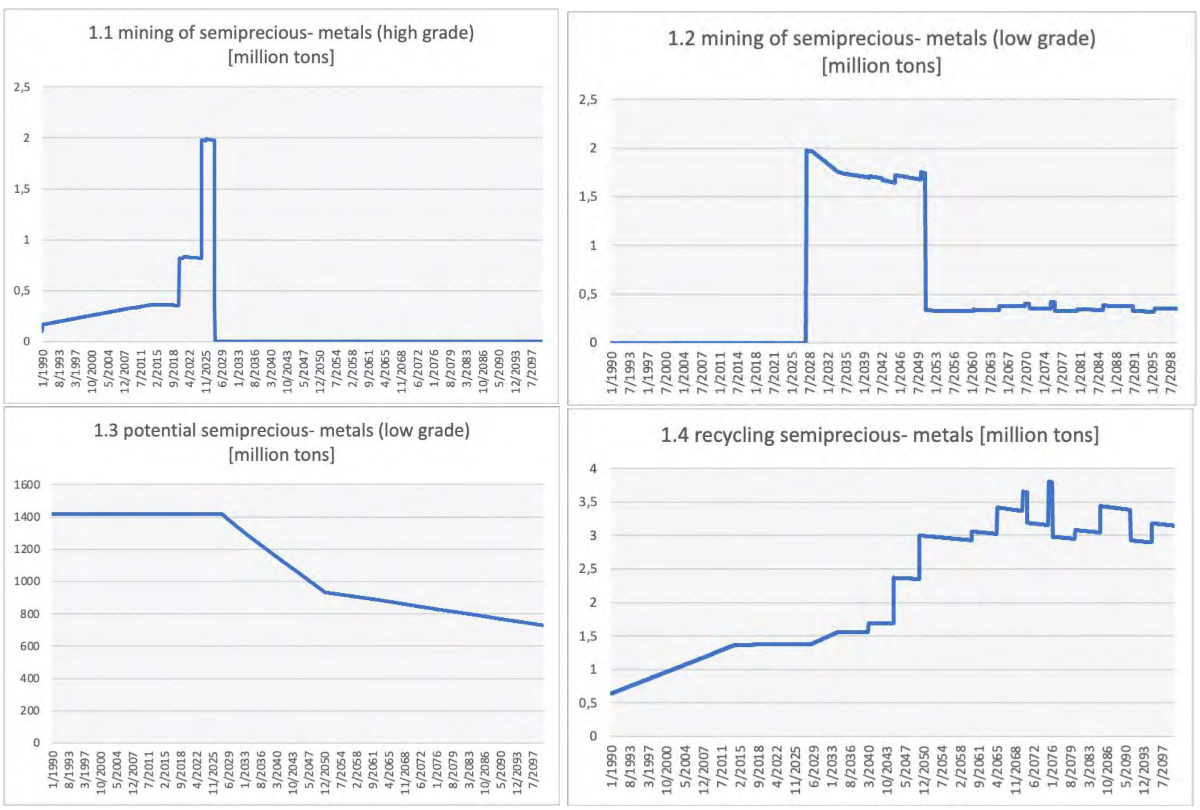
Fact sheet #4/6: Potential constraints towards reaching 100% renewables

This fact sheet shows the different pathways of a global transition towards 100% renewable energy and their implications for resource demand, needed capacities and the need for global market intervention.

Using larger system dynamics simulation models, we quantitatively analysed different scenarios (see fact sheet #1/6) of the global transition towards renewable energies (wind onshore/offshore, photovoltaics (PV), power-to-liquid/gas (P2L/G), biomass/hydro) and their dependency on raw materials availability as well as on the need for energy from all sectors including that associated with the use of raw materials. We also considered the substitution (based on P2L/G) of material use of fossil resources for the chemical industry. The scenarios are running until 2100 to capture continued raw material needs for repowering, but assuming no changes in energy demand between 2050 and 2100.

Figures 1.1 and 1.2 show for scenario 2the shift from high-grade reserves of materials (using copper as a proxy for other materials[1]) to low-grade reserves of materials around the year 2029. Low grade reserves are most probably more expensive to mine and process. Figure 1.3 shows the development of remaining low-grade copper reserves until 2100 assuming a 90%-rate of recycling (figure 1.4).

Fig. 1: Results for resource demand for scenario 2 reaching 100% renewables by 2055



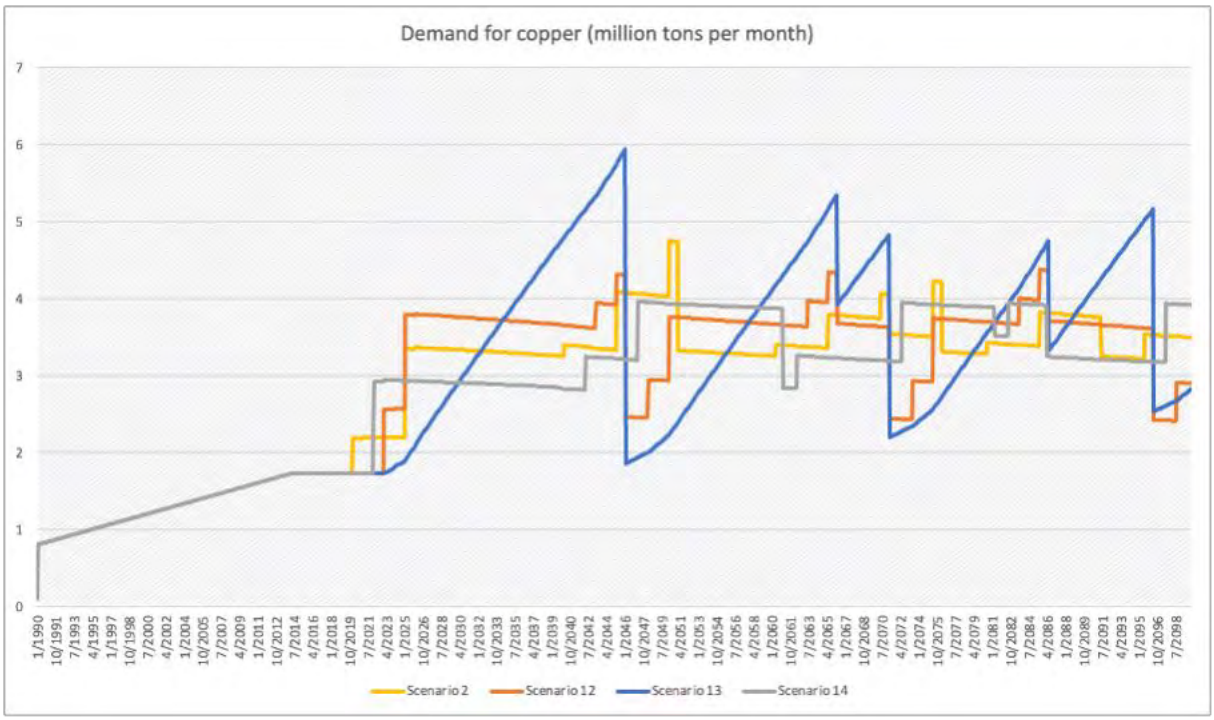
Source: Data from the quantitative ICARE model

So, regarding available resources, a transformation seems to be feasible. Whether such a quick start is politically feasible or the needed ramp up of mining capacities can be realised cannot be assessed. Therefore, figure 2 below compares scenario 2 from figure 1 with different scenarios: a scenario

[1] Aside from copper there are sufficient reserves of other raw materials for renewable energy as well - except for silver, but silver can be substituted by copper.

assuming a later start (2023) and earlier finish (2045) of the transformation (Scenario 12); a scenario where the rate of transformation starts slow and increases constantly (Scenario 13); and a scenario that takes until 2060 to achieve 100% renewables (Scenario 14). Those scenarios imply developments that seem to be highly challenging regarding business models: first for the increase (steps in the curves indicate regions starting later) and then for a sharp decrease (from peaks in which net installations and repowering coincide) of demand. For the increase the economy needs personnel and equipment and when the decline in demand (waiting for massive repowering) is foreseeable investments will decrease as well. It seems unrealistic that market forces and business models alone would cater for these needed investments, possibly calling for market intervention by governments.

Fig. 2: Different pathways showing copper as a proxy for needed resources and construction capacities



Source: Data from the quantitative ICARE model

Therefore, scenarios of constant demand that start on a high level and early within the lifecycle of the different technologies to finish net installations before repowering sets in seem more feasible. Looking at the global need for materials some regions may decide to start the transformation later in the 2020ies, but that would imply that they incur higher prices due to high-grade resources becoming scarce and having to shift to more expensive low-grade resources. If those regions have access to inexpensive fossil resources, it becomes unlikely that they continue their energy system transformation without international political intervention, which could, for instance focus on fostering a circular economy to make secondary raw materials needed for the energy generation available across the globe.

Hence, global policy needs to speed up the transformation towards renewable energy to secure access to affordable materials and to meet existing targets of reduction of greenhouse gas emissions.

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.