Workshop report on circular economy in climate protection scenarios

Deliverable 4.9

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1. Introduction

1.1. Background

Although circularity measures are widely recognised as an important pillar for greenhouse gas mitigation in the heavy industry, their actual implementation still stands at a very low level. Currently, the issue is gaining momentum and projections of long-term pathways towards a carbon neutral heavy industry increasingly relate to circularity. However, most of these existing scenario studies at best include a few circularity measures but usually no coherent circular economy (CE) strategy. Therefore, the REINVENT project aims at initiating pioneering work in this field and will create location-specific CE scenarios for a future carbon neutral steel and chemicals industry.

1.2. Objective

In the framework of our workshop, we connected the steel and chemicals industry with emission mitigating CE measures to create consistent and viable future CE pathways. Basing on the potential development of material demand (steel, plastics), we discussed how that demand could be met: which types of processes, technologies and emission mitigation strategies might be implemented, including the potential for recycling etc. Furthermore, feasible combinations of pathways and related timelines as well as possibly fore-running regions were identified. In order to achieve this, we combined the unique knowledge of the SCI4Climate and REINVENT projects, inviting experts from industry, science and society. The results of the discussion provide valuable input to scenario storylines for the EU framework scenarios to be calculated in REINVENT (by WI and PBL) and also for NRW scenarios to be developed later on in SCI4Climate.

1.3. Participants

Name	Institution
Julia Schleier	RWTH Aachen University
Theresa Overbeck	VDEh Institute for Applied Research
Annika Sophie Schmitz	Interseroh
Frank Düssler	Georgsmarienhütte
Peter Weyell	Rain Carbon
Stefan Dietl	Logex
Clemens Schneider	Wuppertal Institut
Katharina Knoop	Wuppertal Institut
Mathieu Saurat	Wuppertal Institut
Sören Steger	Wuppertal Institut
Holger Berg	Wuppertal Institut
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1.4. Agenda

Friday, June 14th, 2019, 10:00-16:00

Wuppertal Institute for Climate, Environment, Energy, Döppersberg 19, 42103 Wuppertal, Germany

Time	Agenda item
10.00 – 10.10	Welcome and introduction
10.10 – 10.30	Introduction projects REINVENT & SCI4Climate.NRW
10.30 -10.40	Presentation: Our idea of a climate neutral CE by 2050
10.40 – 11.20	**Session 1: Demand in 2050: What and how much will be consumed?** Introductory presentation: Potential development of demand for products and services by 2050 Introductory presentation: Impact on demand for basic materials in the steel and plastics industry
11.20 – 11.30	Coffee break
11.30 – 12.45	**Session 2: How will demand for basic materials be met by 2050?** Introductory presentation: Possible future steel cycle & plastics cycle Discussion: Which waste streams occur in the four demand sectors of buildings, vehicles, packaging, consumer goods? Discussion: How will demand for steel in the four demand sectors be met by 2050?
12.45 – 13.30	Lunch
13.30 – 13.50	Discussion: How will demand for plastics in the four demand sectors be met by 2050?
13.50 – 14.30	**Session 3: Which regions/actors could pioneer the transition to a CE?** Introductory presentation: W2C Rotterdam Discussion
14.30 – 14.40	Coffee break (if desired)
14.40 – 15.45	**Session 4: Discussion of CE storylines by 2050** Discussion: Synthesise outputs of Sessions 1-3
15.45 – 16.00	Feedback & Goodbye

This workshop report summarises key messages from the presentations and subsequent discussions.

Session 1: What and how much will be consumed?

After introducing the participants to the REINVENT and SCI4climate.NRW projects, the background and objectives of the workshop (see Introduction) were recalled before starting with Session 1.

Session 1 showed that demand of products and services by 2050 could vary tremendously depending on societal developments. Future consumption patterns could e.g. focus on material possessions (materialism) or – in sharp contrast – favour dematerialisation. Moreover, consumption and individual property could even gain in importance but a development towards a sharing economy is possible as well. Such factors as well as unforeseeable mega trends will thus also strongly influence future demand for basic materials. While a continuation of current trends contradicts the realisation of climate protection targets, the transition towards a circular economy carries great potential for demand reduction.

Demand for **steel** is especially high in the sectors of construction, transport, industrial machinery and metal products. If current trends prevail, the 'business as usual scenario' of a study by Material Economics (2019)[1] e.g. expects an increase of demand for steel in the EU28 of 14 per cent by 2050 in those four sectors (versus 2017). In contrast, in a 'lean steel scenario' demand for steel could decrease by 21 per cent. This might be achieved by material efficiency and circular economy measures in the areas of buildings and transport. The study's 'middle-of-the-road scenario' expects a similar level of demand by 2050 compared to 2017.
This is matched by the German steel industry's demand projection for 2050. Generally, the scenario's focus on the EU28 might rather underestimate future basic materials demand. This is due to the fact that the desire for additional infrastructure is even higher in less developed countries, e.g. non-EU Balkan countries. Since current steel recycling rates already amount to almost 100 per cent, industry representatives do not expect changes in German secondary steel production shares. Indeed, scrap is today net exported to a considerable extent, but this is often of poor quality and is thus down-cycled to construction steel needed in high amounts in emerging economies like Turkey. High electricity prices are also quoted as a reason for a stalling number of electric steel furnaces.

Demand for **plastics** also mainly originates from the construction and transport sectors, but additionally from electronics, packaging and others. In this case, the WI's 'business as usual scenario' developed in REINVENT WP 4.2 shows a rise in demand of 28 per cent by 2050 for the above-mentioned sectors (versus 2017). In comparison, the proposed 'lean plastics scenario' developed in WP 4.3 reaches a demand reduction of 21 per cent, assuming an (ambitious) halving of all packaging in the EU28. As in the steel sector, the 'middle of the road scenario' projects approximately constant plastics demand in 2017 and 2050.
Currently, demand for plastics increases strongly in the packaging sector as cardboard boxes are more and more replaced by plastic films (plus 20 per cent annually in food packaging, plus 30 per cent in textiles). As these require less space, transport cost can be reduced. Demand for plastics could grow much stronger, if the mail order business keeps on expanding. While recycling rates in business-to-business (B2B) relationships are already high in Germany, strong improvements are required in the business-to-customer (B2C) trade.

[1] Material Economics (2019): Material Economics (2019). Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry.

Session 2: How will demand for basic materials be met by 2050?

As mentioned above, the German **steel** industry assumes demand by 2050 to be similar to today's level. However, it is expected that due to better alloys etc. material input will decrease while quality can be maintained. As annual steel scrap flow volumes are expected to increase by 2050, it could then theoretically suffice to cover 80 per cent of steel demand within the EU28 (excluding exports), according to the 'business as usual scenario' by Material Economics. Therefore, also enough secondary steel mills are needed across the EU to avoid scrap exports. This is however a theoretical potential that neglects scrap quality issues, especially copper contamination.

Workshop participants believe that there will still be primary steel production as product quality differs from secondary steel, although this is also of high quality. It is expected that in 2050 instead of coke hydrogen will be used for the direct reduction process in primary steel making. Hence, direct GHG emissions would be lowered as not CO_2 but water vapour would result from the process. (It is assumed that hydrogen will be sourced sustainably.) Since the hydrogen route is and will be more costly, companies can only maintain their economic competitiveness if this production method is employed globally. If such a global level playing field existed, there could also still be regional markets in 2050. However, cost differences of European products to the global market might also be compensated by a tariff or subsidy regime.

Regarding the availability and quality of steel scrap, several challenges exist. Those include product design, consequential pollution of steel scrap with other metals and scrap utilisation.
Depending on the design of steel products, they can be rather easy (e.g. in the case of white goods, i.e. household appliances) or very difficult (such as ferroconcrete or brown goods, e.g. electronic goods containing motors, capacitors etc.) to disassemble. If a steel product is very difficult to disassemble, there are no economic incentives to do so and it is usually shredded including other materials. As a result, steel scrap is available in many different qualities, sometimes pure but often polluted with other elements. Most problematic in this regard are copper and tin but the problem also relates to other elements from the periodic system.
The pollution of steel scrap complicates the utilisation of the recycled material. Shredder light fraction e.g. is hardly reusable but also unsuitable for incineration in waste-to-energy plants, due to its high heating value compared to other waste streams. Furthermore, steel scrap can often not be sourced locally as local scrap does not match particular quality requirements.
A solution to the quality problem of recycled steel should start with changes in product design. Products should be created with the target of easy disassembly, remanufacturing or refurbishment in mind. If it was e.g. easier to disassemble a product, the process would be less costly. As a result, disassembling steel products would be more economically attractive for recycling companies, also because of increased scrap quality and rising commodity prices. In case product design changes are ineligible, there should be incentives for recyclers for better scrap sorting.

While Wuppertal Institute's 'middle of the road scenario' projects constant **plastics** demand by 2050, due to current trends it appears rather ambitious to end up in such a pathway. Workshop

participants believe that it requires either completely different consumption patterns (sharing, longer service lives) or strong political interventions to change the trajectory.
An issue for future plastics production is the availability of fossil fuels (mainly naphtha) as feedstock for primary plastics production. If less oil was available, an alternative might be carbon originating as a residual from pulp production processes (see REINVENT deliverable 4.5). However, this could only be used if electricity and heat for the pulp industry would be supplied from external renewable energy sources. Another option would be the use of recycled plastics. WP 4.3 work shows that even in a 'middle of the road scenario' with constant demand in 2050, total annual plastic waste flows will probably not suffice to meet the demand of EU plastic converters. Great challenges have to be overcome to actually achieve a high utilisation rate of recycled plastics, as discussed detailed further below.
Since the material properties of plastics will still be requested in the future, society could also try to substitute plastics. In packaging, this might e.g. be an option because in this case plastics represent the means to an end (protecting the good). However, substituting plastics is not an easy task. Current alternatives in packaging e.g. also have a significant negative impact on the environment. This is true for the production of paper and cardboard as well as the use of bio-based plastic, which is not completely degradable and (depending on the biomass source) could also entail competition in the usage vs. food.

In view of a transition towards a circular economy, the current situation in the plastics sector involves great challenges. Compared to steel, an even broader variety of products are used in different sectors. More and more types of mixed plastics enter the market which complicate sorting by recycling companies. Furthermore, there are materials such as polyurethanes in buildings, which are not suitable for mechanical or chemical recycling. Existing sorting plants are not designed for the processing of bioplastics. Workshop participants believe that waste-to-energy plants will still be needed for plastic waste in 2050 because e.g. clinical waste has to be incinerated for hygienic reasons. (In this case, CCU might be an option.)
Focusing on circular economy measures, many plastic products cannot be disassembled into original materials (e.g. plastics from the automotive industry contain flame retardants and plasticizers). Thus, they are shreddered containing different materials, resulting in lower quality recyclates. In many cases, this is not in line with the required plastic waste qualities required by companies using recyclates.
Furthermore, economic aspects hinder the utilisation of recycled plastics. Recycled PET, e.g., is even more expensive than primary PET, among other reasons because many externalities such as logistics and CO_2 costs are not included in the price.
Using local plastic scrap for the production of new plastic products is currently further complicated by a lack of recycling capacity in Europe. While the German recycling industry lags far behind, capacities are being increased especially in the Netherlands, Poland and the Baltics. Additionally, a lot of import and export of recyclates takes places with China.
There are, however, also silver linings on the horizon. Discount supermarkets are currently strongly contributing to bring the issue of plastics waste and recycling into society. An effective regulation could strongly support the transition towards a circular economy. One important instrument may be a properly functioning European Emissions Trading System (including plastic waste treatment). An extended producer responsibility where plastic producers are also responsible for product recycling represents another option (which is already implemented in other sectors). Further leverage points could e.g. be taxing (instead of subsidising) crude oil and incentivising better scrap sorting. More homogenised products (e.g. identically shaped bottles from the same material) allow for a broader reuse and better recyclability. (The German deposit system proves that a suitably designed system

can be successfully implemented.) As in the case of steel, products should be designed with the target of comparatively easy disassembly, remanufacturing or refurbishment.
From a technical point of view, chemical recycling technologies could be employed more extensively by 2050. While such technologies are so far not being operated commercially on a larger scale, they hold the promise of turning residual waste into a resource (although their operation is quite energy-intensive).

Session 3: Which regions/actors could pioneer the transition to a Circular Economy?

Considering **Germany**, there are arguments against as well as in favour of a pioneering role in the transition towards a circular economy.
On a regional level, experiences show that pioneering projects are easier to implement and often more successful in smaller federal states such as Hamburg or Berlin. Official authorisations are comparatively faster to obtain there compared to bigger states like North Rhine-Westphalia (NRW) or Bavaria.
In certain areas Germany already has the means from which to successfully start a circular economy: Waste statistics are good as waste collection works relatively well compared to other countries. There are markets and additional market potentials for recycling of products. Many companies are working in this field and are located within rather short distances, especially in NRW. Circular economy measures in business-to-business relationships are being implemented successfully (good facilities and infrastructure). Infrastructure for road transport is good. There are interesting model regions, e.g. around Bitterfeld in Saxony-Anhalt.
However, there are also arguments against the German potential for a pioneering role in the transition to a circular economy: While markets for recycling exist, this is less true for repairing and remanufacturing. Companies might be located close to each other, but if they are competitors, they are usually not keen on cooperating. Moreover, in view of actual recycling from business-to-customer trade relationships, Germany has not been successful so far. Although road infrastructure is well developed, this is not the case for railways and especially digital infrastructure.

As with the German federal states, also on a national level workshop participants believe that it is easier to implement innovative projects in comparatively small countries. Especially Northern European countries and the Netherlands appear to be in a good position to become pioneers on the pathway to a circular economy.
Estonia, e.g., possesses a very good infrastructure, especially regarding digital interconnectivity. Additionally, due to a relatively low population density there is also space for building facilities. This is also true for **Sweden**, where already today biomass plays an important role in the economy. In **the Netherlands**, authorisation and funding processes appear to be completed within shorter time frames compared to its larger neighbour to the East.
Nevertheless, successful projects from the past do not automatically mean that this development will be continued in the future. The successful Swedish tax on CO_2, e.g., could mainly be established due to the use of nuclear energy. Public support for the further development of chemical recycling facilites in the Netherlands is rather fueled by the target of job preservation than by sustainability considerations.

Generally, a well-developed digital infrastructure is crucial for the transition towards a circular economy. A successful recycling industry e.g. requires up-to-date information on waste collection and sorting as well as the availability of recyclates. This includes data on time, location and amount of available recyclates, which is currently usually hard to obtain.

Another important factor for the development of a circular economy is the political system and mentality. If economic targets are preferred over climate protection objectives, sometimes measures contradicting environmental protection are implemented. Meanwhile, if a public entity supports a particular technology or project, such as the City of Rotterdam does with chemical recycling, this plays an important role for the potential success of a measure. While interventions such as taxes or especially subsidies are regarded as useful in some cases, stable framework conditions are considered most important by the workshop participants. These comprise clear and precise regulations which ensure investment security for the companies concerned. Such regulation in combination with a clear communication of enforcement responsibilities is required on all levels, from EU to local authorities. In order to foster the development of a circular economy, e.g. measures such as long-term recycling quotas could be useful. In addition to that, public entities can lead by example by considering circular economy effort in public procurement or reward responsible sourcing of private companies.

Altogether, workshop participants believe that starting points for a successful transition exist almost everywhere. It should be possible to realise circular economy measures as long as there is a true willingness to do so.

Session 4: Overall Circular Economy storylines by 2050

First, potential future developments in certain **important sectors** have been discussed:
With regard to buildings, participants did not agree whether building refurbishments, in combination with repurposing of old buildings, will suffice for a successful transition to a low-carbon economy. In contrast, it might also be necessary to actually tear down and rebuild buildings.
In transport, new mobility concepts and strenghtening the role of public transport are considered necessary. Among others, this could be achieved by larger fleets and increased clock speed.
Concerning energy production, workshop participants were rather unsure whether energy cost will play a major role in the future. While consumers do not really consider them in the case of some products (e.g. smartphones), they gain in importance especially when they become clearly visible (e.g. in form of electricity bills). With regard to energy storage, a further decentralisation of the energy system is expected as storage solutions become more sophisticated.

One of the major factors influencing production and consumption in 2050 will be people's **lifestyles and consumption patterns**.
Overall no dramatic shifts of consumption patterns are expected. A reduction of consumption opportunities is considered to result in protest and support for political parties representing anti-European positions. As many consumers are only paying lip service to climate protection, rather step-by-step developments are considered realistic. Change might be induced if all externalities would be included in product prices. Another option would be to promote (supply driven) new consumer

markets for Circular Economy related services. There are also single events leading to mind shifts but in generally change happens to slowly.
If new consumption patterns would indeed be accepted and implemented by society, workshop participants expect more communal living and sharing. Quality will gain in importance while it might not be necessary that all products are available at any time. Nevertheless, many developments would be unsure. Will products be used more intensively and thus have a shorter lifespan (e.g. due to sharing) or the other way around? Which waste and resource flows will occur?

The **storyline for a 'lean material scenario'** could e.g. include the following elements:
Demand for products and materials decreases as a result of efforts from industry combined with political measures. Where possible, production is based on recycled waste materials. If additional feedstock is required, it originates from sustainable sources as far as possible, e.g. 'green' hydrogen. Advantages of sustainable solutions are highlighted, such as fancy computer software resulting in fewer business trips.
Only the most efficient products are allowed to enter the market (top runner approach). If possible, product life spans are prolonged by replacing parts of the product instead of whole products. More sharing could result in shorter product life cycles.
There are strong improvements in the digital infrastructure. As a result, e.g. businesses can easily share information on the availability of recyclates.

The **storyline for a 'middle of the road scenario'** would read a little different:
As demand remains constant, production is based on primary feedstock as well as on secondary materials. The focus of the steel industry is on primary steel, the plastics industry still requires carbon as a feedstock. Since global stocks of primary materials are limited, supply of feedstock depends on the planetary boundaries. The use of secondary materials could be fostered by economic incentives. Product life cycles remain similar if they are not shortened as a result of shorter innovation cycles. Existing buildings are used as long as possible.