Workshop report on biogenic carbon as feedstock

Deliverable 4.5

Fredric Bauer and Lars J Nilsson

2019-11-30

Preface

The REINVENT project had originally planned sectoral workshops on decarbonization pathways in the steel, paper and plastics industries. As research proceeded, we realized that it is rather the interconnectedness, new cross-sectoral value chains, and principal pathways that needed to be explored. Hence, workshops on electrification, circular economy and biogenic carbon as feedstock were organized instead of sectoral workshops. This report summarizes the presentations and discussions held on the topic of biogenic carbon as feedstock.

The workshop raised new issues around sourcing of carbon feedstock in a fossil-free economy with hydrogen-based production, and the geographical implications of this. It also raised issues around actors, power and agency. For the chemicals industry, new partnerships with waste industries, power companies, forestry and agriculture are needed for closing the carbon loop and making a shift to biogenic carbon. The historically close connections between the petroleum and chemicals industries will have to be replaced by new integrated networks of energy, feedstock, products, people and organizations where the carbon we use is no longer sourced from fossil feedstock.

Expert roundtable on closed loop biogenic carbon economy

Background: The chemicals industry is one of the hard to decarbonize sectors and carbon will continue to be a key building block in fuels, organic chemicals and plastics. Thus decarbonization in this case does not mean to remove the need for carbon completely, but to eliminate the need for fossil carbon resources. Promising technologies are being developed and tested with carbon dioxide, electricity and hydrogen as input. Transition pathways are emerging through the work of Cefic and Dechema and through research efforts such as Voltachem and REINVENT. It is high time to strategize around such transition pathways and analyze what steps are needed in the short (5-10 yrs) and medium (10-20 yrs) term.

Objective for the workshop: Explore and discuss pathways for a climate neutral carbon economy. What are the resource, geographic and sectoral coupling implications? What markets, partnerships and capabilities are needed? What are the implications for future policy and research?

This workshop report summarizes key messages from the presentations and the discussions.

List of participants

Last Name	First Name	Institution
Appelman	Eric	Brightlands
Chahid	Dominik	EEA
Chertkovskaya	Ekaterina	Lund University
Dael	Suzanne	EEA
Ericsson	Karin	Lund University
Hannerz	Nils	IKEM
Nilsson	Lars J	Lund University
Palm	Ellen	Lund University
Philibert	Cedric	IEA
Reichel	Almut	EEA
Schneider	Clemens	Wuppertal Institute
Strunge	Till	IASS Potsdam
Valle	Antti	EU Commission
van Dooren	Nico	Port of Rotterdam
Westin	Johan	Vattenfall

Agenda

12.00	**Lunch**
13.00 – 13.30	**Welcome and introduction** *Objective: informing participants on REINVENT objectives and setting the frame for the workshop* ***Speakers: Hans Bruyninckx, European Environmental Agency and Lars J Nilsson, Lund University***
13.30 – 13.50	**Use of GHG neutral carbon: A glance on possible future resource and trade flows** *Objective: Showing the implications of new decarbonized resource use for trade patterns* ***Speaker: Clemens Schneider, Wuppertal Institute***
14.00 – 14.20	**Renewable energy for industry and fuels** *Objective: Presenting opportunities for green hydrogen in industrial use* ***Speaker: Cedric Philibert, International Energy Agency***
14.30 – 14.50	**Energy transition and circularity from an industry perspective** *Objective: Introducing challenges and opportunities for decarbonizing the chemical industry beyond energy use* ***Speaker: Eric Appelman, Brightlands***
15.00 – 15.30	**Coffee break**
15.30 – 15.50	**A special relationship – Partnerships for a closed loop biogenic carbon economy** *Objective: Presenting challenges for new partnerships for decarbonization* ***Speaker: Fredric Bauer, Lund University***
16.00 – 16.20	**Pathways to a decarbonised (trans)port** *Objective: Presenting ongoing collaborative work in Rotterdam* ***Speaker: Nico van Dooren, Port of Rotterdam***
16.30 – 16.50	**EU policies and initiatives for decarbonisation beyond ETS** *Objective: Informing participants on ongoing policy development for decarbonising the European economy* ***Speaker: Antti Valle, EU Commission DG Grow***
17.00 – 17.15	**Wrap-up** ***Speakers: Lars J Nilsson and Fredric Bauer, Lund University***
18.00	**Working dinner**

Session 1: Resources, flows, geographies and system integration in 2050

From a climate perspective, the recent development in petrochemicals is going in the wrong direction. Large investments are being made in fossil-based plastics production, not least in North America, and the flow of crude oil through clusters such as the Port of Rotterdam is increasing. Plastics and other petrochemicals constitute the largest growth area for petroleum demand until 2030 according to projections from IEA and other actors. Globally, there seems to be few significant initiatives for deep decarbonization of the chemicals industry. On the contrary, chemicals and plastics from fossil feedstock are seen as a promising future business for the petroleum industry when demand for transport fuels is expected to decrease. The demand for bio-based plastics is very small and does not seem to grow substantially. Carbon based materials such as fibres and plastics are promising for the future to substitute for other scarce resources or to make lightweight materials as there is in fact plenty of carbon and hydrogen. However, the supply of these resources has to be fossil-free.

Key resources for this decarbonization are thus recycled materials such as recycled plastics which can be processed in centralized clusters, although the degree of centralization remains an issue to look into further. Pre-processing in decentralized nodes and then shipping the material for further processing in larger clusters is one opportunity that opens up for new value chains and material flows. For Scandinavia, especially Sweden and Finland with large forest industries, exporting wood fibres/pulp and pulping residues for new applications is another opportunity for making use of significant bio-resources for which there is already an industrial infrastructure. There are however limits to the production potential in these regions.

Renewable electricity at low costs – and lots of it – is another key resource that has the opportunity to decarbonize large parts of the chemical industry which are now dependent on fossil hydrocarbons for the production of hydrogen and necessary process heat. Fuel combustion for high temperature heating is responsible for almost half of the carbon dioxide emissions from the chemical industry and this could possibly be mitigated with renewable electricity in many applications. The largest demand for renewable electricity would however be for the production of hydrogen through electrolysis which could substitute for hydrogen generated from fossil resources (e.g. steam reforming of natural gas). Green hydrogen fits well into several carbon intensive processing industries such as steel making and chemical synthesis. Ammonia production could be completely decarbonized in this way, and apart from its current applications – it is mainly further processed to different nitrogen fertilizers – it has also been shown to be a fuel that could be used in shipping or balancing power plants. Methanol is another key intermediate that could become greener with green hydrogen, although the carbon still has to be supplied. Green hydrogen is also necessary for the processing of bio-feedstocks, CCU and potentially also recycled feedstocks into hydrocarbons. The potential demand is thus enormous and it is questionable whether Europe could meet this demand. This opens up a potential for new global trade of ammonia produced in regions with a higher availability of renewable energy such as Australia or the Middle-East. Taking a national perspective on this transition is however with almost complete certainty seen as too narrow. Europe is the smallest relevant scale to consider this transition at.

CCU is a possibility as there are large carbon losses from current industrial processes, but caution has to be exercised when supporting this development to not create perverse incentives that create inefficiencies at the system level. Supporting CCU from fossil carbon sources may also create further lock-ins into fossil resource use, e.g. coal based steel making. A possibility would be to only support CCU that captures carbon from the air or bio-fuelled processes, but would this be enough to drive the development?

Time remains a critical factor. Time is still needed to demonstrate several of the promising technologies at an industrial scale; to build up and harmonize new infrastructure such as renewable power generation and transmission grids, port terminals, and recycling facilities – both sorting and processing facilities; to fit into the investment cycles of the large facilities that need to be converted but have decades long depreciation time. More tools for accelerating the transition are likely necessary.

Session 2: Early markets, new partnerships, capabilities and industrial policy

There is a long history of close connections between the petroleum and chemicals industries with integrated networks of energy, feedstock, products, people, and organizations. These connections may now be growing even stronger as the petro-chemical industry is investing in bio-based plastics and recycling, in addition to traditional chemicals and plastics. It is an open question whether this is a problem or not. Can the incumbent petroleum and chemicals industries transform themselves and establish new connections with other actors in a fossil free system?

In the global context, Europe is an anomaly with its focus on decarbonization including also heavy industries. But even within Europe there is still not a clear sense of direction for how to decarbonize chemicals and plastics except through recent calls for increased recycling and different industry initiatives. For example, the Port of Rotterdam stands out through its pioneering work on developing decarbonization pathways (called Closed Carbon Cycle, Biomass and CCS, and Technological Progress) and efforts to initiate and support new projects and collaborations between different actors in the port. Formulating a clear direction through pathways and facilitating experimentation through projects are two important conditions for making a change.

An important feature of decarbonization is the emergence of new value chains and thus new actor constellations. For chemicals, new partnerships with waste industries, power companies, forestry and agriculture are needed for closing the loop on carbon and making a shift to biogenic carbon. From innovation studies we know that it takes time to establish trust and understanding in new and diverse networks. This is also the experience from the Port of Rotterdam where perhaps 80 % of the effort in new projects has been about solving what may be called social issues (e.g., building trust and agreeing on business models or which company maturation processes to follow). The technical innovation part then represents 20 % of the effort.

In many other sectors, SMEs are important and driving in innovation. Many large firms are supporting this and engage with start-ups and SMEs. This does not seem to be the case in the heavy industry and one question is how we can change the industrial (innovation) ecosystem? It may be

that SMEs have less of a role to play in chemicals and plastics but it is very clear that the links to fossil energy and feedstock must be broken and new links to recycling, renewable energy and biogenic carbon must be developed.

In addition to direction and experimentation, research also shows the importance of articulating demand and coordinating policy in order to make a change. This implies that we need stronger collaboration between producers and consumers, and not only between producers in new value chains. Demand articulation can also be achieved through demand-pull policies by which regulation, labelling or economic incentives are used to create markets for greener materials and products. This can help create the predictability industry needs for de-risking new investments.

Looking at the problem of transforming the chemicals and plastics industry to become fossil-free it seems obvious that a price on carbon is not enough (and in any case it will not become high enough in Europe due to risk of carbon leakage). Broad and sequential industrial policy strategies will be needed to pilot, demonstrate and upscale new technologies at the same time as markets are developed, institutional capacity built, the old and fossil-based phased out, and negative socio-economic impacts handled. There seems to be an increasing recognition in Europe that this is an industrial transformation challenge rather than an emissions problem that is fixed through EU-ETS and climate policy alone.

Part of the governance challenge also has to do with what will be reasonable interventions at different scales. To what extent can Europe or even North-Western Europe be a forerunner in a global context without creating carbon leakage? What can be done by individual companies or existing chemical clusters? How far can we get in global agreements and how can early European initiatives help shape such agreements? Can border tax adjustments play a role and what are the implications for state-aid and competition policy?