IEooc_Application4_Exercise5: Energy Supply Scenarios

Goal: *Estimate RE potential and assess how a given energy demand can be met using different RE sources. Estimate the GHG mitigation potential and land use of a given RE scenario.*

Task: Create a simple energy supply scenario for a country/region of your choice for 2040! The scenario (both the amount of energy, the split into different energy carriers, and the electricity mix) should be a likely one according to your judgement.

1) **Assess the GHG intensity and area usage of that scenario and compare it to set or debated policy targets, if existent. Future energy demand can be estimated, e.g., by first looking at energy demand by sector in 2022 (IEA energy statistics!) and then assuming sector-specific growth rates until 2040.**
2) **How much electricity is generated each year in your scenario? This quantity can be reported as amount, like '500 TWh' or as energy flow '500 TWh/yr'.**
3) **Assuming this electricity is generated only by onshore wind turbines, which operate 2000 hours per year, how large is the installed capacity and what unit does it have?**
4) **Assuming that the wind turbines have a lifetime of 20 years and the capacity stock is in a steady state (constant stock and constant inflow = outflow each year), how much capacity is added and demolished each year and what is the unit of this quantity?**

Table 1 lists typical values for the specific global warming potential and the specific land use for a number of RE and fossil-based energy carriers that can be used as reference. Not that actual impacts are often site-specific and vary substantially!

Table 1: Specific GWP and land requirement of RE and fossil-based energy carriers.

Energy carrier/source	Spec. global warming potential, GWP, kg CO2-eq. per MWh	Spec. land use, m^2/MWh
PV electricity	25	10
Hydro electricity	25	20
Wind electricity	15	2
Coal electricity	800	25
Natural gas electricity	500	2
Coal electricity plus CCS	200	25
Natural gas electricity plus CCS	200	2
Biofuels	130	450
Coal (fuel use)	400	10
Natural gas (fuel use)	260	0.8

CCS: Carbon capture and storage. **Data sources:** DOI 10.1073/pnas.1312753111 for electricity, https://en.wikipedia.org/wiki/Energy_content_of_biofuel for coal and gas, biofuels: assumed 50% life cycle GHG savings compared to natural gas, and area yield from https://www.agmrc.org/renewable-energy/ethanol/brazils-ethanol-industry/, plus specific energy content from https://en.wikipedia.org/wiki/Energy_content_of_biofuel.

Additional possible considerations:

a) Could the primary energy demand determined be met with domestic fossil energy? How many resources would have to be mined and how long would they last?

b) Could the primary energy demand determined be met with domestic renewable energy? How much area would be needed (for solar, wind, biomass, and geothermal) or how many dams (for hydropower)?

c) How feasible and realistic is a 100% renewable energy scenario for 2040 in the region that you considered?