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WIND DROUGHTS AND WINTER COLD THREATEN EUROPE'S FUTURE ENERGY SECURITY

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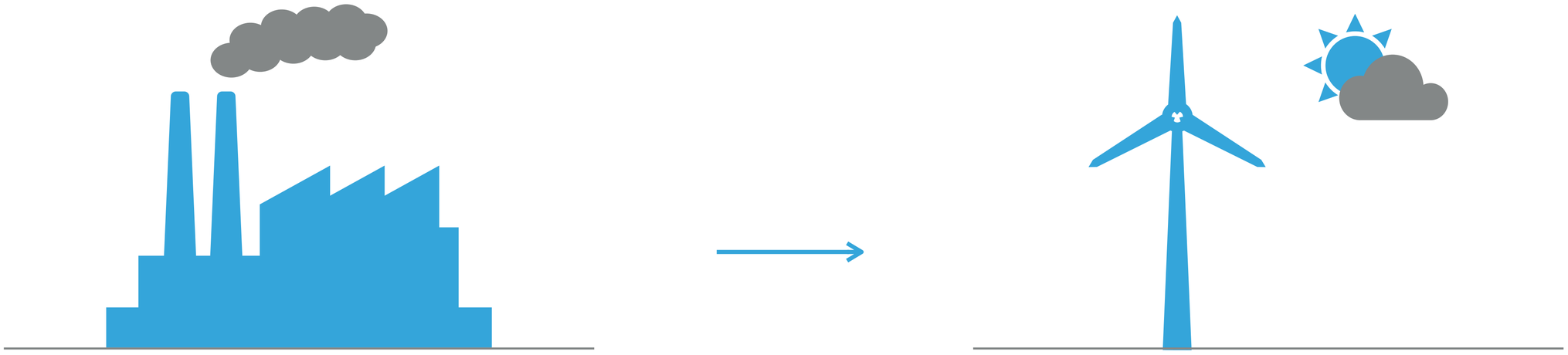
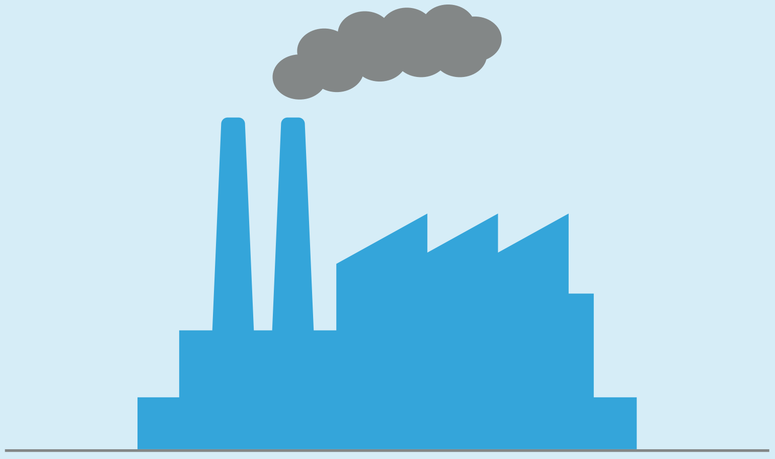
ENERGY TRANSITION – AMBITION

- Limit CO_2 emissions to mitigate further global climate change
- Transition from carbon-intensive fossil fuels to renewable energy sources

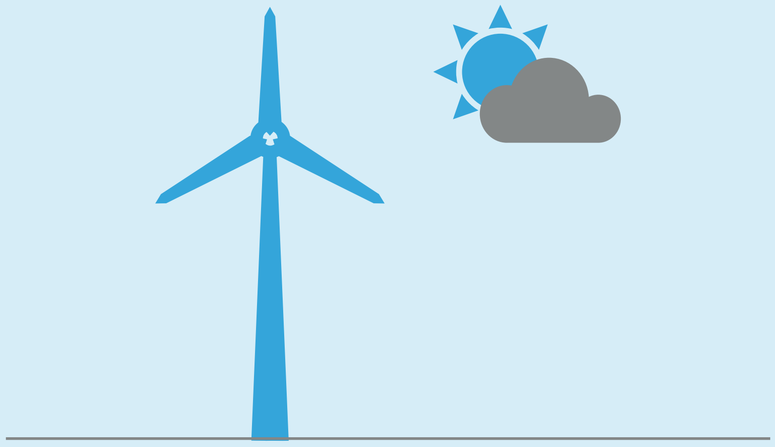


ENERGY TRANSITION – CONSEQUENCES

- Carbon-intensive fossil fuels
- Production can be planned

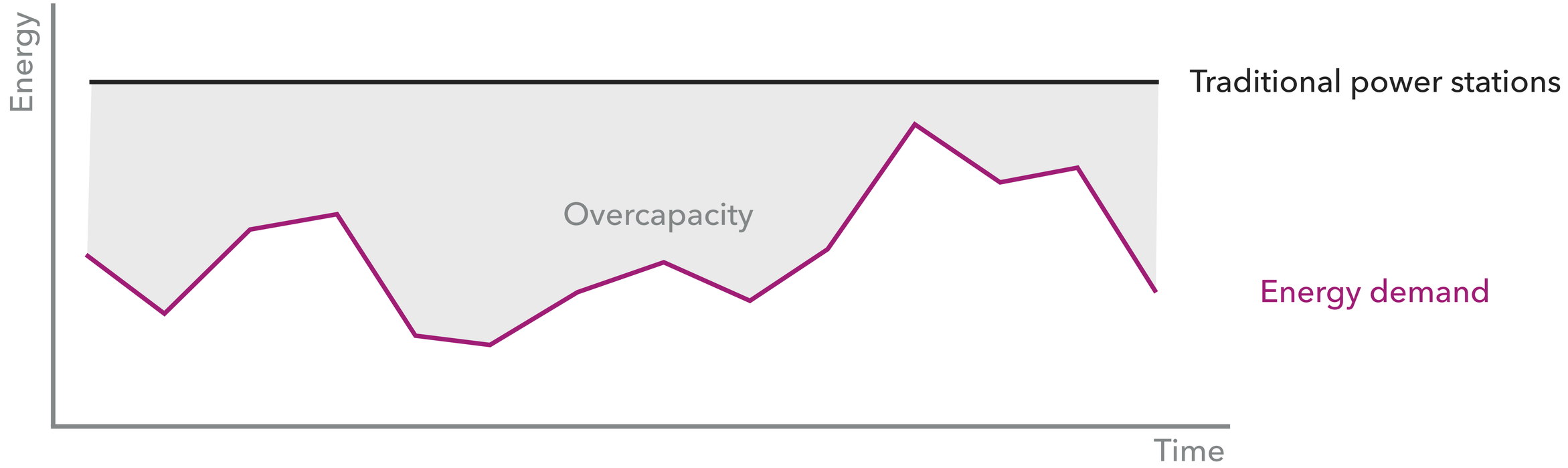


- Low-carbon renewable energy
- Production will depend on the weather



ENERGY TRANSITION – CHALLENGE

- Matching variable energy demand with variable energy production



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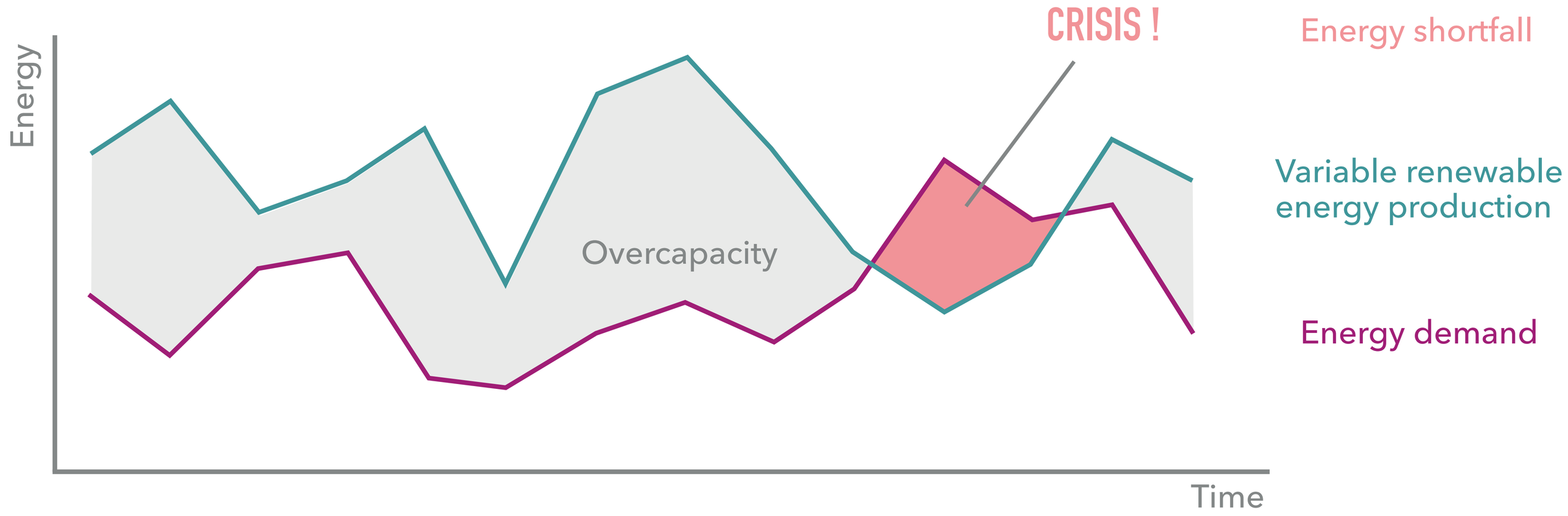


RESEARCH OBJECTIVE

Investigate the meteorological conditions that lead to high risk for European energy safety in a highly renewable power system

LARGE ENSEMBLE MODELLING METHOD

Simulate 2000 years of present-day weather

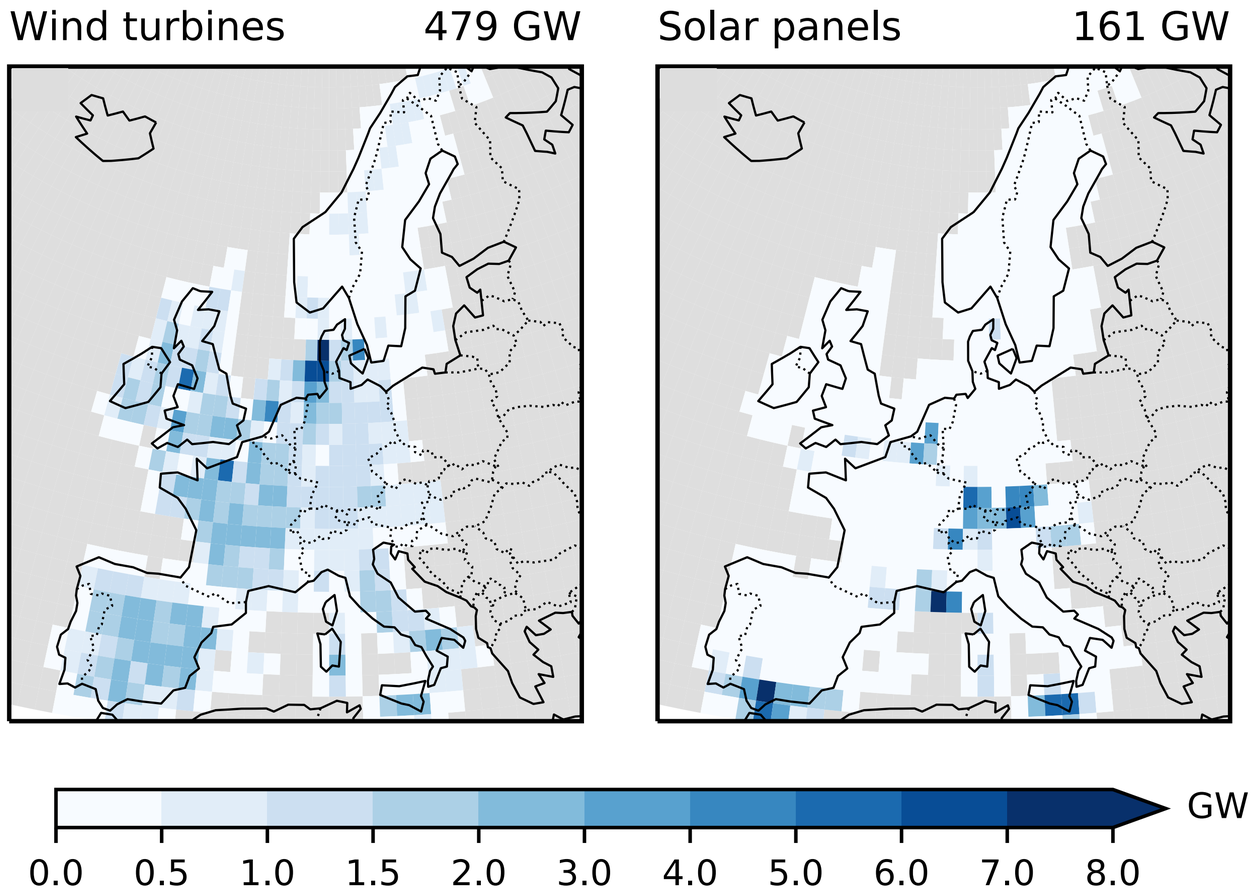
↳ Calculate 2000 years of energy variables

↳ Select 1-in-10 year extreme events

↳ Investigate meteorological conditions

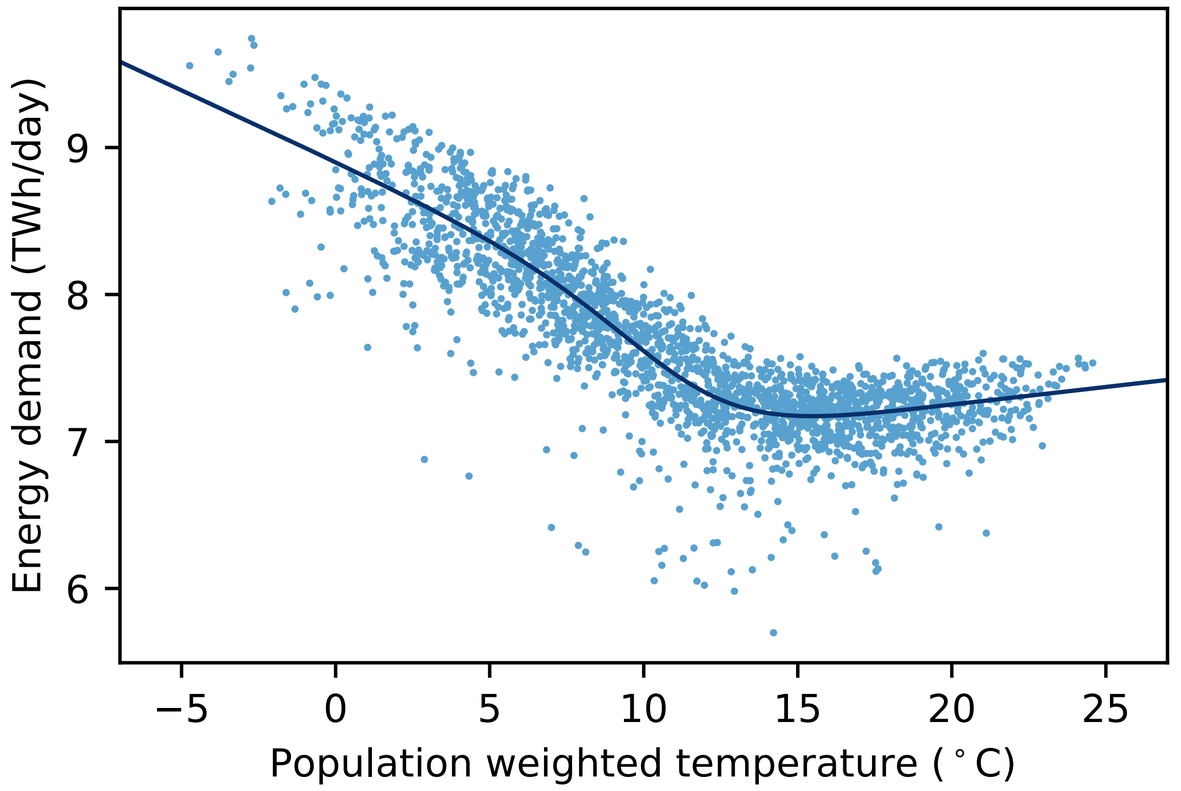
INTERMEZZO – ENERGY MODEL

- 15 western European countries
- Energy production
  Wind turbines, solar panels

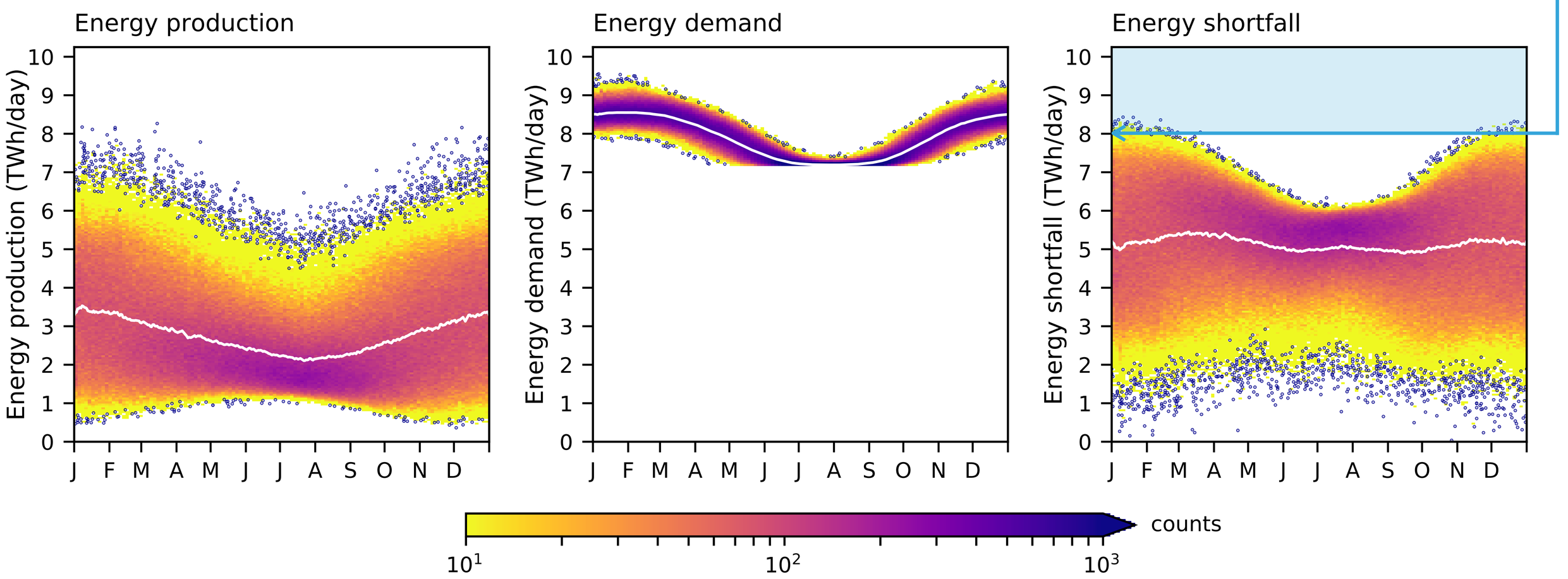


INTERMEZZO – ENERGY MODEL

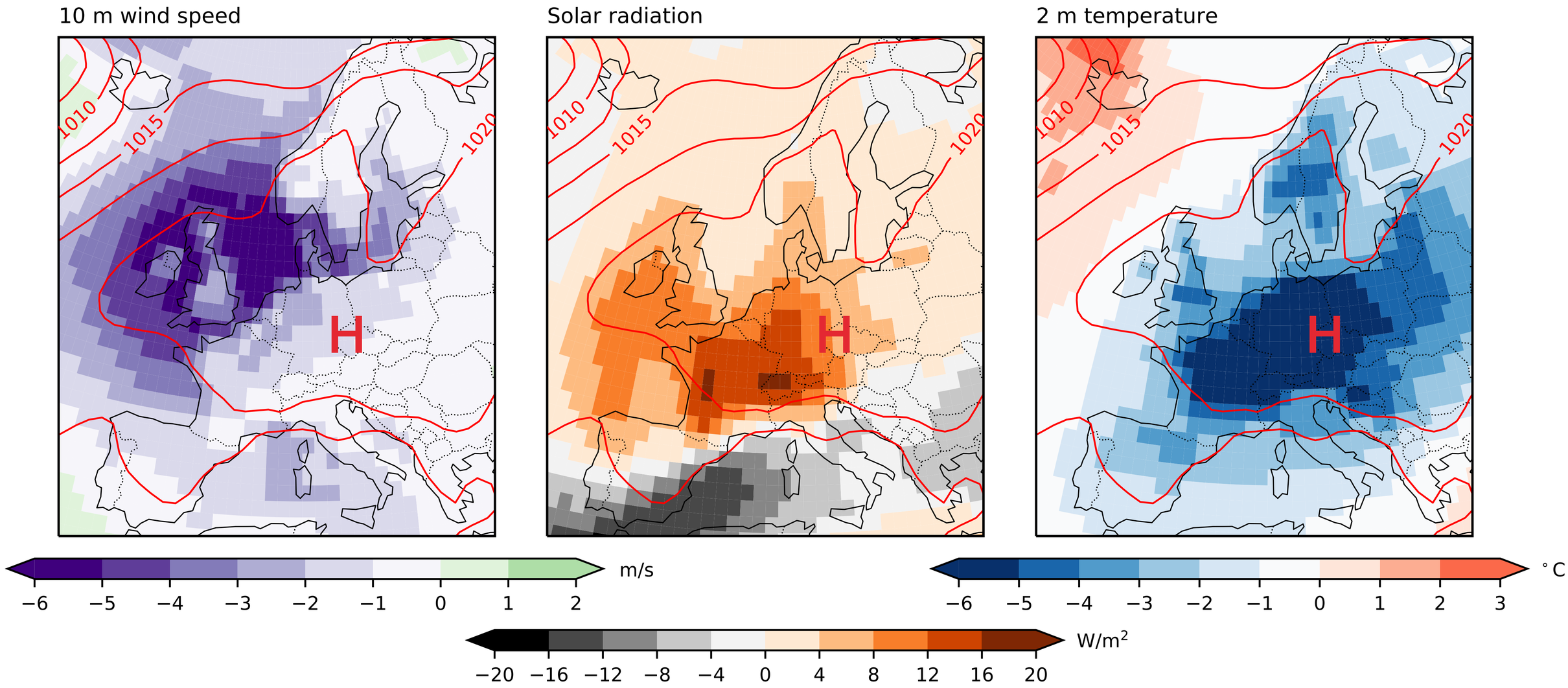
- 15 western European countries
- Energy production
  Wind turbines, solar panels
- Energy demand
  Winter heating, summer cooling



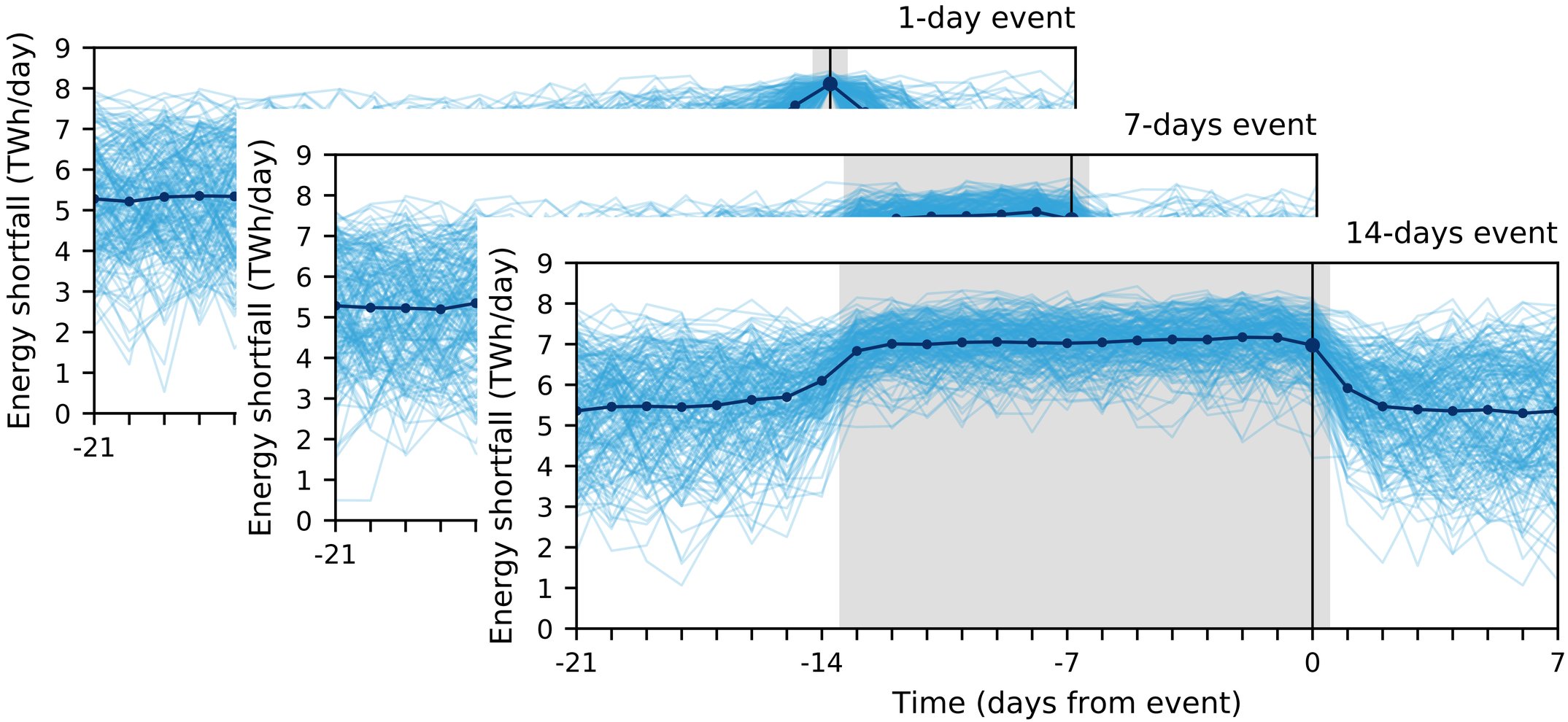
ANNUAL CYCLE OF ENERGY VARIABLES



METEOROLOGICAL CONDITIONS FOR HIGH ENERGY SHORTFALL



LONG LASTING HIGH ENERGY SHORTFALL



SUMMARY

Ambition European energy transition to mitigate climate change

Challenge Match variable energy demand with variable energy production

Extreme high energy shortfall due to **wintertime high pressure systems**

Low wind speeds → low production

Low temperatures → high demand

⊢→ high shortfall

Implication Design our future energy system with these events in mind

Next for me Investigate predictability of these events

RESEARCH PAPER

Van der Wiel et al. (2019): **Meteorological conditions leading to extreme low variable renewable energy production and extreme high energy shortfall**, in review for Renewable & Sustainable Energy Reviews.

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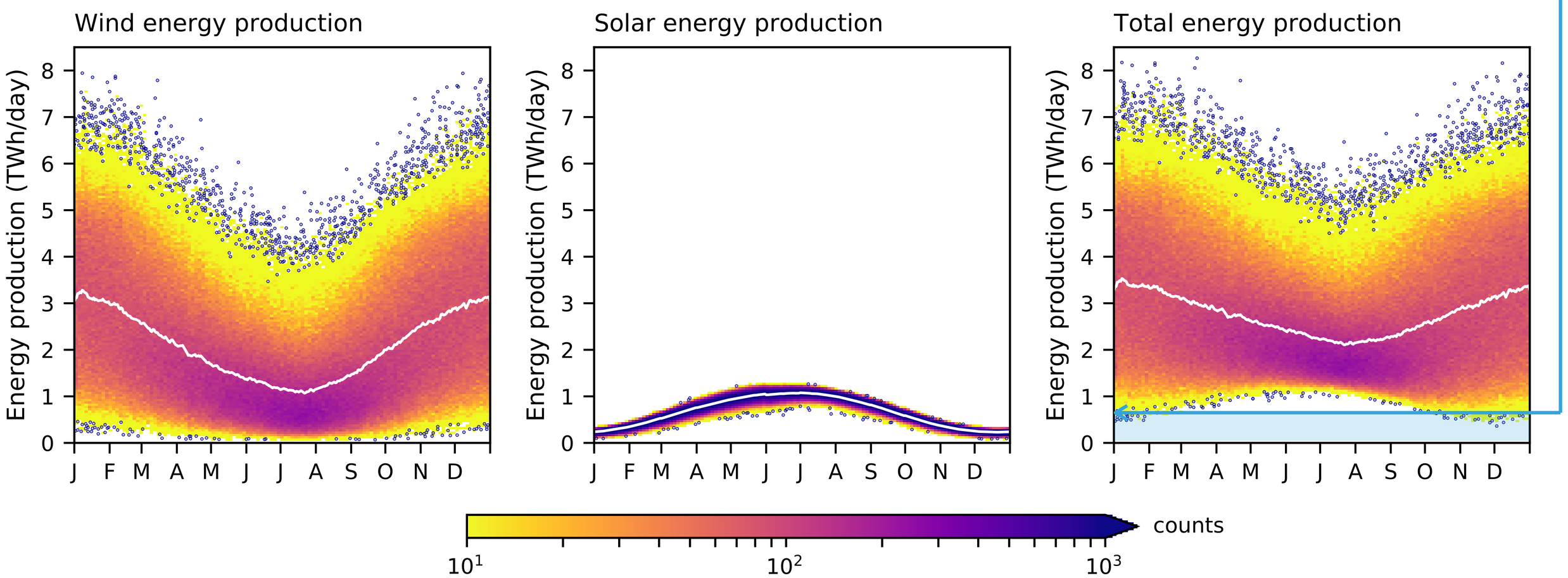
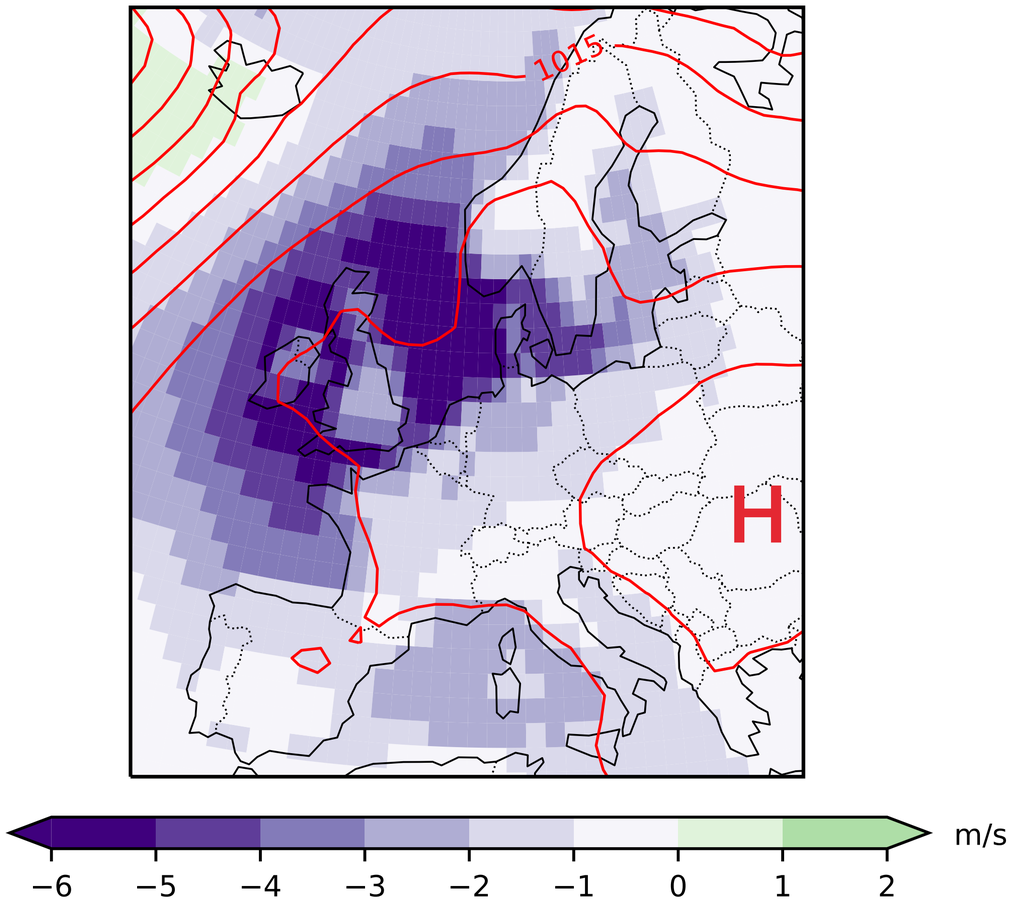
EXTRA SLIDES

ANNUAL CYCLE OF ENERGY VARIABLES

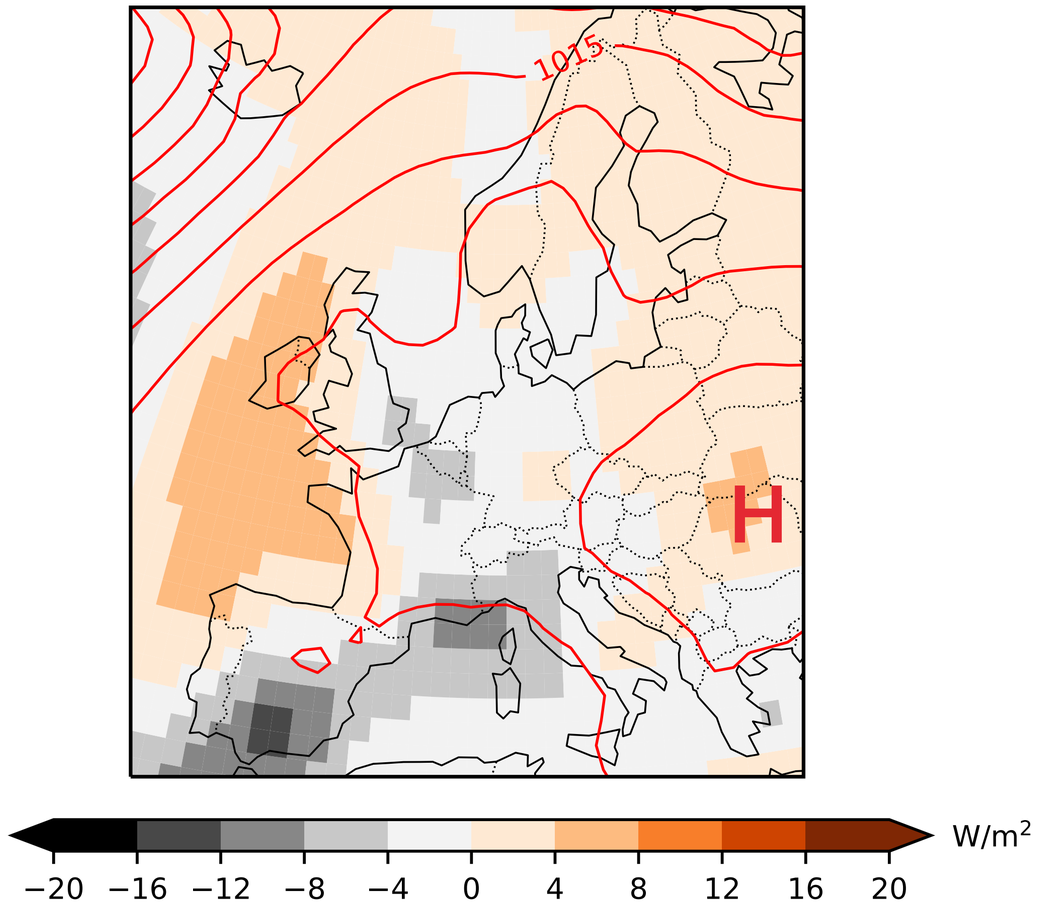


METEOROLOGICAL CONDITIONS FOR LOW ENERGY PRODUCTION

10 m wind speed

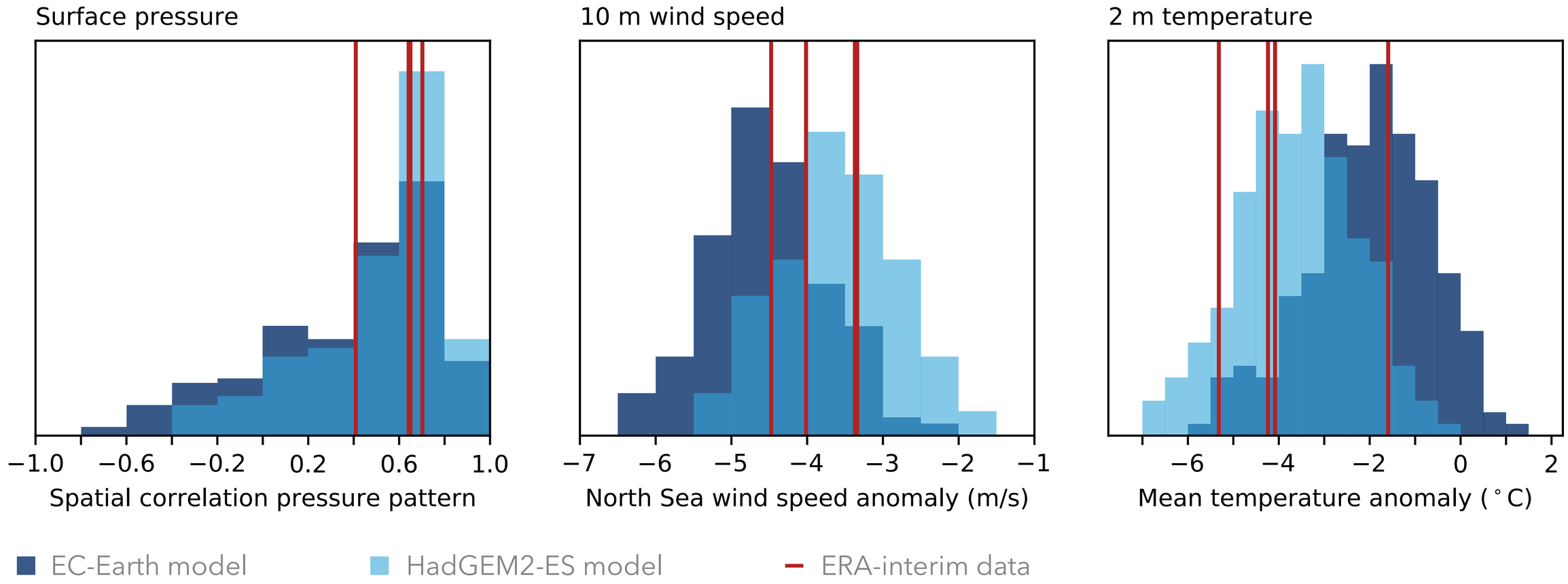


Solar radiation



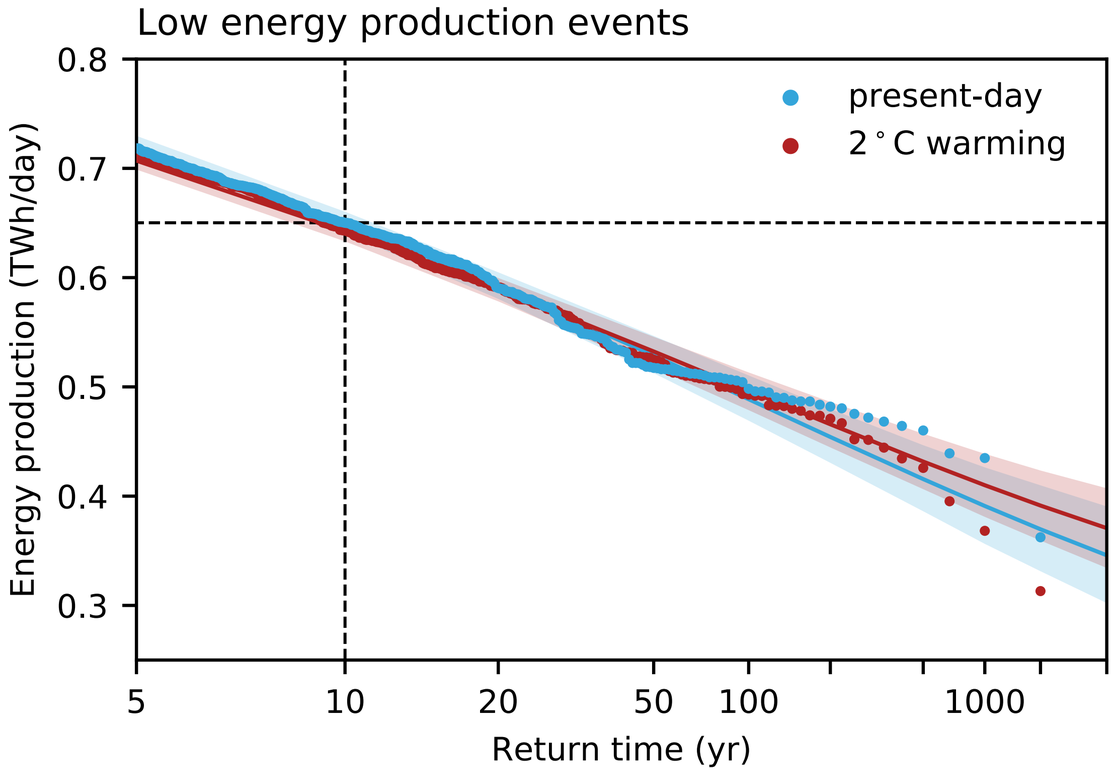
MODEL RESULTS VERSUS OBSERVATIONAL EVIDENCE

- Observed shortfall events fall in the distributions of modelled shortfall events



CLIMATE CHANGE EFFECTS – LOW PRODUCTION

- Interannual variability exceeds changes due to further global climate change
- No significant change in risk of low production



CLIMATE CHANGE EFFECTS – HIGH SHORTFALL

- Further global climate change decreases winter energy demand
- Reduced risk of high shortfall

CAUTION Energy demand model based on the temperature-demand relationship as in 2006-2015, this is expected to change