HIGH-RESOLUTION AIR POLLUTANT EMISSIONS FROM THERMAL POWER PLANTS IN EU DECARBONISATION SCENARIOS

Patrick Draheim, Jan Buschmann, Lars Maiwald, Yvonne Scholz, Thomas Pregger

German Aerospace Center (DLR), Institute of Networked Energy Systems

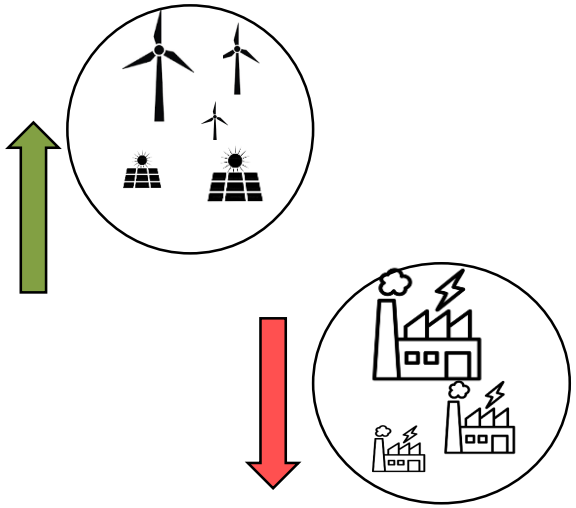
GEIA Conference Abidjan, 9th – 11th July 2025

Introduction and conclusions

Introduction

- EU power system is expected to transition quickly towards renewable energy (EU Commission 2024)
- Power system models represent dynamic decarbonisation developments

→ NO_x, SO_2 and PM emissions in high resolution in year 2030 scenarios



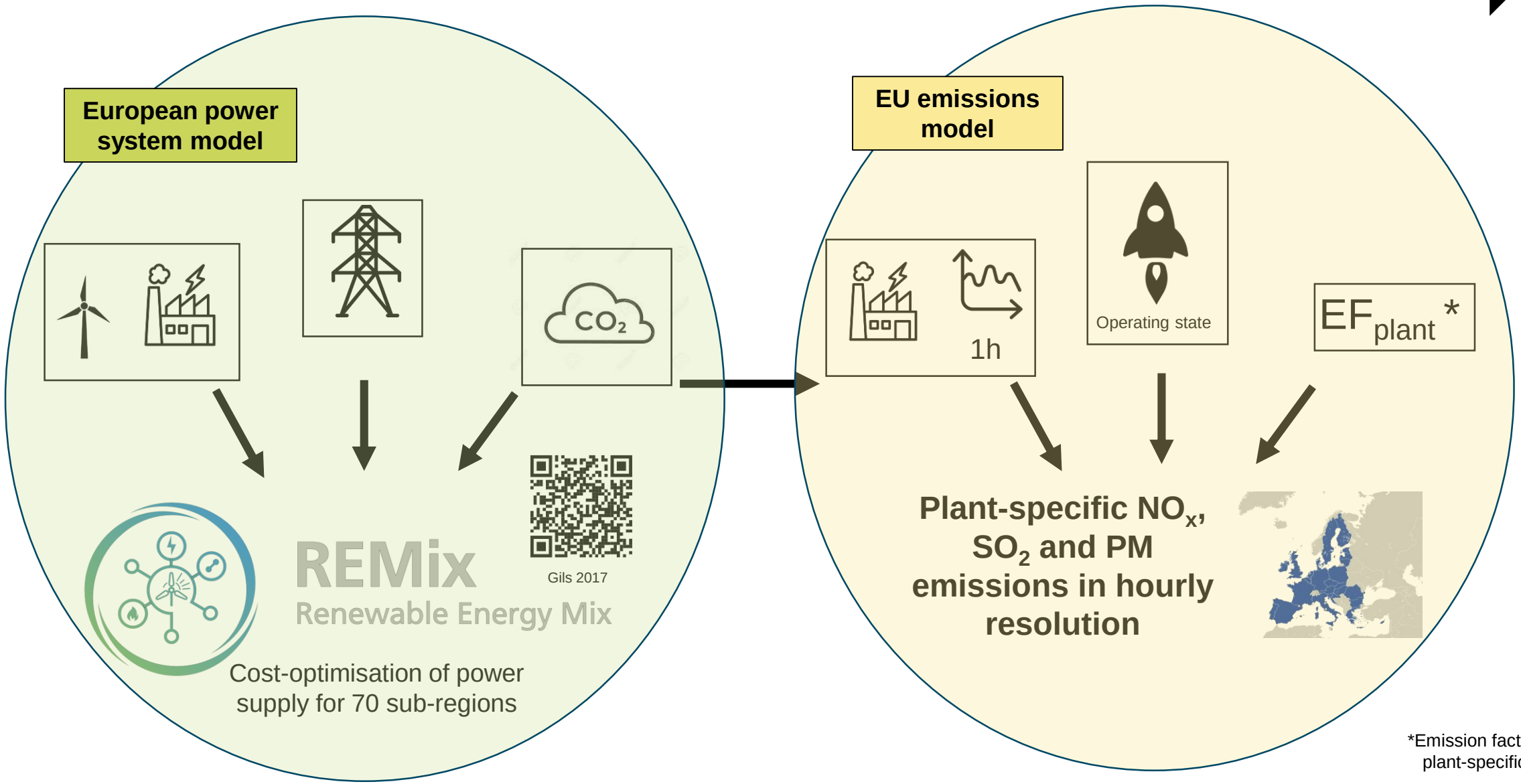
Conclusions

- The power system model shows emission dynamics during decarbonisation scenarios
- Increasing relevance of emissions during inefficient plant operation (esp. startup)

Next steps

- Estimate the impact on air quality and human health

Method



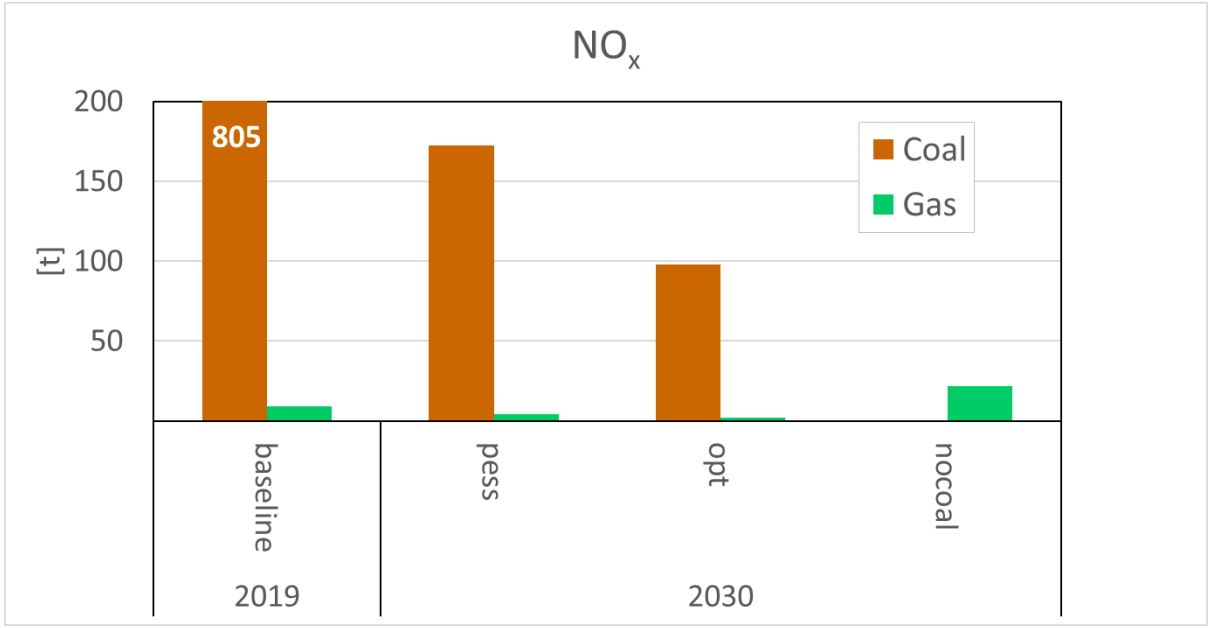
*Emission factor, plant-specific

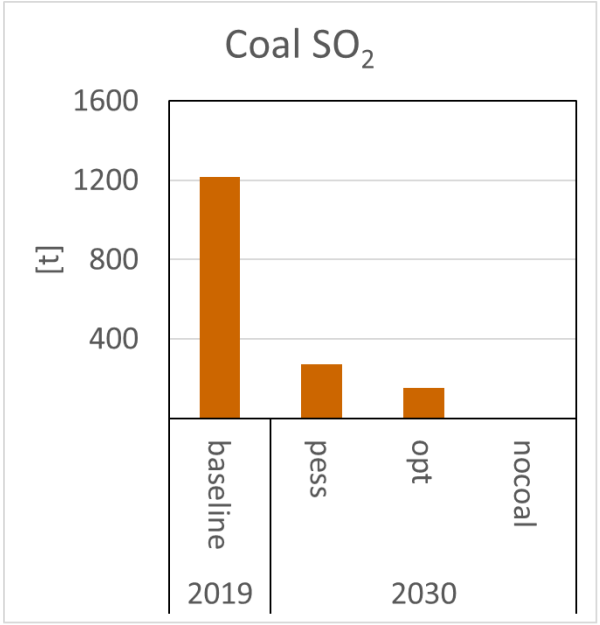
Decarbonisation scenarios

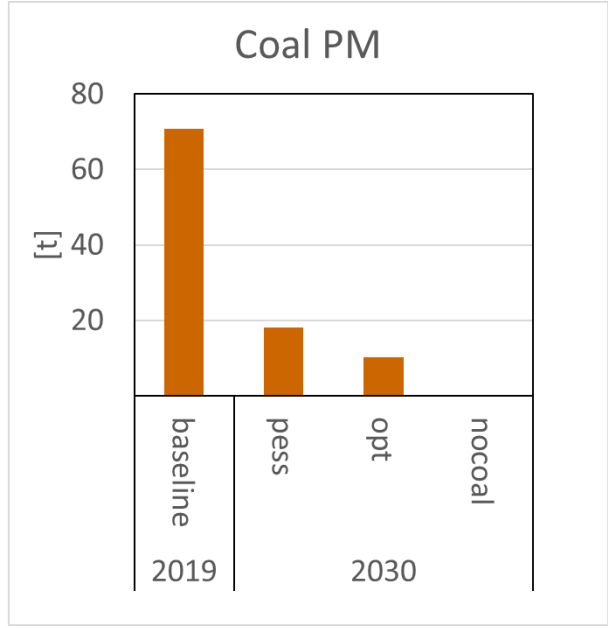
Scenario		Wind & Solar capacities [1 4 5]	Power Plant dataset [2 4 5]
2019	baseline	2019	2019
2030	pess	75% of 2030 targets	2030
	opt	100% of 2030 targets	
	nocoal		2030 without coal

1 EU Commission 2025
2 EEA 2025
3 UNFCCC 2025
4 Enerdata 2022
5 Neon Neue Energieökonomik GmbH et al. 2020

Results – absolute emissions



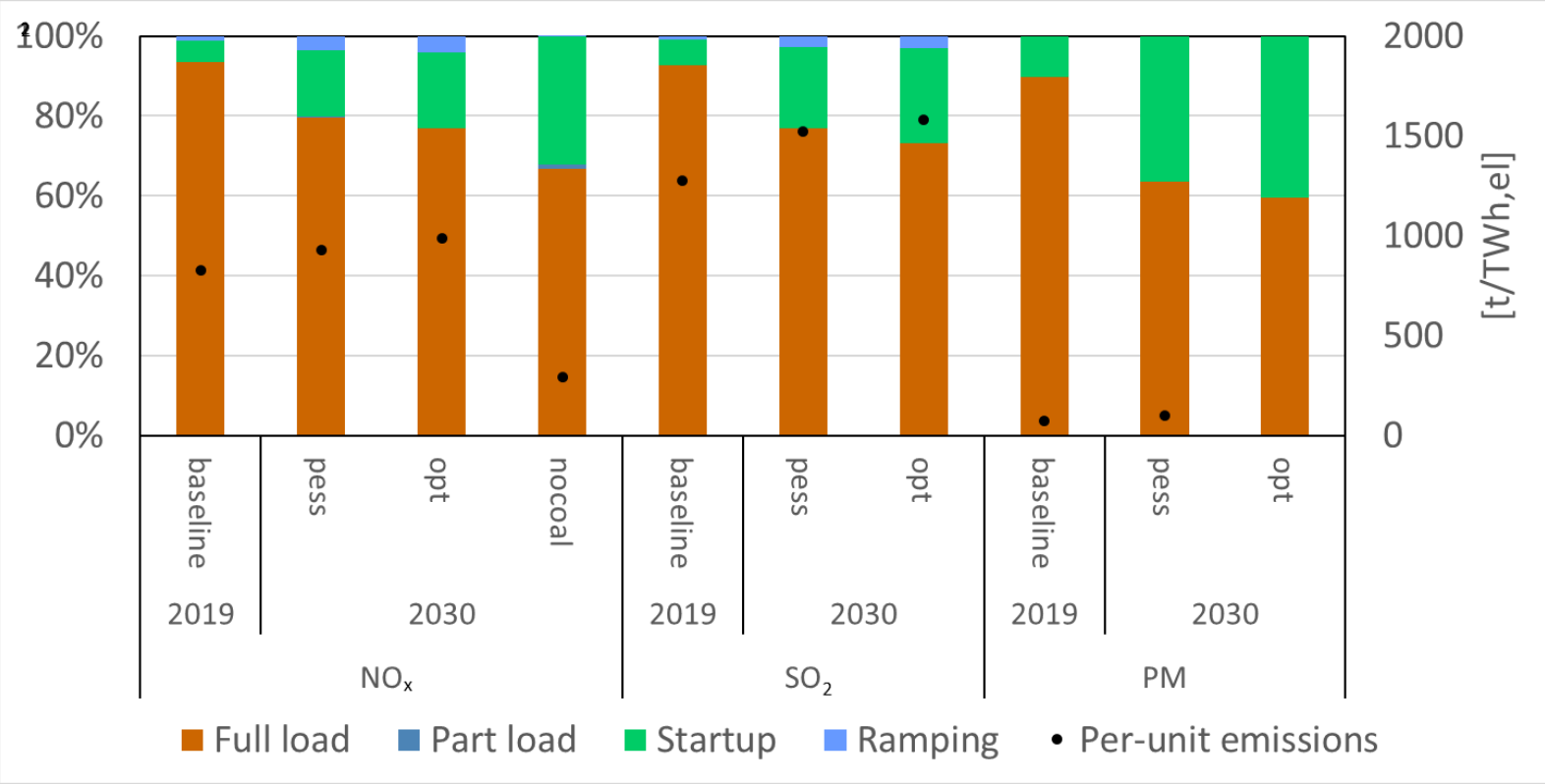




- Overall strong decrease in total emissions can be expected
  - exception: higher utilisation and emissions of gas plants in nocoal scenario

→ effect of dynamic power system modeling

Results – emission contribution of operating states

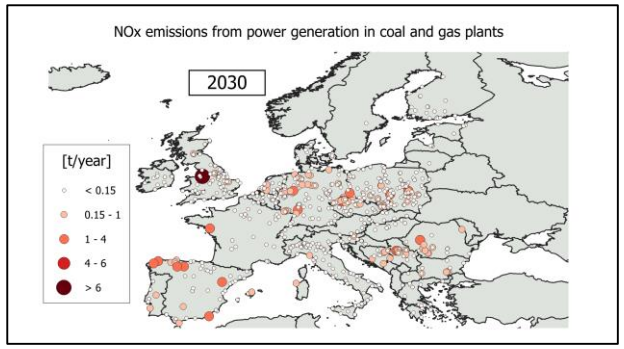


- Increasing relevance of emissions in non-optimal operating states
  - up to 40% of total emissions
  - especially during startup
- Higher per-TWh emissions from in 2030 coal scenarios

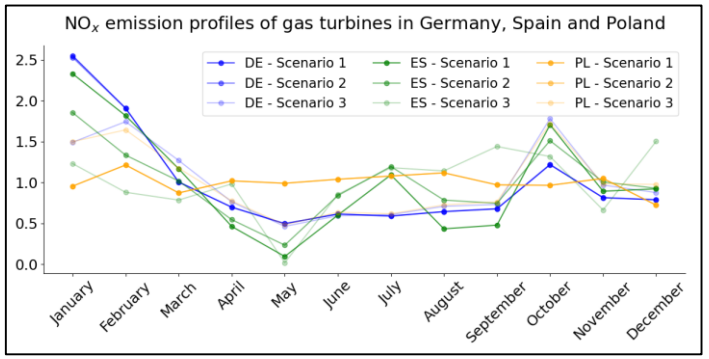
...and many more results

Plant-specific NOx, SO2 and PM emissions in hourly resolution

spatial analyses



temporal analses



country analyses

References

- Enerdata 2022: Power Plant Tracker. https://www.enerdata.net/research/power-plant-database.html (accessed: 27. June 2025)
- EU Commission 2025: National energy and climate plans. Online at: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en (accessed: 27. June 2025)
- European Environment Agency (EEA) 2025: Industrial Reporting under the Industrial Emissions Directive 2010/75/EU and European Pollutant Release and Transfer Register Regulation (EC) No 166/2006. Online at: https://www.eea.europa.eu/en/datahub/datahubitem-view/9405f714-8015-4b5b-a63c-280b82861b3d (accessed: 27. June 2025)
- Gils, Hans Christian; Scholz, Yvonne; Pregger, Thomas; Luca de Tena, Diego; Heide, Dominik (2017): Integrated modelling of variable renewable energy-based power supply in Europe. In Energy 123, pp. 173–188. DOI: 10.1016/j.energy.2017.01.115.
- Neon Neue Energieökonomik GmbH et al. 2020: Open Power System Data. https://open-power-system-data.org/ (accessed: 27. June 2025)
- United Nations Framework Convention on Climate Change (UNFCCC) 2025: National Inventory Submissions 2023. Online at: https://unfccc.int/ghg-inventories-annex-i-parties/2023 (accessed: 27. June 2025)

Thank you for your attention!

Patrick Draheim

German Aerospace Center (DLR)

patrick.draheim@dlr.de