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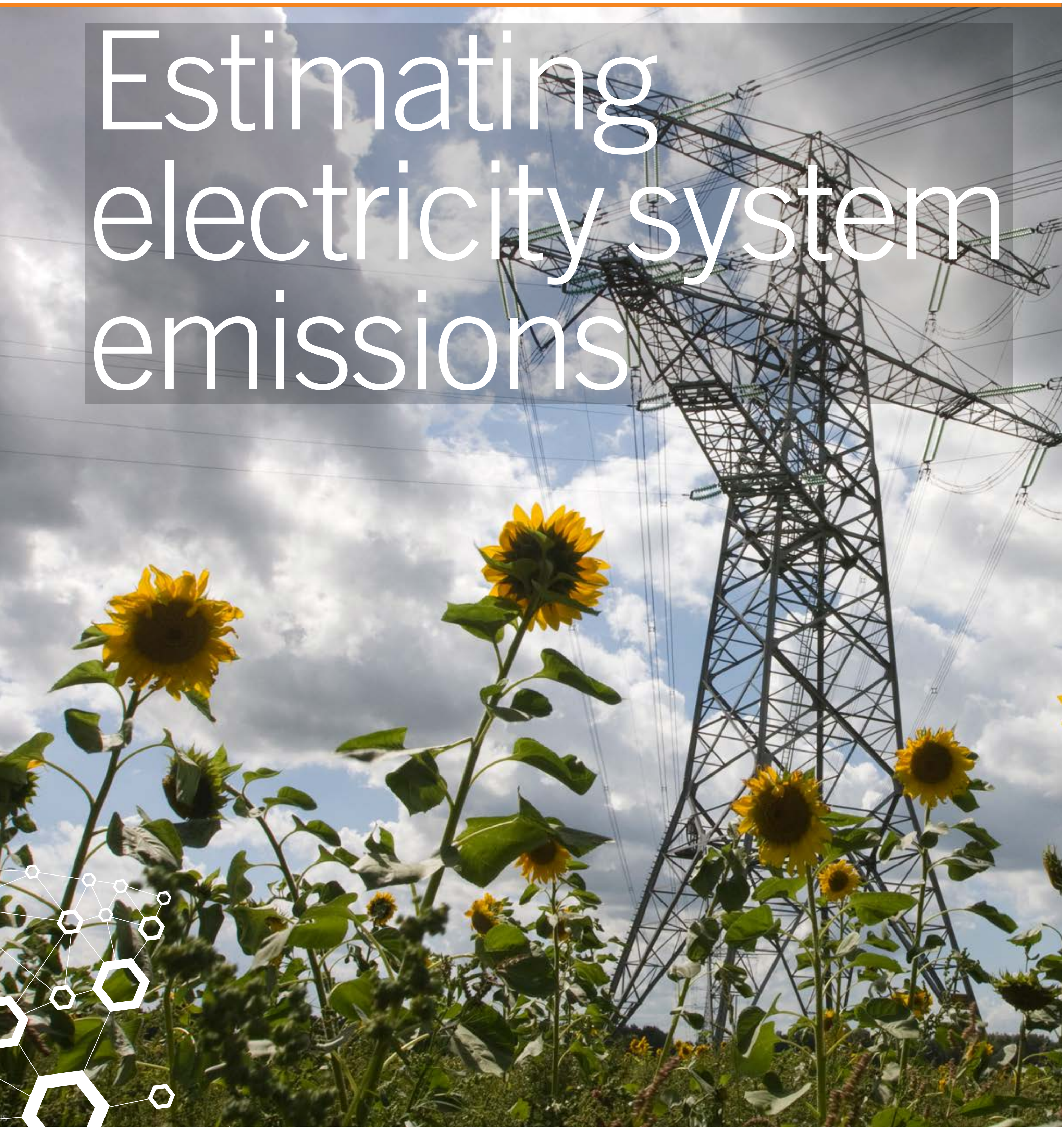
PÖYRY POINT OF VIEW - JULY 2019

Estimating electricity system emissions



Calculating the GHG emissions from a changed electricity system

Minimum energy targets for 2030 in the EU[2]

- 40% reduction of GHG emissions compared to 1990
- Renewables cover 32% of the final energy consuption
- A 32.5% advance in energy efficiency compared to projections[3]
- Interconnection capacity amounting to 15% of installed production capacity[4]

As a key enabler of greenhouse gas (GHG) reduction, the electricity system is undergoing significant change. To estimate the emissions arising, different system configurations modelling can be a helpful tool.

TARGETING THE ENERGY SECTOR

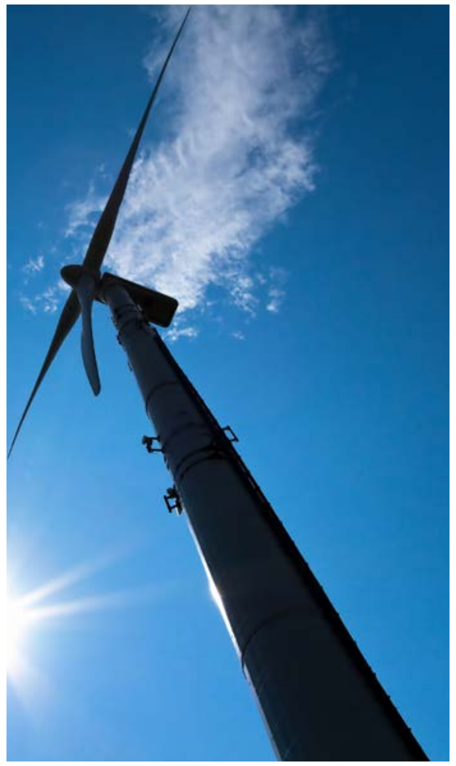
It is now commonly accepted that emissions of GHG´s have a harmful impact on the Earth's climate. The European Commission acknowledge that 75% of EU emissions arise from the energy sector[1], making the industry a promising target for reductive measures, such as increasing the share of renewables in the energy mix and improving energy efficiency. Also in line with these aims, the EU is headed towards large-scale power grid expansions.

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 replaced 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 an 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 can potentially be saved by increasing interconnections between areas, modelling can be used. 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 cheapest power production and demand may be located in different areas geographically, the model attempts to transfer the excess production from some areas to those with deficits. If imbalances still exist a second market process is initiated locally.



1 European Commission, "COMMUNICATION FROM THE COMMISSION - A Clean Planet for all". European Commission, Brussels, 2018 (https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf)

2 European Commission, 2030 climate & energy framework (https://ec.europa.eu/clima/policies/strategies/2030_en)

3 European Commission, Energy efficiency targets for 2020 and 2030 (https://ec.europa.eu/energy/en/topics/energy-efficiency)

4 European Commission, The European Union leading in renewables (https://ec.europa.eu/energy/sites/ener/files/documents/cop21-brochure-web.pdf)

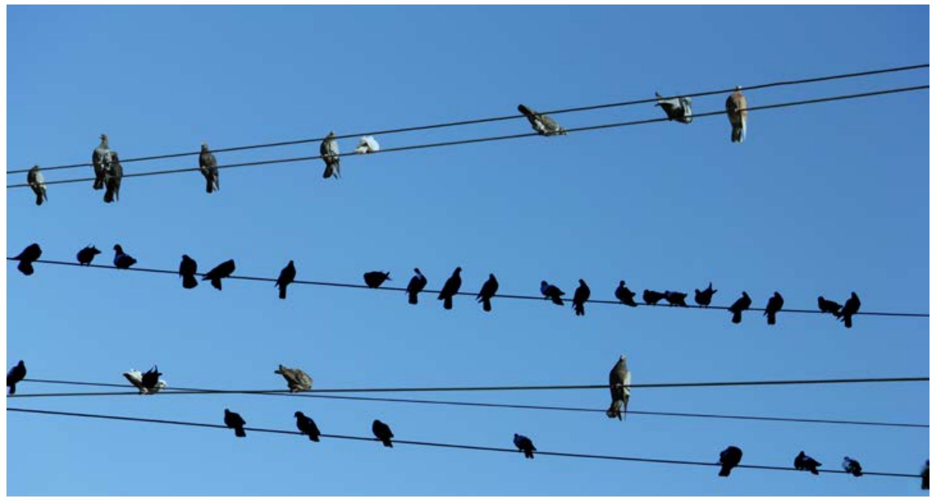
Country	Nuclear Capacity 2018 from ENTSO_E [MW]	Expected Nuclear Capacity 2024 [MW]
Sweden	8586	3284
Norway	0	0
Denmark	0	0
Finland	2782	4369
Estonia	0	0
Latvia	0	0
Lithuania	0	0
Germany	9516	0
United Kingdom	8974	4643
Netherlands	485	485
Poland	0	0

Table 1.
Recent and expected nuclear capacity.

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, as can be seen in table 1. 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 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, with all other input remaining the same. The model output gives a 2% increase in emissions from the 2018 base case, contrary to expectations. This could be explained by the (intermittent) renewable production not being modelled to increase as it should in reality. The unexpected result can also be due to a malfunctioning segment of code – it has been found that exchange balances when calculated from the output data of transmission traffic are incorrect. On the other hand, considering total demand and production, the system balances well.



USE OF THE MODEL

The purpose of the built model was to indicate what impacts different configurations of the electricity system may have on the emissions from the power sector. The built model has produced some interesting results, however many improvements should be made. Most important from a technical perspective, the transmitted electricity must be made to balance. An increase in the growth of renewable electricity sources is vital, particularly wind and solar. Other improvements could be developing a comprehensive model of hydropower production, altering the manner of which demand and wind power production are modelled, along with improving the differentiation between base, peak and reserve power. The current model is a promising basis for further development – if the improvements are made and the model´s function validated, it may become a helpful tool for calculating emissions.

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