# Modelling the effects of climate change on Austrian future electricity system

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## Background & Objective

The transition of Austria's electricity system towards a safe and sustainable future in times of climate change (CC) brings a broad range of challenges and opportunities into the policy debate where timely decisions on the way forward are of key relevance. In this respect this work aims

- to define a suitable set of future trend scenarios for electricity sector and
- to conduct a comprehensive model-based scenario analysis of Austria's future electricity sector, targeted to secure a reliable, sustainable, and cost-efficient transition of Austria's electricity sector in times of CC.

This paper aims to provide an outlook on the scenario design and modelling results. It also shows the analysis of Residual Load (RL), since it determines the part of the load that must be covered by flexibility options such as storages or cross-border exchange.

## Method

The modelling system covers Austria but also other European countries to represent cross-border electricity exchange. The main aspect of scenario design is the combination of energy transition pathways for 2030 and 2050 with proper CC scenarios, formed from simulations in accordance with Representative Concentrated Pathways (RCP). Two pathways have been defined: A Reference (REF) and a Decarbonisation Needs (DN) scenario. For REF, Austrian and EU-wide existing measures and goals as identified in the National Trends scenario of ENTSOe-TYNDP2022 [1] and coupled with a strong CC scenario (RCP 8.5). The DN represents a strong decarbonation ambition across the whole EU based on [2] with a moderate CC scenario (RCP 4.5). Both scenarios build on the detailed analysis of future demand trends, grid developments [1] and incorporate different flexibility options (e.g., storages).

For the modelling the open-source energy system modelling tool Balmorel [3] is used. Scenarios are simulated with representative and extreme weather years (i.e. cold and heat waves)- to reflect critical power system bottlenecks.

Determining the need for flexibility is conducted based on the RL-analysis. RL expressed as an hourly power value in GW, represents the difference between the total electricity demand and the electricity infeed from variable renewables including hydro run-of-river, wind, and photovoltaics. RL can be positive (temporary generation deficit), negative (temporary generation surplus), or, in individual cases, zero (generation and consumption balanced).

## Principal findings and Conclusions

Modelling is currently ongoing. Figure 1 shows annual balance of RL for DN 2030 scenario.

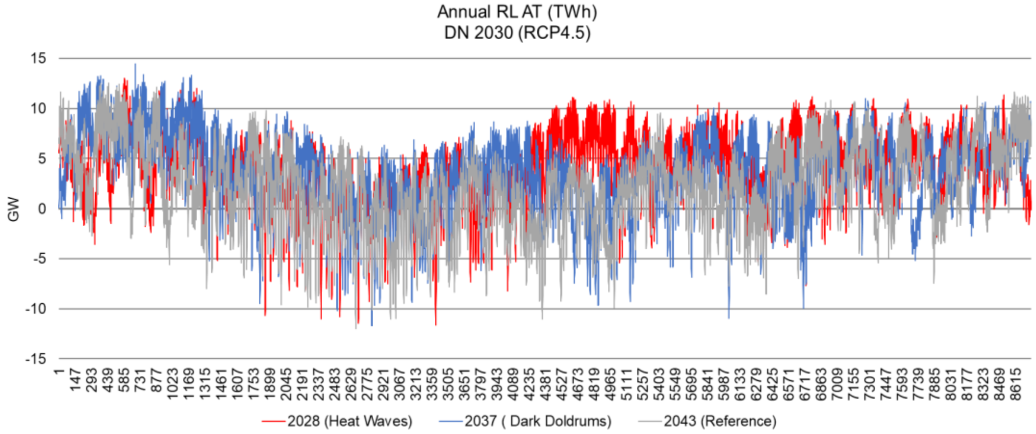

Figure 1: Annual balance of RL for DN 2030 scenario

Table 1 compares the annual balance and extreme values (maximum and hourly gradient/ramp) of RL in 2020 [4] and in DN scenarios for both target years, 2030 and 2050, combined with reference and extreme weather years. The results show that in DN-scenarios the extreme weather conditions increase the annual RL, especially in DN-2050 scenario. In this scenario, a strong increase of negative and positive gradients of RL (GW/h) due to growing temporary power gaps and surpluses can also be projected.

Table 1: Overview of RL values

| | | | DN-2030 (RCP4.5) | | | DN-2050 (RCP4.5) | | |
|---|---|---|---|---|---|---|---|---|
| | Unit | 2020 [4] | 2043 (Reference) | 2028 (Heat Waves) | 2037 (Dark Doldrums) | 2062 (Reference) | 2046 (Heat Waves) | 2037 (Dark Doldrums) |
| RL-Annual Balance | TWh | 24.4 | 18.09 | 30.26 | 28.61 | 7.90 | 22.63 | 26.51 |
| Total-Positive RL | TWh | 8.24 | 26.00 | 34.45 | 33.74 | 47.05 | 58.36 | 59.77 |
| Total-Negative RL | TWh | -3.25 | -7.91 | -4.20 | -5.13 | -39.16 | -35.73 | -33.27 |
| Max. Positive- RL | GW | 8.24 | 12.58 | 13.05 | 14.48 | 22.08 | 22.51 | 26.07 |
| Max. Negative- RL | GW | -3.25 | -12.00 | -11.64 | -11.71 | -44.95 | -44.88 | -40.39 |
| Max. Gradient-Positive | ΔGW/h | 6.25 | 3.89 | 3.77 | 4.16 | 12.28 | 13.11 | 12.84 |
| Max. Gradient-Negative | ΔGW/h | -4.35 | -6.22 | -3.88 | -6.29 | -12.95 | -14.68 | -13.64 |

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1. References [1] E. and ENTSO-E, ‘TYNDP 2022 Scenario Report: Download’, Sep. 28, 2021. https://2022.entsos-tyndp-scenarios.eu/download/ (accessed Nov. 21, 2022). [2] G. Resch et al., ‘Technical Report on the Modelling of RES auctions –Key insights on the model-based analyses’, p. 77, Jun. 2022. [3] H. Ravn, ‘The Balmorel Model Structure’, Jun. 2016. [Online]. Available: http://balmorel.com/images/downloads/model/BMS303-20160907.pdf [4] E-Control, ‘Flexibilitätsangebot und-Nachfrage im Elektritzitätssystem Österreichs 2020/2030’. 2022. [Online]. Available: https://www.e-control.at/documents/1785851/1811582/20220207_Flexibilitaetsstudie_Bericht_FINAL.pdf/244c4f3c-c8a2-1114-c287-6d6b81d07817?t=1650436768857