

# What Spatial Planning for the Energy Transition? Unraveling the Territorial Implications of Solar Energy Production in Portugal

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## INTRODUCTION

› The transition to renewable energy sources has become a paramount global objective, primarily motivated by the pressing challenges of climate change, energy security and environmental degradation.

› The ambitious goals of clean energy production will imply massive territorial transformations, since renewable sources have lower power densities (Lovering *et al.*, 2022). The energy transition is expected to present space allocation challenges (Scheidel & Sorman, 2012), that needs to be addressed in relation to agricultural and forestry production while preserving the natural heritage.

› Solar energy in Portugal is projected to expand at a rate of approximately 44% annually until 2030 (SolarPower Europe, 2021), which constitutes a source of land use conflict and territorial competition.

› This study aims to assess changes in land use associated with the energy transition in Portugal, specifically focusing on the implementation of photovoltaic solar power plants.

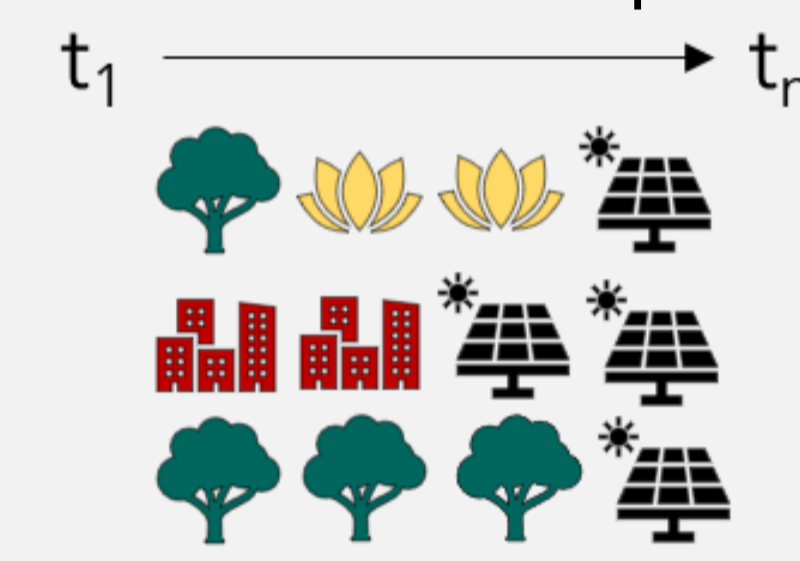
## DATA AND METHODS

› A spatial analysis approach in geographic information systems was conducted to quantify the area changed by solar power plants and the most typical trajectories (1995–2022). Data used was *Carta de Uso e Ocupação do Solo* (COS), from *Direção-Geral do Território* (DGT), and polygons of solar power plants from *Direção-Geral de Energia e Geologia* (DGE) and *Associação Portuguesa de Energias Renováveis* (APREN).

1. Intersect analysis – based on the previous class.



2. Combinatorial analysis – considering the 1995-2018 series of land use and cover map.



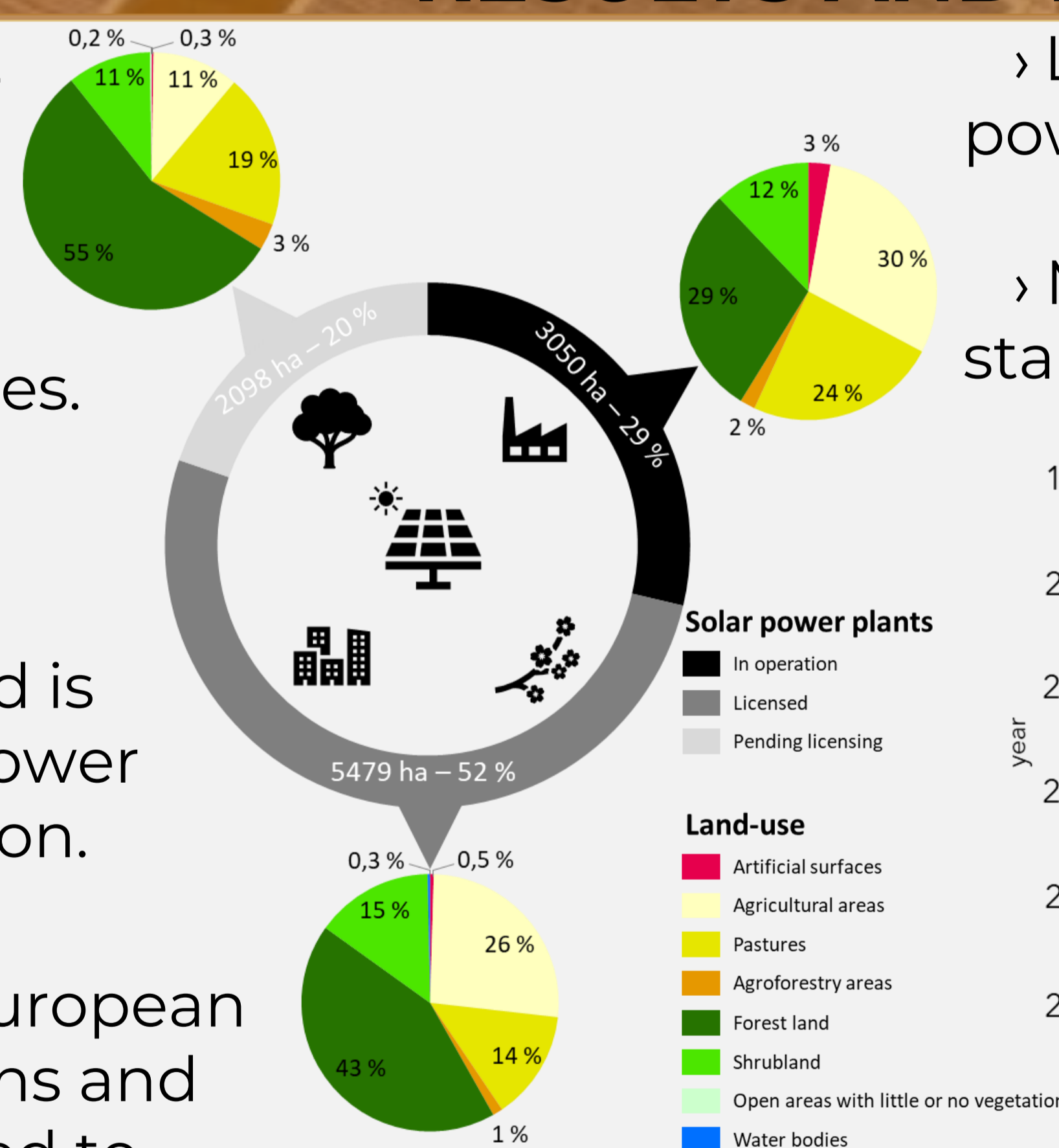
## RESULTS AND DISCUSSION

› The implementation of solar power plants in Portugal has triggered changes in land use patterns, affecting mainly agriculture, forests, and pastures.

› The potential of artificial surfaces for solar energy production is underutilised and is anticipated that future solar power plants will increase deforestation.

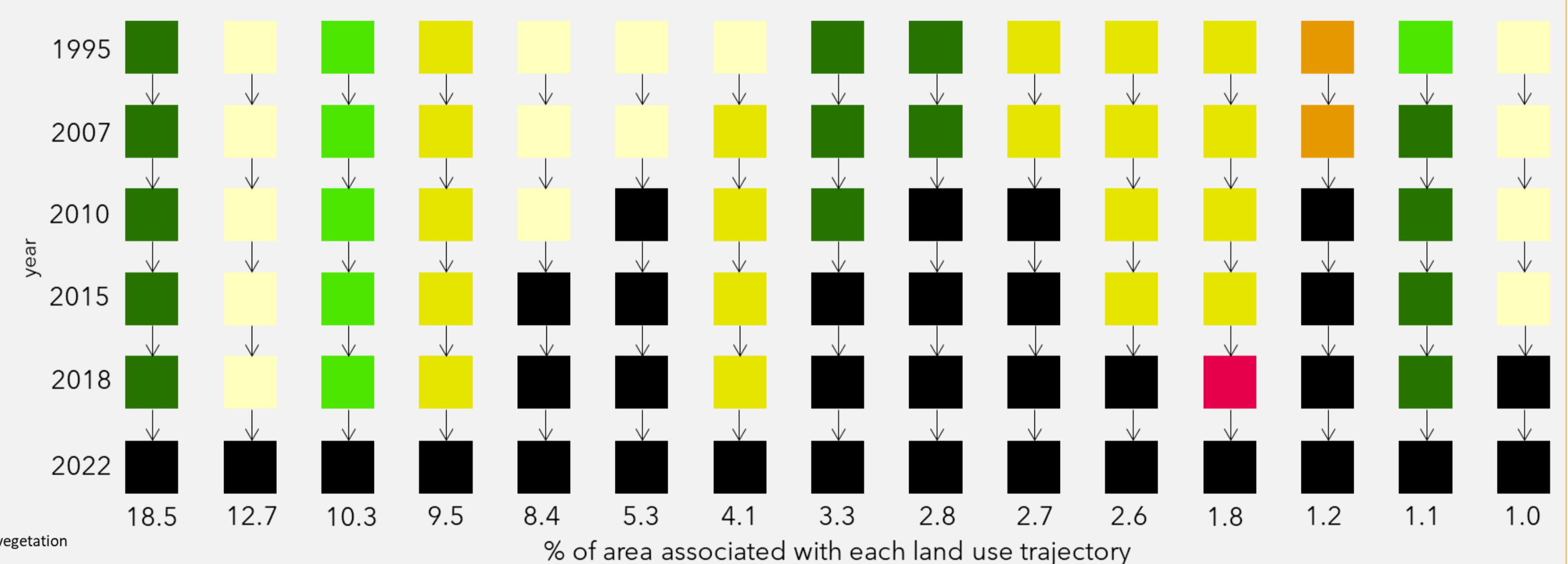
› The findings conflict with European Commission Recommendations and highlight a dichotomy: the need to rapidly grow the renewable share while considering the impacts on land use.

› Similar impacts have been noted in other countries, including in protected areas (Cole *et al.*, 2022; Hernandez *et al.*, 2015).



› Land use trajectories highlight the post 2018 growth of solar power plants.

› Most conversions appear to have taken place in areas with a stable history of land use.



## CONCLUSIONS

- › The land use impacts of solar power plants raise concerns for land management amid a sustainable energy transition.
- › Future locations need to be optimized by balancing multiple dimensions.
- › The Portuguese spatial planning system may not be prepared for rapid decarbonization, lacking integrated spatial and energy planning.

## REFERENCES

- Cole, B., et al. (2022). Dynamic Landscapes in the UK Driven by Pressures from Energy Production and Forestry—Results of the CORINE Land Cover Map 2018. *Land*, 11(2), Article 192. <https://doi.org/10.3390/land11020192>
- Hernandez, R. R., Hernandez, R. R., Hoffacker, M. K., Murphy-Mariscal, M. L., Wu, G. C., & Allen, M. F. (2015). Solar energy development impacts on land cover change and protected areas. *Proceedings of the National Academy of Sciences*, 112(44). <https://doi.org/10.1073/PNAS.1517656112>
- Lovering, J., Swain, M., Blomqvist, L., & Hernandez, R. R. (2022). Land-use intensity of electricity production and tomorrow's energy landscape. *PLoS ONE*, 17, 1–17. <https://doi.org/10.1371/journal.pone.0270155>
- Scheidel, A., & Sorman, A. H. (2012). Energy transitions and the global land rush: Ultimate drivers and persistent consequences. *Global Environmental Change*, 22(3), 588–595. <https://doi.org/10.1016/j.gloenvcha.2011.12.005>
- SolarPower Europe. (2021). *EU Market Outlook for Solar Power 2021-2025*. ISBN: 9789464444292. Retrieved from [https://api.solarpowereurope.org/uploads/EU\\_Market\\_Outlook\\_for\\_Solar\\_Power\\_2021\\_2025\\_Solar\\_Power\\_Europe\\_d485a0bd2c.pdf](https://api.solarpowereurope.org/uploads/EU_Market_Outlook_for_Solar_Power_2021_2025_Solar_Power_Europe_d485a0bd2c.pdf)

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