Karlsruher Institut für Technologie

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Impact of weather years on the investment decisions in agent-based modeling

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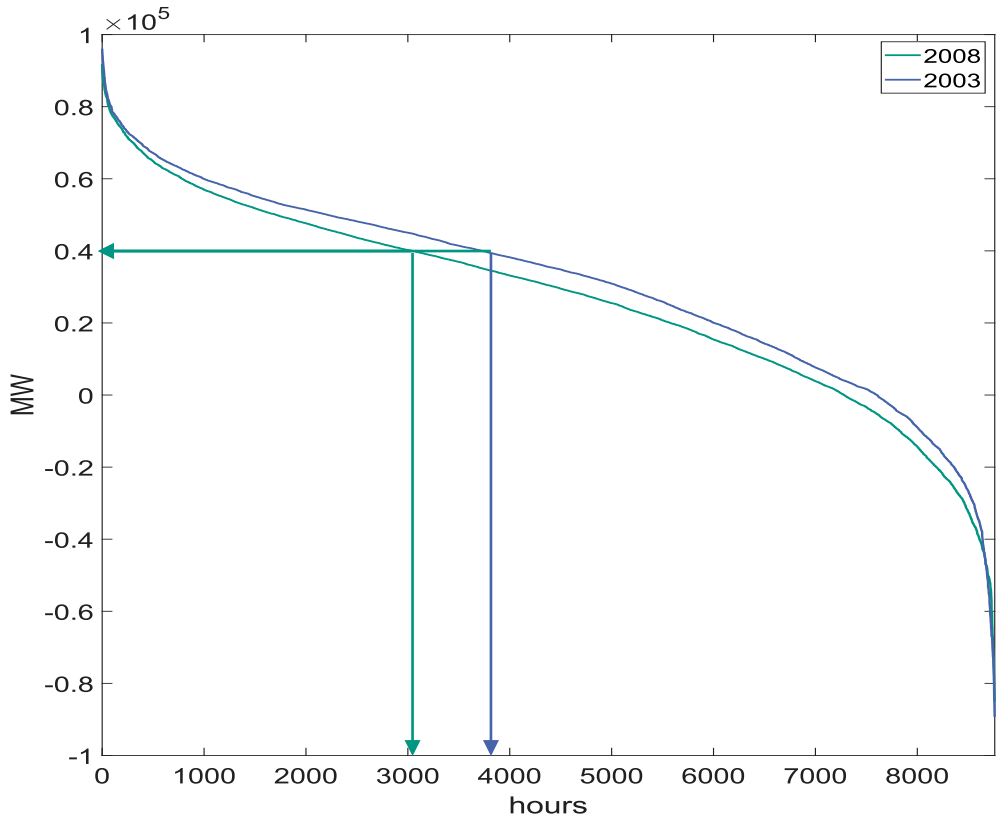
Agenda

1. **Motivation**
2. **Methodology**
3. **Results**
4. **Limitations**
5. **Conclusion**

Increasing weather dependencies

Residual load duration curve



- Weather influences
  - RES production
  - Load profiles
- Effect getting more significant in the future
- The same weather year is often used several times

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Research Question

How do different weather years influence investment decisions and generation adequacy in the electricity market?

Do market model results become more robust when different weather years are randomly concatenated?

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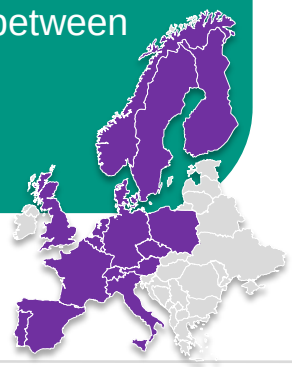
Agent-based electricity market simulation with integrated capacity expansion

PowerACE

Input Data

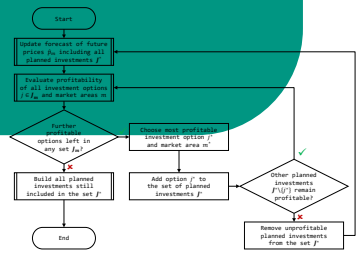
- Fuel and CO_2 prices
- Detailed power plant data with techno-economical parameters (e.g., efficiency, …)
- Hourly RES profiles and demand profiles
- Trading capacities between market areas



Source: Genoese (2010), Fraunholz (2021), Zimmermann & Keles (2023)

Characteristics

- Hourly simulation of the day-ahead market (8760 h/a)
- Yearly investment decisions
- Time horizon until 2050
- No perfect foresight, i.e., investment decisions
- Cross border effects



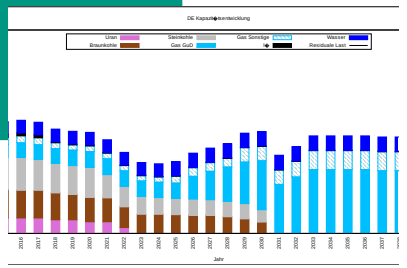
Model results

From market simulation, e.g.,

- Electricity production
- Spot market prices and volumes
- CO_2 - Emissions

From investment evaluation, e.g.

- Capacity development
- Investment decisions



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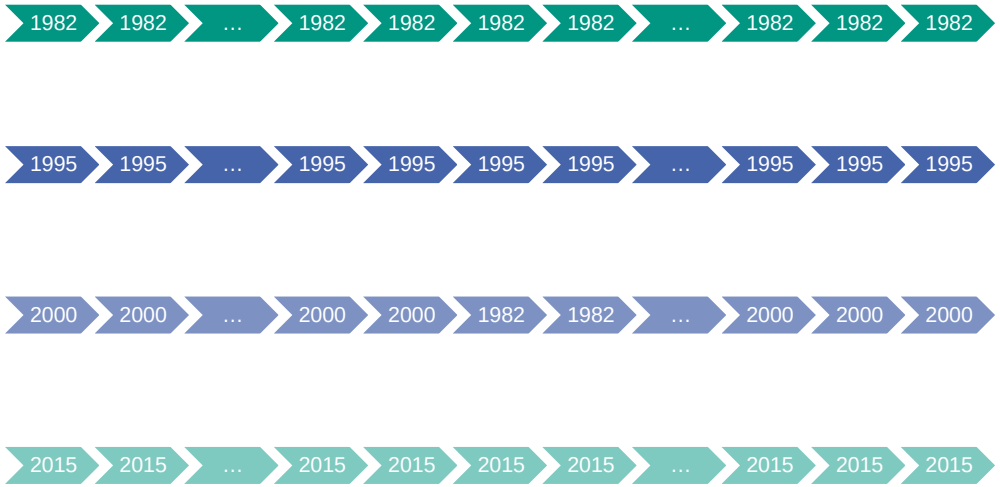
Simulation scope within this work

- Germany and neighboring countries
- Load profiles TYNDP 2022 NT
- 2015 – 2040
- RES profiles from renewables.ninja

Sequence of same weather year

- Simulation for different weather years
- One weather year per simulation run
- Changed total load and load profile
- Linear interpolation of missing values (TYNDP provides 2025, 2030 and 2040)
- Changed total RES production and RES profile
- 28 different weather years simulated



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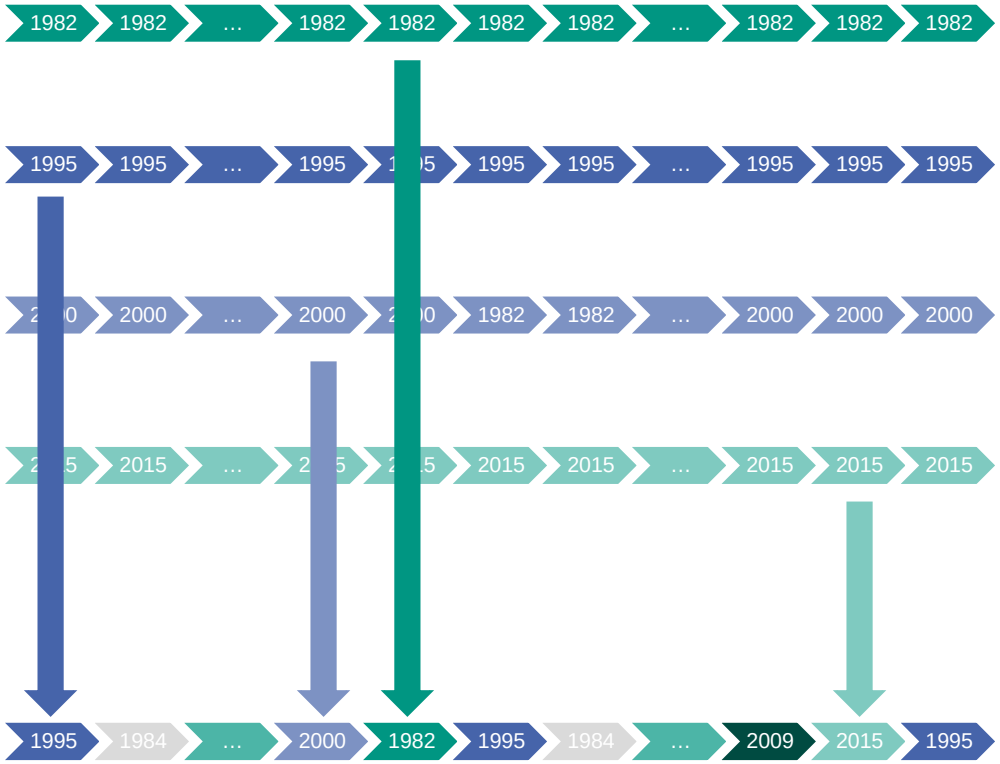
Sequence of random weather years

- Randomly picked weather years for simulation years 2023-2040
- Different weather years per simulation run
- Different load and RES production profiles per year
- First linear interpolation of TYNDP data, then picking of values
- 48 different sequences simulated



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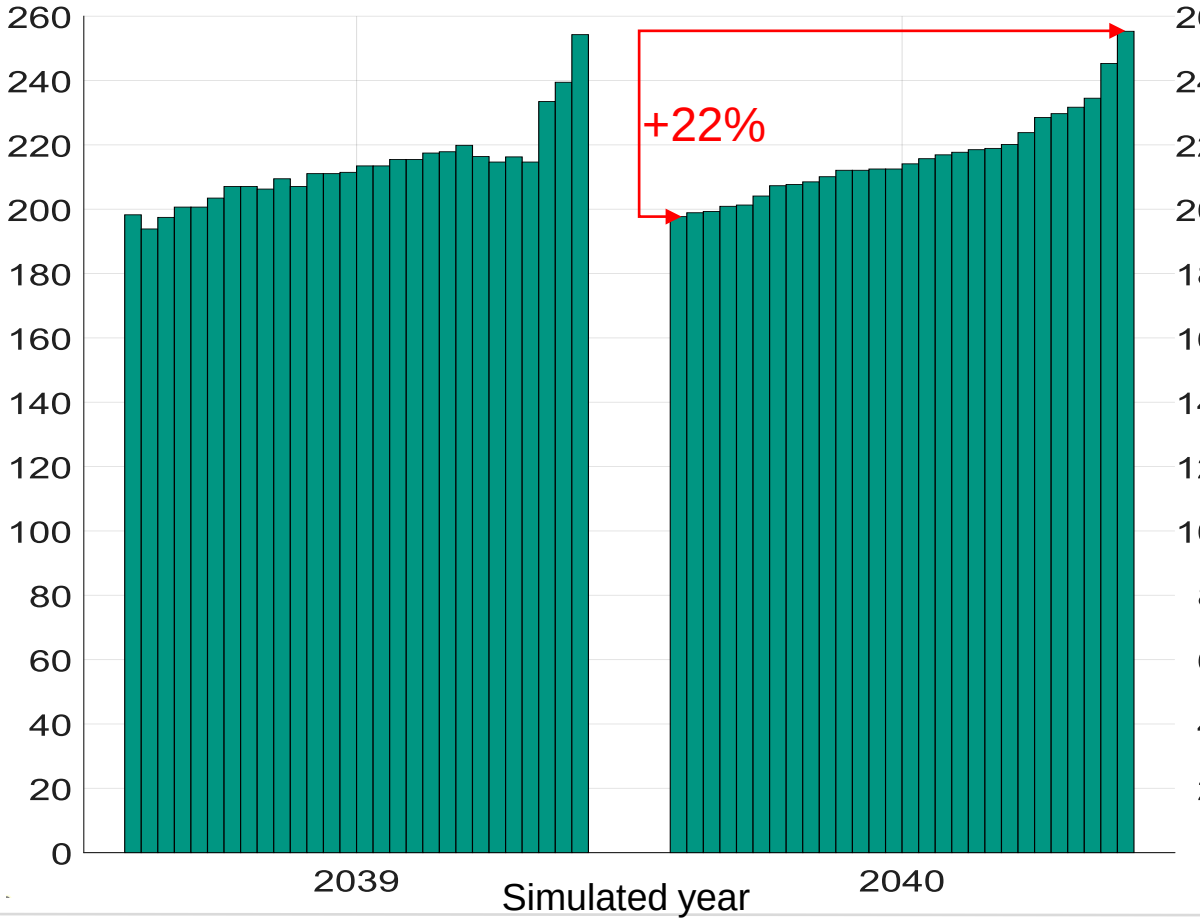
PRELIMINARY

Agenda

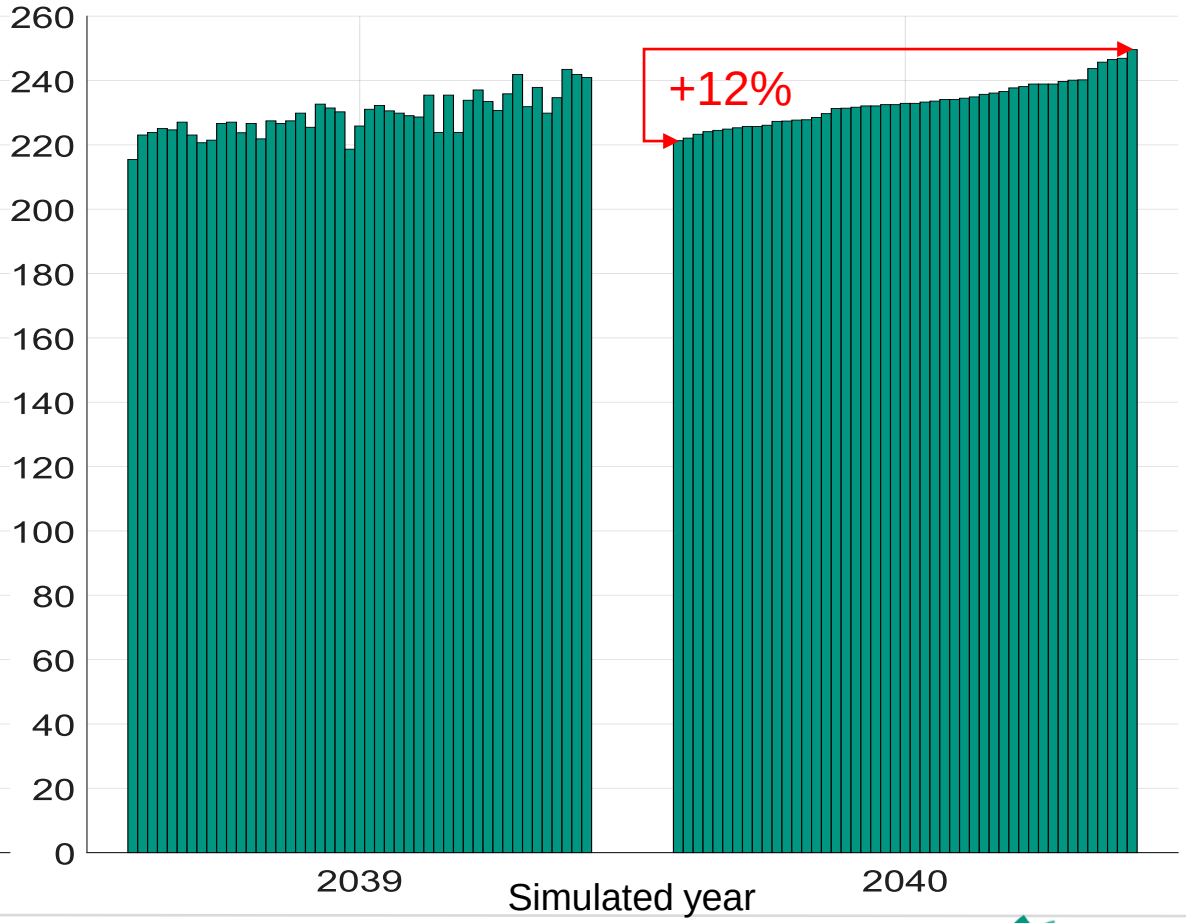
PRELIMINARY

Firm capacities [GW]

Same weather year



Radom weather years



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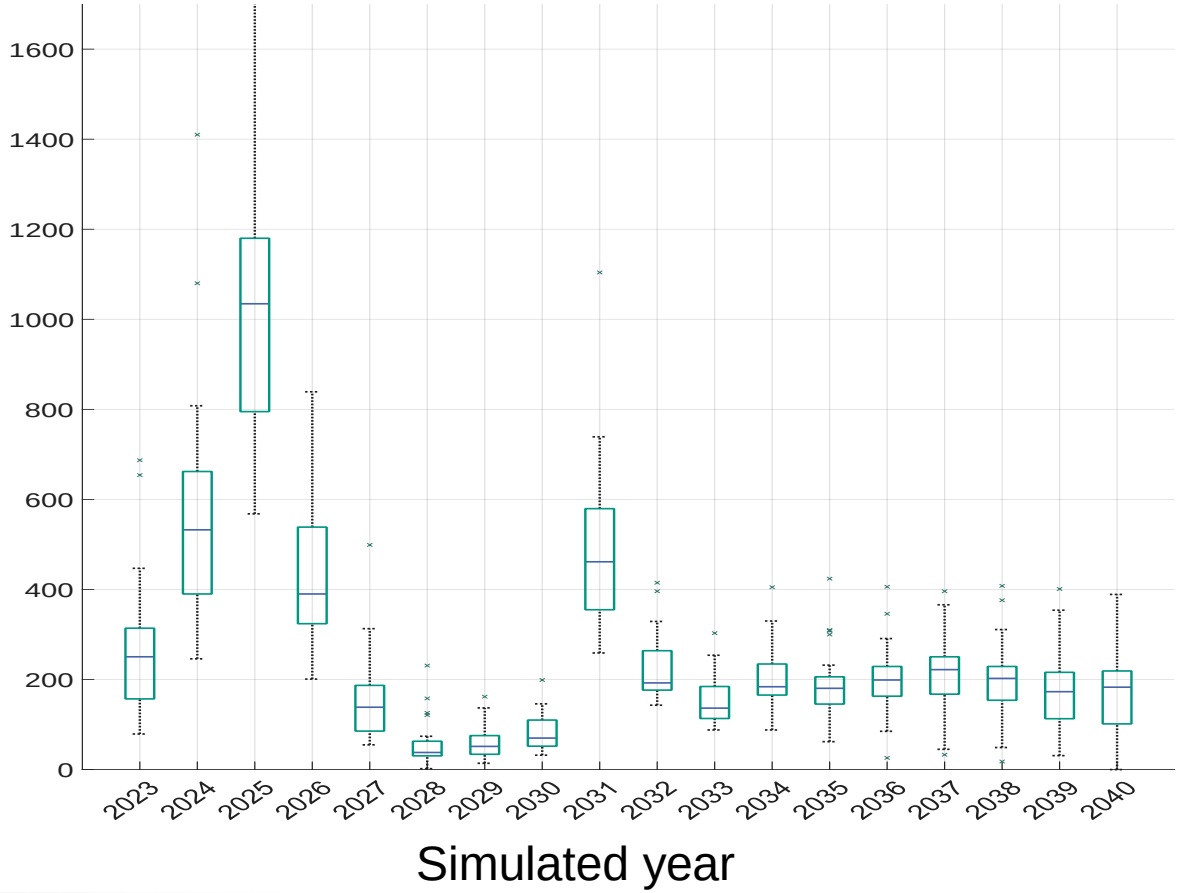
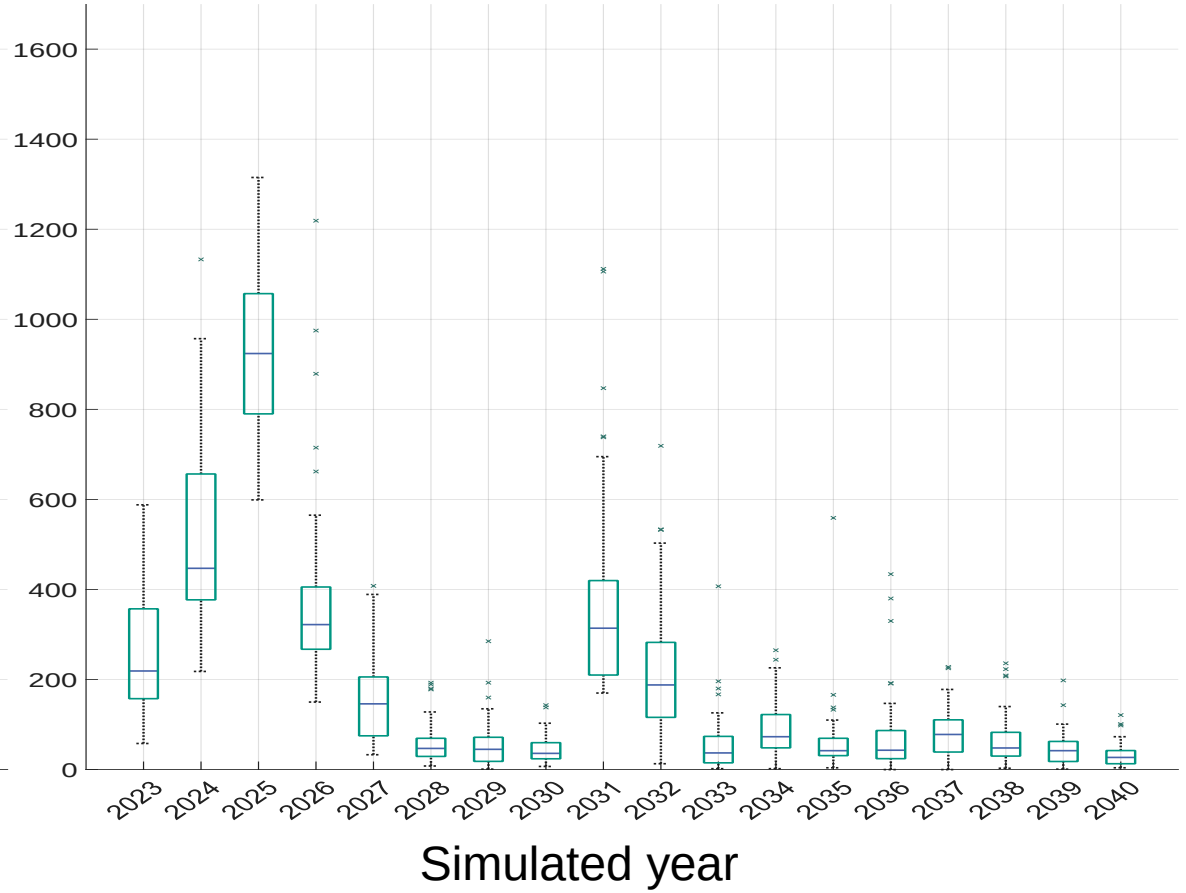
PRELIMINARY

Loss of load expectation (LOLE) for Germany [h]

Same weather year



Radom weather years



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Limitations

- Only a small number of the potential combinations were simulated
- Years with extreme scarcity signals need to be further investigated
- Only a few market areas were considered
- RES profiles for the historic power plant fleet

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Conclusion

The selection of a specific weather year significantly impacts the simulated investment decisions and generation adequacy

The utilization of randomly arranged weather years leads to a more robust simulation results, higher investments and lower LOLE values

The methodology is crucial for probabilistic analysis

The methodology is suitable to investigate extreme weather events

Thank you for your attention!