CALCULATING THE GHG EMISSIONS FROM A CHANGED ELECTRICITY SYSTEM

In line with their climate goals, the EU is headed towards large-scale power grid expansions. The amount of green-house gas (GHG) emissions that could potentially be saved may be calculated by means of modelling.

It is now commonly accepted that emissions of GHGs have a harmful impact on the Earth's climate. The European Commission acknowledge that 75 % of EU emissions arise from the energy sector*, prompting reductive measures such as increasing renewables and energy efficiency.

HOW GRID EXPANSION CAN HELP

In the Nordic countries, hydro and nuclear power, which emit rather little GHGs, are utilised to a great extent as base power. Other countries, such as Germany and Poland produce power with a larger share of fossil fuels, which emit more GHGs. By connecting countries with more fossil production with the Nordics, power that otherwise would have been produced locally by fossil fuels can be displaced by power which causes less emissions. The increased connection also gives more possibilities to increase the amount of deployed intermittent renewables: high voltage lines can export power from an area with excess, so the power is not wasted. However, if for instance the wind does not blow in a local wind park, power from windier areas can be imported.

HOW TO CALCULATE GHG EMISSIONS

To calculate the GHG emissions that potentially can be saved by increasing interconnections between areas, modelling could be employed. Such a model of the Northern European electricity system was built to consider the variability of demand and wind power production, the power production capacities in each country and the transmission lines in between. The model emulates reality by first determining the power types that would be activated (and their locations) in a market setting without interconnection constraints – that is, total load is met at the lowest cost of power. Next, as the cheapest power production and demand may be located in different areas geographically, the model attempts to transfer the excess production from some areas to areas with deficits. If imbalances still exist a second market process is initiated locally.

OUTCOME OF AN EMISSIONS MODEL

The model discussed here was found to produce values relatively close to actual recorded values for 2018 if input for the same year was provided. By adjusting parameters in the model, different scenarios can be tested. One such scenario included adjusting all nuclear and transmission capacities to what they are expected to be in 2024. Keeping all other input the same as the 2018 base case, the results showed that the carbon emissions would increase by around 25 %. This is likely to be a trustworthy *indication* as there were few flaws associated with the most vital parts of the algorithm and as much of the input data is not expected to change radically between 2018 and 2024. Another investigated scenario was the realisation of expected network developments up until 2035 materialise, all other input remaining the same. The model output gives a 2 % increase in emissions from the 2018 base case, on the contrary to expectations. This could be explained by discovered faults in the model, yet also that the (intermittent) renewable production was not modelled to increase, as it should in reality.

USE OF THE MODEL

The purpose of the built model was to indicate what impacts that different configurations of the electricity system may have on the emissions from the power sector. The built model may have produced some interesting results, however many improvements should be made – most importantly with respect to resolving faults, including growth of renewable energy in future scenarios and improving hydro power modelling. The current model is a promising basis for further development – if the improvements are made and the models function validated, it may become a helpful tool for calculating emissions.

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* European Commission, "COMMUNICATION FROM THE COMMISSION - A Clean Planet for all," European Commission, Brussels, 2018