This interview will last approximately 75 minutes and will be conducted by David Taylor (Principal Energy Modeller) and Jonathan Black (Global Modelling Director). I am also sending out a technical exercise that will be a point of discussion during this second-round interview. Please see the details of the technical exercise from the hiring manager below:

Congratulations on being invited to the second round! Ahead of this interview, we would like you to complete a technical exercise that will form the basis for a discussion in the second round interview. We will be looking for the following:

- Ability to process a problem and come up with a sensible and practical model design
- Clear and structured communication of the modelling process and outcome
- A strong understanding of the fundamentals behind mathematical optimisation and how they can be applied to real-world situations

We expect this challenge to take up to 4 hours. We do not expect you to source any additional data than that provided, and you are not required to use all the data provided. There are many ways in which this problem can be approached - we are not looking for a "correct answer". This exercise can be performed in a programming language of your choice. You are free to use the internet, any freely available libraries, and an open-source external solver. If it looks like you will need more than 4 hours, please consider simplifying the specification to reduce the amount of time you need.
Please send us your deliverables at least 24 hours before your second interview.

Context
In typical liberalised wholesale electricity markets, power generators sell the energy they produce and retailers buy energy on behalf of their customers. Like other goods, the price of electricity depends on supply and demand. However, both demand and supply fluctuate significantly with time - due to factors such as weather variability and daily work patterns. Although it is possible to store electricity (for example in batteries or hydroelectric dams), it is not cheap to do so. As a result, wholesale electricity prices vary significantly in the short term (e.g. over the course of a day), based on the underlying supply and demand. This price variability creates an opportunity for generators with storage capabilities to generate profits by buying electricity when prices are low and selling when prices are high.

Task
Please build an optimisation model to charge/discharge the battery over the time period provided (2018-2020) in order to maximise profits. You may assume that the battery is a price-taker (ie. the actions of the battery have no impact on the market prices).
In this exercise, we allow the battery to trade across 3 wholesale electricity markets, with prices included in the data file. In each of these markets, the battery can choose to provide some power for some duration of time. The units of the market price are in £/MWh. If the battery were to provide 5MW of power for 30 mins when the market price was 50 £/MWh, it would be paid £125 (5 * 0.5 * 50).

- The battery can export any amount of power up to its maximum discharge rate for any duration of time, as long as it has sufficient energy stored to do so
    - Likewise, the battery can import any amount of power up to its maximum charge rate for any duration of time, as long as it has sufficient remaining storage capacity to do so
- Markets 1 and 2 are traded at half-hourly time granularity, whereas Market 3 is traded at daily granularity
    - This means that the price for Markets 1 and 2 changes from one half-hour to the next, whereas the price for Market 3 changes from one day to the next
- The battery cannot sell the *same* unit of power into multiple markets, but can divide its power across the markets
    - e.g. a battery exporting 5MW of power may sell 2MW into Market 1 and 3MW into market, but may *not* sell 5MW into both Markets 1 and 2

- For the battery to participate in Markets 1 and 2, it must export/import a constant level of power for the full half-hour period
- For the battery to participate in Market 3, it must export/import a constant level of power for the full day
    - i.e. it is not allowed to export/import for a few specific hours only

This exercise is not designed to mimic very realistic battery trading in order to keep the scope of the exercise small. You are free to decide whether to include/exclude your own knowledge about electricity markets and/or batteries that is beyond the specification of this exercise.

Deliverables

Please send the following at least a day before your second interview:

- File(s) containing your optimisation model - please upload to a remote repository which we can access
- Excel file containing:
    - Half-hourly battery charging
    - Half-hourly battery discharging
    - Total yearly profits over the time period
    - [Optional] Other variables that you choose to use that would be helpful to understanding the underlying logic of your model
- List of external dependencies (e.g. solvers, packages) that your model uses
- A brief (no more than 1 paragraph) summary of your approach

Looking forward to hearing your response and please let me know if you have any questions.