2020-IP23 – CCUS FOR LOW CARBON STRATEGIES IN INDUSTRIES WORKSHOP- 18TH SEPTEMBER & 21ST OCTOBER 2020

BACKGROUND

The RECORD Association organised a "CCUS for Low Carbon Strategies in Industries" workshop, inviting international experts to discuss topics of relevance within the CCUS area.

The workshop was divided in two sessions, which took place on 18th September and 21st October 2020. The first session aimed to identify the key issues, and the second session was designed to characterize how these will be addressed.

These topics are closely related to the IEAGHG strategy on CCUS for the industrial sector, and to extensive CCUS topics IEAGHG is assessing.

This document presents a brief summary of the presentations and discussions that took place during this workshop.

SUMMARY FROM THE RECORD WORKSHOP AND DISCUSSIONS

Jean-Paul Cazalets (Total/Record) and **Florence Delprat-Jannaud (IFPEN/Club CO2)** welcomed the attendees and opened the session.

Jean-Paul Cazalets mentioned the role of CCUS on electricity and industries' decarbonisation and the need to assess it. Florence Delprat-Jannaud highlighted the importance of this workshop for a better understanding of the next actions in the field of CCUS, an important solution to achieve carbon neutrality and ready to be deployed.

Dominique Copin, and **Priscilla Moukouri (Suez)** presented the programme, introducing the agenda and speakers.

Monica Garcia Ortega (IEAGHG) presented the recent events on CCUS in the industrial sector, highlighting its importance in Europe. Other non-European events were introduced in order to gain from the international experience that could be potentially transferred to Europe.

The workshop opened with a fruitful introduction from the industrial organisations, represented by **Jean-François Bricaud (Calcia), Sophie Castanet (EDF), David Savary (Solvay), Sandra Andreu (Suez), Gauthier Perdu (Technip Energies),** and **Jérôme Perrin (Renault)**. The speakers expressed their perspective on the implementation of CCUS systems and questions around it. The main aspects are included in .

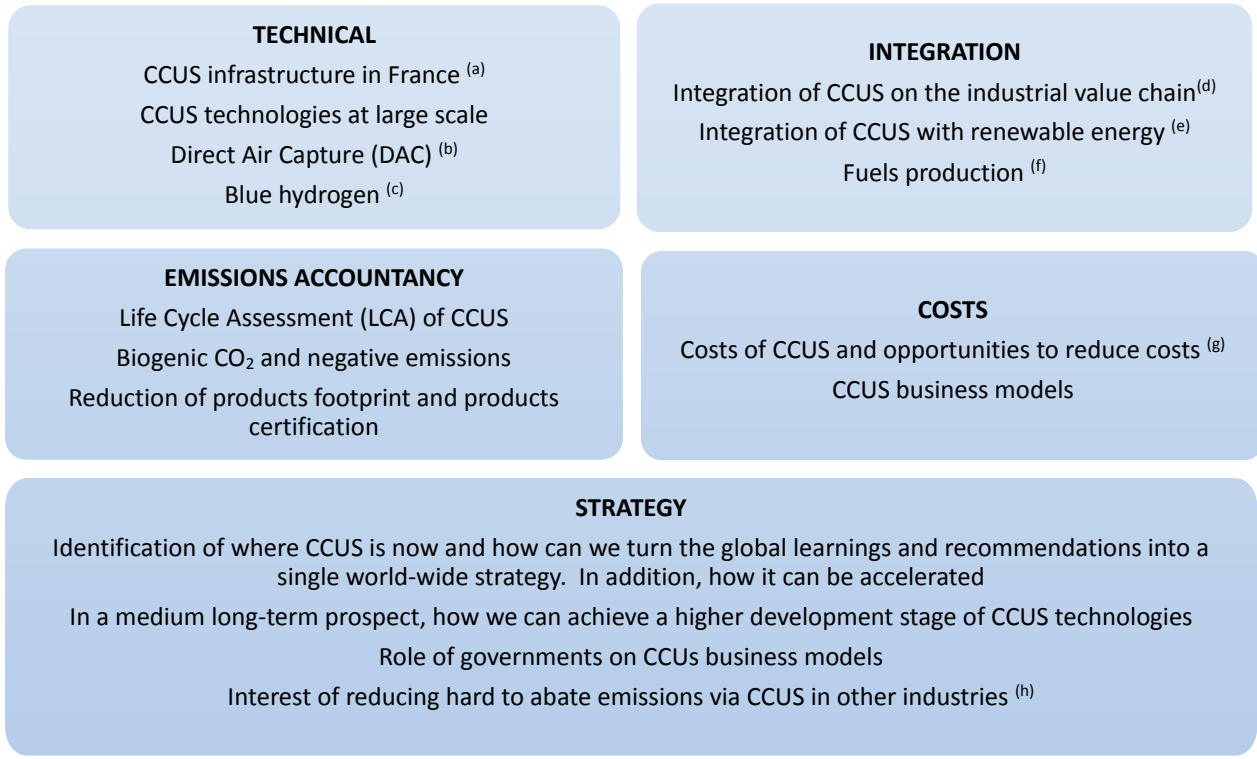

Figure 1 *Areas initially identified by industries to assess the industrial CCUS in France.*

(a) Considering that some industries are not close to ports and costs associated to these;
(b) As a tool to reduce residual emissions;
(c) Also as a tool to accelerate the CCUS development
(d) Including the CO_2 as feedstock and as part of industrial synergies (energy, heat, CO_2) and CO_2 market, and as part of industrial clusters
(e) Reliable and at low cost
(f) How CO_2 as a feedstock and decarbonised electricity will impact on the emissions from this sector
(g) Not only on CO_2 capture technologies but also on commissioning, CO2 liquefaction, transport, and utilisation
(h) "Other industries" refers to industries considered as not-adequate for CCUS

During the two days, international speakers (**Filip Johnsson (Chalmers University), Julien Leclaire (University Lyon), David Savary (Solvay**), **Pierre-Olivier Roy (CIRAIG Polytechnique Montreal), Jannick Gerner Bjerkås (Fortum Oslo Varme), Luc-Antoine Etoré (CALCIA- Heidelberg Cement), Niall MacDowell (Imperial College London), Aïcha El Khamlichi (ADEME), Samantha McCulloch (IEA), Paul Bonnetblanc (DGEC) Aïcha El Khamlichi, and Monica Garcia Ortega (IEAGHG)**) contributed to the knowledge transfer and discussion on CCUS and, in particular, on the industrial sector. As main highlights:

- A value chain analysis on the different products is key. This shows the low impact of the CCUS cost on the final products costs. While the cost of cement and steel might increase by 70% and 25% respectively through the implementation of CCUS, the final products, such a building or a car, might be increased by less than 0.5% (even less through the mixture of it with other strategies such as light materials or carbon neutral buildings).
- The biogenic and fossil emissions from the industrial sector, and the integration of industrial processes on heat district schemes, have been studied in the past and are relevant for future strategies.

- Based on the CO_2 properties the biochemical CO_2 utilisation pathways have been explored, including options in combination with CO_2 capture, and chemical utilisation as a source of inorganic materials. Moreover, some comments on the need for high efficiency CO_2 conversion processes to increase the competitiveness of these processes with fossil sources were presented, together with the time to reach their respective markets.

- The LCA (Life cycle analysis) was presented as a significant tool to evaluate the environmental impact of CCUS and for comparison with other decarbonising strategies. An important contribution to the discussion was the analysis of the net-zero emissions goal in Sweden.

- The IEA report on CCUS was highlighted. It showed that new policies in the USA have recently accelerated CCUS and commitments to reach global climate change goals. Strong government commitments and industries include almost US$ 4 billion in 2020. The role of CCUS can be seen as an essential tool to tackle emissions from existing energy assets, a platform for low carbon hydrogen production, a solution for the most challenging emissions in sectors such as heavy industry and aviation, as well as an instrument for direct removal of CO_2 from the atmosphere.

  CCUS as a cost-competitive option was highlighted for specific sectors such as iron and steel, ammonia, cement, and power generation.

  The main government priorities identified in the IEA report are to: create the conditions for CCUS investment; target the development of industrial hubs with shared CO_2 infrastructure; identify and encourage the development of CO_2 storage; and boost innovation for critical CCUS technologies.

- The French long-term strategy, which is update every 5 years, was presented. The CCUS contribution will be increased from 2030 and integrated within four pillars (zero carbon energy by 2050, a sharp decrease in energy consumption in all sectors, strong reduction of non-energy emissions, and an increase of the carbon sink). 13 cross-cutting orientations and 208 sectorial organisations were identified and consulted. In summary, the CCUS is identified as a necessity (15 Mt CO_2eq by 2050 abated by CCUS), while decarbonisation and energy efficiency will be considered first.

  Costs are identified as the main barrier, together with social acceptance and territorial challenges. Additionally, regulatory aspects and the dependency of storage on other countries (e.g. Netherlands, Norway) are significant.

- From an integration perspective, the electricity grid is key. The translation of technical issues to social-economic impact must be addressed. This approach is more complex but also more relevant, and can be tailored to different regions, where the importance and best possible integration can be extracted. It shows that carbon taxes alone will not deliver the expected net zero emissions scenarios, and that the inclusion of CCUS in low carbon strategies for electricity generation would result in optimum integration and fulfilment of the UN Sustainable Development Goals

- Net zero goals should consider permanent CO_2 mitigation (1,000 years approximately), which must be measurable, and have a minimal environmental drawback.

IEAGHG has explored relevant topics for CCUS in the industrial sector and specific areas identified in the workshop [1-11].

Highlights from the RECORD and Club CO_2 Members (**Jannick Gerner Bjerkås (Fortum Oslo Varme), Keith Birch (Suez UK), Erik de Coninck (Arcerol Mittal), Raffaele Luce and Ambroise Feydeau (TOTAL)** are summarized below:

- The large-scale project on CCUS for the waste-to-energy (WtE) sector implemented by Fortum Oslo Varme, and its integration on the Norwegian full scale project (now called Longship project)[1], was presented as an example where experience could be transferred to other WtE facilities as well as other sectors. The CO_2 transport from the plant to the port will take place by free emission vehicles and to the storage site firstly by ship and then undersea pipeline. The goal is to capture 400,000 tons of CO_2/year (90% of CO_2 capture rate), and 50% of these will be biogenic. This strategy is based on successful CCUS pilot testing (5,500 test hours accumulated, with up to 85% of capture rate), the integration of CCUS with other decarbonising solutions, heat/energy strategies, and considering spatial constraints.

  In October, The Norwegian Government approved conditionally and partially this large-scale project, subject to obtaining additional funding from other sources.

- Norcem Brevik, linked to the Longship initiative, was presented. It will be the first CCUS large scale in the cement sector, capturing approximately 400,000 tCO_2/year (50% of the cement plant emissions). It is expected to start in 2021 subject to parliament approval. In this case, the CO_2 transport will be by ship, with an intermediate storage facility on the quay. External funding will represent approximately 80% of the project's budget.

- The UK carbon capture hub projects, including the Net-Zero Teesside project, are of significant relevance. It includes the strong local political and industrial support, the existing hydrogen distribution system, and synergies on CO_2 production and utilisation onsite. The funding model is based on EU and UK grants together with private finance investment, UK government subsidies and an increased taxation on the carbon emissions. Additionally, CCUS technologies selection can be tailored to the specific sites.

- ArcelorMittal has an ambition to achieve 30% emissions reductions by 2030 and carbon neutrality by 2050. Their strategy is based on an increased use of scrap and innovative production processes. Moreover, the integration of a group of decarbonisation strategies in their processes will be key, including energy efficiency and recovery, use of renewables and carbon-free hydrogen, use of biomass and circular carbon products, and CCUS.

- Existing and planned CCS projects in the North Sea region, that are also linked to the Longship Project, have shown significant advances over the last few years. The CO_2 and net-zero emissions goals in the different regions, and linked to these activities, were highlighted. Potential CCUS business models show that government support is necessary. Identified technical aspects need updated policies and efforts are also required to increase the level of social acceptance.

➢ **Panel discussion (First day)**

The panel (**Monica Garcia Ortega, Juho Lipponen (CEM), Gauthier Perdu, Julien Leclaire, and Priscilla Moukouri**) had the opportunity to provide inputs to the RECORD Association on topics considered during the workshop and potential topics to be considered in their future strategy. The inputs from these experts are summarized below:

Defining the role of CCUS in the power and industrial sectors in France will be essential to assess the potential in that country region. Additionally, clusters will be a key consideration as part of a common infrastructure.

The market and competitiveness in France, Europe, and globally, are important factors to consider in the CCUS costs, business models, policies, and trading. Moreover, from a system perspective, tailoring technical specifications and CO_2 capture systems to specific facilities and the region is of high relevance to advance on CO_2 capture technologies and assess their potential.

[1] This update was presented before approval and publication of the funding decision

Blue hydrogen as a CCUS opportunity and a clean option for the industrial sector must be assessed. Additionally, LCA studies on CCUS systems and their integration in the industries, defining boundaries and within a circular economy, should be considered as part of a carbon management strategy.

Along these actions, the role of the finance sector in the implementation of CCUS projects will be relevant, together with the social acceptance of CCUS.

Panel Discussion (Second day)

All attendees were invited to discuss the priority topics that the RECORD Association should focus on during the near future strategy. These were based on the discussion during the first day and the exchange of information with the invited international experts and RECORD Members. The main areas are included below:

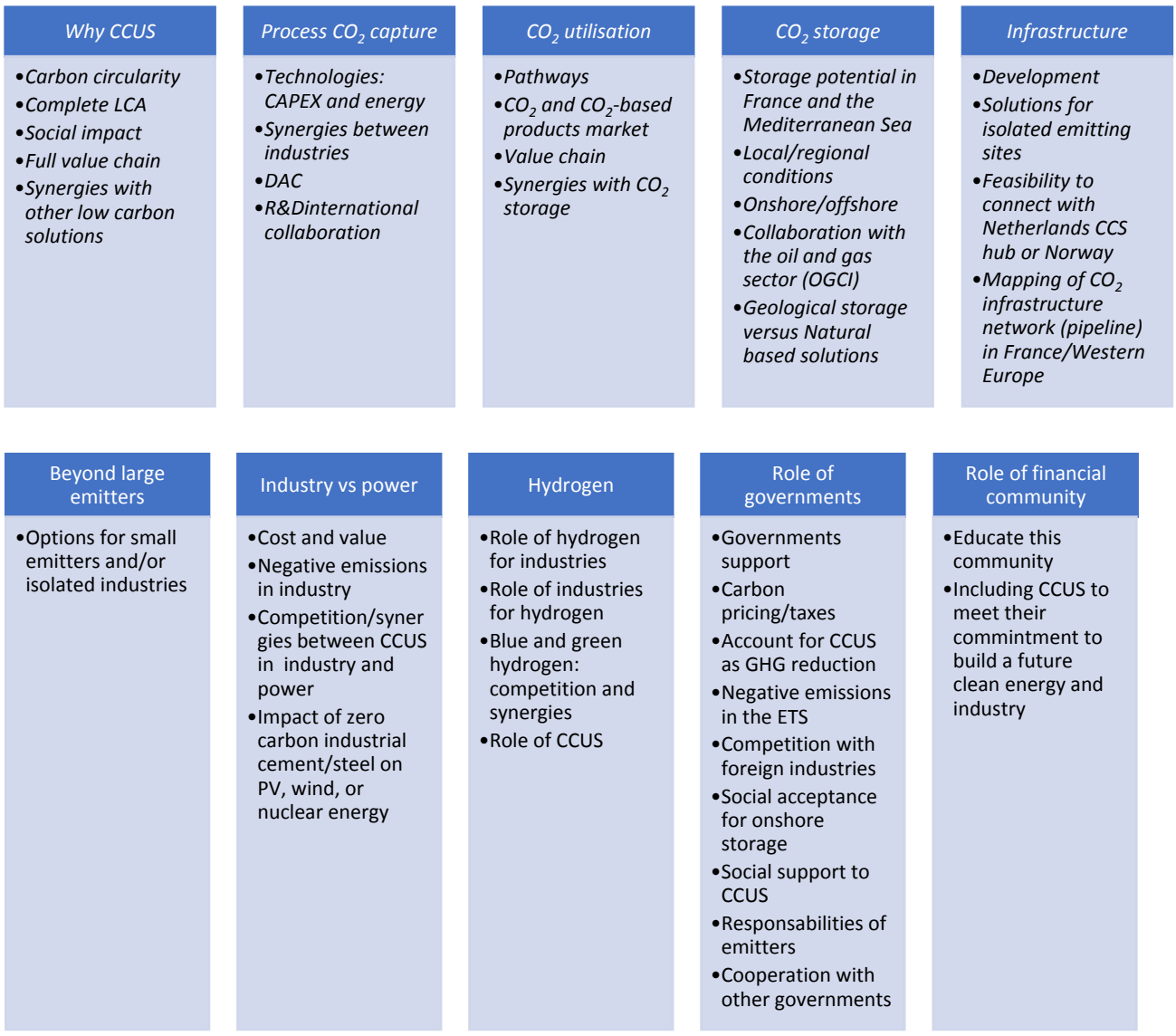

Figure 2 *Relevant areas identified during the workshop and discussed during the second day*

In addition, the discussions identified beneficial cooperation with Clean Energy Ministerial (CEM), CCS Association (CCSA), IEAGHG, and the National Petroleum Council in USA.

Outputs from the RECORD Association

Based on the workshop and the discussions, the RECORD Association members has identified their targets to assess, as described below:

- Write a position paper or a roadmap from the industry perspective to advocate for governments action
- CO_2 storage capacity in France
- Synergies between CCU and CCUS
- Social impacts of CCUS
- Global approach on LCA of CCU and CCS
- Transport to CO_2 large capacity storage sites (e.g. North Sea)
- Blue and green hydrogen
- Direct Air Capture (DAC): energy balance, and steam or power contributions
- Collaboration with the financial sector considering the evolution of its commitments for clean energy
- Collaborations with other organisations, such as IEAGHG or CCSA, and monitoring the progress in USA via the National Petroleum Council

Concluding remarks

Key aspects on CCUS for its implementation on the industrial sector were discussed during this two-day workshop.

This event was a successful opportunity to combine international and local expertise on regional CCUS development in France. The workshop also made a constructive contribution to the next steps of the RECORD programme and the members of RECORD Association will prioritize the actions to be implemented to progress on these matters.

IEAGHG recommendations

IEAGHG has explored several topics discussed during this 2-day workshop and these priorities are in line with the current and future IEAGHG work on CO_2 capture in the industrial sector, CO_2 transportation, and cluster development. Monica Garcia Ortega, from IEAGHG, has contributed to the discussion through presentations, suggestions, and feedback. She covered topics such as the importance of CCUS on the low-emissions and net zero goals, costs, business plans, and market. As in previous reports, she mentioned the importance of tailoring CO_2 capture systems and their integration to specific facilities, industrial clusters, and specific regions.

IEAGHG will continue monitoring these topics, collaborating with RECORD, and contributing to the international discussion on the implementation of CCUS in the industrial sector. Further information about the IEAGHG work can be found in the further reading references, while the presentations will

be available for the attendees, and RECORD and CLUB CO2 members on the RECORD website (www.record-net.eu).

References IEAGHG: further reading

[1] Garcia M. and Berghout N. (2019), Toward a common method of cost-review for carbon capture technologies in the industrial sector: cement and iron and steel plants, International Journal of Greenhouse Gas Control 87, (142-158) https://www.sciencedirect.com/science/article/abs/pii/S1750583618307643

[2] IEAGHG 2018-TR03 Cost of CO_2 capture in the industrial sector : cement and iron and steel industries (www.ieaghg.org)

[3] IEAGHG 2020- TR01 Hydrogen Production with CCS workshop (Summary) https://www.cslforum.org/cslf/sites/default/files/documents/Chatou2019/IEAGHG-R-and-D-Programme-Technical-Review-of-Workshop.pdf

[4] IEAGHG 2017-TR5 Evaluating the Costs of Retrofitting CO2 Captured in an Integrated Oil Refinery (www.ieaghg.org)

[5] IEAGHG 2016-10 Techno-economic evaluation of retrofitting CCS in a market pulp mill and an integrated pulp and board mill (www.ieaghg.org)

[6] IEAGHG 2013-04 Iron and steel CCS study (Techno-economic integrated steel mill) (www.ieaghg.org)

[7] IEAGHG 2013-19 Deployment of CCS in the Cement industry (www.ieaghg.org)

[8] IEAGHG 2017-04 CO_2 Capture in Natural Gas Production by Adsorption Processes for CO_2 Storage, EOR and EGR (www.ieaghg.org)

[9] IEAGHG 2017-03 Techno-Economic Evaluation of Hyco Plant Integrated to Ammonia / Urea or Methanol Production (www.ieaghg.org)

[10] IEAGHG 2017-02 Techno-economic evaluation of SMR based standalone (merchant) hydrogen plant with CCS (www.ieaghg.org)

[11] 2019-IP13: CCUS AND EIIS WORKSHOP https://www.cslforum.org/cslf/sites/default/files/documents/Chatou2019/CCUS-in-EIIs-Workshop_Summary.pdf

Monica Garcia Ortega