

Materials for Circular Economy: facts and limits

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Decarbonizing world economies and thereby avoiding a 2°C global average temperature increase implies the urgent adoption of the so called “green technologies”. Their deployment will mean a renovation of the energy sector toward using renewable sources and zero emission transport technologies. This renovation will require a huge amount of raw materials some of them considered to have high supply risks. Accordingly, the electrification of vehicles will be probably constrained by the use of cobalt, lithium and nickel. Additionally, there could be constraints regarding the manufacturing of steel alloys that need chromium, molybdenum or vanadium and with certain electric and electronic equipments, which require neodymium, dysprosium, silver, copper or tantalum. In the case of solar photovoltaic, it will demand materials such as indium, silver, selenium, tin and tellurium. For wind power, the highest risks are associated to the use of permanent magnets, as they require neodymium and dysprosium...

Arguably, there is going to be a shift from fossil fuels to mineral resources dependency because “green technologies” have a greater demand in minerals than conventional technologies (i.e. conventional power plants or internal combustion vehicles vs. renewable or hybrid and electric vehicles). Avoiding the dependency on fossil fuels will thus imply to accept the dependency on raw materials.

Europe is particularly vulnerable to the supply of certain raw materials, as no or very few mines with such minerals exist in the region. In fact, in the European Union, the initial concern on raw material supply started decades ago, and this issue has been progressively becoming more and more relevant, establishing policies to reduce the use and dependency and elaborating several reports on this matter. Apart from setting a critical raw material list for Europe based on supply risks and economic importance, the European Union has adopted the so-called Circular Economy Package, with the objective of “Making the transition to a stronger and more circular economy where resources are used in a more sustainable way. [...] The proposed actions will contribute to “closing the loop” of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy.”

Yet, as will be seen in this talk, the Circular Economy is an illusory concept. It is like declaring the existence of the perpetuum mobile of fourth species. This is because the energy needed to recover the last small particle is unsurmountable high, just infinite. This is in fact the consequence of the Second Law of Thermodynamics. If we recognize that material cycles cannot be fully closed, we can also recognize how close or how far we are from circularity. That is, one can quantify the true efficiency of these closing processes. Only by accepting such spiral behaviour can we see how far we are from circular ideality.

That said, it is important to recognize that even if it is a myth, Circular Economy is an urgent social need, because we live in a linear society that uses natural resources and dissipates them at an increasing speed. Indeed, society is far from closing even the first cycle, and the future goes in the opposite direction unless drastic and improbable changes occur. This is because today, only bulky, not valuable, materials are recycled. Current

recycling processes generate more and more irretrievable waste as they focus on recovering the "paying metal."

In summary, neither circular nor linear, the economic practice should recognize the spirality nature of recycling processes: moving towards an "In-Spiral Economy".