Breakout Group 2: Climate uncertainty and power system planning

Names have been removed in line with the Chatham House Rule used within the NextGenEC series.

Topic description
A typical goal of power system planning involves identifying the infrastructure required to satisfy the demand of energy consumers at minimal overall cost. In the past, power systems were planned on the premise of controlling a small number of centralised generation units such that they delivered power to end users on demand via extensive transmission and distribution grids. Increasing shares of weather-dependent renewable generation fundamentally challenge this premise and make novel approaches to power system design and operation necessary. As power system infrastructure evolves slowly - on timescales of decades - climate uncertainty has therefore become a major aspect of future power system design.

In the first part of the session a set of presentations where given and following questions and ideas were discussed. In the second half a set of questions was used as a starting ground for the discussion. Part of the second session was devoted to the idea of a paper on the need of easily accessible hourly data for impact analysis (more on that later).

Thoughts related to the talks and first part
To provide some background two speakers were invited to give a background talk on this topic. Karin van der Wiel provided a perspective from the side of a climate scientist, Bryn Pickering provided the perspective from the energy side.

Starting from Karin's talk on large scale events a discussion was had on the use of subsampling of large sets of weather years to successfully use in energy system models. Two variants where proposed:

- Selection of the most extreme weather years
    - energy system models may provide a different result on the impact of more/less extreme weather years on the design (least cost) of the energy system.
- The use of stochastic/robust optimisation
    - This is very computationally intensive, but is possible with ~10-50 weather years (stochastic optimisation, esp. with decompositions approaches) or if we don't mind being a bit over-cautious (robust optimisation)

The use of high resolution weather information covering years of climatemodel inputs was also discussed, including methods on how to get the highest resolution available.

- regional statistical downscaling
    - This isn't always the best option, since assumptions (e.g. fixed aerosols) on the regional level can lead to, counterintuitively, less 'accurate' representations of the region than the global climate model.
- climate scientists don't do 30min resolution modelling. How can the energy community push for it?

In Bryn Pickering's talk a large set of possible solutions for a future energy system and possible issues were discussed. He provided us with this nice overview:

1. Overcapacity
2. Sub-daily, inter-seasonal, and inter-annual storage
3. Regional interconnectivity
4. Electricity -> liquid/gaseous fuels
5. Demand-side management (smart vehicle charging, home heat storage)

1. Expect high curtailment
2. Year-to-year operation may vary considerably
3. Requires international cooperation
4. High efficiency losses
5. Requires consumer buy-in

During the discussion, the challenge of dealing with the uncertainty in future climate was also raised. For both demand (Deroubaix et al 2021, https://www.nature.com/articles/s41467-021-25504-8) and production (with renewable energy). The energy demand for cooling buildings will probably grow in Europe, with warmer summers, leading to the acquisition of air conditioning systems. An open question there is how is it taken into account in energy models?

Broader discussion in the second part

Leading questions for the second part were drawn up in advance. Not all were discussed in detail.

1. What is meant by climate uncertainty in power system planning and how can it be quantified?
2. Which power-system technologies (or combinations of technologies) can be utilized to reduce the impact of climate change and climate uncertainty?
3. How can climate uncertainty be compared to other sources of power system planning uncertainty (such as those of economic, social or technical assumptions)?
4. How do we best approach climate uncertainty: should the focus be on producing 'more accurate' longer-term climate predictions or on 'improving' power system design methodologies to ensure that their solutions are robust to a wider range of possible future climatic conditions?

The main conclusion of the second part was to make a joint paper about bridging the gap between energy & climate system modellers. A possible skeleton of such a paper was fleshed out during the workshop in the notes and later used by a small sub-group as a starting point for a commentary. *All those involved in the discussion will receive an invitation to give their two-cents about this at a later stage.*

Some noteworthy comments made during this discussion:
P1: Think is partly also a commentary directed both ways. E.g., we really need to move away from the 'single representative weather year' in energy modelling too. (<--- THIS!!! ESM needs to move to ensemble modeling. P2)
P3: I have attempted showing the importance of adequately representing internal variability for impact studies, https://doi.org/10.1088/1748-9326/ab7668