Break out groups – detailed theme descriptions

Group 1: Modelling infrastructure damage in current and future energy systems
Hannah Bloomfield & Matt Deakin

Within the energy-meteorology community there are now numerous power system models available for both optimising the running costs of present-day power systems or for optimizing future investment in low carbon technologies. The models can either be run over individual nations, or across an interconnected grid of countries. As national power systems decarbonise to meet climate mitigation targets their weather dependence is increasing. It is therefore becoming increasingly common to include multiple years of weather and climate data within power system modelling simulations, and the reliance on a 'typical meteorological year' is slowly easing. However, the use of multiple years of weather data in these modelling tools is generally focussed on the balance of supply and demand and little attention is given to the possible influences of extreme weather events on critical energy infrastructure. Examples of these weather types include: damaging storms, flooding, wildfires, extreme heat and cold, drought and icing (see https://doi.org/10.1016/j.ssci.2017.12.022 for a comprehensive description of their impacts).

Within an interconnected power system modelling framework a period of very high summer temperatures in Southern Europe accompanied by anomalously low wind speeds has the potential for a summer peak demand, with low supply from wind power. However, the potential sagging of transmission lines in warm temperatures (exacerbated by low wind conditions), and therefore potentially reduced capacity is not commonly included, which may lead to overconfident simulations.

Another example could be a large tropical cyclone passing over the Southern United states or Mexico, which could appear to provide favourable conditions across large regions for wind power generation, but the power system models often fail to include the potential damage to energy infrastructure from extremely high wind conditions.

This breakout group will begin with some talks showing state of the art research on modelling the impacts of weather and climate on energy infrastructure followed by discussion around the following questions:

1. Which extreme weather events impact energy infrastructure?
2. How might climate change impact energy infrastructure?
3. Can we design simple experiments using energy models to test some of the previous discussion points? *Note: this may build on the models used in the 'training camp' on Monday, but attendance at the training camp is not a prerequisite for participating here.*

Group 2: Planning for black and green swans - storylines for managing rapid transformations in climate & energy

Marta Victoria, Marianne Zeyringer and Laurens Stoop

Multi-year modeling and optimization of power systems is becoming increasingly researched. The balance of supply and demand is analyzed over longer time spans with varying conditions. While the inherent risks of a power system are typically modeled in relative detail, the modeling of 'unforeseen' or black swan events is limited. And yet in 2022, we are witnessing an unexpected rise in the price of fossil fuels and limited availability in some regions as a consequence of geopolitical conflicts. At the same time, the climate is a source of uncertainty that can give way to rare events with high impact on the energy system, these are so called green swans. Technically we can model such events from the climate perspective, but incorporating this in the design of an optimal system is not difficult due to their low probability. Modelling the impact of rare events is however something that should be done, but is not widespread.

Similarly, the running of an energy model requires a scenario of the future, the development of these are sometimes outrun by policy development. Recent RePower EU and the Fit for 55 plan puts much more focus on a rapid transformation to reach independence from Russian gas. Plans for doubling wind and solar by 2025 and tripling by 2030, combined with 10 million heat pumps installed in the next five years are suddenly more realistic than before.
When different drivers of impact in the power system come together, their effects can compound. This can be created by the simulteneous stresses due to an unexpected geopolitical or climate event. Modeling such compound events is difficult and requires a rethinking of the methods used.

In this breakout group, we explore black/green swans, extreme and compound events and their impact on the current state of the art research. Through the discussion and talks we aim to determine what these events are, how we could better understand them and what would be needed to design stress-tests and apply them to models to prepare against such events.

Questions for discussion:

1. What do we think about when discussing extremes, black/green swans or compound events?
2. What would be needed to better understand these events?
3. Can we design a checklist/method to stress test our models for these events?

Group 3: Forecasting and predictability - planning and managing variable renewables

Paula González, Jan Wohland, Jethro Browell, Marisol Osman

Energy system optimization models, which determine optimal installed capacities by minimizing costs, are commonly used tools in energy research and planning. Energy systems are significantly and increasingly sensitive to weather and climate, but weather and climate are oftentimes incorporated in simplified ways. One of such simplifications is the typical assumption of "perfect foresight" in which full knowledge of the future evolution of a set of variables (e.g., temperature, wind, load) is assumed when modeling energy system operation. However, we know that even short-term weather forecasts are imperfect and fundamental limits exist regarding longer-term (i.e., lead times of many weeks and beyond) predictability, which challenges operability.

In this breakout group, we will discuss how to improve the representation of imperfect foresight at interface between climate and energy modeling, including:

- What assumptions are currently made by energy system modelers and where do these assumptions come from (e.g., perfect foresight can be a meaningful upper bound of efficiently operating a power system)?
- What are the current limits of predictability in energy-relevant timescales? How variable/regional dependent are they?
- What are pragmatic and meaningful approaches to overcome the perfect foresight assumption in energy system models?
- Should large/extreme forecast errors be considered as a new category of stress event? On what spatial/time scale?
- Can we quantify how predictability is likely to change due to future deployment of low-carbon technologies, CC and/or computational and scientific advances?

Group 4: Energy models for all - open access to knowledge & tools for energy and climate modelling

Matteo De Felice and Ekaterina Fedotova

In the last years, the tools and data that are needed to create high-quality and useful information to analyse the link between energy and climate increased both in number and in accessibility. However, we can still see that most of the modelling initiatives and available datasets are focused on a few regions of the world (Europe, North America, etc.) while global coverage is crucial for the climate change mitigation.

The emerging global energy modelling initiatives aim to fill this gap and support the energy transition in all regions of the globe. New standards of the transparent, reproducible and credible energy modelling are being developed by combining the open-source approach, open data and open-source solvers. The potential gains include:

- Improve transparency and credibility by citizens and investors
- Create reference system for scenario analysis by institutions and users
- Increase perception of the energy transition across energy engineers, stakeholders and broader society
- Quantify investment opportunities in renewable energy

The key to the success of each modelling or a model-derived policy activity is a correct representation of a unique regional combination of the climate conditions, energy demand patterns and energy supply options as well as of the social and economic situation.

...And that's where we need your help.

This BOG will discuss with all the participants:

1. 1. What are the obstacles and gaps you experienced when approaching energy and climate modelling in terms of tools and data?
2. 2. What is the importance of having open models and datasets for transparency and reproducibility from your perspective?

The discussion will be opened with a presentation from Ekaterina Fedotova with the title *"PyPSA meets Earth: making energy modelling global"*