Generation of Coherent Pan- European Scenario Data

Themenbereich: (2) Energieerzeugung/-infrastruktur und Netze

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Motivation and central question

The European Union aims at being climate neutral by 2050 and the associated integration of Renewable Energy Sources (RES) requires grid expansion throughout Europe. Due to the highly interconnected system, line expansions influence the overall power flow, so the system must be considered entirely to ensure optimal decisions. However, a full pan-European grid simulation is too complex and computationally demanding. Hence, another approach was developed, namely splitting the system into regional cases and considering coherent cross-border conditions between them, raising the issue of how to determine these border conditions and consequently how to regionalize RES in different countries.

Methodical approach

The cross-border conditions depend on the interaction of generation and load in each country, which hence has to be known at each time step. For this, common scenario datasets for different future scenarios are generated by analyzing and combining various sources.

As the time of generation depends on the availability of primary energy resources, the spatial distribution of the different RES has to be considered. The distribution strongly depends on environmental conditions, which can vary between the considered countries. Thus, locations of existing and planned RES as well as their environments were analyzed and different influencing parameters identified. The parameters were used to develop tailored regionalization methods for different types of RES based on structural data. These methods are used to determine regional installed capacities, which are subsequently utilized to calculate time series for RES injection, considering weather data. Based on these time series, a market simulation is applied to optimize power plant and storage schedules as well as cross-border power flows between the different European countries. The tailored regionalization methods were developed within the MILES (Model of International Energy Systems) framework [1], and existing modules of MILES were applied and adapted to the context.

Results and conclusions

The following describes two exemplary regionalization methods. Onshore wind farms are mostly located in agricultural areas with low population density. Hence, the regionalization factor, describing the share of total installed capacity in the considered region, is chosen in correlation to the number of agricultural areas and reciprocally to population density. The oldest and hence least efficient farms are located at widely excepted places with optimal wind conditions. As they have a limited lifetime, repowering is becoming more beneficial. [2] Thus, the installed capacity in regions with existing plants is partly scaled up, while partially new locations are determined considering regionalization factors. Figure 1 shows exemplary results for France.

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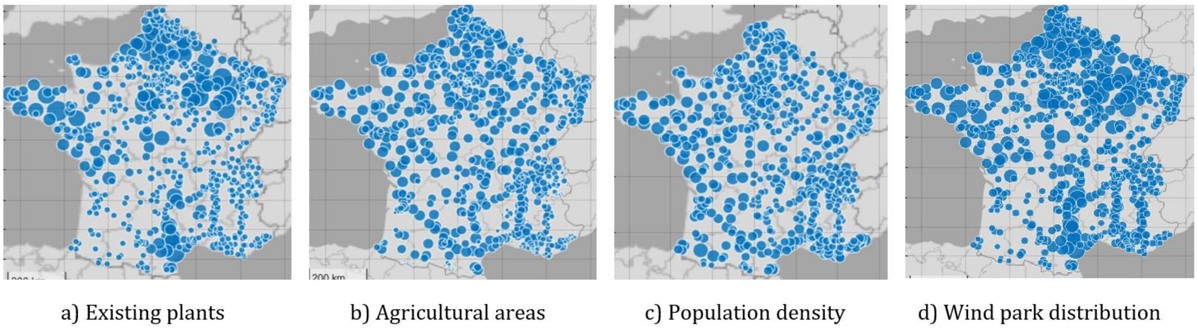

Figure 1: Spatial distribution of wind farms in France

For photovoltaic systems, the countries are differentiated according to their solar irradiation. In countries with lower solar irradiation, plants are mainly private and usually placed close to consumers, i.e., on rooftops, in contrast to countries with high solar irradiation, where larger photovoltaic systems are predominantly ground-mounted. Thus, two different regionalization factors are used, a correlation with urban areas and with non-irrigated arable land.

Figure 2 depicts the finally obtained cross-border conditions between the regional cases. The full paper will provide more details on the regionalization methodology and the overall framework of the study.

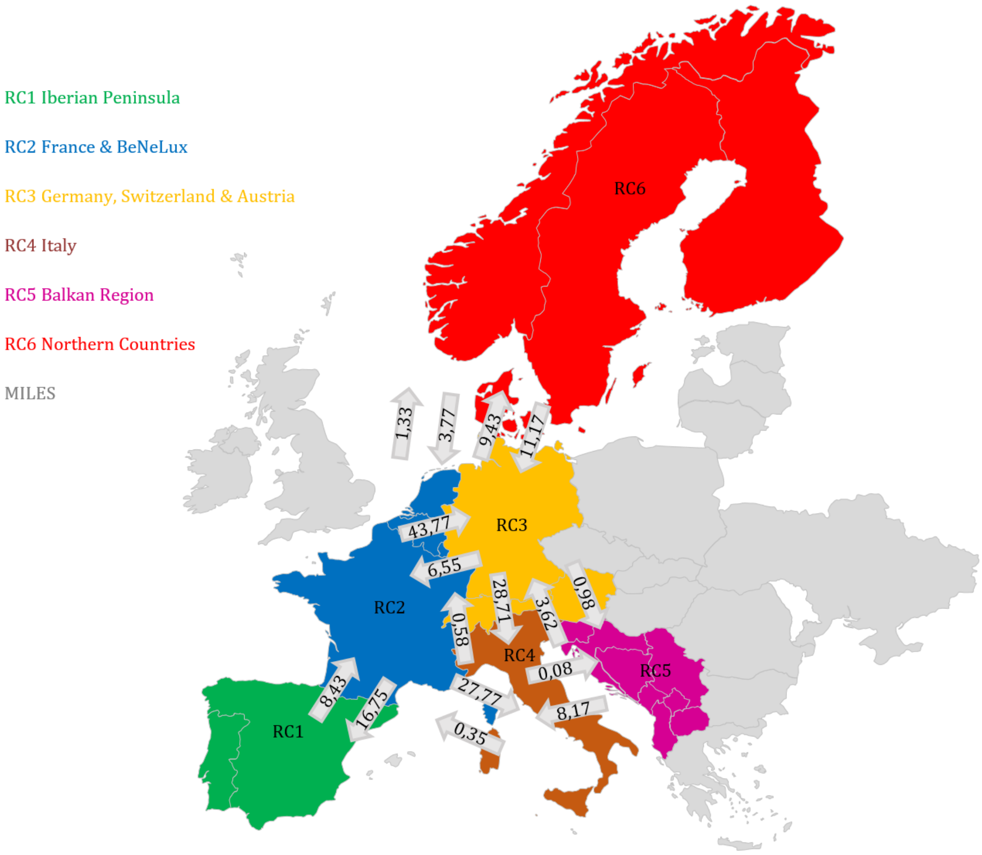

Figure 2: Yearly Exchanges between Regional Cases in TWh

Bibliography

[1] C. Spieker, Europäische Strommarkt- und Übertragungsnetzsimulation zur techno-ökonomischen Bewertung der Netzentwicklung, Dortmund, 2019.

[2] Wind europe, „Wind energy in Europe: Scenarios for 2030," 2017.