



CES 2010

Climate change and UK electricity network capacity

*Lucy Cradden, Gareth Harrison
University of Edinburgh*



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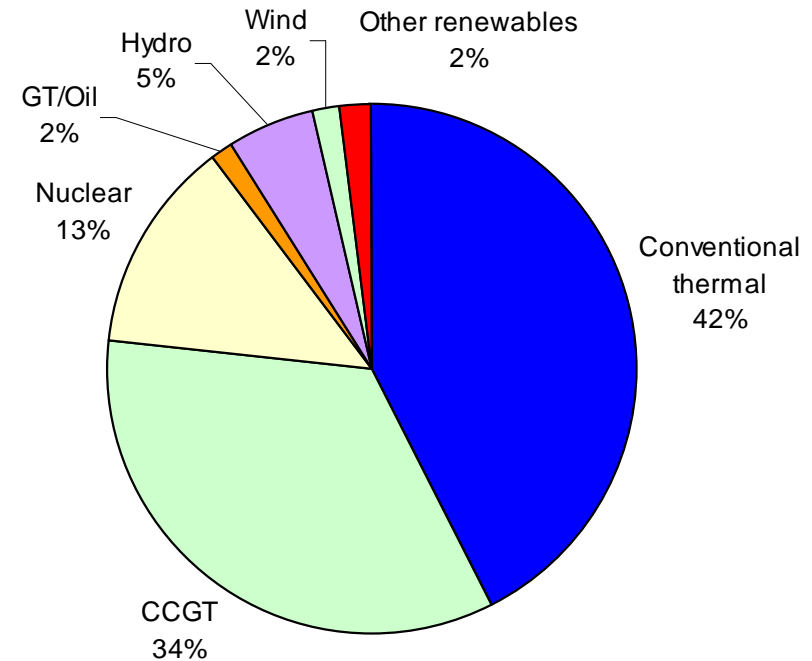
- Why is electricity network capacity important
 - Particularly for increased renewable energy?
- How does climate influence capacity?
- What are the projections for UK climate change?
- What effect could this have on network capacity?
- How could it be mitigated?



UK electricity system



*Generation capacity mix
at December 2008
(total capacity is 83.5 GW)*



Research on future networks including using climate scenarios



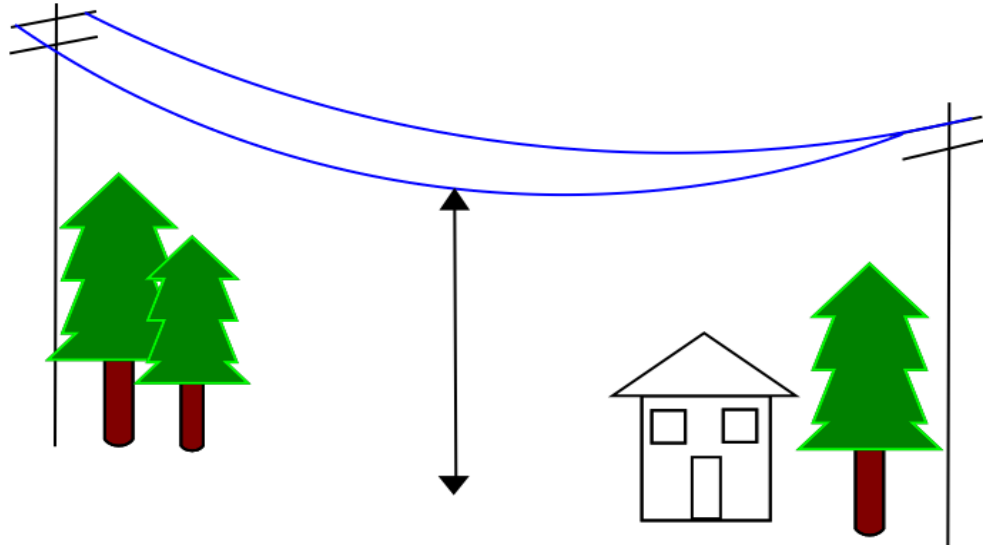


Network capacity (ampacity)



- Electric current running through a wire generates heat
- Ambient conditions superimpose both heating and cooling effects, i.e.,
 - wind = cooling
 - temperature, solar radiation = heating

Network capacity (ampacity)



Too much heat causes 'sag' where minimum ground clearance is not achieved

- Limit to how much heat the wire can be exposed to
- Amount of allowable current based on ambient conditions is known as '*rating*'

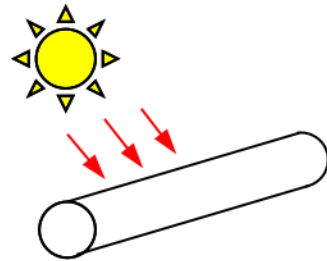


How are ratings determined?

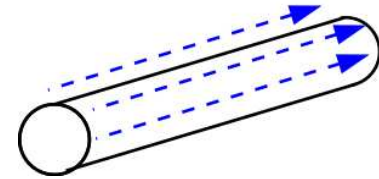


- Based on thermodynamic and heat transfer models accounting for:

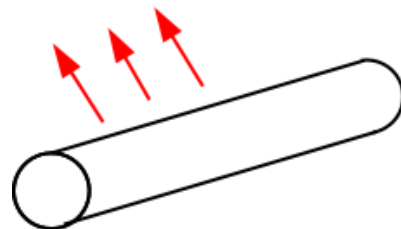
Solar heating



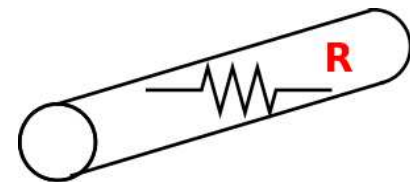
Convective cooling



Radiative cooling



Wire resistance



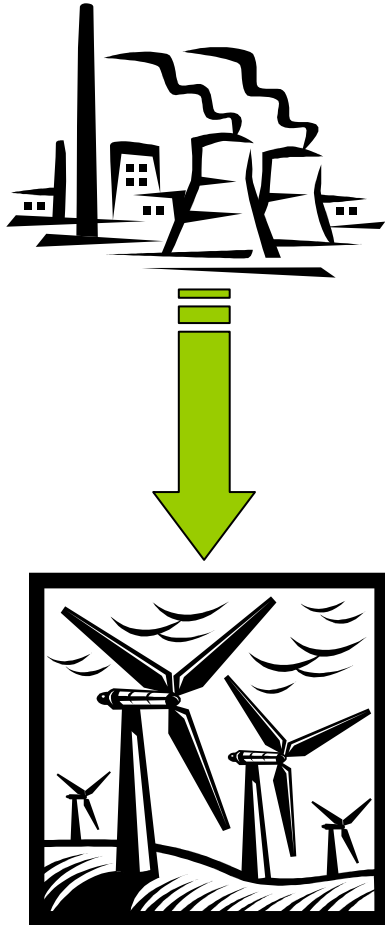


How are ratings determined?



- UK network standards assume seasonal average temperatures and worst-case wind conditions, i.e. low wind speeds
 - Summer → 20°C; Spring/Autumn → 9°C;
 - Winter → 2°C
- Real-time monitoring (*'dynamic rating'*) is not commonly applied but is gaining interest

Renewable energy



- UK network – designed for large, centralised thermal generation
- Increased levels of renewable generation
 - ‘Distributed’ generation
 - Generation often in places where population is low and network is currently sparse
 - Higher levels of flow on lower voltage lines may lead to breaches of thermal limits or the need to constrain generation



Climate change



- Alteration in climate conditions from current expectations
 - **Increasing temperature/solar radiation**
 - Wind variations
- Need to quantify the potential effects on network capacity
 - And understand adaptation/mitigation strategies



UK climate projections

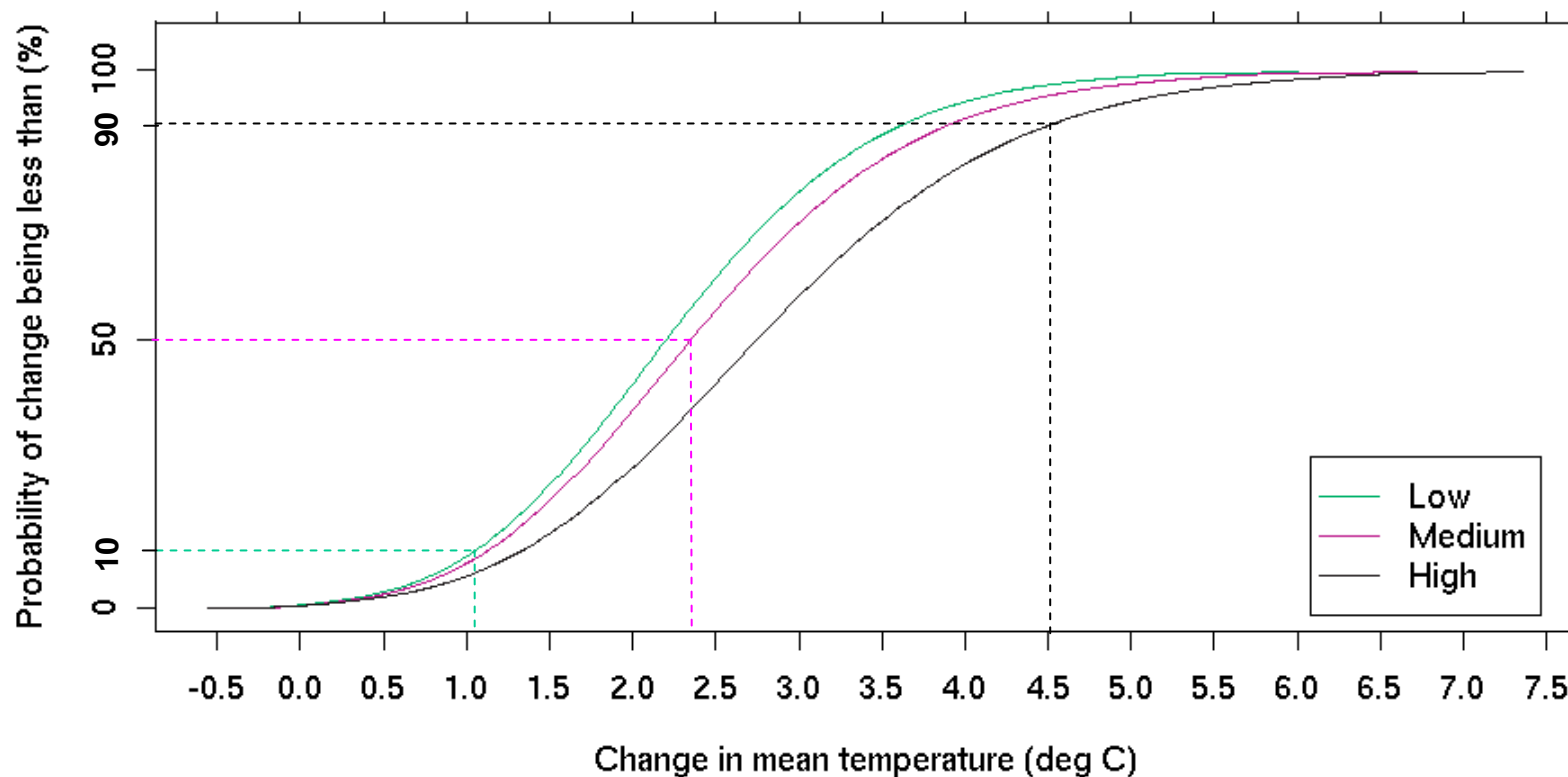


- UKCP09 – UK Climate Projections 2009
- Probabilistic projections for 30-year moving periods over the next 100 years under various emissions scenarios
- Temperature and solar radiation
- Wind climate projections limited (not probabilistic)

UK climate projections



Plot Details:	
Data Source: Probabilistic Land	Temporal Average: JJA
Future Climate Change: True	Spatial Average: Region
Variables: temp_dmean_tmean_abs	Location: Eastern Scotland
Emissions Scenario: Low, Medium, High	Probability Data Type: cdf
Time Period: 2040-2069	

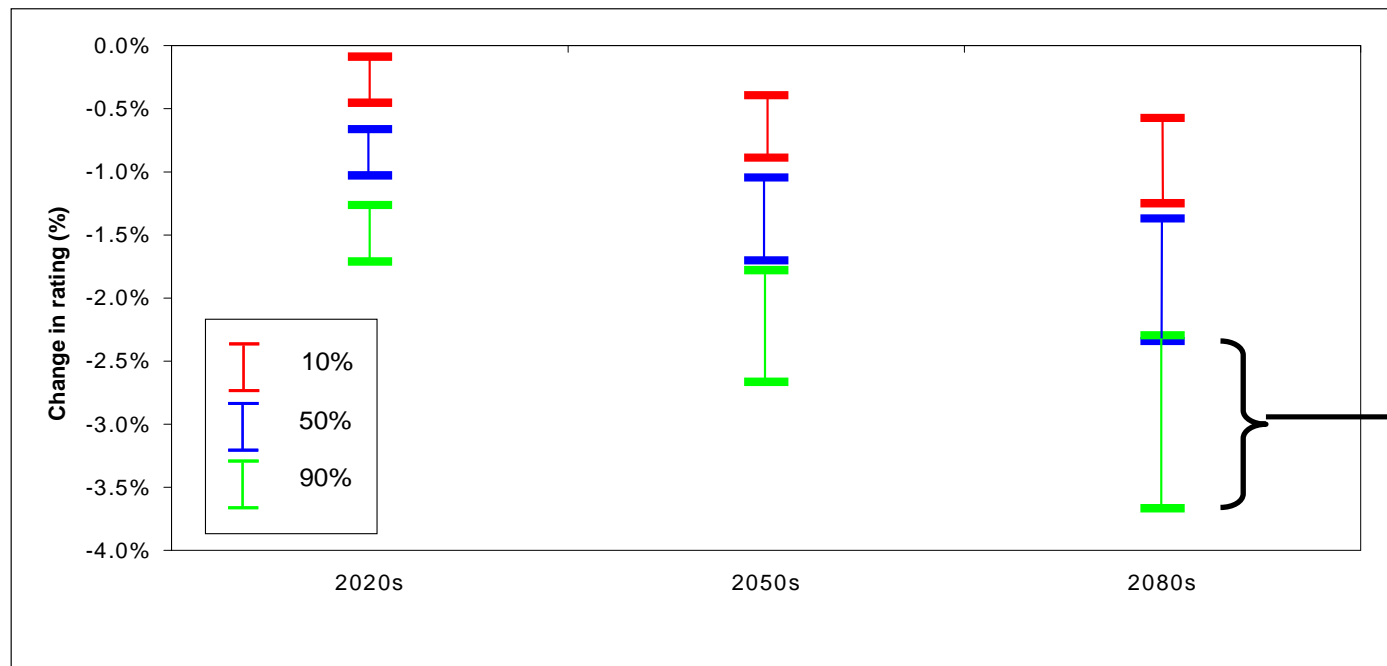




How do seasonal temperature increases impact ratings?



- Projections for change in summer mean ratings over the UK (medium emissions):



Each bar shows range over whole UK spatial area

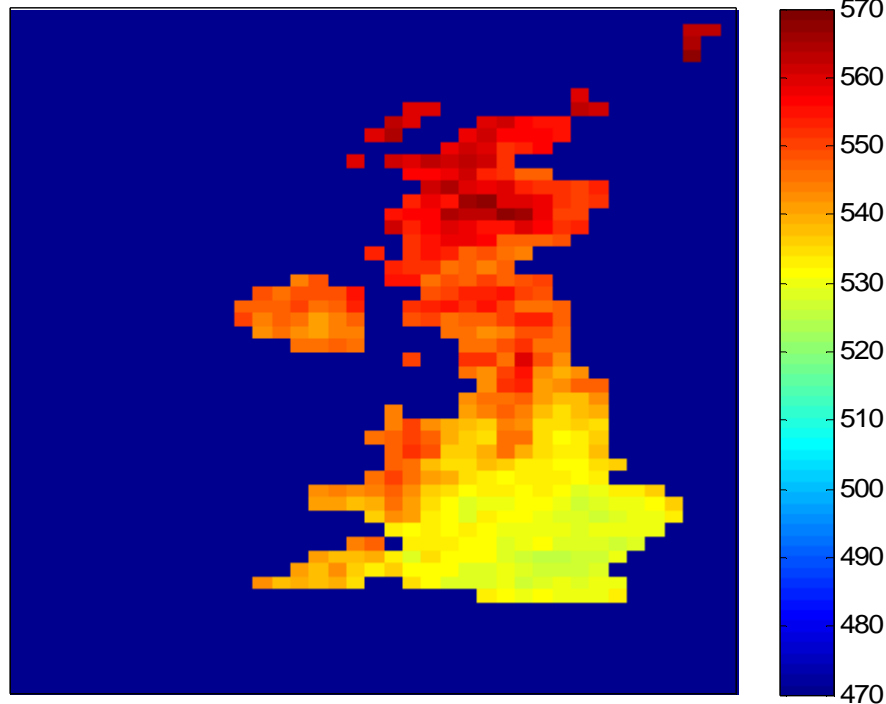


Is the impact similar over the whole UK?

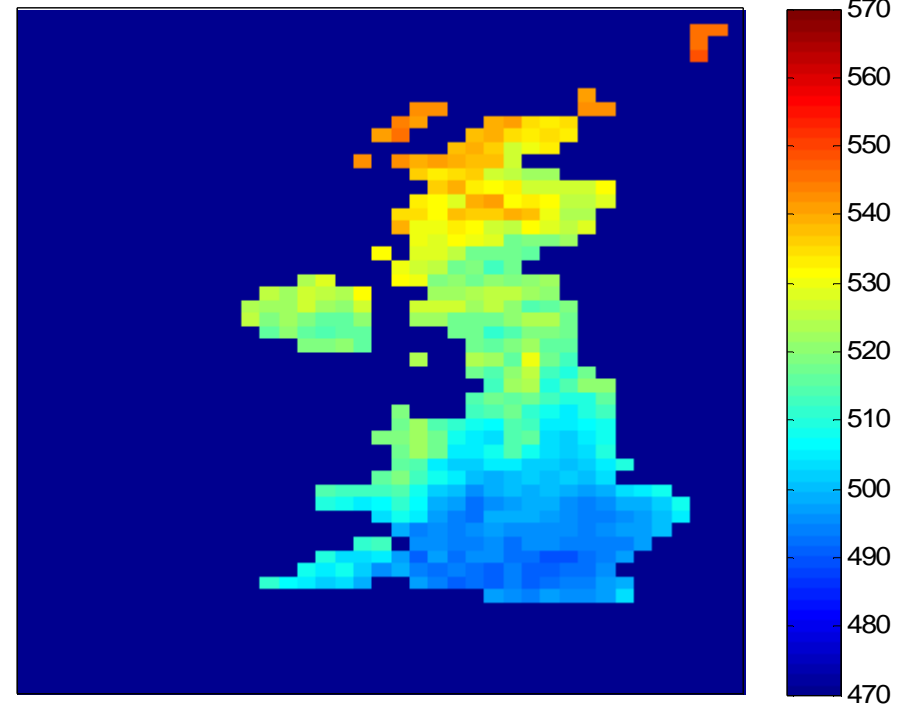


- Changes in the summer minimum rating, i.e. worst-case conditions – max temperature:

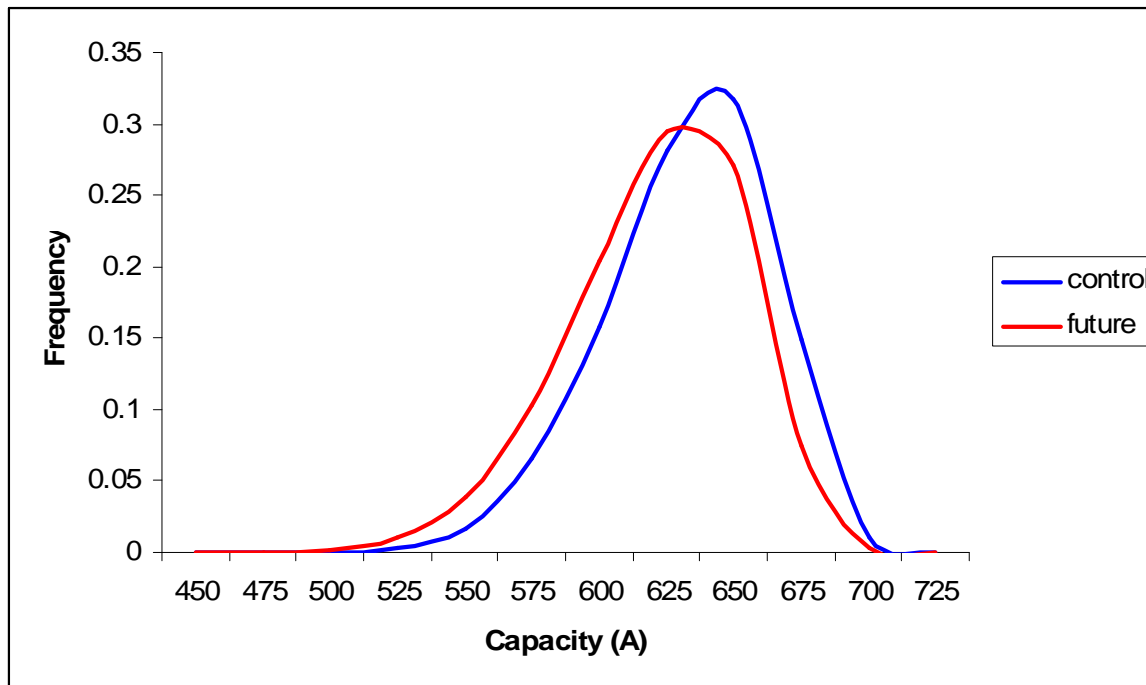
Rating at baseline period 1961-90 (Amps)



Rating at 90% for 2050s period (Amps)



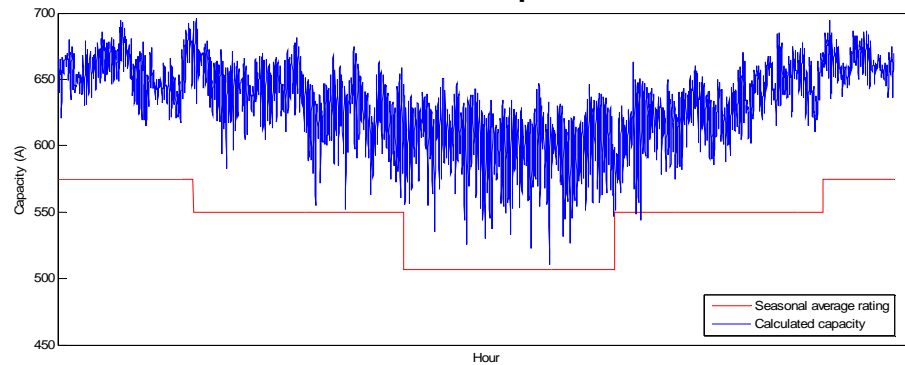
- Using the UKCP09 ‘weather generator’ to determine temperature and solar radiation for control period and future scenario: 2050s, medium emissions



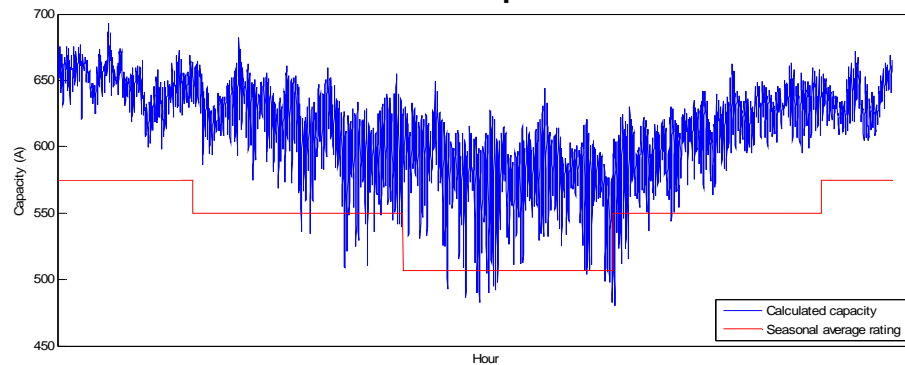
	% change
mean	-1.74
min	-8.32
max	-0.68
std dev (as % of mean)	+0.4

Time series

Control period



Future period



The future scenario contains around 20 times the number of 'breaches' of the static seasonal average rating, most of which occur in summer



Mitigation



- Real-time monitoring of weather conditions rather than seasonal average assumptions
- Includes detail of wind speeds – allowing stretching of capacity for shipping larger amounts of wind power
- Studies have shown it can allow better utilisation of networks without large investments
- Could go some way to mitigate the effects of rising temperatures



Conclusions

- Network capacity will be stretched to accommodate new renewable generation
- Climate change introduces increased risk of reaching thermal limits due to temperature rises
- Dynamic rating solutions may provide mitigation strategy by incorporating local weather effects



Thank you!
Takk!