“There will be a need to better distinguish between different recycled material streams for different applications. Today, (non-brominated) organic and inorganic flame retardants are mixed. Considering the (unknown) environmental impact that such mixtures have, which manufacturing process should use recycled plastics containing such mixtures including unknown reaction products that were formed during recycling?”

-Siddharth Prakash, Clara Löw

Image Source: Wikimedia Commons. June 21, 2018. Remains from a plastics processing machine at a recycling centre. Photo Credit: Ermell. https://commons.wikimedia.org/wiki/File:Kunststoff_Plastik_Rest_Abfall-20180621-RM-114314.jpg

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## Dealing with future complex supply chains and products: Two hypotheses

There is consensus among various stakeholders in the private and the public sector that the transition to a circular economy can play a vital role when it comes to slowing environmental degradation, curbing resource consumption, contributing to climate protection and upholding biodiversity. We would like to discuss the current state of complex products and supply chains and how the circular economy can be embedded into them. The following two hypotheses can be looked at as an inventory of aspects that the Öko-Institut is working on.

## Circular Business Models are effective, when they operate in short and well-known supply chains

Logistics and value chain management play an important role in the environmental impact of a product. Thus, for example, control of quality as well as compliance with supply chain agreements and standards is easier with fewer, well-known suppliers. The fewer suppliers, the better you can control them, which is especially important in large and volatile markets.

Let us give some examples from different a dimension. Currently, we are supporting several countries in Southeast Asia in their ambition to reduce single-use plastics, for example through design and a strong recycling market. The share of recycled plastic continues to be very low in packaging due to higher costs of recycled material, existing subsidies for virgin plastics and possible contaminants.

We repeatedly emphasize that measures such as recycled content targets can only be effective if applied in the context of the domestic recycling market. Ideally, increased demand for recycled plastic would trigger enhanced collecting and sorting practices in the domestic economy. But if the target is only being achieved through well-sorted imported plastics, the recycled content target isn't unfolding its potential and this transformation will not be achieved. Thus, there no solutions to the local littering problems.

In addition, transportation of goods and waste to and from consumers is often inefficient. Take the example of delivery services in the European context. Packaging material is widely distributed to customers and later collected again by waste collection services. Wouldn't it be most efficient if, for example, food delivery services use reusable packaging and take back food boxes and pizza packaging from yesterday's meal when driving by? Benefits would include the need for less transportation  and less resource consumption. However, more collaboration and information exchange would be needed to implement such a system.

So, if we agree that Circular Business Models operate in short and well-known value chains, open questions arise in two areas. First, are we heading towards a broad logistics system that requires not only the transmission of goods but also of a bundle of information on compliance, trace substances, origin of materials including reverse logistics, which is much more extensive than today? Second, how do regional value chains work within existing globalization processes? Here, related questions arise. Do these regional value chains exist in parallel or do they need to be supported with policies against globalization processes? How would such policies relate to world trade regulations? What problems and opportunities would this bring? Is the solution for each country to make its own circular economy?



**Handling increasing complexity of contamination of products in non-toxic material cycles – a Sisyphean task**

We have observed two diametral trends:

HYPOTHESIS 1: On the one hand, increasingly complex products are brought to the market, containing various additional complex additives to fulfill very detailed functions in a very short time. The more products there are, the more complicated it becomes to separate the material cycles from one another. Today, innovations in the recycling sector are not that fast to keep up with new products and to disentangle the complexity effectively!

For example, the furnishing style of some people relies on old furniture, such as those from household clearance by family members. However, lacquers and paints of such furniture may contain heavy metals, such as lead, which was not prohibited in the past, but is today. Heavy metals in indoor air or dust can have serious health effects. Does that actually mean the end of life for old, lacquered furniture, and everyone would have to buy new closets and sideboards? That would not be in the spirit of the circular economy.

HYPOTHESIS 2: On the other hand, from a realistic perspective, circular economy measures must, in many cases, implicitly lead to a reduction in complexity in order to achieve the desired longevity, easy separability, reparability and better recyclability. This includes the phase-out of harmful

chemicals for recycled materials to be an attractive substitute of primary resources. For instance, we look at certain components in electrical and electronic equipment that contain flame retardants. Today, for higher effectiveness through an interplay of several flame retarding mechanisms, (non-brominated) organic and inorganic flame retardants are mixed.

Considering the (unknown) environmental impact that such mixtures have, which manufacturing process would use recycled plastics containing such mixtures including unknown reaction products that were formed during recycling? Potentially contaminated recycled material will therefore only be used in specific applications where certain pollutants and interfering substances do not matter. There will be a need to better distinguish between different recycled material streams for different applications.

How can we effectively steer the circularity trend, on the one hand, and manage the complexity of products and contamination of recycled materials, on the other hand?

Based on our current presumption, some sectors, such as packaging, will have to simplify and reduce material use very much. Harmful chemicals need a quick phase-out. And for other complex products – such as Information and Communications Technologies (ICT) and Electrical and Electronic Equipment – reuse, repair and recycling centers need to be well equipped with financial resources, manpower, time and knowledge. Additionally, these services will need high appreciation and reputation within the society. The organization of all that is currently unclear and unassigned but not insurmountable.

Öko-Institut Case Study: Germany's Exit from Coal
https://www.oeko.de/en/research-consultancy/issues/energy-and-climate-protection/germanys-exit-from-coal-managing-a-sustainable-transition

Coal has historically been an affordable and reliable energy source across the globe. Many emerging economies were looking forward to tapping into coal to ensure low-energy prices while accelerating industrialization. The COP22 Paris Agreement on a global phase out of the use of coal has created an urgent need for innovation in both highly industrialized and emerging industrial economies.

Many Global South leaders are decrying the phasing out of coal as a deliberate attempt to dampen economic growth. However, an examination of Germany's lignite industry helps explain why coal power plants are financially unsustainable in the long-term.

Due to the low prices for electricity on the exchange, newer lignite-fired power plants can cover the operating costs of the power plant and the connected opencast mines, but no longer the capital costs of the investment. Larger maintenance or expansion investments in the supplying opencast mines are no longer worthwhile for older lignite-fired power plant blocks. As soon as fixed operating costs can be reduced to a greater extent in these opencast mines, closure is more economical than continued operation.

Hence, focusing on green industrial fuel technologies such as hydrogen is a better leapfrog approach for emerging markets. Green hydrogen can be produced from a number of waste sources making industrial energy transitions less dependent on the geographic distribution of coal deposits.