Temporal and spatial dynamics of NO_x, SO_2 and PM_{10} emissions from European power plants under different energy transition scenarios

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Motivation

- The European power sector is subject to large transformations until 2030 due to CO_2 reduction targets (by on average 69% compared to 2019 in the EU27 countries) and renewable energy (RE) expansion plans. [2]
- Different transformation scenarios could have diverse effects on the temporal and spatial distribution of air pollutant emissions like SO_2, NO_x and PM_{10}, e.g. due to the phaseout of coal power plants.
- In addition, plant-level emissions could even increase e.g. due to frequent emission-intensive start-ups, ramping and part load operation.

Method

2030 Scenario 1
Current country-level targets for CO_2 emissions, RE expansion & coal phaseout [1][2]
Current emission factors

2030 Scenario 2
Current country-level targets for CO_2 emissions, RE expansion & coal phaseout [1][2]
Strict emission factors (BAT)

2030 Scenario 3
Current country-level targets for CO_2 emissions & RE expansion; **complete coal phaseout** [1][2]
Current emission factors

Cost-optimized energy system model [4]
REMix Renewable Energy Mix → Hourly power plant activities

Specific emission factors [3][5][6][7][8][9]
Country | Fuel | Operation mode

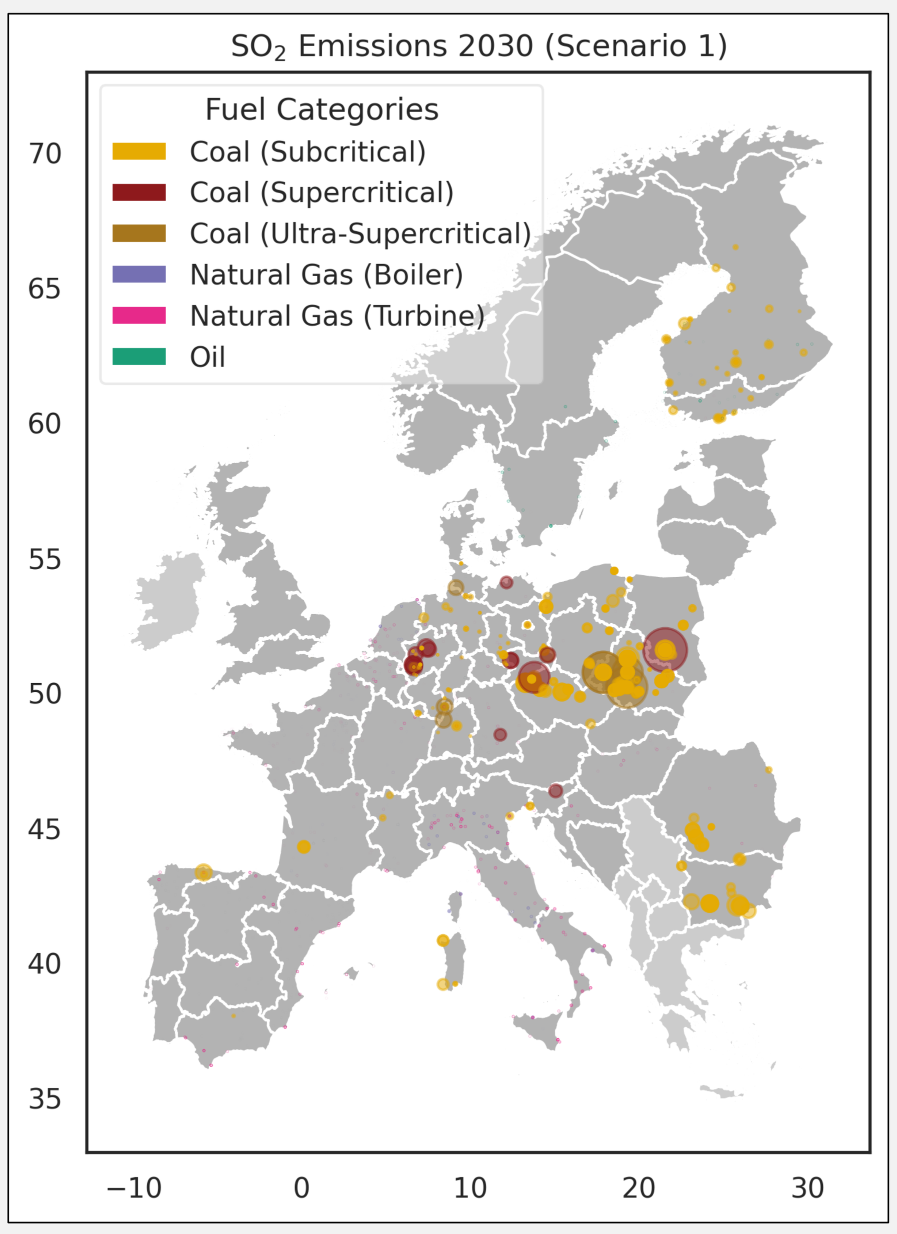
Emissions model
NO_x, SO_2 and PM_{10} emissions in high temporal and spatial resolution

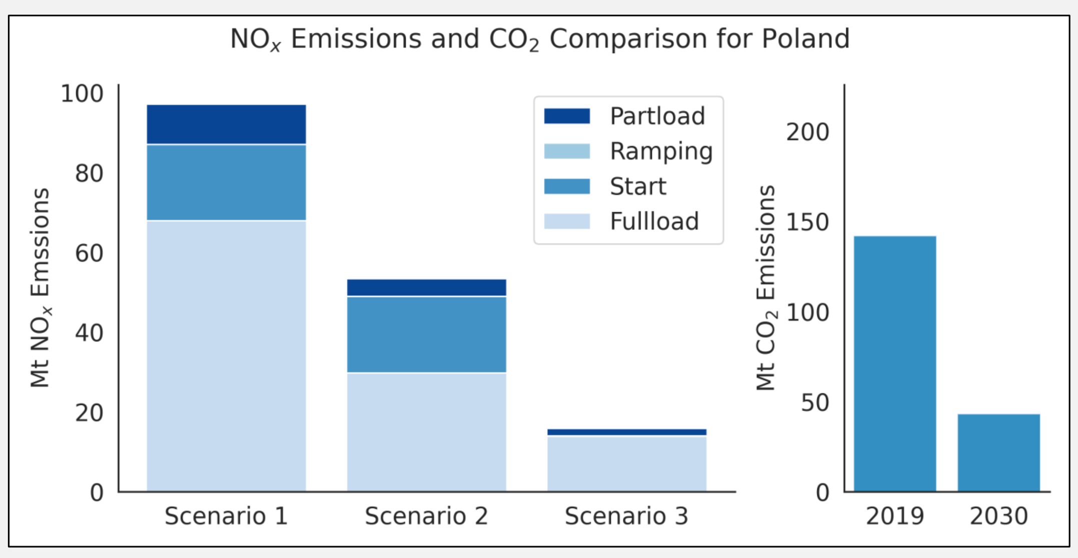
Results

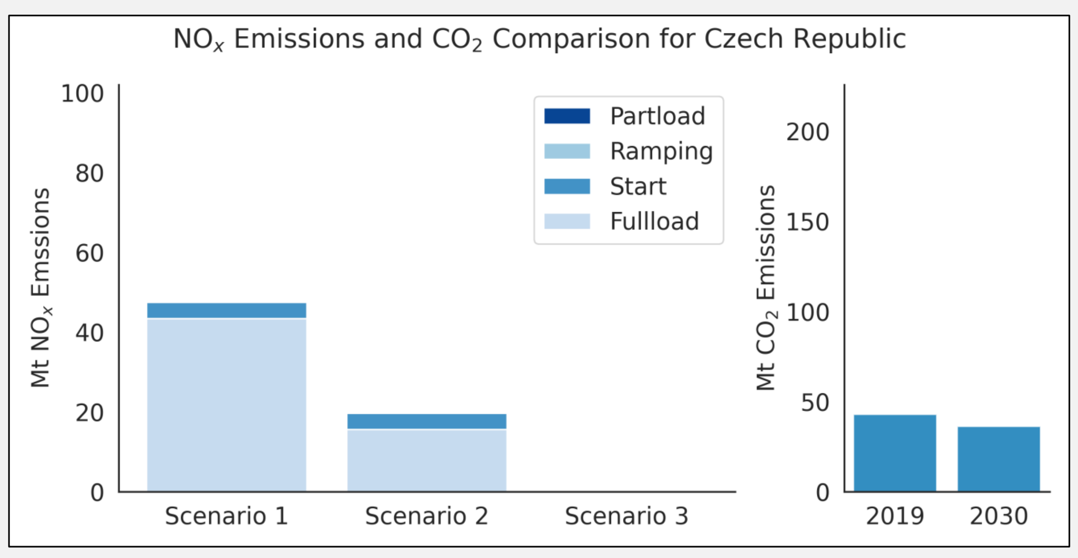
- The different scenarios have strong implications on the spatial distribution of power plant emissions.
- Emission hotspots could pertain in Central Europe until 2030.
- Depending on the country, the temporal distribution of emissions differ notably between the scenarios.
- Emissions from suboptimal operation of coal and gas power plants could potentially make up substantial shares of total emissions.
- In some countries, emissions will decrease strongly once the BAT (Best Available Technologies) emission standards are implemented.

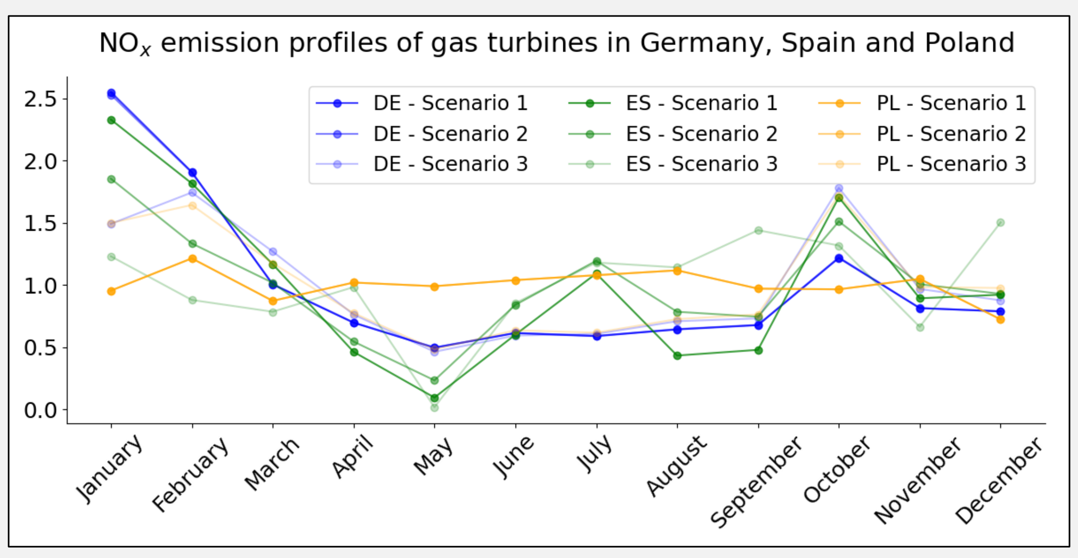
Conclusion

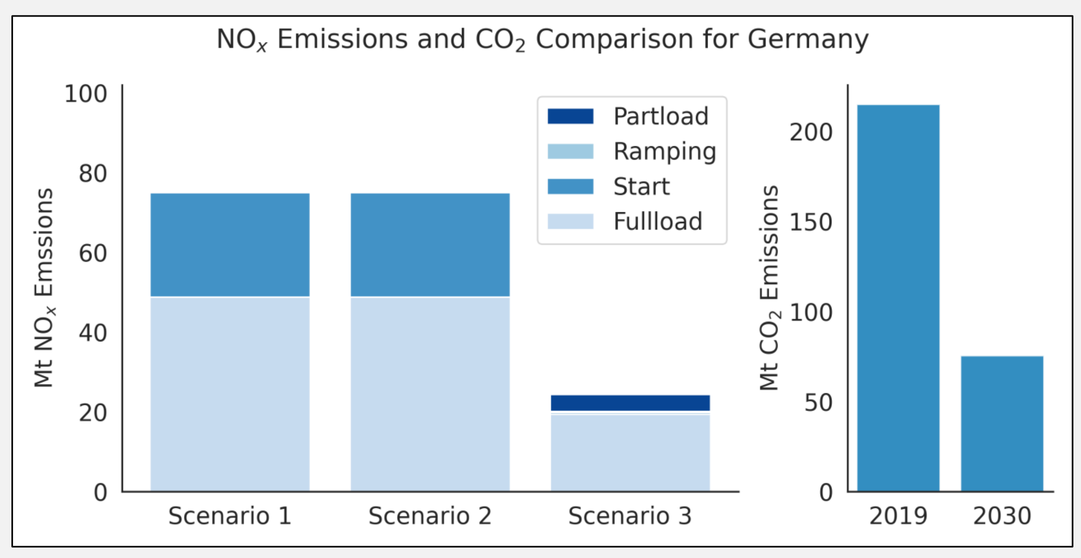
- Temporal and spatial distribution of NO_x, SO_2 and PM_{10} emissions show strong differences between scenarios in countries of the EU27 with potentially large implications on future air quality and health.
- Higher emissions through non-optimal plant operation might counterbalance emission reductions from lower fuel use.











References:
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