Nikolaos Papastefanakis, Valentin Russeil and Sandrine Selosse

THE ENERGY AUTONOMY OF REUNION ISLAND CONFRONTED WITH LAND USE CONFLICTS

Nikolaos Papastefanakis, Mines Paris - PSL University, CMA - Centre for Applied Mathematics, 1 Rue Claude Daunesse, 06560 Valbonne, France, +33676019203, nikolaos.papastefanakis@minesparis.psl.eu

Sandrine Selosse, Mines Paris - PSL University, CMA - Centre for Applied Mathematics, 1 Rue Claude Daunesse, 06560 Valbonne, France, sandrine.selosse@minesparis.psl.eu

Valentin Russeil, Laboratoire PIMENT, Université de la Réunion, Le Tampon 97430, La Réunion, valentin.russeil@univ-reunion.fr

Overview

Mitigating climate change requires low-carbon strategies in order to transition from a highly carbon emissive economy to a neutral one. In this context, most island territories are also particularly challenged with energy autonomy issues, facing constraints such as energy dependence and security as well as demographic pressures. In order to face their high dependence on imported fossil fuels, a significant share of renewable energy sources must integrate the technology mix of small islands electricity production.

This is the case of Reunion Island, a French overseas region heavily dependent on fossil fuels, which is pursuing its objective of producing 100% of its electricity from renewable energy sources by 2030 in order to become energy autonomous. In this respect, for example, by the end of 2023, Reunion will definitively abandon the use of fossil coal and will convert its second power plant to 100% biomass. The island also possesses a significant potential of renewable energy sources, but it is still insufficiently exploited and is also confronted with a limited land surface, protected natural areas, urbanisation, technical constraints and an agricultural area which is occupied by 50% by sugar cane, the latter contributing to energy autonomy by recovering bagasse.

In this context and based on an analysis of a 100% renewable electricity system applied to Reunion Island in 2030 and up to 2050, the aim of this study is to compare different trajectories of electrical autonomy with the synergies and conflicts of land use in this territory. Land allocation and its development in order to optimise food and energy self-sufficiency is then researched, and then the question arises as to the land use policies that would enable both to be optimised by 2050. Moreover, the validated decisions of the PPE (Multiannual Energy Plan) make Reunion dependent on biomass imports following the 2030 objective, the horizon being extended to 2050. Several scenarios are thus analysed, and the results discussed with a view to shedding light on challenges, notably energy and food autonomy, security of supply, carbon neutrality, land constraints and use conflicts. This analysis is carried out with the TIMES-Reunion optimisation model, which was specifically built to evaluate the development of the Reunion electricity system.

Methods

The bottom-up models of the TIMES family (ETSAP/IEA) are widely used tools to provide plausible options for the long-term development of power and energy systems as they offer a technology-rich representation of the represented system where each process is defined by a set of economic and technological attributes (such as investment costs, lifetime, availability factors, residual capacities, etc.) as well as the different primary energy sources, whether imported or domestic. The model minimises the total discounted cost of the system under constraints (technical, demand-side, capacity and activity limits, environment) over a time horizon. Secondly, the model aims to provide energy services at the minimum overall cost by simultaneously making decisions on investment and operation of equipment, and on the supply of primary energy. Different long-term trajectories are formalised and analysed according to various energy constraints to which have been associated constraints related to land use and food autonomy issues. These scenarios outline some key patterns in the evolution of the electricity system, the technological choices throughout the time horizon, and, therefore, the impact in terms of resources.

Results

Although Reunion is isolated, equipped with a poorly meshed grid that make it vulnerable and located far from mainland France, the island possesses significant potential in terms of renewables, such as, not only hydropower, but solar, wind, biomass, geothermal and marine energy. As for some other islands, renewable energy sources are thus sufficiently abundant to explore opportunities for an autonomous, sustainable power system (Fontaine et al., 2022; Selosse et al., 2018a, b). Despite a large increase of photovoltaic (PV) installations that has been observed, the maximum share of intermittent energy is normally limited to 30% within the island's electricity grid, due to

reliability reasons, or more depending on the storage capacities installed. The geography of the island (climate, sunshine, pluviometry, etc.) facilitates the establishment of a power mix combining hydroelectricity, photovoltaics, wind, and bagasse. The sugarcane industry has a long history and is an important pillar of the Reunion. The sugar industry could be called to re-engineer itself in order to support the bio-refinery concept. Production of biofuel for the electricity sector, even bioethanol for the transportation sector, could be promoted. This development must be assessed considering land constraints and other issues, particularly food issues (Russeil, 2023), in the area. The scenarios analysed in this study are in line with this. The contribution of the potential of waste recovery is also envisaged to this goal.

Conclusions

As many small islands, over the last decades, Reunion Island committed to use their own resources in a more sustainable manner from an economic, environmental, and social perspective. This leads it to seek to exploit the local available renewable energy resources, rather than continue to be dependent on foreign oil reserves. The results of the different scenarios thus analysed would allow to conduct a technical and policy-oriented discussion. The originality of this study lies in the consideration of use conflicts (energy and food) and the associated land limits in the development of energy and food autonomy scenarios for the territory.

References

Drouineau Mathilde. Modélisation prospective et analyse spatio-temporelle : intégration de la dynamique du réseau électrique. Thèse de doctorat ; Contrôle, optimisation, prospective. École Nationale Supérieure des Mines de Paris, Décembre 2011.

Fontaine Ludovic, Morau Dominique, Praene Jean-Philippe. Analysis and Estimation of Short-Term Residual Household Waste Production: Case Study Reunion Island. *Sustainability*, 2022, 15

Russeil Valentin, Co-construction d'une prospective territoriale pour l'appui aux politiques publiques sur l'autonomie alimentaire et énergétique de l'île de La Réunion, Thèse de doctorat ; Université de la Réunion, 2023, to be published.

Selosse Sandrine, Ricci Olivia, Garabedian Sabine, Maïzi Nadia. Exploring sustainable energy future in Reunion Island. *Utilities Policy*, 2018, 55, pp.158 – 166

Selosse Sandrine, Garabedian Sabine, Ricci Olivia, Maïzi Nadia. The renewable energy revolution of Reunion island. *Renewable and Sustainable Energy Reviews*, 2018, 89, pp.99-105