IS RENEWABLE ENERGY RESOURCES AVAILABILITY DECISIVE FOR ENERGY COOPERATIVES' EXISTENCE?

A SPATIOTEMPORAL ANALYSIS

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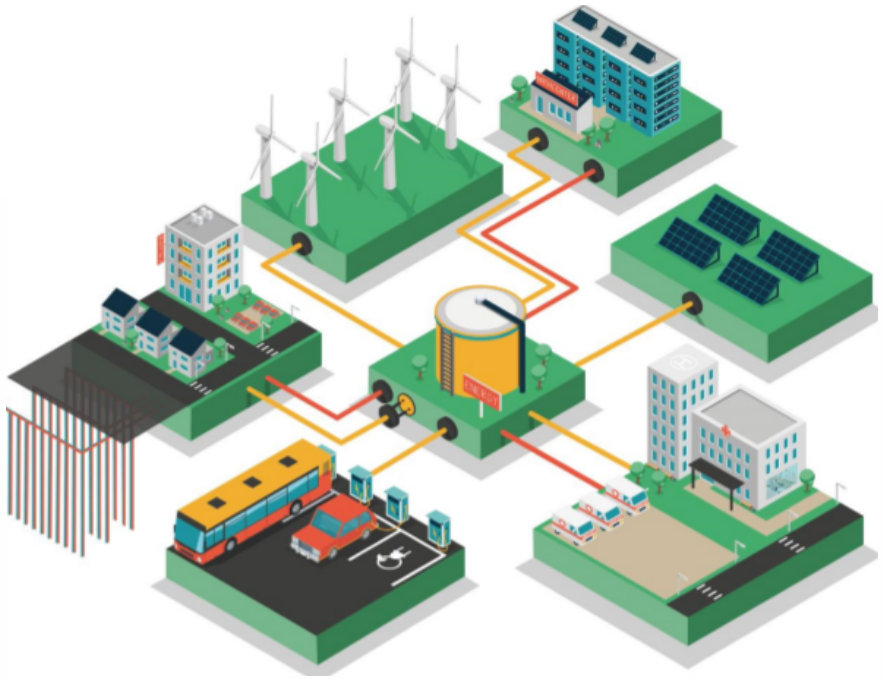
This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

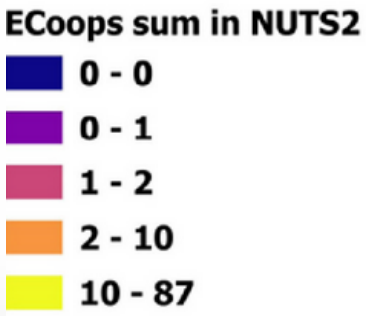
WHY ARE ENERGY COOPERATIVES (ECOOPS) IMPORTANT?

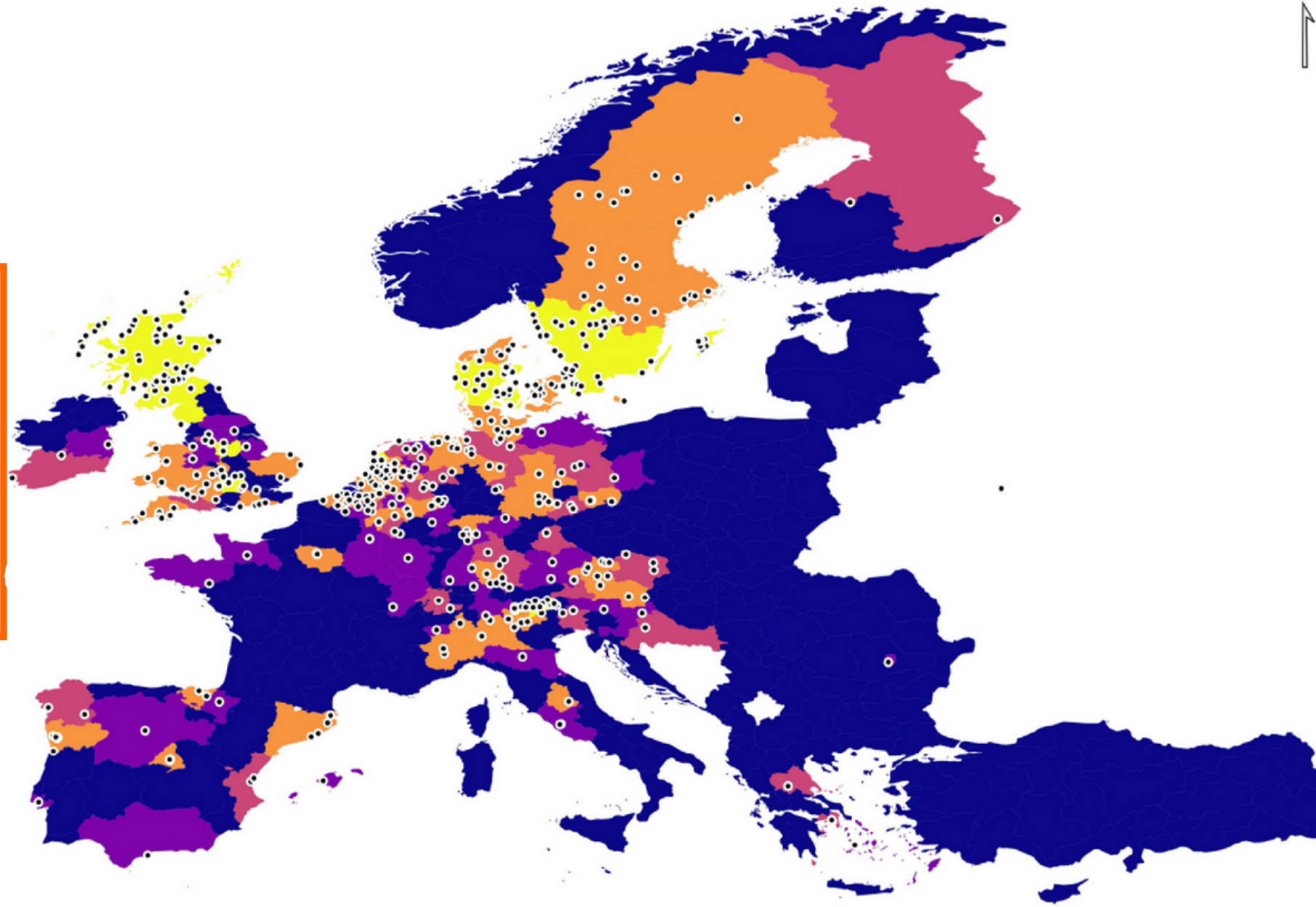


- Ecoops are the most common legal form for Renewable Energy Communities (RECs): end-user ownership and participation in the integration of renewables
- European directives on RECs are currently transposed to national law
- Diffusion of ECoops (and RECs) uneven over time and space

ECOOPS IN EUROPE

Database of the European Federation of Citizen Ecoops
(currently best available European wide database on RECs)





Cartography: Luis Ramirez Camargo, 2021
Data: NUTS2 for EUROPE from EUROSTAT and Rescoo

PRIOR STUDY: ECOOPS AND SOCIAL COHESION

An exploratory (spatial) data analysis studied 100+ socio-economic indicators and which co-occure with the presence of ECoops[1]:

Most indicators present values significantly better at the regions where the ECoops are located compared to all EU regions.

Using Local Moran statistics different local clusters emerged throughout the European continent

[1]Lode, M. L., Coosemans, T., & Ramirez Camargo, L. (2022). Is social cohesion decisive for energy cooperatives existence? A quantitative analysis. *Environmental Innovation and Societal Transitions*, *43*, 173–199. https://doi.org/10.1016/j.eist.2022.04.002

Which indicators of renewable energy sources co-occure with the presence of Ecoops?

Data

NUTS2 and NUTS3 regions and ECoops data base

+ERA5 data (last 43 years ~100 GB of data)

38 variable renewable energy related indicators: resources availability for solar and wind energy, capacity factors, complementarity (spearman correlation) and resources droughts

Methodology based on

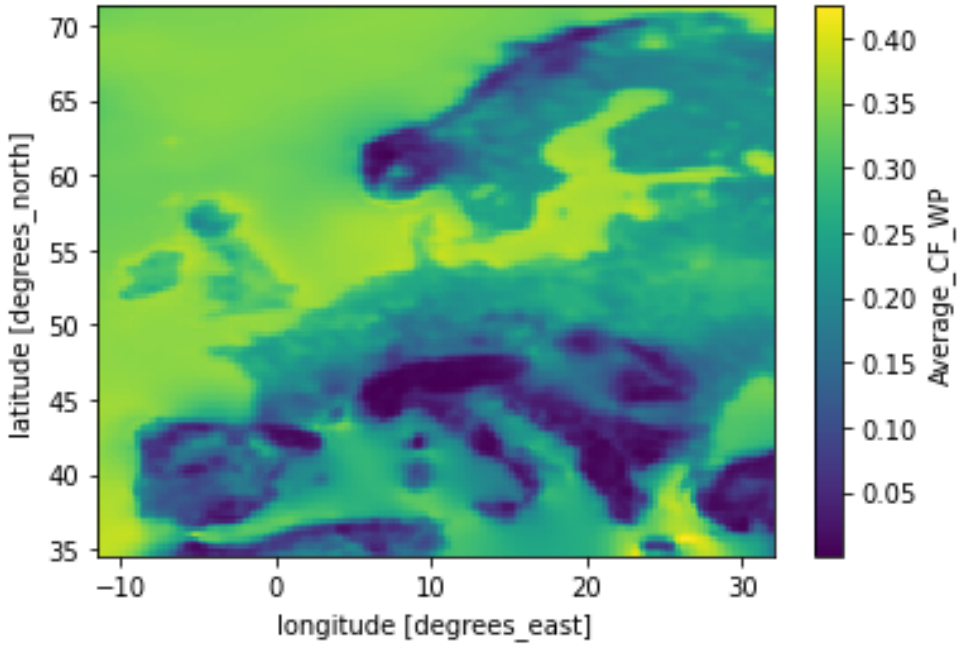
Brown, P. T., Farnham, D. J., & Caldeira, K. (2021). Meteorology and climatology of historical weekly wind and solar power resource droughts over western North America in ERA5. *SN Applied Sciences*, *3*(10), 814. https://doi.org/10.1007/s42452-021-04794-z

(for weeks)

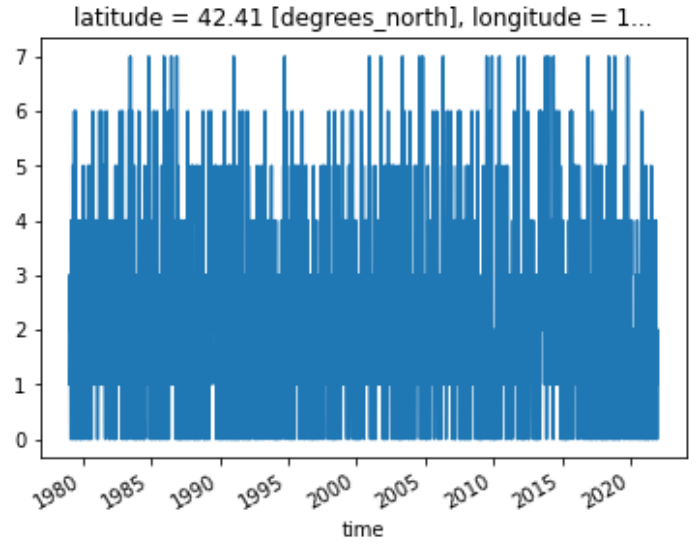
Jurasz, J., Mikulik, J., Dąbek, P. B., Guezgouz, M., & Kaźmierczak, B. (2021). Complementarity and 'Resource Droughts' of Solar and Wind Energy in Poland: An ERA5-Based Analysis. *Energies*, *14*(4), 1118. https://doi.org/10.3390/en14041118

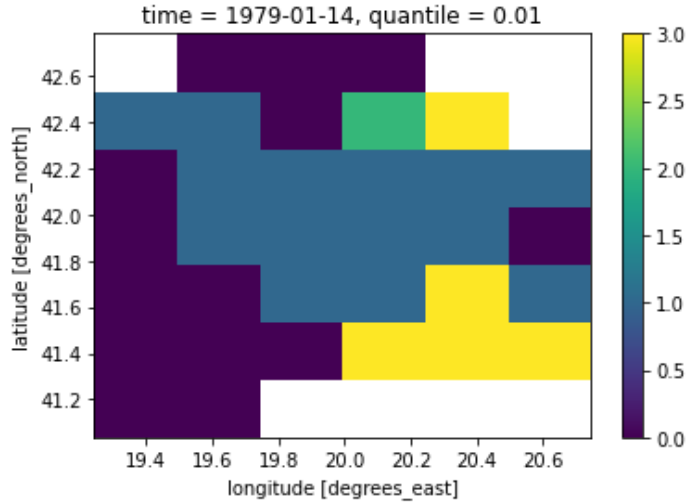
(for days)

EXAMPLES OF THE INDICATORS:



Average wind power capacity factor for the continent on a pixel by pixel basis





Number of drought days for wind power capacity factor per week (NUTS2 region)

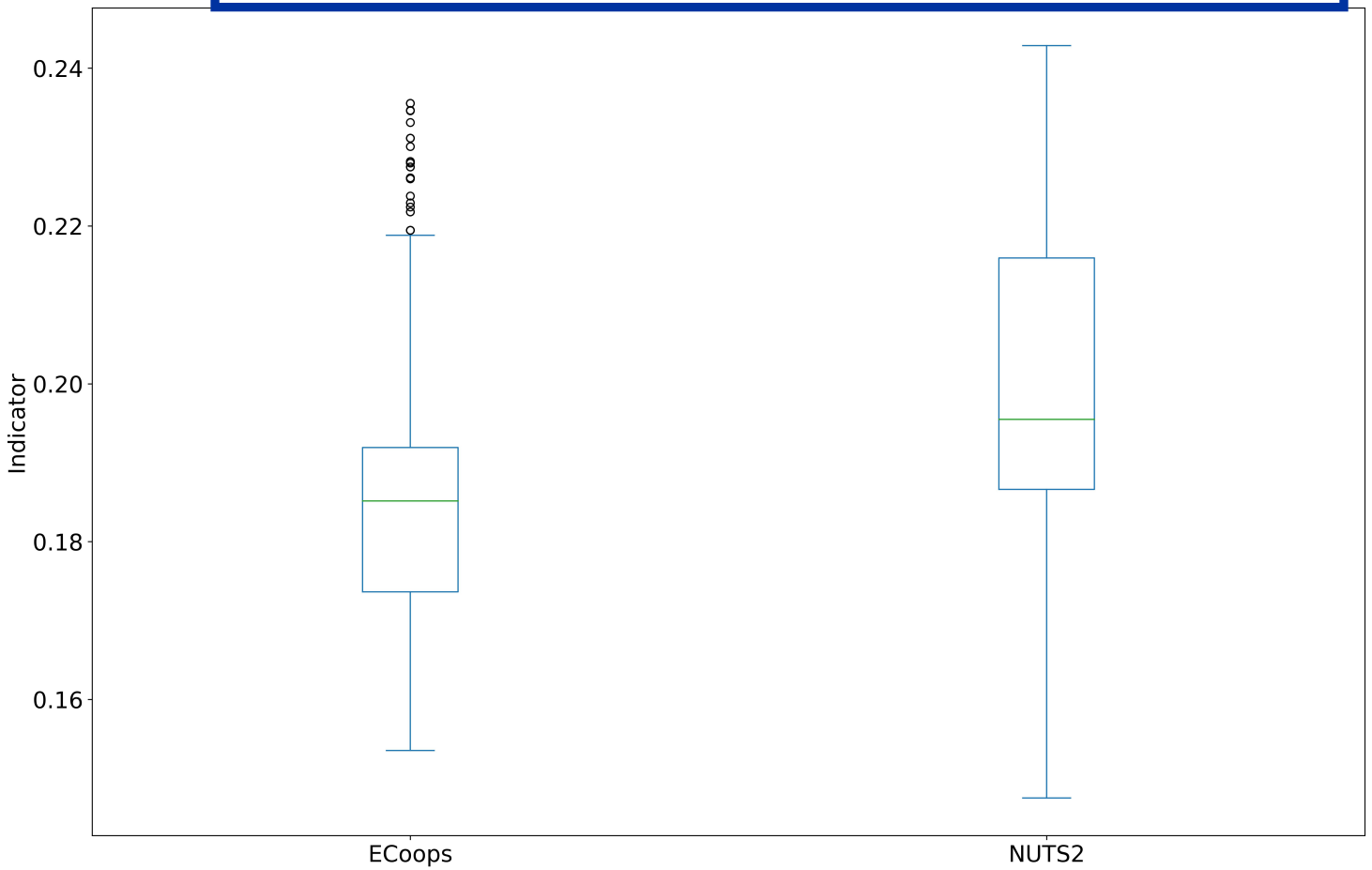
INDICATORS PERFORMANCE FOR REGIONS WITH ECOOPS COMPARED WITH ALL REGIONS

Not all indicators show significant differences

Relation negative for solar and PV

Relation positive for wind speed and wind power

Photovoltaic power capacity factor average
Comparing average for all NUTS2, and average of regions where Ecoops are (significant for pv-cf-avg)



HIGHEST POSITIVE AND NEGATIVE CORRELATIONS OF THE INDICATORS

NUTS2

Wind Speed Average	0.242
Wind power capacity factor average	0.221
Complementarity per month and per pixel lowest value (close to 1)	0.153
Complementarity per week and per pixel highest value (close to -1)	-0.165
Photovoltaic power capacity factor average	-0.254
global horizontal irradiance average	-0.255

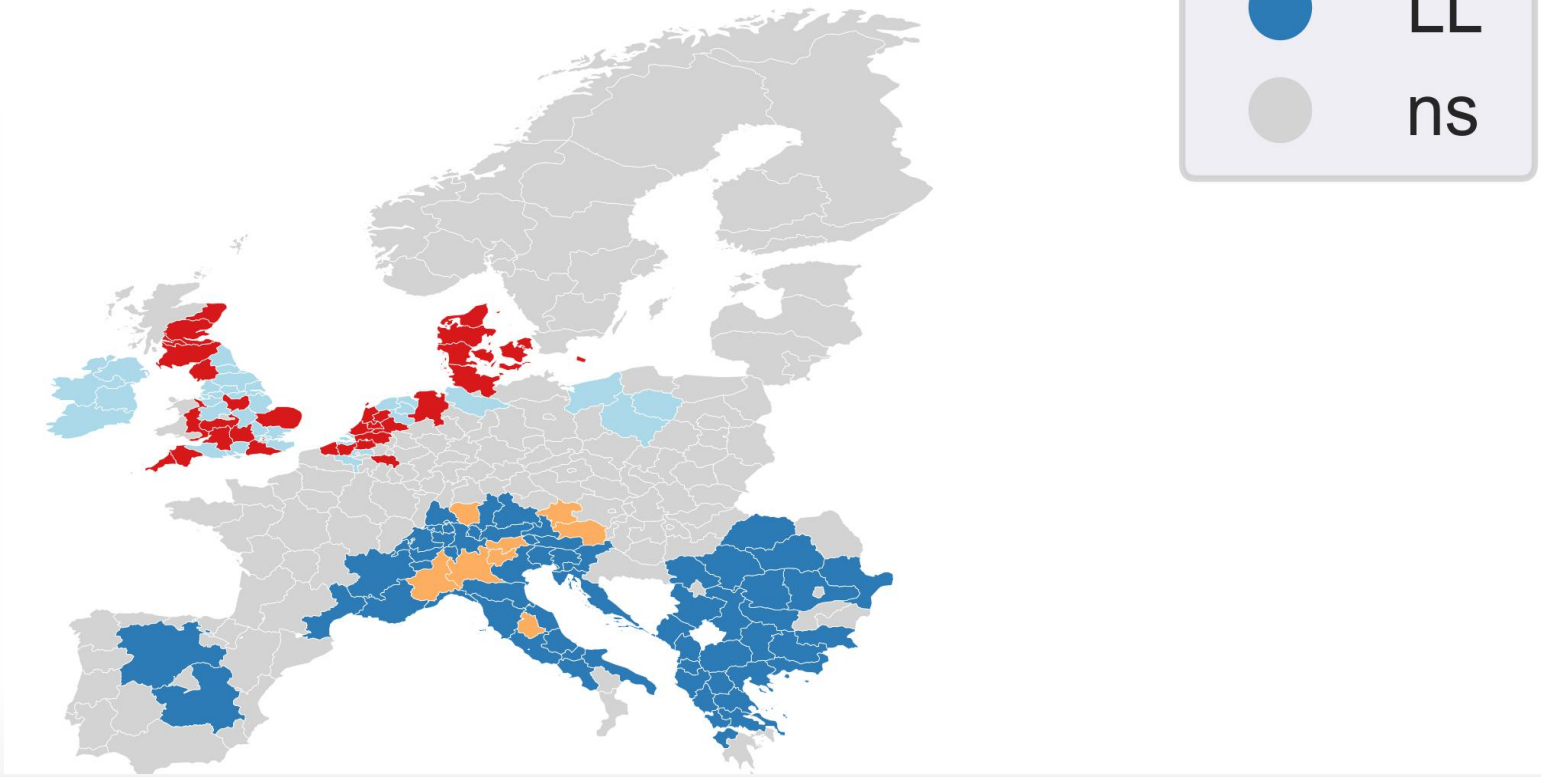
NUTS3

Wind Speed Average	0.187
Wind power capacity factor average	0.175
Complementarity per month and per pixel lowest value	0.122
Complementarity per week and per pixel highest value	-0.075
Photovoltaic power capacity factor average	-0.189
global horizontal irradiance average	-0.190

- General correlations very low, lower than in our study on Social Cohesion
- Wind speed average is positive correlated and the relation with solar PV is negative correlated

SPATIAL ANALYSIS – BIVARIATE MORAN STATISTICS

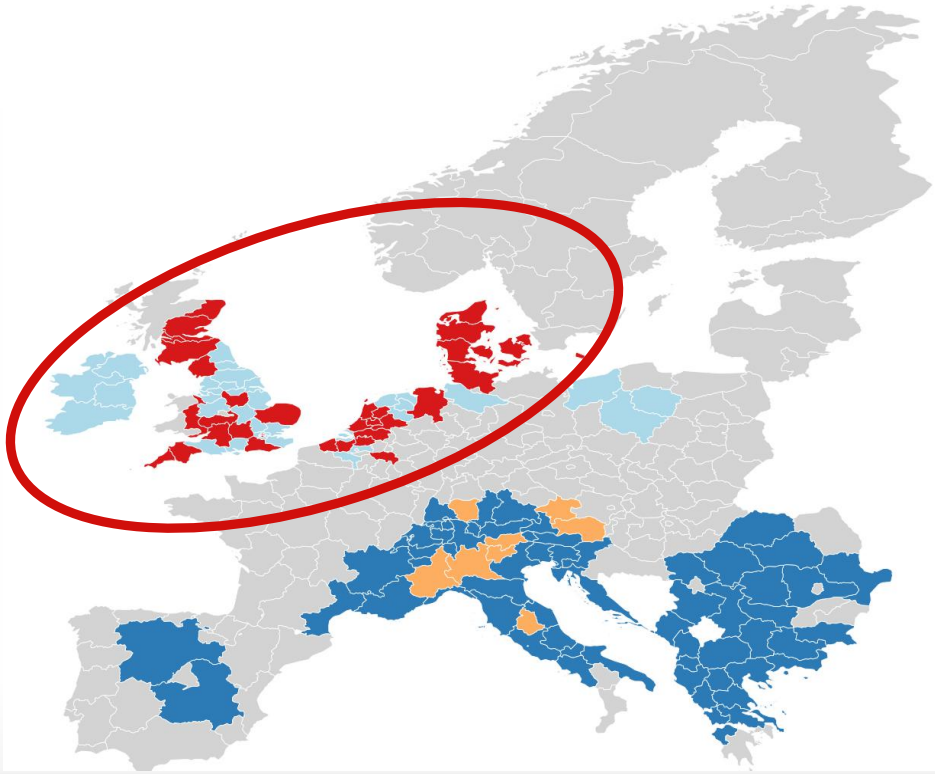
NUTS2 ECOOPS and wind speed average [m/s]

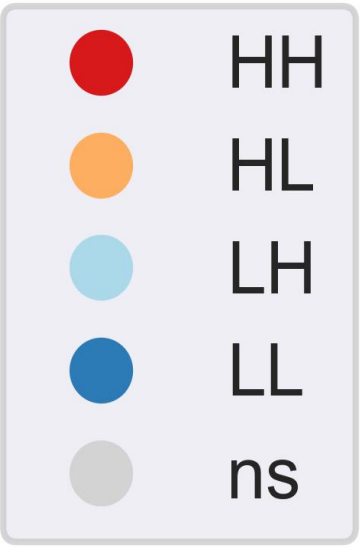


SPATIAL ANALYSIS – BIVARIATE MORAN STATISTICS

NUTS2 ECOOPS and wind speed average [m/s]

- Clusters of HH clusters in Denmark, UK, and Benelux

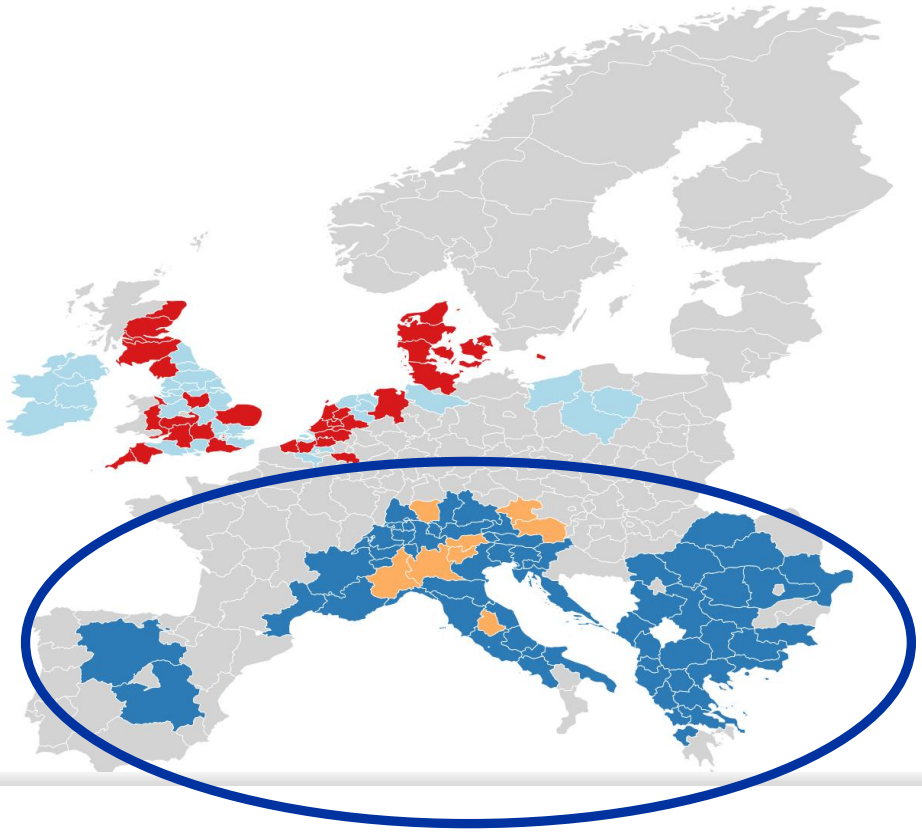




SPATIAL ANALYSIS – BIVARIATE MORAN STATISTICS

NUTS2 ECOOPS and wind speed average [m/s]

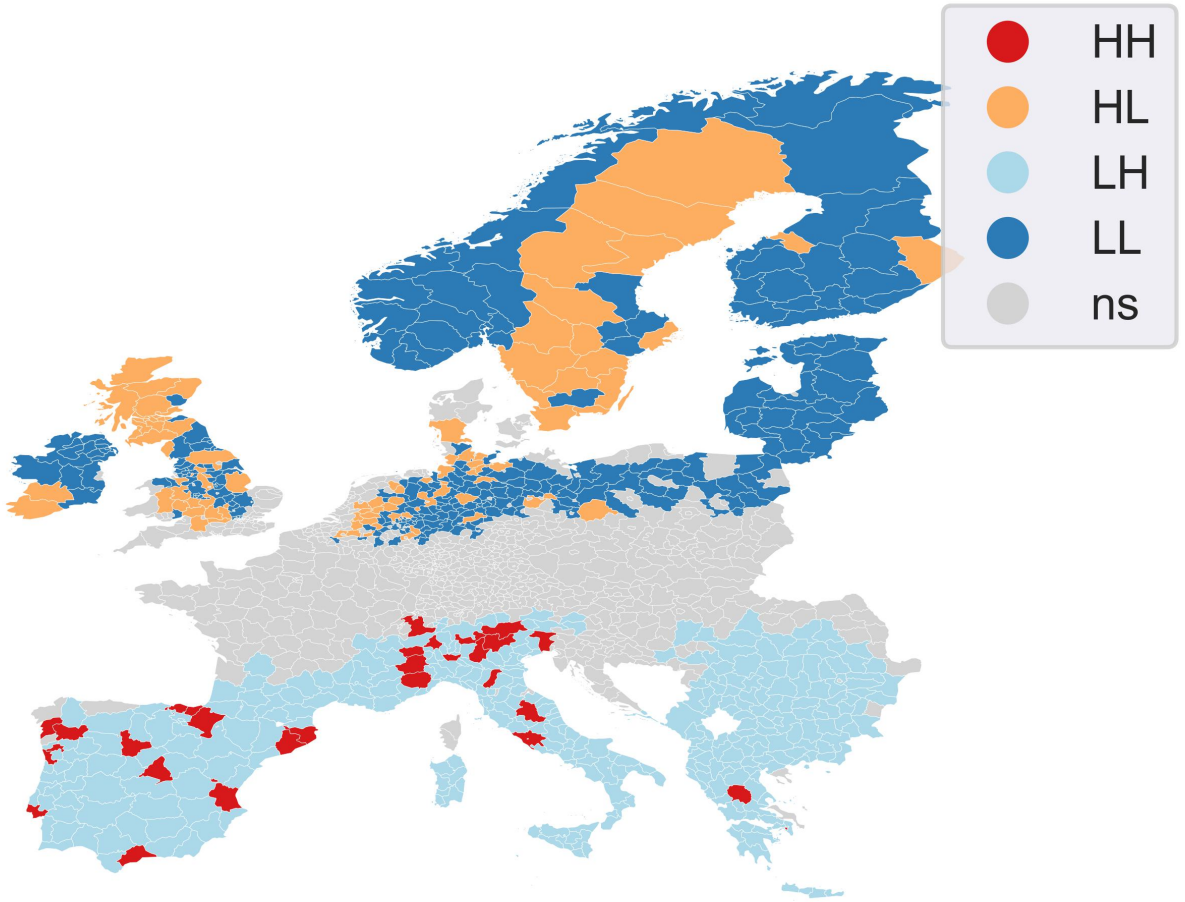
- Clusters of LL found in Spain, and Italy



HH
HL
LH
LL
ns

SPATIAL ANALYSIS – BIVARIATE MORAN STATISTICS

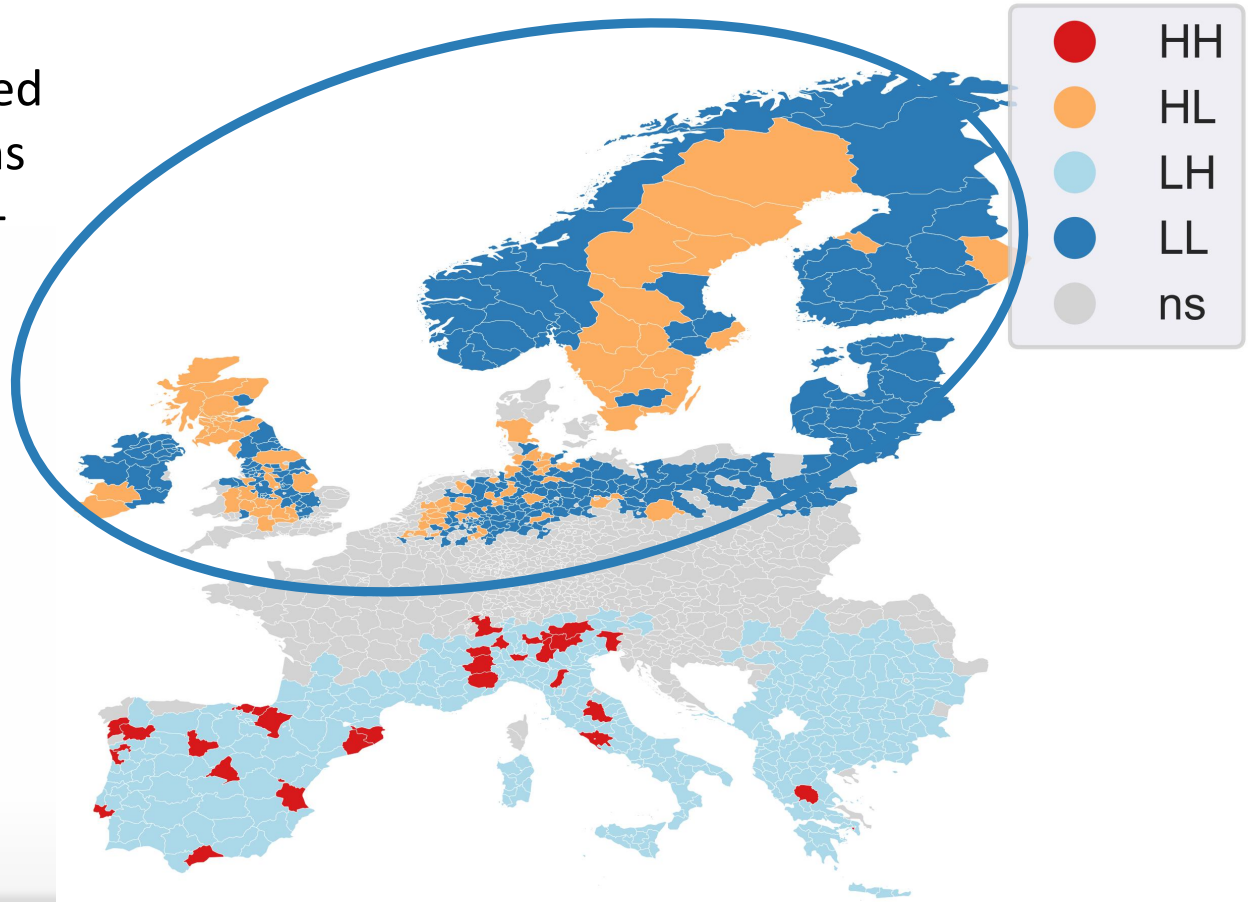
NUTS3 ECoops and GHI yearly average [kWh/a]



SPATIAL ANALYSIS – BIVARIATE MORAN STATISTICS

NUTS3 ECoops and GHI yearly average [kWh/a]

- Clusters of HL, ECoops surrounded by low GHI regions in the north (UK + Scandinavia)



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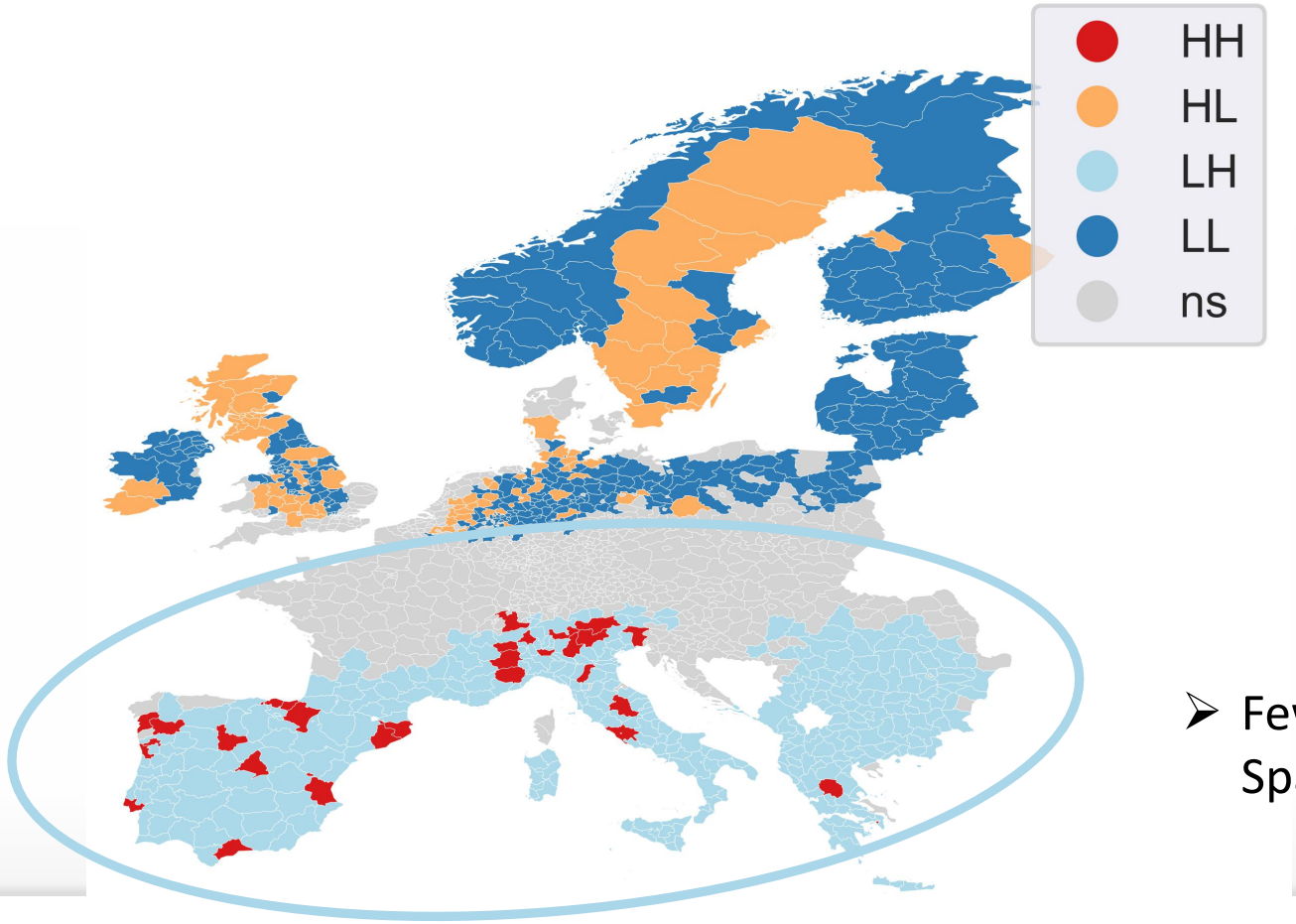
NUTS3 ECoops and GHI yearly average [kWh/a]



- Fewer clusters of HH in Spain and Italy

CONCLUSIONS

Generally: Resource availability was not shown to co-occure with ECoops, but spatial local clusters of HH, HL, LL, LH were build across Europe

Results highly dependent on database for ECoops used
--> better database would improve reliability of results, any database? Please contact us

Do local clusters correlate with the main generation asset of the ECoops? (potential future research)

QUESTIONS?

ANY IDEAS TO FURTHER USE THE COMPLEMENTARITY AND DROUGHTS DATA? PLEASE GET IN TOUCH!

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