

# Report on interim workshop on case studies

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Deliverable 3.4

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# Summary

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The interim workshop on case studies took place 29 November 2018 in Brussels, Belgium. It was titled “Understanding Innovation Dynamics for Low-Carbon Transitions in Resource-Intensive Industries”.

The overarching aim of the workshop was to share the results of REINVENT’s case studies so far with various stakeholders, both to inform them on the work of REINVENT and to discuss the findings. 34 people took part in the workshop, representing all the key stakeholder groups of REINVENT: scientific community, business and sector associations, and policy and governance stakeholders.

The workshop took place during the whole day, and consisted of presentations from REINVENT, as well as a Gallery Walk – an interactive format where the insights from selected case studies for each sector were visualised in the poster format. The key issues that came up during the Gallery Walk were further addressed in the plenary.

The rest of this document provides the agenda of the event, the list of participants and the summary of discussions.

## Agenda

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10.30	<b>Get together</b>
11.00 – 11.15	<b>Welcome and REINVENT objectives</b> <i>Objective: informing participants on REINVENT objectives and setting the frame for the workshop</i> <i>Speaker: Lars J. Nilsson, Project Coordinator, Lund University</i>
11.15 – 11.30	<b>Pathways towards a low-carbon industry: scenarios and mitigation requirements for the REINVENT key sectors (plastics, steel, paper, meat &amp; dairy)</b> <i>Objective: Showing the need for innovation in REINVENT key sectors due to substantial mitigation requirements until 2050</i> <i>Speaker: Clemens Schneider, Wuppertal Institute</i>
11.30 – 11.45	<b>Innovating resource-intensive industries: drivers of innovation for deep decarbonisation within the REINVENT key sectors</b> <i>Objective: informing participants on WP3 objectives and portfolio of case studies</i> <i>Speaker: Daniel Vallentin and Katja Witte, Wuppertal Institute</i>
11.45 – 12.10	<b>Q&amp;A</b>
12.10 – 13.00	<b>Gallery Walk: Innovation dynamics and preliminary meta-learning from case studies for deep decarbonisation in the REINVENT key sectors</b>

	<i>Poster session with experts from REINVENT from all key sectors</i>
<b>13.00 – 13.45</b>	<b>Lunch</b>
13.45 – 14.15	<b>Wrap-up of gallery walk</b>
14.15 – 15.00	<p><b>Deep-dive into innovation dynamics in the REINVENT key sectors</b></p> <p><b>Steel/chemical industry: the Carbon2Chem project</b>  <i>Speaker: Helena Mölter, Wuppertal Institute</i></p> <p><b>Plastics: plastic-free supermarkets</b>  <i>Speaker: Jacob Hasselbalch, Lund University</i></p> <p><b>Meat &amp; Dairy / Finance: FrieslandCampina's Green Schuldschein</b>  <i>Speaker: Bregje van Veelen, Durham University</i></p>
<b>15.00 – 15.15</b>	<b>Short Coffee Break</b>
15.15 – 16.15	<p><b>Discussion:</b></p> <ul style="list-style-type: none"> <li>- Which aspects/conditions from the case studies are essential to speed up and upscale innovations for achieving deep decarbonisation in and across REINVENT key sectors and beyond?</li> <li>- How can these aspects/conditions be translated into practice in order to trigger innovation processes in resource-intensive industries?</li> </ul>
16:15 – 16.30	<p><b>Summing-up, forecast and farewell</b></p> <p><i>How to proceed with workshop results within REINVENT, announcement of synthesis workshop</i></p> <p><b><i>Speaker: Lars J. Nilsson, Project Coordinator, Lund University</i></b></p>
<b>16:30</b>	<b>Closing</b>

# List of Participants

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Last Name	First Name	Institution
Axelson	Matilda	VUB
Bauer	Fredric	Lund University
Blomberg	Erik	Tierra
Chertkovskaya	Ekaterina	Lund University
de Coninck	Eric	ArcelorMittal
Dela Fiamor	Roxana	European Commission
Dropmann	Katharina	IUCN
Dufour	Manon	E3G
Edsjö	Karl	Electrolux
Hasenohr	Steffen	idagroup
Hasselbach	Jacob	Lund University
Hekkert	Marko	Utrecht University
Hermwille	Lukas	Wuppertal Institute
Jungk	Gunnar	ThyssenKrupp
Khandekar	Gauri	VUB
Kovacova	Katarina	HSBC
Lane	Richard	Utrecht University
Lehr	Dorit	Provadis
Mamalis	Petros	DG Research
Mölter	Helena	Wuppertal Institute
Negro	Simona	Utrecht University
Nilsson	Lars	Lund University
Oliveira	Carina	PBL
Perrey	Karen	Covestro
Prates	Ines	DG Climate
Schneider	Clemens	Wuppertal Institute
Schure	Klara	PBL
Valle	Antti	European Commission
Vallentin	Daniel	Wuppertal Institute
van Sluisveld	Mariessa	PBL
van Veelen	Bregje	Durham University
Vascotto	Sara	Business Europe
Wilson	Mark	One Policy Place
Witte	Katja	Wuppertal Institute



# Welcome and REINVENT Objectives

*Lars J. Nilsson, Lund University*

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Lars J. Nilsson introduced the REINVENT project to the plenary. The project looks at pathways towards zero emissions from a bottom-up perspective in order to understand climate innovation and initiatives within selected key sectors: steel, plastics, pulp & paper and meat & dairy.

REINVENT assesses the viability, challenges and governance implications of deep decarbonisation pathways in these key sectors. All sectors are facing significantly different challenges and framework conditions but also imply cross-sectoral synergies or inter-linkages. Therefore, REINVENT will identify new interdependencies between sectors which need to be tapped to implement key strategies for carbon mitigation, such as electrification or new value chains combining different industries.



## **What is REINVENT about?**

- Zero emissions – a liberating thought. New questions to ask.
- REINVENT complements “top-down” with a “bottom-up” perspective to understand climate innovation and initiatives from within sectors.
- Assess the viability, challenges and governance implications of deep decarbonisation pathways in key emissions intensive sectors.
- A platform for dialogue and learning so that policies can be better aligned with needs and conditions.

REINVENT also aims to offer a platform for dialogue and mutual learning by engaging with stakeholders through workshops, site visits and bilateral exchanges.

## Pathways towards a Low-Carbon Industry: Scenarios and Mitigation Requirements for the REINVENT Key Sectors

*Clemens Schneider, Wuppertal Institute*

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Clemens Schneider explained the roles of models and scenarios in the REINVENT project and how they interplay with other work packages.

The IMAGE model by PBL Netherlands applies a top-down approach to analyse possible contributions of the REINVENT sectors to GHG reduction over time in accordance with the 1.5-degree target. The WISEE model by Wuppertal Institute applies a bottom-up approach to assess the existing stock of

industry plants and CO<sub>2</sub> sources. The model aims to help identify challenges and windows of opportunity within the sectors for decarbonising the plant stock.

The modelling team works closely with the case study teams and other more qualitative work packages within the project to integrate a more realistic view on how and when innovation can be phased in.

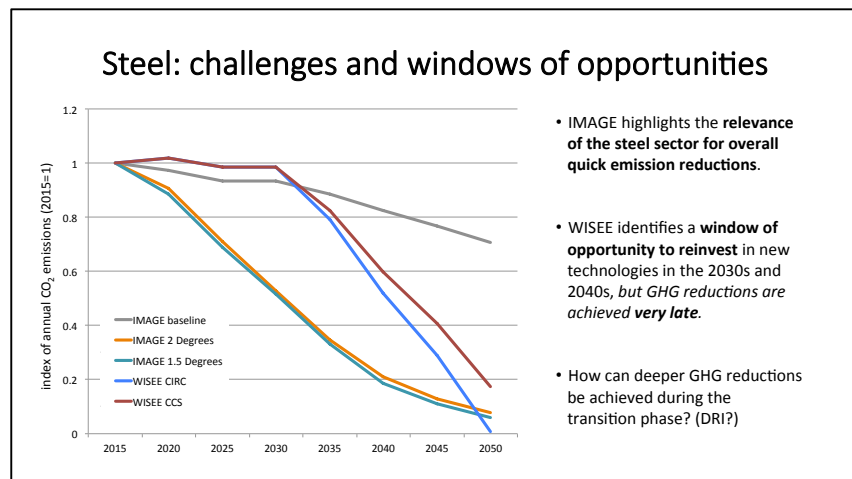
### ***Deep dive into steel industry:***

Clemens Schneider showed different carbon mitigation pathways from 2015-2050 for the steel sector in IMAGE and WISEE.

IMAGE indicates a rather steady reduction pathway with declining emissions starting from 2015 onwards.

Contrary to this, only minor emission reductions are

achieved in the WISEE model before 2035 and a steep decline takes place from 2035 to 2050 when breakthrough technologies such as CCS or electrified steelmaking based on hydrogen from renewable energies are expected to be implemented. The slow mitigation in the beginning of the pathways is mainly due to conservative basic assumptions. However, the late decline of emissions constitutes a challenge in this scenario.



### ***Deep dive into plastics sector:***

About 60 Mt of plastics are currently being produced per year in Europe. Large portions of supply are exported or discharged to the environment. Clemens Schneider presented two different 2050 scenarios: one focusing on CCS; another one focussing on closing material circles through recycling. The latter implies a high share of feedstock recycling which avoids about 40% of new feedstock.

Both 2050 scenarios still indicate a need for large amounts of carbon feedstock. Thus, it needs to be discussed how this carbon can be supplied, e.g. through carbon capture and use (CCU) or biomass. Furthermore, Clemens Schneider concluded that most breakthrough technologies with substantial mitigation potentials in the REINVENT key sectors are technically feasible but more knowledge is needed on how their adoption can be accelerated.

In a next step of the project, the modelling team will put stronger emphasis on the demand side and demand side innovation in the considered key sectors. The scenario pathways will be interlinked with the case study work conducted within the project. All key sectors of REINVENT have specific innovation systems and, thus, require specific approaches to successfully implement innovations. Therefore, the approach of REINVENT to look deeply into single innovation cases in order to understand their socio-economic barriers and drivers is highly relevant for modelling low-carbon industry pathways.






# Innovating Resource-Intensive Industries: Drivers of Innovation for Deep Decarbonisation within the REINVENT Key Sectors

*Katja Witte and Daniel Vallentin, Wuppertal Institute*

Katja Witte presented an overview of the portfolio of case studies conducted in the REINVENT project as well as the conceptual framework of the case studies.

The case studies explicitly focus on non-technical factors supporting or inhibiting innovations in key sectors. They investigate the dynamics between inertia and innovation by conditions of political economy, structure of markets, forms of infrastructure and investments. The case studies also aim to reveal linkages and interactions among the key sectors and identify agents of change, power dynamics etc.

Overall, the REINVENT team is analysing 20 in-depth innovation case studies in the key sectors at different stages of the value chain. Besides sectoral case studies, the role of finance is being addressed as a cross-sectoral aspect. The list of case studies per sector is illustrated on the right side.

Overview of case studies within REINVENT			
Analysing 20 in-depth case studies of specific innovations in key sectors			
			
<ol style="list-style-type: none"><li>1. Enerkem</li><li>2. Deterra outdoor jacket</li><li>3. <u>Plastic-free supermarkets</u></li><li>4. Triodos &amp; Naty</li><li>5. DuraSense</li></ol>	<ol style="list-style-type: none"><li>1. Castrip</li><li>2. Carbon2Chem</li><li>3. HYBRIT</li><li>4. 3DMetal Printing</li><li>5. Docol light steel from SSAB</li></ol>	<ol style="list-style-type: none"><li>1. Friesland/Campina</li><li>2. Green Protein Alliance</li><li>3. Oatly</li><li>4. Memphis Meats</li></ol>	<ol style="list-style-type: none"><li>1. Äänekoski bioproduct mill</li><li>2. Bioenergy fuelled lime kiln conversion</li><li>3. Dewatering Drying Technologies</li></ol>
 <ol style="list-style-type: none"><li>1. EIB – Commitment for Minimum Quota for Climate-Directed Finance</li><li>2. Fossil-free churches</li></ol>			

The case studies were selected based on a set of criteria, including: carbon significance, spread across value chain stages, different types of innovations, linkages to other work packages, scale-up potential and feasibility of being analysed by the project team (accessibility of data etc.). Thus, the portfolio represents a comprehensive mix of innovations in the key sectors.

Daniel Vallentin explained the concept and idea of the following gallery walk to the audience. The project team had prepared two posters for each sector: one poster summarised key facts about selected innovation cases in the sector; the second poster illustrated preliminary findings with regard to meta-learning of barriers and drivers across the key sectors as well as questions or hypotheses that occurred during the research process. The posters presented in the gallery will be sent to the workshop participants as separate files.

# Q&A Session

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***WISEE model shows significant mitigation effects starting from 2035. When would breakthrough technologies start being implemented to achieve these mitigation effects?***

Production stock in steelmaking would be transformed in the period from 2030-2035. Before 2030, the focus is on pilot plants; it is difficult to feed reinvestments into the circle based on timelines of currently on-going R&D initiatives. This causes significant challenges compared to the IMAGE model in whose pathways emissions decline significantly earlier. Therefore, it needs to be discussed how transition can be accelerated. Interesting research on “rapid transition” will be published by the University of Sussex soon.

***How can the case study approach help to improve the scenarios/models?***

The value chain perspective of the case study work package is key, as industry needs customers and demand for new products. E.g. Heidelberg Cement introduced a new type of cement to the market at slightly higher costs compared to conventional cement. However, the innovative cement product has not been taken up by customers. Therefore, the value chain perspective is highly important to enable a successful market entry of innovations, as suppliers need to understand the markets and interests/economic capacities of their customers. Lack of demand is a strong concern for industry, as establishing new production processes and introducing new products to the market requires high investments.

***How realistic are models? Are models over-optimistic?***

Models “always seem possible” and imply “technology optimism” but real data and trends suggest a different picture, especially as industry strongly focuses on costs and demand. Thus, stringent policy and new governance schemes are needed to trigger transformation. One possibility of the REINVENT project is to be “less optimistic” and show that, given what we know at the time being, the transformation would not be possible. Therefore, the message should be that technical initiatives and policy instruments need to foster radical change. It is important to challenge the models and to produce most realistic scenarios in the end.

## Wrap up of Gallery Walk

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**Steel Sector, Helena Mölter, Wuppertal Institute:**

Participants have discussed the following aspects/questions at the poster station for the steel sector:

***Hydrogen – myth or reality?:*** Is it possible to make the vision of a hydrogen economy a reality due to high costs? Where would energy for hydrogen production come from?

***Willingness to pay for decarbonised steel:*** What incentive would be needed to create demand for decarbonised? Might certificates or brands/labels for decarbonised steel be suitable instruments to introduce these steel types to the market? Would this be of higher value for customers than low-cost steel from China?

**Picking winners:** How can we be certain that the pathways of Carbon2Chem or HYBRIT are the best options? When would they be ready for adoption?

#### **Pulp and paper Sector, Fredric Bauer, Lund University:**

The following topics and questions were discussed at the pulp and paper poster station:

**Product diversification:** Into what sectors will/could the pulp and paper industry differentiate through bio-refinery pathways (fuels, other types of materials etc.)?

**Consumer awareness:** Customers often don't see the ecological value or impact of pulp and paper products; how could pressure on consumers be increased so that they take up alternative products?

**Export potentials:** What are the export potentials of presented cases (lime kiln and bio-refinery in Sweden and Finland) to other countries such as Poland?

#### **Plastics Sector, Jacob Hasselbalch, Lund University:**

The discussion at the plastics posters can be aggregated into the following key questions:

**Value chain:** What happens at the earlier stages of the value chain of plastics production? Why doesn't REINVENT focus more on these stages of the value chain?

**Potentials and Opportunities of Recycling:** Does recycling lead to an increased dependency on fossil fuels? This should be considered in the case studies or other work packages.

**Bio-plastics:** To what extent are we able to scale up bio-plastics? If so, what does it mean with regard to recyclability and other plastics waste streams?

**Rising demand:** Industry intends to double global demand for plastics; thus, the sector needs to move faster to innovate and realise innovations in this sector. How can this be achieved?

#### **Meat and Dairy Sector, Simona Negro, Utrecht University:**

The aspects discussed at the poster station for meat and dairy can be summed up as follows:

**New industry structures needed:** There still is a very strong lobby that controls the structure of supply chains and markets within the meat and dairy industry. However, the main challenge is to replace the conventional meat and dairy industry with another industry, as alternative products require radical change.

**New regulation:** The key is: What type of new regulation is needed to foster the development and market entry of new products and radical industry transformation?

#### **Modelling/Scenarios, Mariësse van Sluisveld, PBL Netherlands:**

Topics discussed in modelling/scenarios are:

**Diversified strategies:** Scenarios should avoid presenting silver bullets; instead, diversified strategies for the future are needed.

**Timing:** It is important to communicate better about windows of opportunity when breakthrough technologies need to be upscaled/implemented to transform industrial production stocks.

**Realistic scenarios:** Technological change scenarios should factor in current developments and foreseeable trends in order to be most realistic and feasible.

## Deep Dive into Innovation Dynamics in the REINVENT Key Sectors

### Steel/Chemical Industry: The Carbon2Chem Project, Helena Mölter, Wuppertal Institute

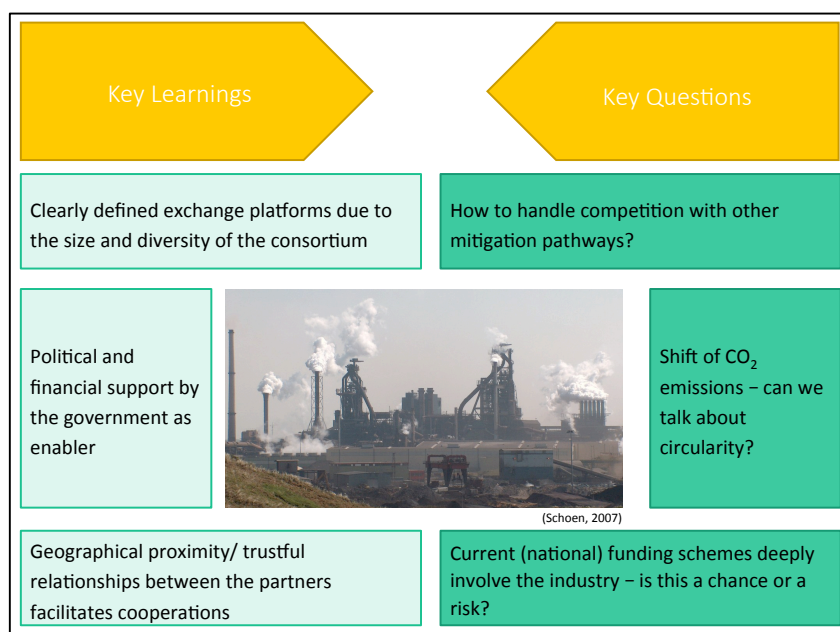
The Carbon2Chem (C2C) project converts waste gases from blast furnaces in the steel industry into chemical products based on hydrogen from CCU and renewable energies. The project is conducted by a large consortium of 18 institutions from different industries (including major players such as thyssenkrupp, Covestro, Linde or Siemens) and science. It includes different stages of the innovation process ranging from research/development to piloting and upscaling. The project is one of the most prominent European examples of cross-industrial cooperation in energy-intensive industries.

The idea for the project was stimulated by the leading edge cluster competition of the German Federal Ministry of Education and Research (BMBF). BMBF funds the project with 60 Mill. EUR. The project is also (ideally) supported by the state of North Rhine-Westphalia (NRW) – Germany's most important regional centre for energy-intensive industries. For NRW, the objective of keeping the value chain within the region has worked as a strong driver to support C2C. Important external drivers of the project were an anticipated increase of the costs of CO<sub>2</sub> certificates and regulatory pressure; furthermore, the Paris agreement worked as a stimulus to take action for reducing emissions of the industry sector.

For the implementation and progress of the project, it has proven to be of high importance that the project is supervised by a steering committee consisting of high-level decision-makers of the involved companies.

Furthermore, the project is carried by motivated staff from industry and academia with support of highly qualified R&D departments from the participating companies.

The C2C initiative is organised in sub-projects, each of which is led by an industrial partner to ensure high





market applicability. Already at this point, collaboration among industry and academia as well as different industry sectors has generated some interesting learnings for cross-industrial cooperation. These include:

- Cross-industrial cooperation comes with complex legal and contractual questions, especially with regard to intellectual property rights (IPR) and confidentiality of sensitive information/data. Thus, examples and sufficient time is needed to solve these matters in a way that avoids negative impact on project implementation.
- Cooperation in large cross-industrial project consortia requires trust and, thus, clear communication channels and rules. It is key to define such communication channels and rules and make sure that trust can be built.
- In many large multi-national companies, collaboration among departments is just as complex as collaboration with other companies. Thus, cross-industrial cooperation should not only concentrate on communication channels among companies but also within them.
- In the case of C2C, funding of BMBF has worked as an enabler and encouragement for companies to implement the project. However, public funding for R&D activities may only be the first step. A shared effort of industry and politics is needed to enable the upscaling and commercialisation of the project approach.
- A mature monitoring framework of the mitigation impact of the project is very important. Therefore, a lifecycle assessment of the full project chain is among the most important but also very complex tasks of the consortium and requires sufficient resources and capacities.

#### **Plastics: plastic-free supermarkets, Jacob Hasselbalch, Lund University:**

REINVENT looks at supermarkets as packaging represents 40% of plastic demand and 60% of plastic waste in Europe. Most packaging is single use and large shares of its value are lost to the economy after a short first use. Supermarkets are the main interface between consumers and packaged goods. Plastic-free supermarkets are the most radical social innovation at the consumption stage in the plastics value chain at the time being.

Key actors in the case study are zero-waste stores, farming cooperatives and initiatives within established conventional retailers. Plastic-free supermarkets are triggered by supporting casts, such as zero-waste lifestyle authors, bloggers or social media influencers. Furthermore, NGOs such as Zero Waste Europe, are lobbying for reducing plastic waste.

Established retailers have also set up initiatives for plastic reduction. In Amsterdam, the organic supermarket chain Ekoplaza has opened the world's first shopping aisle free of conventional plastics. The aisle encompasses about 700 grocery items whose packages are biodegradable, though still made of plastics and are not necessarily free of fossil.



### ***What has been achieved?***

There is exponential growth of plastic-free supermarkets but it still is very much a niche. Plastic-free stores make an important contribution to education and awareness. They often trigger a public debate on the future role of plastics in society. It increases industry's attention to eco-design and better packaging.

### ***Opportunities and barriers for upscaling:***

Zero-waste stores mostly have a local focus, as they like to use local suppliers and customers have to bring their own containers. Strong proponents of zero-waste shops are women (urban and affluent). Momentum in the broad mass of customers and changes in consumption patterns still needs to be spurred. However, in earlier years, consumers also had to be convinced to buy packed groceries, such as fruits. This shows that it is possible to teach people new consumption patterns. If conventional supermarkets would like to take up zero-waste models, it would mean radical changes for their operations, procurement and logistics.

### **Meat & Dairy / Finance: FrieslandCampina's "Green Schuldschein", Bregje van Veelen, Durham University**

Financing is among the REINVENT key focuses, as financing of low-carbon innovation is an important cross-sectoral aspect and affects all stages of the supply chain. Four finance-specific case studies are being conducted. The case study presented in the workshop looks at the "Green Schuldscheine" initiative by FrieslandCampina. The case has been selected as it is interesting both from a meat and dairy and from a financial perspective. FrieslandCampina is the sixth largest dairy company in the world and causes significant carbon emissions (13,000 kt of CO<sub>2</sub> in 2017).

Schuldscheine are an old instrument to attract investment but is newly used to trigger green investments. FrieslandCampina has issued Schuldscheine equivalent to about 300 Mill. EUR. 80-90% of funds were used to reduce the environmental footprint and reduce emissions in production factories by 20% per tonne of product. Furthermore, the initiative aimed to improve the financial health of the company.

The instrument has been quite effective in reducing the environmental footprint of FrieslandCampina's factory production. However, 70% of its emissions are farm-based; thus, the instrument did not address the most important source of emissions. This was also due to the fact that a reduction of cows to reduce CO<sub>2</sub> emissions has been highly controversial.

The "Green Schuldscheine" initiative has also been criticised for the fact that it refinanced existing projects rather than created new ones. Furthermore, it is not transparent whether the money raised by the "Schuldscheine" has actually led to clearly quantified GHG emission reductions. This may also

### FrieslandCampina's Green Schuldschein



- Interesting case from both dairy/decarbonisation and finance perspective:
- 6<sup>th</sup> largest dairy company
- Novel financial instrument
- Part of growing Green Bond market (52% in 2017)
- One of few clear examples of flows of 'green finance' to REINVENT sectors.



be due to the fact that FrieslandCampina never intended to decarbonise its value chain but wanted to be “seen to be green” and diversify investors.

**Conclusions:**

- There is potential in Green Bonds and Green Schuldscheine, but one needs to be wary of greenwashing.
- Finance does not necessarily flow into the parts of the value chain with the greatest potential for CO<sub>2</sub> savings.
- Intermediaries are very important to provide legitimacy and explain what is needed for products to be labelled “green”. Thus, one of the key questions is whether there should be stricter regulation of intermediaries that assess and certify green bonds.

## Plenary Discussion and Summary of the Workshop

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The plenary discussion focused on the following two guiding questions:

- Which aspects/conditions from the case studies are essential to speed up and upscale innovations for achieving deep decarbonisation in and across REINVENT’s key sectors and beyond?
- How can these aspects/conditions be translated into practice in order to trigger innovation processes in resource-intensive industries?

***The discussion led to these conclusions:***

We need radical innovations quickly in order to catch up with the 2050 CO<sub>2</sub> mitigation targets. These innovations involve high costs and risks and often require substantial change of consumption patterns. Stringent governance is key to deliver this. However, it also is a highly complex task due to the different situations and challenges in the considered industrial key sectors.

In the following, the audience discussed potential next steps for an effective and efficient policy strategy to tackle these challenges:

***Enabling key technical strategies:***

The important role of carbon capture and use (CCU) and hydrogen in the industry sector was strongly emphasised by industry representatives. According to them, in order to scale up these technologies, policy-makers need to remove existing legal barriers and create a market framework.

Public funding (especially market push instruments) often serves as enabler for low-carbon innovation; it triggers R&D and piloting of low-carbon technologies. However, there is a lack of market entry instruments and stringent regulation (market pull instruments); a public market for low-carbon products is needed which requires strong political will.

Many breakthrough technologies are cross-sectoral innovations. Thus, a policy framework for low-carbon innovations in the industry needs to facilitate cooperation across the value chain and help to create a culture of cooperation, especially with regard to key issues such as IPR, competitiveness and

confidentiality of data and other sensitive information. Cooperation across up- and downstream stages of the value chain is key to ensure demand for low-carbon products and increase certainty of returns for investments in new products and production stocks.

***Systemic coordination mechanisms/processes for closing materials and resources cycles:***

Closing cycles of materials and resource flows is among the key challenges and tasks of a low-carbon innovation policy in industry. For this, systemic coordination among producers and consumers is necessary. Due to the large number of different types of plastics, it is recommended to first focus on the largest streams of plastics, identify technical solutions and figure out how to implement them. Industry regions might be a good starting point for improving coordination among producers and consumers of plastics due to the high geographic concentration of plastics supply and demand.

***Putting basic material industries back on industrial policy agenda:***

In recent years, the agenda of the European industrial policy was dominated by cross-sectoral trends, such as digitalisation. However, decarbonisation of material industries such as the REINVENT key sectors should become the impetus of a new European industry policy for low-carbon innovation.

***Enhancing societal momentum/spill-over:***

Besides optimising and implementing technical solutions, participants agreed that it is necessary to create a societal momentum to enable the broad adoption of low-carbon innovations in REINVENT's key sectors. Education and awareness raising is key to meet this challenge. Furthermore, co-benefits/synergies with other policy fields need to be tapped, as the case of CO<sub>2</sub> mitigation does not seem to be sufficiently strong to trigger quick and broad action by politics, industry and society. Depending on the sector, potentially synergetic policy fields are health and environmental policy (pollution of air, water and soil), regulations for advertisement or standards for public procurement.

***Conclusion:***

A policy package for a new European industry policy for low-carbon innovation is desirable. The package should combine market push and pull instruments for enabling the development and upscaling of key technologies. Especially pull instruments should be a high priority, as an effective instrument, which triggers the market entry of low-carbon innovations, is missing.

The policy package needs to facilitate cooperation and implementation of low-carbon innovations across industry sectors and value chain stages. This involves solutions of contractual and legal issues so that trust can be built. Industry policy could be framed by supporting policies in synergetic policy fields, especially health and environmental policy, public procurement, and campaigns for education and awareness to facilitate a broad societal momentum for low-carbon innovations.