



Circular value chains - demanding, but necessary!

With ever-increasing geopolitical tensions, Europe has to become more independent of third-country resources such as China and Russia in order to meet the green and digital shift. To succeed in this, we must maximize the value of our raw materials by closing the material loops by using waste and side streams. This requires the development of circular value chains through the establishment of new robust industrial partnerships.

During spring 2023, the European Commission launched an updated list of strategic and critical raw materials. Two of the raw materials on the list are silicon and manganese, of which Norway is the largest producer in Europe. These are among the necessary building blocks in the green and digital shift.

NTNU is at the forefront of several major EU-funded initiatives where the aim of one project is to close the material loops in the silicon and aluminum industry, through the patented SisAl process. In this process, aluminum scrap or dross is used instead of carbon to produce silicon from quartz (silicon oxide), with no direct process emissions of CO₂. If we succeed, the SisAl process will make a strong contribution to more circular value chains through industrial symbiosis where the aluminum industry will function as both raw material supplier and end user to the silicon industry.

Here, however, it is important to take a step back. Circular economy is an alluring concept, but this is really demanding, not least in relation to incorporated industrial processes and relationships. We can compare the new processes with the traditional way of producing silicon, where quartz reacts with carbon in an arc furnace to form silicon and CO₂. This more than 100-year-old processes represents linear value chains with easily understandable relationships between various actors, built up over many years. With the new SisAl process, it is not just about introducing a new innovation or two. One must also succeed in changing the relationship between different industries on a deeper level.

According to Suchek et al. (2021), the transition to a circular economy will require a systemic change in companies, industries and economies through radical changes in societal values, norms and behaviour. One step on the way is to get the companies into the same room, and we have succeeded in this through the EU project "SisAl Pilot" with heavy partners from both the aluminum industry such as Hydro and Mytilineos and from the silicon industry such as Elkem, Wacker and Dow. Another important step on the way is the introduction of costs for harmful emissions, where Norway and the EU have come the furthest with emissions of CO₂ equivalents. However, circular value chains also bring in other externalities that currently do not have any economic consequences in themselves. Among other things, the SisAl process has very low, if any, emissions of NO_x, SO_x, PAH and dust, and secondary raw materials are largely reused. A third important step would therefore be to factor in the effect of such conditions during the transition to circular industrial processes.

The transition from a linear "take-make-dispose" economy to the circular economy will become inevitable over time if we want to take care of nature.

Suchek, N., Fernandes, C. I., Kraus, S., Filser, M., & Sjögrén, H. (2021). Innovation and the circular economy: A systematic literature review. *Business Strategy and the Environment*, 30(8), 3686–3702. <https://doi.org/10.1002/bse.2834>



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