CCUS SET-PLAN

Deliverable 3.8

DEVELOP RECOMMENDATIONS ON THE STEPS REQUIRED TO DELIVER R&I ACTIVITY 8. MODELLING

FEBRUARY 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 842214

Project's name: IMPACTS9. IMPACTS9 is a Horizon 2020 project (Coordinated and Support Action) funded by the European Commission for 3 years (from 1 May 2019 until 30 April 2022). Its purpose is to accelerate the progress realised within the CCUS SET-Plan and to support delivery of the R&I activities in the CCUS Implementation Plan.

https://www.ccus-setplan.eu/

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Introduction about the SET-Plan, CCUS SET-Plan and the European Green Deal

The European Strategic Energy Technology Plan (SET-Plan) aims to accelerate the deployment of low-carbon technologies, improve new technologies and bring down costs by coordinating national research efforts. The SET-Plan brings together EU countries, the European Commission, industries, and research institutions. The SET-Plan defined ten priority areas, covering a wide range of sectors including CCUS, wind, solar, geothermal, renewable heating and cooling, biofuels, etc. The Implementation Working Group 9 (CCUS SET-Plan) has been established to help the progress of Research and Innovation (R&I) activities required to achieve the 2020 targets for CCS and CCU agreed by the European Commission, SET-Plan countries, and industry.

The CCUS SET-Plan is composed of 11 SET-Plan countries (Czechia, France, Germany, Hungary, Italy, Norway, The Netherlands, Turkey, Spain, Sweden and the UK), industrial stakeholders, non-governmental organisations, and research institutions. The work is chaired by the Netherlands, Norway, and the Zero Emissions Platform.

Reaching climate neutrality by 2050 will require major efforts from all economic sectors and European society. Higher climate goals mean that all low-carbon technologies under the European Commission's SET-Plan will be crucial in contributing to the transition to a climate neutral economy by 2050 and to accelerate knowledge development as well as technology transfer and up-take. CCS and CCU will play an important role in the delivery of climate neutrality by 2050, enabling a cost-efficient trajectory towards a low-carbon economy with EU's climate objectives.

As part of the European Green Deal workplan, the European Commission has announced new initiatives – such as the European Climate Law, the Hydrogen strategy, the Industrial strategy – and intends to revise existing pieces of legislation, such as the EU ETS directive and TEN-E regulation. All these initiatives are key to ensure that more CCS and CCU projects are deployed in Europe, overcoming current barriers and securing more announcements such as the Longship project and funding awarded through the Connecting Europe Facility for Energy (CEF) programme to European CCS and CCU projects (Porthos, Athos, Antwerp CO2, Acorn Sapling, Ervia).

The European Green Deal, Europe's new growth strategy, set the legally binding target of net-zero greenhouse gas emissions by 2050, formally adopted in the European Climate Law. All economic sectors and member states will need to make strong efforts to reduce greenhouse gas emissions. This means that all low-carbon technologies with a scientifically proven role in achieving climate change mitigation should be developed and deployed. In this context, carbon capture technologies have been highlighted as necessary in order for Europe to reach climate-neutrality in all credible Integrated Assessment Models and scenarios (including the 1.5 degrees IPCC report and the European Commission Clean Planet for all, long-term strategy).

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Recommendations on the steps required to deliver R&I activity 8. Modelling

Background

One of the activities identified in the CCUS SET-Plan Implementation Plan is the need for greater work to understand the role of CCS and CCU in meeting European and national energy and climate change goals. Specifically there is a need for greater analysis and understanding of long-term decarbonisation scenarios at the European, regional and national levels as well as the socio-economic implications of deploying these technologies. For this reason, IMPACTS9 commissioned a study to provide evidence on the role that CCS and CCU technologies are expected to play in delivering a net zero Europe – receiving Integrated Assessment Models and develop credible ranges for the levels of CO_2 mitigation delivered by these technologies.

The output of the analysis is used to provide input to the work of the European Commission on the Green New Deal agenda as well as the national energy and climate plans being developed by Member States.

Tender, request for Proposals

A request for proposals, below, was sent out to possible contributors in April 2020. From the three replies, the UCL Energy Institute was selected.

The contribution of CCS and CCU to EU climate goals

Project Specification

Introduction

The Paris Agreement adopted in 2015 committed governments to avoid dangerous climate change by limiting temperature rises to "well below 2°C" target and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

The EU submitted its contribution to the Paris Agreement of at least a 40% domestic reduction in greenhouse gas emissions by 2030. This is expected to put the EU on a path to reduce its long-term emissions by 80% as its part of a wider need for developed countries to reduce their emissions by 80-95% by 2050.

The new candidate for President of the European Commission, Ursula von der Leyen, has stated that delivering the world's first net zero continent is a priority for the incoming Commission. To deliver this a new climate law will be introduced to ensure that net zero will be reached by 2050. This will require greater ambition for the EU's 2030 targets, and it has been proposed that a reduction of at least 50% and possibly 55% will be required by 2030.

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Integrated assessment models (IAMs) are a key methodological tool for investigating long term trade-offs between the energy system, the climate system and the broader economic system. They are developed and operated by a wide range of international, national, academic and industrial organisations. IAMs generally aim to minimise total energy system cost for a range of different scenarios and simulate or project what should happen under a given set of assumptions (they are not forecasts or predictions). Their results are used to inform how changes or developments in technologies, costs or regulation, say, might influence matters such as CO_2 reductions, energy security and energy affordability, issues that are important drivers of energy policy. CCS is represented in most, if not all, IAMs and plays a key role in a large number of energy and emissions scenarios. CCU has been less analysed within IAMs although there have been some recent efforts to understand its role in energy systems.

The EU Strategic Energy Technology Plan (SET-Plan) work on CCS and CCU has identified eight priority Research and Innovation activities that should be progressed to deliver on CCS and CCU targets. This includes activity 8 "Understanding and communicating the role of CCS in meeting European and national energy and climate change goals". This action noted the need for more analysis and understanding of long-term decarbonisation scenarios at the European, regional and national levels as well as the socio-economic implications of deploying these technologies.

STUDY OBJECTIVE

Review the IAMs that underpin European decarbonisation scenarios to identify credible ranges of CO_2 mitigation delivered by CCS, CCU and CCS/CCU enabled negative emissions against different level of European CO_2 emission reduction ambition. The review should also identify the role that low carbon hydrogen can play in supporting decarbonisation. Investigate these models further to provide insights on the sectoral and geographical allocation of the CO_2 mitigation and the insights these provide on the socio-economic impact of CCS and CCU technologies.

SCOPE OF WORK

The following tasks will be undertaken:

Task 1. Review the IAMs used to analyse decarbonisation scenarios at the European, regional and national level. These will have been developed by a range of international organisations, national governments, academia and industry.

Task 2. Identify a subset of the most influential IAMs, e.g. those feeding into the IPCC processes, for further interrogation and develop a credible range of CCS and CCU enabled CO_2 mitigation for scenarios that are consistent with an 80% emission reduction by 2050 as well as scenarios that deliver net zero in 2050 (The study may also need to consider scenarios that focus on carbon budgets that deliver net zero later than 2050 but rely on higher levels of negative emissions post-2050). Identify milestones for expected levels of CCS and CCU enabled CO_2 mitigation for

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emission reductions of 40%, 50% and 55% in 2030. Identify project and associated infrastructure deployment scenarios consistent with this level of CO_2 mitigation.

Task 3. For the scenarios selected, investigate these models further to provide insights on the EU's sectoral and geographical allocation of the CO_2 mitigation as well as the role of CCS/CCU enabled negative emission technologies (e.g. Direct Air Capture or sustainable bio-energy) and any insights these provide on the socio-economic impact of CCS and CCU technologies.

Task 4. For the scenarios selected, identify the underlying assumptions, data, associated quantitative sensitivities and calculations behind the results that would have an impact on the CCS and CCU projections. Explore similarities and differences, for example, in the range of technologies included the timing of entry of various more advanced technologies and the performance data and costs applied to those technologies. Areas of interest, for example, might include: the limit on the CO_2 capture rate; CCS/CCU forecast cost reductions and associated impacts on their value to decarbonisation efforts; assumptions underpinning key alternative technologies to CCS and CCU; the impact of large scale hydrogen use; and present and future limits on biomass availability for BECCS. Identify any evidence gaps on CCS and CCU technologies that is being used as input data to the IAMs and any key uncertainties that should be addressed.

Task 5. From the investigation undertaken, summarise the reasons for the variations in results and messaging from different models. Identify, if possible, examples of best practice, explaining clearly why those examples were selected. What lessons may be drawn from the findings by the modellers? Are there recommendations that may be made for users of the projections, e.g. for policy makers, industry and research communities?

CONTRACT SCHEDULE

Timing. It is anticipated that the study would be completed within [four][six] months of the date of the kick-off meeting.

Milestones. Major milestones and their completion dates will be detailed in the project proposal.

Reporting. Reporting requirements and their completion dates will be detailed in the project proposal.

Dissemination of results. Dissemination results and their completion dates will be detailed in the project proposal.

Progress reviews. Allowance should be made for an appropriate number of progress meetings. The final meeting number and approach to meeting, e.g. in person or virtual will be finalised during the bid development process.

Deliverables. The key deliverable will be a written report and an associated slide pack that will be used for dissemination and communication activities of the main findings of the study. The proposal should

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include developed datasets of relevant data which could be used for further studies and modelling exercises by policy makers.

Form of proposal. The proposal will describe in principle how each of the tasks described in the scope of work will be addressed. A schedule for completion of the work will be included. A preferred date for delivery of the draft study report will be provided. If the contractor feels this date is inappropriate, for whatever reason, a new date may be suggested for agreement.

The proposal will summarise the contractor's experience in relevant areas. The names and relevant experience of the persons who would be involved in the study will be provided and a project manager responsible for the timely and competent completion of the work will be nominated. Any sub- other work-sharing arrangements will be clearly stated, listing those involved, their proposed role and relevant experience.

A fixed cost in EUR will be quoted for completion of the study as described in this specification. A schedule of daily rates will be given (holding for six months after completion of the study) which would be used in the event of identifying useful supplementary activities.

The names and contact details of two independent referees familiar with the work of those tendering for this contract should be provided. It will not be necessary to provide statements from the referees.

The work process

A kick-off meeting for the work was held in June 2020 and a mid-term meeting in early August. Two external reviewers were also assigned from IEAGHG and the SUPEERA project (that supports the implementation of the SET-Plan). The UCL presented draft results to the IWG9 Strategic Coordination Group and the Zero Emissions Platform Advisory Council. The final report was delivered in September and presented to the IWG9 Plenary in October 2020.

Results/Recommendations

The study by UCL reviewed the role of CCS and CCU in Europe in decarbonisation scenarios consistent with the 1.5°C and 2°C global temperature targets. The scenarios – produced by a range of global and Europe-scale models – provide insights on the combinations of technologies that could be compatible with the climate targets under different conditions.

The study indicates that *CCS is essential for Europe to reach net zero CO_2 emissions by 2050* – consistent with the 1.5°C global target. Under the 2°C target, most scenarios suggest a prominent role for CCS. This implies that *Europe needs a large-scale CCS industry to meet future targets*.

In the 1.5°C scenarios, the median CO_2 captured by CCS is 230-430 $MtCO_2$/yr in 2030, increasing to 930-1200 $MtCO_2$/yr by 2050 (the 2°C scenarios indicates less CO_2 captured by CCS, 35-100 $MtCO_2$/yr in 2030, increasing

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to 600-930 $MtCO_2$/yr by 2050). There is *a significant range across these scenarios, implying some key uncertainties as to the actual level that might be required*.

CCS enables CO_2 removal when combined with bioenergy, provided biomass is sourced sustainably. *Bioenergy with CCS (BECCS) plays a key role in the modelled scenarios for Europe*. In the 1.5°C scenarios, the median CO_2 captured by BECCS is 30 $MtCO_2$/yr in 2030, increasing to 400 $MtCO_2$/yr by 2050 (the 2°C scenarios indicates less CO_2 captured by BECCS, 1-5 $MtCO_2$/yr in 2030, increasing to 150-230 $MtCO_2$/yr by 2050).

The study indicates that *significant annual investments are needed in CCS in Europe until 2050*, amounting to $14 billion (median) in 1.5°C scenarios ($11 billion in 2°C scenarios).

The study does not give a clear consensus if and how CCU can play a role in European decarbonisation. Some studies foresee a significant role while others do not consider it.

Scenario design strongly influences the amount of CCS deployed in both the 1.5°C and 2°C scenarios. Assumptions such as high future energy demands or low levels of renewable deployment lead to higher levels of CCS deployment, and vice versa. European-scale models were found to suggest lower levels of CCS deployment. *More research is needed to understand what drives these differences*.

The study identified priorities for further research, including:

- *Modelling to examine the optimal sectoral deployment of CCS, and to better quantify the role for CCU*
- *A synthesis of the research, and potentially updated research, on the spatial layout of CO_2 infrastructure and the system cost implications of CCS and CCU*
- *More analysis on the role of CCS in Europe in scenarios of low future energy demands, and on the risks associated with CCS failing to scale up.*

Distribution and use

The report has been distributed broadly to policymakers on EU and national government level, to the CCUS community, to the wider stakeholders, and to other SET-plan steering group and secretariat and other SET-Plan implementation working Groups.

The result from the study has been used as input for the IWG9 work on assessing and updating the CCUS SET-Plan Implementation Plan targets and the CCUS Roadmap to 2030, as well as for the continued work within the IWG9 (and the IMPACTS9). The study has also been used and referenced in many other organisations' work.

The study (link) is accessible at the CCUS SET-Plan website.

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