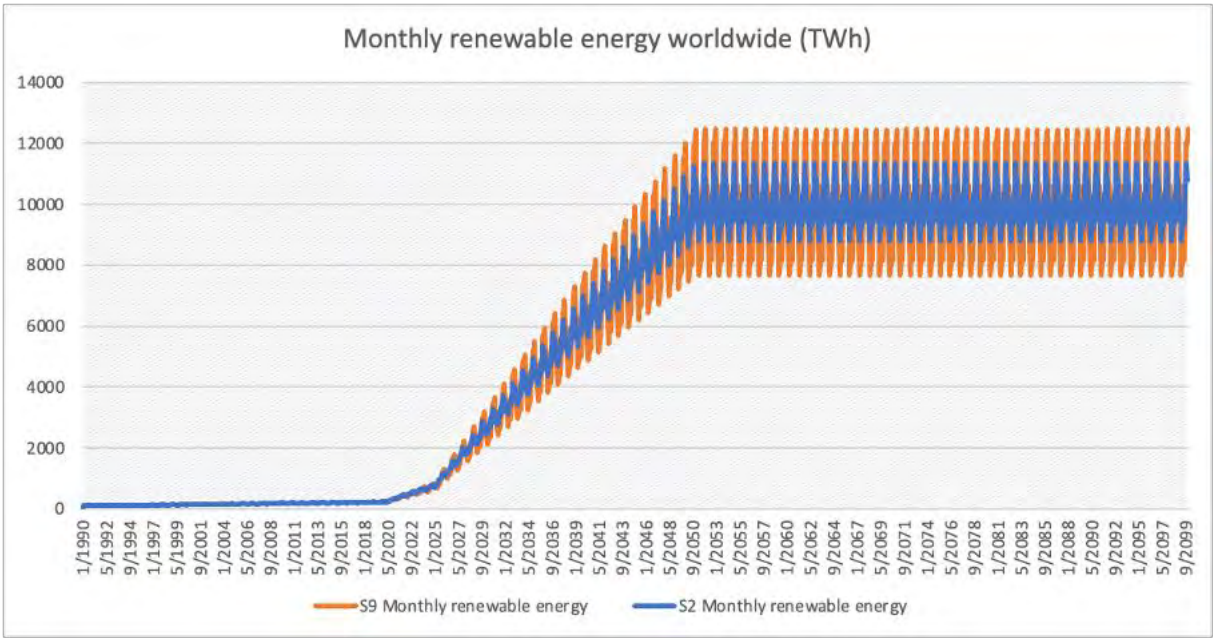
Fact sheet #2/6: Using Photovoltaics and P2L/G towards reaching 100% renewables

This fact sheet explores the implications from more use of seemingly inexpensive photovoltaics (PV) instead of wind power. It looks if the fluctuation of periods with and without sunshine could lead to an increased use of inefficient conversion of renewable energy into power-to-liquid/gas (P2L/G) and back again by re-electrification in times without sunshine.

Using larger system dynamics simulation models, we quantitatively analysed different scenarios of the global transition towards renewable energies (wind onshore/offshore, PV, power-to-liquid/gas (P2L/G), biomass/hydro) and their dependency on resource availability as well as on the need for energy from all sectors including that associated with the use of raw materials (see Fact sheet #1/6). We also considered the substitution (based on P2L/G) of material use of fossil resources for the chemical industry.

For this fact sheet scenario 2 assumes the GreenEe's mix of renewables[1] according to the German Environment Agency's RESCUE study[2], and its level of electrification of the sectors (transportation, industry, housing). Scenario 2 is compared to scenario 9 (see fact sheet #1/6) with globally twice the capacity for PV and accordingly less capacity for wind power accordingly.

Fig. 1: Comparison of monthly energy generation depending on the proportion of PV



Source: Data from the quantitative ICARE model

Figure 1 shows that the variations of energy supply from increased capacities of PV would be large due to variations of sunshine (min-max values of S9). Overall, the total of renewable energy production would increase only slightly. The explanation is that the surplus from PV-based electricity generation could almost completely be used for P2L that is needed for material use for the chemical industry and

[1] The GreenEe scenario from before 2019 assumes a large share of wind power since the decrease of prices for PV is a more recent development.

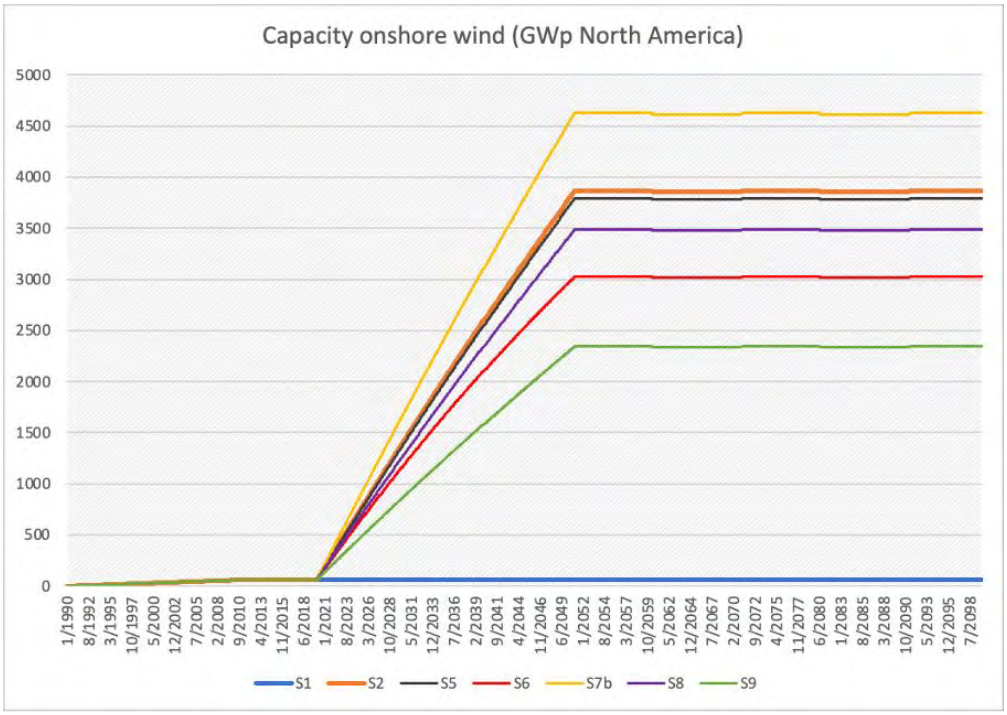
[2] See https://www.umweltbundesamt.de/en/topics/climate-energy/climate-protection-energy-policy-in-germany/a-resource-efficient-greenhouse-gas-neutral-germany/rescue-scenarios-greenee1-greenee2.

for synthetic fuels for aviation, sea shipping and parts of industry that could not be electrified. So, the assumed doubling of PV would not necessarily imply a loss of efficiency from re-electrification in periods of less sunshine.

To be a feasible scenario, the regions covered in the model (see fact sheet #1/6) need to share electricity from sunnier parts with effective networks for transmission. Also, huge variations of surpluses would require capacities for P2L/G (electrolysers), which remain underutilised in times of little sunshine. That poses challenges for any business model to thrive and might call for political market intervention.

Otherwise, a global vicious cycle might set in: Inexpensive PV, the need to utilise P2L/G facilities, and the resistance from parts of the population against further installations of renewable energy, in particular wind power, could lead to even higher proportions of PV and more imports of synthetic fuels from sunnier regions that could then lead to less electrification of transportation and building energy. The inefficiency of transforming electric energy into P2L/G leads to an additional need for capacities of PV that would imply even more use of raw materials and more capacities for installations. Figure 2 shows a scenario (S7b, see fact sheet #1/6) with more use of P2L/G instead of massive electrification of all sectors and how this would require more installations of wind energy in Northern America as a proxy for all regions and all kinds of renewable energy.

Fig. 2: The implications of more P2L/G regarding the overall need of renewables



Source: Data from the quantitative ICARE model

Therefore, we could increase the proportion of PV compared to the mix from the GreenEe scenario, but only to the extent that the surpluses could be used for the P2L/G amounts necessary anyway. That would imply underutilised electrolysers and the need of transportation of electricity within the regions.

Disclaimer: This paper was developed within the project „Erkennen und Bewerten der Wechselwirkungen von internationaler Klima- und Ressourcenschonungspolitik“, FKZ 3718 31 101 0, for the German Environment Agency, coordinated by Dr. Martin Hirschnitz-Garbers from Ecologic Institute and modelling done by Kai Neumann from Consideo GmbH. The responsibility for the content of this publication lies with the authors and does not necessarily reflect the opinion or the policies of the German Environment Agency.