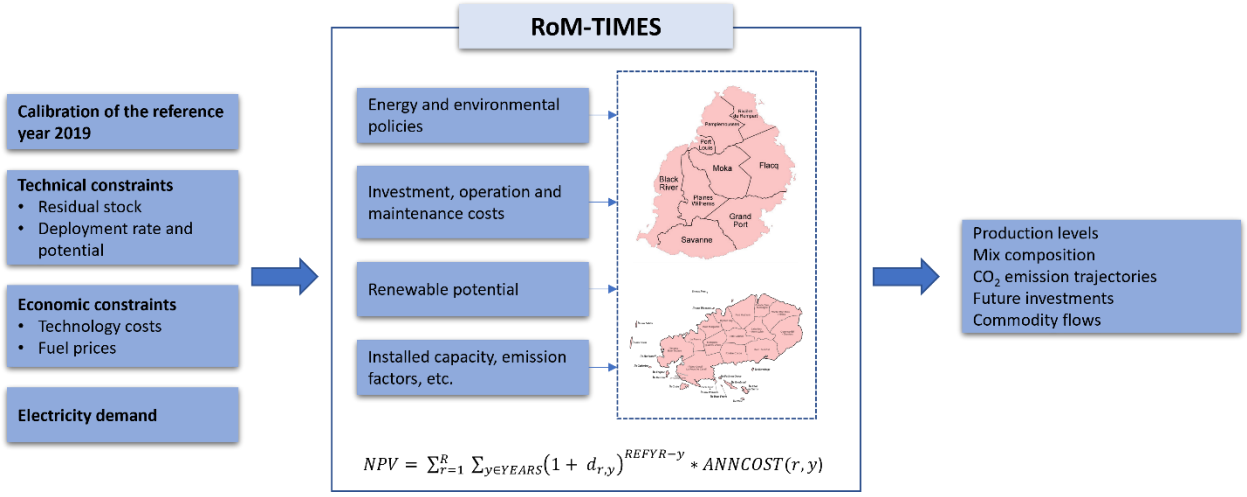

Figure 1 Overview of the main exogenous inputs considered in RoM-TIMES (source: the authors)

Results

Overall, transitioning to a less carbon-intensive power system requires fuel switching and a higher share of low-carbon/zero-emission technologies. As a result, over the period 2019-2050, a total of 24.4 Mt of cumulative CO_2 emissions can be avoided in Mauritius following emission reduction targets (30GHG scenario) compared to the BAU scenario. On the other hand, the results do not significantly change in the 35RE scenario of both islands, suggesting that the 35% RE target set by the government of Mauritius is not ambitious enough and needs to be revised upwards since the reference scenario achieves similar results.

Our results show that the power systems progressively become more diverse as targets become more stringent in constrained scenarios, particularly the 30GHG scenario. Policymakers should thus work towards maintaining this level of diversity and balance, as a diverse power system acts as a bulwark against major external shocks that could potentially disrupt the supply chain. In addition, transitioning to a low-carbon energy system implies switching from

high-carbon content technologies to low-carbon/carbon-neutral technologies. Figure 2 illustrates the primary energy supply requirements for power generation in Mauritius and Rodrigues. As a result, the energy systems in both islands are less reliant on imported fossil fuels, especially more polluting ones (such as coal for Mauritius and HFO for Rodrigues), to meet their primary energy requirements. This is a crucial benefit for a small island state like the RoM, which has historically relied heavily on imported fossil fuels and has been exposed to energy price fluctuations in international energy markets and supply chain disruptions. However, the question of old dependencies versus new ones remains. Indeed, the results show that 15% of the electricity production in 2050 comes from imported biomass, which may be a barrier for Mauritius if it aspires to electricity autonomy one day.

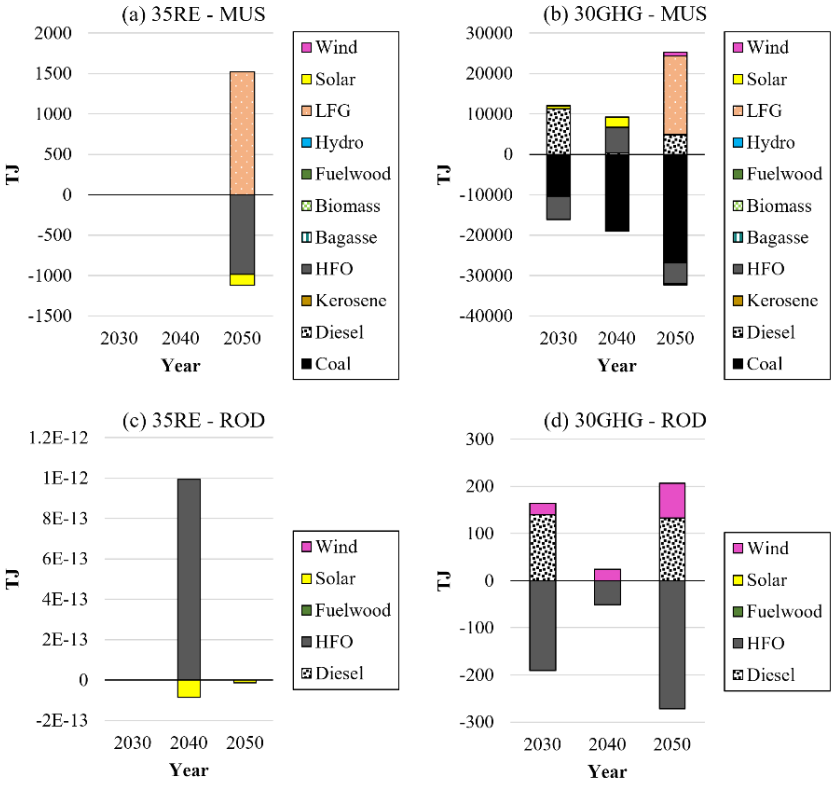

Figure 2 Difference in primary energy supply (TJ) requirements w.r.t the BAU scenario (source: the authors)

Conclusions

This study investigated how the Republic of Mauritius can enhance energy security through cost-optimal power system energy transition. Our results show that the climate mitigation target is more likely to achieve energy security in the RoM. Mauritius and Rodrigues Island can reduce their dependence on energy imports for power generation based on the gradual fuel switch from HFO and coal to domestic energy sources (including solar, wind and local biomass) within the optimization framework and modelling horizon. Moreover, the 30GHG scenario enhances the diversification of the power mix compared to the reference scenario. However, although biomass imports contribute to the decarbonization of the power generation portfolio, reliance on imported biomass still represents energy security issues for Mauritius. This situation typically highlights conflicting targets that call for trade-offs from policymakers. The RoM should work out implementable milestones for sustainable and low-carbon pathways to simultaneously achieve the so-called 3Es (energy security, economic efficiency and environmental protection). In addition, the promotion and development of more domestic renewable sources should be enhanced. Energy independence and generation mix diversity, amongst others, are indicators that convey information about a power system's global performance. While this study showed that achieving energy security through climate change mitigation is technically and economically feasible, international funding is still critically required for its successful implementation. Although funding for mitigation projects has been steadily increasing, technical assistance and capacity building in small island nations like the RoM is limited, as reported by Atteridge and Savvidou (2019).

References

Atteridge, A., & Savvidou, G. (2019). Development aid for energy in small island developing states. Energy, Sustainability and Society, 9(1), 1-16.

Genave, A., Blancard, S., & Garabedian, S. (2020). An assessment of energy vulnerability in Small Island Developing States. Ecological Economics, 171, 106595.