Decarbonisation of electricity

Is a deep decarbonisation of the EU's electricity system by 2050 feasible and viable?

Overview

The EU has set ambitious decarbonisation targets for 2030 and 2050. The power sector is expected to reach almost zero GHG emissions by 2050. In MAGIC, we take a biophysical approach to model the decarbonisation of the power sector, by considering the GHG emissions associated to infrastructural changes. Our results show that the EU's decarbonisation scenarios are optimistic and miss key questions related to grid flexibility and associated emissions.

DECARBONISATION IN EU POLICY

BY 2030:

- 40% cuts in GHG emissions (from 1990 levels)
- 27% of EU energy from renewables

BY 2050:

- 80% cuts in GHG emissions (from 1990 levels)

THE POWER SECTOR

The power sector is expected to play an important role as more functions of the economy are electrified, and to reach (almost) zero emissions by 2050

What does decarbonisation entail from a biophysical perspective?

In 2016, the EU power sector accounted for 30% of all GHG emissions [1], mostly due to the combustion of fossil fuels. As the motor that powers a range of economic activities, decarbonising the power sector is central to decarbonising the economy at large. A complete decarbonisation of the economy is considered to be "feasible and viable" [2] by the EU, and the main hurdles to decarbonisation are framed as being of financial nature [3].

In MAGIC, we take a biophysical perspective when analysing a shift to renewable electricity. Looking at the complex energy system, electricity is a flow being produced within the system and being consumed by all sectors (including the energy sector). To be able to produce electricity, patterns of infrastructure (power plants, power lines, etc.) need to be built and maintained, and are associated with patterns of nexus elements across different scales (e.g. the water consumed by power plants or the electricity consumed by pumped hydroelectric storage).

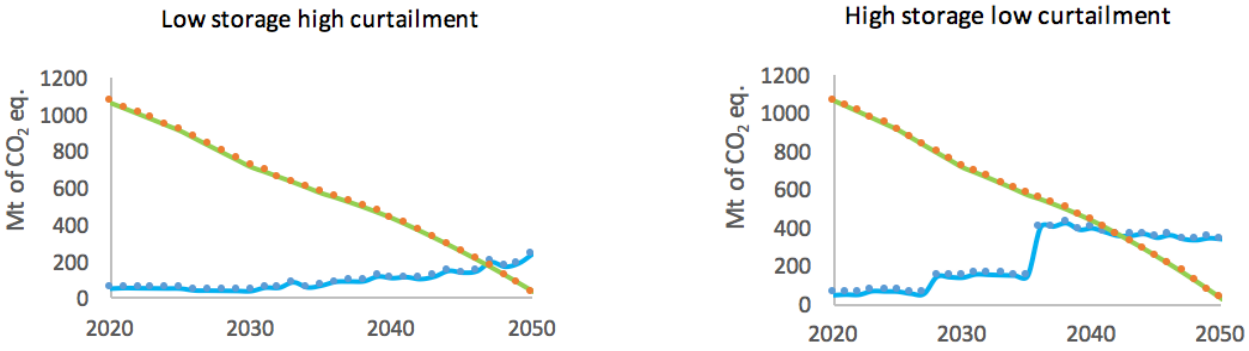
There are two key points that are essential in the biophysical analysis of renewable electricity:

1. The distinction between different types of electricity: baseload, peak and intermittent.
2. The analysis of funds (for example, power plants and storage infrastructure) beyond monetary readings, including the nexus elements needed to build and maintain the funds (for example, the water consumed in lithium extraction).

GHG emissions of a renewable electricity transition in the EU

To ensure that the intermittent electricity generated from renewable sources is dispatchable at all times, grid flexibility needs to be improved. One possible way is through curtailment: this implies installing more renewable capacity than what is needed, and only using the electricity produced when it is needed. Another way is by storing excessive electricity when it is produced. Both methods are associated with GHG emissions: curtailment requires the construction of large amounts of power capacity, and the manufacturing of storage technologies is not carbon neutral.

We modelled two pathways for the decarbonisation of the EU's power sector to 2050, the first with high curtailment and the second with high storage. In both pathways, cumulative GHG emissions up to 2050 do not decrease in line with EU climate targets, but amount to 21-24 Gt of CO_2 equivalent, which is approximately **25% of the total carbon budget available to the EU up to 2100**.



The two figures show alternative decarbonisation pathways under different grid flexibility assumptions in the EU up to 2050. The green line shows the emissions associated to the operation of power plants, while the blue line shows the emissions associated to infrastructural changes.

Key messages

The decarbonisation pathway results show that **including GHG emissions associated to increased renewable integration and increased grid flexibility measures affects GHG emission curves**. The 21-24 Gt of CO_2 equivalent associated to the power sector up to 2050 suggest that **decarbonising production mixes is not enough to stay within safe carbon budgets**. In addition to GHGs, it is important to associate these pathways with other nexus patterns across different scales, for example: water, land and human activity. In MAGIC, we are developing the tools to do this and to assess the relation between energy and other nexus elements across different scales. To find out more about this case study, see Di Felice et al. (2018) [4].

References

[1] *Eurostat. Greenhouse Gas Emission Statistics—Emission Inventories; Eurostat: Luxembourg, 2018.*
[2] *2050 Low-Carbon Economy|Climate Action. Available online: https://ec.europa.eu/clima/policies/strategies/2050_en*
[3] European Commission. *Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources (Recast)*; European Commission: Brussels, Belgium, 2017; Volume 0382 (COD), pp. 1–116
[4] Di Felice, L.J.; Ripa, M.; Giampietro, M. Deep Decarbonisation from a Biophysical Perspective: GHG Emissions of a Renewable Electricity Transformation in the EU. *Sustainability* **2018**, *10*, 3685.

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