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URBAN CONTRIBUTION TO OPTIMIZED ENERGY TRANSITION PATHWAYS: A PILOT STUDY OVER THE CANARY ISLANDS

Sonia Jerez[1], Judit Carrillo[2], Albano González[3], Juan Pedro Díaz[3], Juan Carlos Pérez Darías[3], Juan Pedro Montávez[1], Victoria Gallardo[1,4], Marcio Cataldi[1] and Nieves Espinosa[1]

[1]*Department of Physics, University of Murcia, Spain*
[2]*Department of Earth and Environmental Science, University of Pennsylvania, USA*
[3]*GOTA group, University of La Laguna, Spain*
[4]*CECI, Université de Toulouse, Cerfacs/CNRS, France*

Extended abstract

Solar and wind powers play a pivotal role in the transition toward decarbonized electricity systems, serving at the cornerstone of climate change mitigation strategies. However, their integration in the energy mix faces significant challenges due to the intermittency of production caused by weather and climate variability. To address this challenge, an open-access step-wise model called CLIMAX has been recently developed (Jerez et al. 2023; http://climax.inf.um.es/). This model provides actionable strategies for deploying wind and solar photovoltaic facilities that exploit their spatio-temporal complementarity (e.g. solar and wind power curves typically exhibit inverted daily and annual cycles, as well as asymmetric responses to the main large-scale teleconnection patterns over different regions) in order to reduce the volatility of their combined production (Schubert & Fahl, 2013).

In this context, the Spanish Government, through the Recovery, Transformation and Resilience Plan, by Next Generation EU, specifically contemplates the investment in "C7.I2 Sustainable energy on the islands". Through an Agenda for Energy Transition on the Islands, the aim is to achieve greater penetration of the renewable energy in island systems. These investments add up to a wide range of specific energy policies in the Canary Islands, both for the promotion and implementation of Citizen Energy Communities, as well as a Energy transition plan for the Canary Islands (PTECAN). In particular, this energy transition plan foresees to reach a total installed renewable capacity of 3,41 GW in 2030 (with a distribution of 2,04 GW in wind, both on-shore and off-shore; 1,31 GW in photovoltaics).

CLIMAX model has been used in this work to generate optimized scenarios of wind and solar installations over the Canary Islands. On the one hand, insulated systems need to be self-sufficient, and, on the other hand, their usually large climatic heterogeneity gives room for wind-solar complementarity to work. For their generation, several constraints are considered, namely the inclusion of operative units, discarded areas due to environmental, accessibility or feasibility reasons, the regulated minimum of a 7.5% of the rooftop area with solar panels, and the maximum capacity density for each technology (Tröndle et al. 2019). The optimized scenarios guarantee the best fit of the daily wind-plus-solar production to the electricity usage

in the region both at day- and nighttime, reducing the undesired fluctuations of the production around 30% as compared to the outputs from a random spatial distribution of the facilities.

Subsequently, under the umbrella of these scenarios, we evaluate the role of the urban areas in promoting the stability of the Canary energy mix while enlarging the penetration of both variable renewable energies, wind and solar. Given the scarcity of practicable non-urban areas on the islands, the results show that maximizing the rooftop area for utility photovoltaic development would have a twofold positive impact: (1) the leadership of urban areas in leveraging the stability of a renewable-based energy system, and (2) the transformation of idle into profitable land uses for the clean energy transition to achieve net greenhouse gas neutrality.

These results should be taken with care as regards the stability, accuracy and feasibility of the scenarios, i.e. their social acceptance and economic pros and cons, their dependence on the training period, the impacts of climate change on the abundance and variability of the resources, changes in the demand side, the reliability of the simulated climate data and the simplicity of the assumptions made for modeling the capacity factors. Nevertheless, these results undeniably underscore the need for continued efforts to navigate a well-thought transition toward net-zero emissions. They also emphasize the relevant role of urban areas in facilitating such transition.

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