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COZMOS

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Efficient CO_2 conversion over multisite Zeolite-Metal nanocatalysts to fuel and OlefinS

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Deliverable Report

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Executive Summary

Understanding the social acceptance of carbon capture and utilisation (CCU), and in particular of COZMOS products, is key to understand the expectations and requirements of the public. In order to assess the social acceptance of CCU and CO_2-based propane and propylene, a survey was carried out. This report presents the key results and findings from the survey.

A total of 1,974 complete responses were recorded in the survey. Overall, 64% of respondents agreed to including CCU in their country's strategy to combat climate change, these results point to a relatively high level of acceptance towards CCU. When asked about the placement of a CCU plant about half of respondents wouldn't accept CCU in their country. However, the acceptance of a CCU plant in the respondent's neighbourhood increased slightly, whether fed with CO_2 captured from a nearby or distant industry.

When exploring willingness to pay, 43% of participants would be willing to pay 50% more. This is an important finding as the cost of fossil-based products is very competitive already, and most CO_2-based products seem to be priced much higher than fossil-based ones.

At the end of the survey, there was an increased level of acceptance for CO_2-based propane/propylene (64% would accept their use) as opposed to the initial resistance towards CO_2-based products. This highlights that even a small amount of information can change the public's perception and receptiveness to a new product or technology. A further exploration of social acceptance could support the implementation and deployment of CCU technologies and should not be an add-on to other assessments for developing technologies. Additionally, creating a robust plan for stakeholder engagement is likely to improve the acceptance of these technologies when deployed.

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1 Introduction

Climate change is linked to an accumulation of greenhouse gases (GHG) in the atmosphere. These GHG emissions are caused mainly by burning fossil fuels like coal, oil and gas, and biomass. COZMOS has provided breakthrough technology for the direct conversion of CO_2 to propane/propylene. The COZMOS process can be environmentally competitive with the fossil-based process. More importantly, it allows for the reuse of CO_2 molecules that would otherwise be emitted. On a large scale, this could lead to significant emission reductions.

The COZMOS process is able to produce CO_2-based propane and propylene. Propane is a fuel that is currently used for industrial and residential purposes. In the residential sector, propane is used for cooling, heating and lighting. Propylene is a chemical used in the production of plastics, packaging and containers. Both propane and propylene are produced as by-products from the refinery processes and are responsible for large CO_2 emissions. Their markets are expected to continue growing. Thus, if propane and propylene could be derived from CO_2 that would otherwise be emitted from industrial processes, this could contribute to the reduced use of fossil fuels.

As the COZMOS technology is still in development, assessing the social acceptance of COZMOS is very important. Through understanding the social acceptance of carbon capture and utilisation (CCU), and in particular of COZMOS products, the project can better understand the expectations and requirements of the public. Through this research, businesses implementing COZMOS in the future will be able to address these expectations and requirements better.

In order to assess the social acceptance of CCU and CO_2-based propane and propylene, a survey was carried out. This report presents the key results and findings from the survey.

2 Methodology

This survey was conducted online using the platform Qualtrics. Overall, 1,974 complete responses were recorded on the survey. The survey was distributed via different channels. It includes responses from staff, research students and university students from the University of Sheffield. It was also distributed within the institutions at project partners. And finally, Qualtrics promoted it among its respondent pool.

The survey responses have captured views from participants who have prior knowledge of CCU and/or industrial decarbonisation. This was considered as part of the survey development and will be considered in the interpretation of results where the results differ from the larger group. However, the collection of responses can be considered a good representation of public perception.

The survey consisted of 26 questions and were separated into five different sections:

1. Demographics
2. Self-perceived knowledge on environment
3. Benefits and concerns about CCU
4. Specific questions on propane and propylene
5. Questions about decision-making stakeholders

The list of survey questions was as follows:

2.1.1.1 Demographics

1. Please select your age group
    1. 18-14
    2. 25-38
    3. 39-49
    4. 50-64
    5. Over 64
2. Which country do you live in?
3. To which gender identity do you most identify?
    1. Female
    2. Male
    3. Transgender/ Non-binary / Other
    4. Prefer not to answer
4. What is your current professional status?
    1. Student
    2. Part-time employment
    3. Full-time employment
    4. Unemployed
    5. Retired
5. What is the highest level of education you have?
    1. Secondary education
    2. High school/College
    3. Bachelor's degree
    4. Master's degree
    5. PhD or higher

2.1.1.2 Self-perceived knowledge on environment

6. What is your living environment?
    1. Urban area
    2. Rural, connected to the power grid
    3. Rural, off-grid
7. Being environmentally friendly is an important part of who I am
    1. Strongly agree
    2. Somewhat agree
    3. Neither agree nor disagree
    4. Somewhat disagree
    5. Strongly disagree
8. Self-perceived knowledge of climate change and CO_2. How much do you know about…? (1: not aware of it, 2: aware, but don't know much, 3: knowledgeable, 4: very knowledgeable)
    1. The different causes of climate change
    2. The impact of CO_2 emission on climate change
    3. The different consequences of climate change
    4. The ways in which we can fight climate change
9. Drag and drop these concerns from highest to lowest significance for you
    1. Climate change/ Global Warming
    2. The cost of the product
    3. Socially just transition
    4. Climate forced migrations
    5. Availability of public transport
    6. Energy and fuel availability
    7. Pollution of air, rivers and oceans
    8. Water availability
    9. Waste generation
10. Self-perceived knowledge of Carbon capture and utilisation (CCU)
    1. Not aware of it
    2. Aware, but don't know much
    3. Knowledgeable
    4. Very knowledgeable

2.1.1.3 Benefits and concerns about Carbon Capture and Utilisation (CCU)

11. Thinking about CO_2-based products. How concerned are you about the following? (1: not concerned at all to 5: highly concerned)
    1. It may support the continued use of new fossil carbon
    2. When the CO_2-based product is used (e.g., CO_2-based fuel is combusted), it will emit the captured CO_2
    3. The increased cost of CO2-based products
    4. When the CO_2-based products will become widely available
12. What impact do you think Carbon capture and utilisation (CCU) will have on the following? (1: no impact at all to 5: high impact)
    1. Combatting climate change
    2. It may avoid the use of new fossil carbon
    3. It creates new technologies to support a more circular economy and reach net zero

4. Improvement in local air quality
5. Job creation in the area
6. Increase in national manufacture of products

13. Would you be in favour of including Carbon capture and utilisation (CCU) in the strategy to combat climate change in your country?
    1. Yes
    2. No
    3. Don't know or not sure
14. If including Carbon Capture and Utilisation (CCU) in the strategy to combat climate change in your country, I would accept... (1: strongly agree, 5: strongly disagree)
    1. A CCU plant in my neighbourhood, fed with CO_2 from a distant industry
    2. A CCU plant in my neighbourhood, capturing emissions from a nearby CO_2-emitting industry
    3. Having CCU somewhere in the country
15. If including CCU in the strategy to combat climate change in your country, I would accept the production of… (1: strongly agree, 5: strongly disagree)
    1. CO_2-based fuels
    2. CO_2-based construction materials
    3. CO_2-based commodity chemicals
    4. CO_2-based plastics
16. Would you be willing to pay more for a CO_2-based product as opposed to the fossil-based one?
    1. Strongly disagree
    2. Somewhat disagree
    3. Neither agree nor disagree
    4. Somewhat agree
    5. Strongly agree
17. How much would you be willing to pay for a CO_2-based product as opposed to the fossil-based one? (1: same price as usual, 5: double price)

2.1.1.4 Propane / Propylene

18. Rate your knowledge on the conventional production of propane and/or propylene
    1. Not aware of it
    2. Aware, but don't know much
    3. Knowledgeable
    4. Very knowledgeable
19. Are you aware of your use of propane?
    1. Not aware of it
    2. Aware, but don't know much
    3. Knowledgeable
    4. Very knowledgeable
20. Do you use any of the following that contain propane? (You may select more than one option)
    1. Lighters
    2. Aerosol deodorant
    3. Propane gas fireplaces
    4. Propane cooking stoves
    5. Grills, barbeques and outdoor kitchens

6. Camping and caravanning gas

21. Are you aware of your use of propylene?
    1. Not aware of it
    2. Aware, but don't know much
    3. Knowledgeable
    4. Very knowledgeable
22. Do you use any of the following that contain propylene (or derived from it)? (You may select more than one option)
    1. Synthetic clothing
    2. Plastic squeeze bottles
    3. Outdoor furniture
    4. Carpets
    5. Upholstery
23. How much would your life be affected if.... (1: no impact at all, 5: high impact)
    1. Fossil-based propane wasn't available?
    2. Fossil-based propylene wasn't available?
24. Would you accept the use of CO_2-based propane/propylene?
    1. Yes
    2. No
    3. Don't know or not sure

2.1.1.5 Decision-making stakeholders

25. Perceived trust in relevant stakeholders concerning decisions on Carbon capture and utilisation (CCU) (1: trust completely, 2: trust somewhat, 3: do not trust very much, 4: do not trust at all)
    1. Government
    2. Industries
    3. Environmental non-government organisation (e.g., Greenpeace, Friends of the Earth)
    4. Scientist and researchers
    5. Environmental influencers (e.g., Great Thunberg, David Attenborough)
    6. Trade/Professional Associations (e.g., The Royal Society, The Institute of Chemical Engineers, Carbon Capture & Storage Association)
26. Who should take responsibility for minimizing the cost increase of CO_2-based products? (You may select more than one option)
    1. Individuals e.g., through democratic vote or consumer choice
    2. Government
    3. Companies e.g., fuel producer via windfall tax / profit cut
    4. Wider economic regions e.g., European Union

3 Summary of results

A total of 1,974 complete responses were recorded in the survey. The top countries represented are Italy, Norway, Germany, France, Denmark, United Kingdom, Turkey and the Netherlands. The respondents from these countries represent 97% of the completed responses. There is a good balance between male (53%) and female (46%) respondents. The majority of respondents are in full-time employment (58%), have graduate or post graduate education (56% overall) and live in an urban area (71%).

Around 50% of the respondents were knowledgeable about climate change, the route to address it, its consequences, the impact of CO_2 emissions and its different causes. From a list of global issues, the issue that was classed as most concerning was climate change, followed by cost of product and socially just transition. With regards to knowledge about CCU, 33% of participants were either knowledgeable or very knowledgeable about the CCU.

When assessing the acceptance of CCU technologies, 64% of respondents agreed to including CCU in their country's strategy to combat climate change, these results point to a relatively high level of acceptance towards CCU. When asked about the placement of a CCU plant, about half of respondents wouldn't accept CCU in their country. However, the acceptance of a CCU plant increased slightly when the respondents considered a CCU plant in their own neighbourhood as opposed to their country in general, regardless of the origin of the CO_2 (from a nearby or distant industry).

A short introduction was provided to CCU but details weren't provided about the range of products that can be produced with CO_2. The level of resistance to CO_2-based plastics was slightly higher than for the other products, this is line with the current public perception around polymers.

When exploring willingness to pay, 43% of participants would be willing to pay 50% more. This is an important finding as the cost of fossil-based product is already very competitive, and most CO_2-based products seem to be priced higher than fossil-based ones.

At the end of the survey, there was an increased level of acceptance for CO_2-based propane/propylene (64% would accept their use) as opposed to the initial resistance towards CO_2-based products. This highlights that even a small amount of information can change the public perception and receptiveness to a new product or technology.

The majority of respondents, 1,519, believed the government should be responsible for ensuring the cost of CO_2-based products was levelized with the fossil alternative.