June 4, 2025

#EU GREEN WEEK

THE WATER-ENERGY-FOOD NEXUS: BUILDING RESILIENCE TO GLOBAL CHALLENGES

Partner Event

Spain's Energy Transition: Local Benefits, Global Burdens?

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Motivation

Renewable technologies for the **energy transition** reduce emissions but require **water**- and **land**-intensive processes for mining, material processing, and infrastructure, affecting the **WEF nexus**.

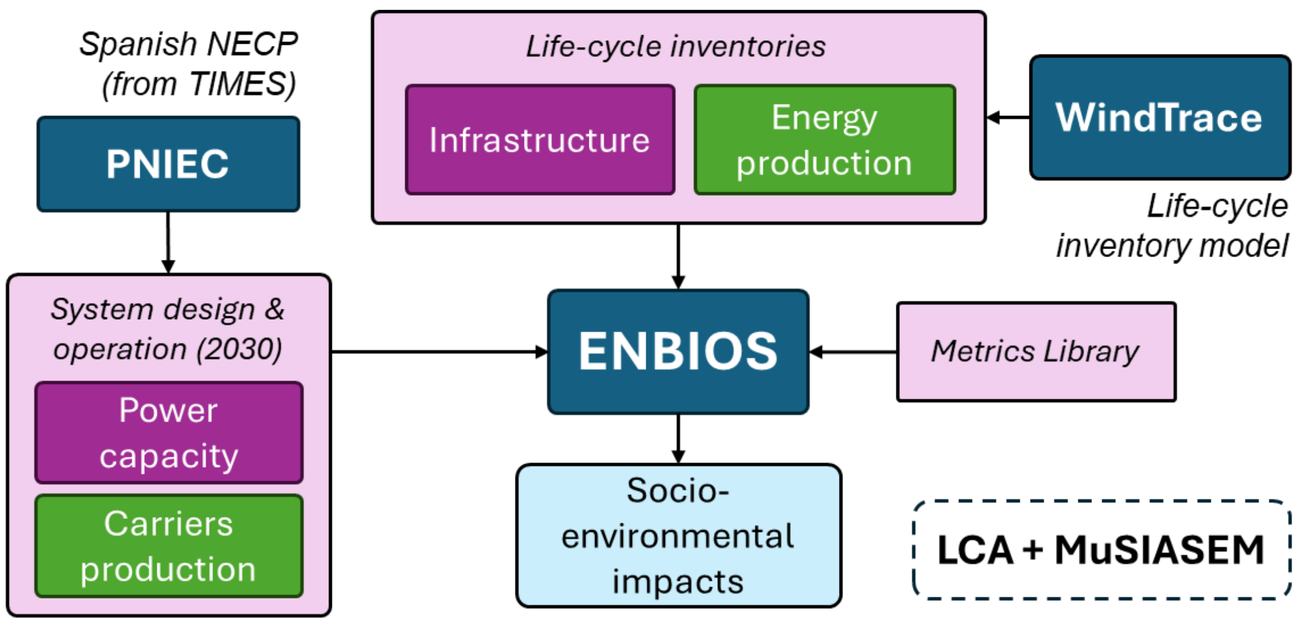
These pressures are often **outsourced** to resource-rich regions far from the point of energy consumption.

Raises **distributional justice concerns**: who bears the environmental burden of clean energy? *[1]*

Goals

*RQ: How does **Spain**'s energy transition impact the links between **energy, water, and land** use, and how are these impacts spread across **local and global regions**?*

Methods



Scenarios

Comparison: PNIEC2023 (**2030**) vs Baseline (**2024**)

Infrastructure | Operation

- *Direct emissions*
- *Primary Energy Sources*
- *Auxiliary materials*

LCA databases: Eoinvent v3.9.1
LCIA methods: EF v3.1
Software: brightway2.5

2024 regional electricity mix from RedElectrica (REE) *[2]*

2030 national electricity mix from PNIEC2023 *[3]*

Onsite inventories: "electricity production" (biosphere)

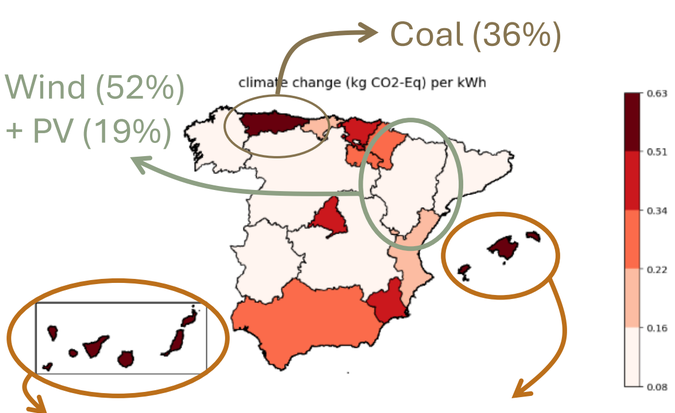
Offsite inventories: "electricity production" (technosphere)

Preliminary results

2024 Operation. Onsite + Offsite

Coal (36%)

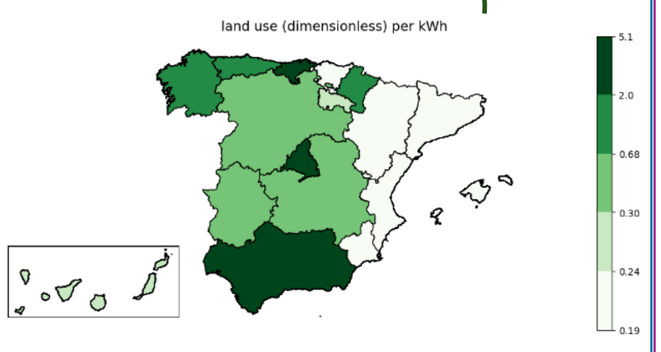
Wind (52%) + PV (19%)

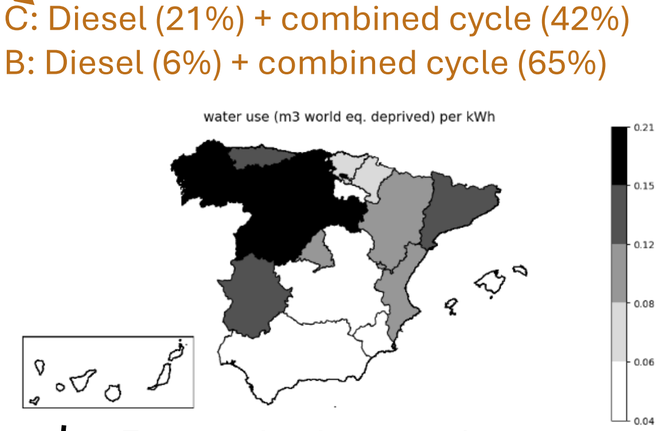


C: Diesel (21%) + combined cycle (42%)

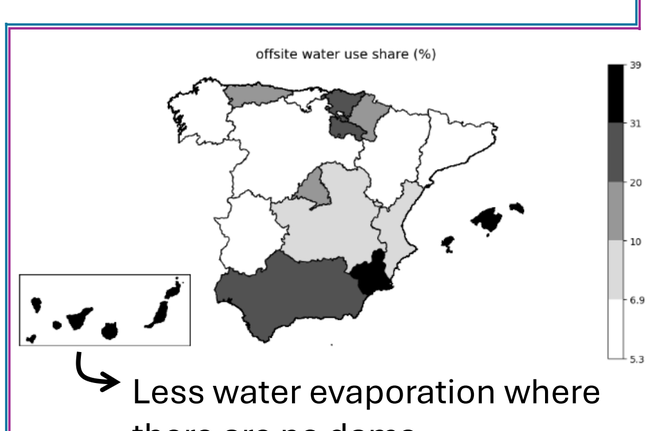
B: Diesel (6%) + combined cycle (65%)

Mostly offsite (biomass)





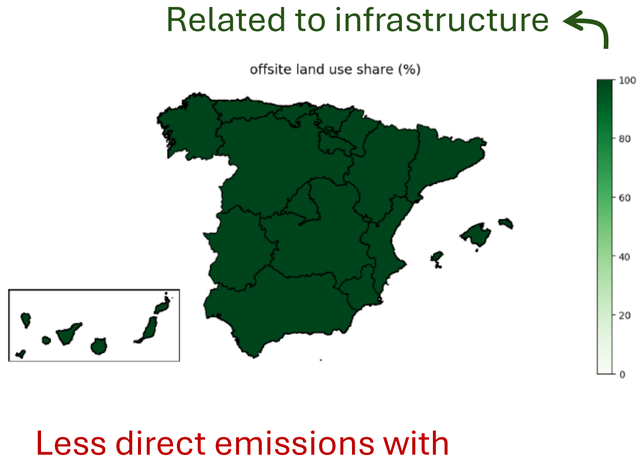
Evaporation in water dams



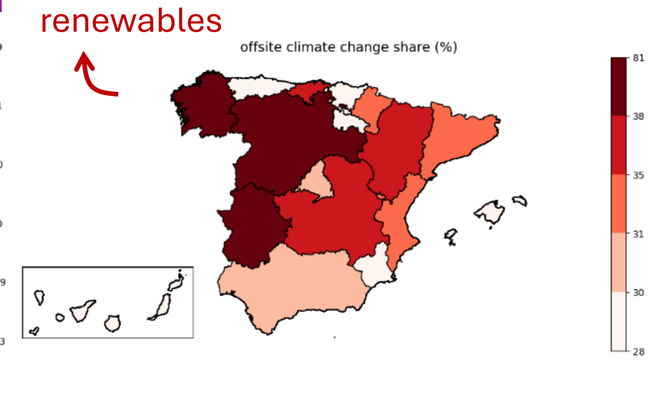
Less water evaporation where there are no dams

2024 Operation. Offsite Only

Related to infrastructure



Less direct emissions with renewables



AND: operating the national system in 2030 will decrease Climate Change (**-55%**) and Water Use (**-45%**), **BUT** increasing Land Use (**+42%**) due to higher biomass use

[1] Sovacool, B. et al. (2017). New frontiers and conceptual frameworks for energy justice. Energy Policy, 105, 677–691. https://doi.org/10.1016/j.enpol.2017.03.005

[2] Ministry for the Ecological Transition and the Demographic Challenge. (2024). *Integrated National Energy and Climate Plan 2023–2030 (PNIEC)*. Government of Spain. https://www.miteco.gob.es/es/energia/estrategia-normativa/pniec-23-30.html

[3] Red Eléctrica de España. (2024). *The Spanish Electricity System Report 2024*. Redeia. https://www.sistemaelectrico-ree.es/sites/default/files/2024-03/ISE_2023.pdf

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