EVALUACIÓN CLIMÁTICA DEL POTENCIAL EÓLICO+SOLAR EN UN SISTEMA INSULAR (LAS ISLAS CANARIAS)

CLIMATIC ASSESSMENT OF THE WIND+SOLAR POTENTIAL IN A INSULATED SYSTEM (THE CANARY ISLANDS)

Sonia Jerez[(1)], Judit Carrillo[(2)], Albano González[(3)], Juan Pedro Díaz[(3)], Juan Pedro Montávez[(1)], Francisco Javier Expósito[(3)], Juan Carlos Pérez-Darías[(3)]

[(1)] Department of Physics, University of Murcia, Murcia, Spain, sonia.jerez@um.es

[(2)] Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, USA

[(3)] GOTA group, University of La Laguna, La Laguna, Spain

SUMMARY

The integration in the energy mix of variable renewable energies (VRE) is neccessary to achieve net-zero emissions, but is highly compromised due to the intermittency of the electricity generation from these sources. To help on that, the CLIMAX tool provides guidance about actionable strategies for the deployment of the facilities that exploit the spatio-temporal complementarity of the two main VRE, wind and solar, in order to reduce the volatility of their combined production. In this case study, we applied CLIMAX over the Canary Islands and evaluate the role of the urban areas in promoting the stability of the Canary energy mix while enlarging the penetration of these two main VRE. Results showed that the optimal scenarios generated with CLIMAX would reduce the undesired fluctuations of the joint wind+solar electricity production around 30% as compared to a baseline deployment scenario, and encourage energy policies aimed at maximizing the rooftop area for utility photovoltaic development.

Solar and wind powers play a main role in the transition toward decarbonized electricity systems, being at the core of climate change mitigation strategies. However, their integration in the energy mix is highly compromised due to the intermittency of their production caused by weather and climate variability. To face the challenge, an open-access step-wise model called CLIMAX has been recently developed (Jerez et al. 2023; http://climax.inf.um.es/). It provides guidance about actionable strategies for wind and solar photovoltaic facilities deployment 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.

In this contribution, we first use CLIMAX to generate optimized scenarios of wind and solar installations over the Canary Islands (Figure 1). 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.

In a second step, 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.

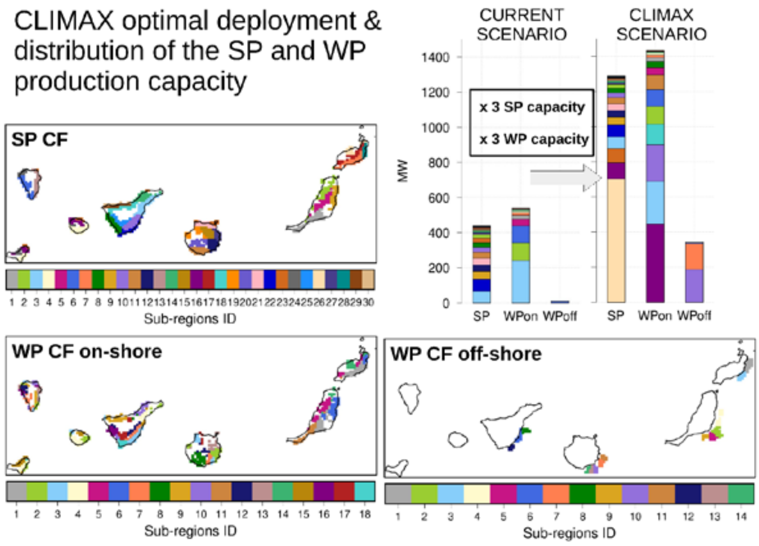

Figure 1 - An example of the optimized scenarios of wind and solar installations over the Canary Islands generated with the CLIMAX tool under several constrains (see text). The bars plot indicate the capacity (in MW) of each technology allocated in each of the regions as displayed in the maps, both for the current scenario and for the optimal situation.

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. Nonetheless they clearly encourage further efforts for transitioning smartly toward net-zero emissions, highlighting the relevant role of urban areas in such transition.

REFERENCES

Jerez, S. et al. (2023): *An Action-Oriented Approach to Make the Most of the Wind and Solar Power Complementarity.* Earth's Future, *11*(6), e2022EF003332.

Tröndle, T., Pfenninger, S., Lilliestam, J. (2019): *Home-made or imported: On the possibility for renewable electricity autarky on all scales in Europe.* Energy strategy reviews, *26*, 100388.

Acknowledgments

This study was supported by the Spanish Ministry of Science, Innovation and Universities–Agencia Estatal de Investigación and the European Regional Development Fund through the Grants TED2021-131074B-I00 and RYC2020-029993-I.