Energy Transitions Commission

Frequently Asked Questions - ETC CCUS Report

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Section 1: About the ETC

What is the Energy Transitions Commission and what is its mission?

The Energy Transitions Commission (ETC) is a global coalition of leaders from across the energy landscape committed to achieving net-zero emissions by mid-century in order to limit global warming to well below 2°C and as close as possible to 1.5°C.

Our Commissioners come from a range of organisations – energy producers, energy-intensive industries, technology providers, finance players and environmental NGOs – which operate across developed and developing countries and play different roles in the energy transition. This diversity of viewpoints informs our work: our analyses are developed with a systems perspective through extensive exchanges with experts and practitioners. Our ambition is to inform the decisions of public and private decision-makers and support the leaders at the forefront of climate action to speed up the deployment of low and zero carbon solutions.

A list of our commissioners can be found here: http://www.energy-transitions.org/who.

Who funds the ETC?

The ETC is primarily funded by the organisations with which our Commissioners are affiliated. Membership fee levels depend on the size and nature (for-profit or not-for profit) of the organisation. Commissioners all have equal voice and representation on the Commission regardless of whether their affiliate organisation finances the ETC or not. In addition, some of the ETC's work programmes, in particular the ETC's work in China and India, are funded by philanthropic organisations.

The funding we receive finances the ETC's secretariat, analytical programmes, stakeholder outreach and communications.

Who are the Commissioners and how were they selected?

As of July 2022, the Commission's membership includes over 50 leaders coming from energy companies, energy-intensive industries, technology providers, financial institutions, environmental NGOs and academia. They operate across developed and developing countries and play different roles in the energy transition. Commissioners are selected based on their commitment to working towards a net-zero-emissions economy by mid-century.

We endeavour to diversify the Commission's membership in terms of sector, nationality and gender. The Commission is chaired by Lord Adair Turner who works alongside Ita Kettleborough, Director and Faustine Delasalle, Vice-Chair. A list of Commissioners and ETC team members can be found on our website at http://www.energytransitions.org/who-we-are.

Are the organizations with which your members are affiliated backing this report?

This report constitutes a collective view of the Energy Transitions Commission. Members of the ETC endorse the general thrust of the arguments made in this report but should not be taken as agreeing with every finding or recommendation. The institutions with which the Commissioners are affiliated have not been asked to formally endorse the report.

Why is [a given Commissioner] not available for questions?

Some of our Commissioners are unfortunately unavailable for questions due to prior commitments, but a number of global reports have now been developed by the Commissioners who not only agree on the importance of reaching net-zero carbon emissions from the energy and industrial systems by mid-century, but also share a broad vision of how the transition can be achieved.

Why have not all ETC Commissioners endorsed the report?

Nearly all our Commissioners have endorsed the report. A few were unable to formally endorse the report before publication due to procedural formalities within their organisation, or have only very recently joined the Commission and therefore were not able to participate in the development of the report.

How does the ETC balance achieving impact with the demands of fossil fuel members?

Commissioners all have equal voice and representation on the Commission. We believe it is critical that the ETC brings together voices from across all sectors, including energy intensive industries, in order to design realistic yet ambitious pathways to net-zero emissions and mobilise all key stakeholders towards this goal. All members of the ETC have agreed to work together to pursue a global net-zero emissions target by mid-century. Our reports are anchored in robust quantitative and qualitative analyses, which are stress-tested and refined with a large panel of experts coming from both our members' organisations and a broader network. The ETC creates a unique space for open dialogue, creating the right conditions for change and advancing the climate agenda.

Does the ETC speak to the challenges of both developed and developing countries?

The ETC develops global roadmaps, while highlighting differences between regional pathways, especially between developed and developing countries. We work with local partners – in China, India, Europe, U.S., Canada and Australia – who have deep country knowledge and play a key role in strengthening and stress-testing our global analyses in light of regional specificities.

The ETC believes that all rich developed economies should and can reach net-zero emissions by 2050 and all developing countries by 2060 at the latest, but that developing countries will require development finance to de-risk and crowd-in private investment. However, some developing countries may be able to achieve full decarbonisation by 2050 or earlier, for example, because they are blessed with significant potential solar and wind resources, dramatically reducing decarbonisation costs.

ETC reports examine scenarios for developed and developing markets. Overall, achieving massive electrification and early power sector decarbonisation, ahead of economy-wide decarbonisation, must be at the heart of all countries' paths to net zero. For example, the ETC calls for developed and developing countries to adopt strategies to achieve grid emissions intensity below 30gCO_2/kWh by the mid-2030s and mid-2040s, respectively.

Section 2: About the paper and its impact

Why have you developed this report and who is the target audience?

The ETC recognised a lack of clarity regarding the appropriate role of CCUS within the broader climate debate, with many actors raising concerns around 'moral hazard' and/or limited funding flowing to CCUS solutions. The ETC, as part of its *Making Mission Possible* series has over the past year sought to understand how CCUS could be used as a complement to other low-carbon technologies such as clean electrification, clean hydrogen and sustainable bioresources – all of which the ETC has produced dedicated views on as part of the same series.

Carbon capture, utilisation and storage will only occur at the required scale with a step change in action from both industry and governments. Collectively these bodies are the target audience for the report, alongside the wider climate community. Working together government and industry can create the enabling conditions for CCUS, and both have a critical role to play in funding their scale up from today. In addition, risks associated with CCUS projects should be managed by a combination of governments, regulators, project developers and industry bodies, working alongside NGOs, local government and the public.

What is the main focus of the report?

In this report the ETC describes the complimentary role carbon capture, utilisation and storage (CCUS) has alongside zero-carbon electricity, clean hydrogen and sustainable bioresources in delivering a net-zero economy by mid-century.

Massive clean electrification is the backbone of global decarbonisation. However, electrification, hydrogen and sustainable bioenergy combined cannot reduce gross emissions completely to zero. In addition, it is almost certain that cumulative CO_2 emissions between now and 2050 will exceed the "carbon budget" consistent with a 1.5°C climate objective. Therefore, in order to limit temperature rises to 1.5°C, carbon removals will be required alongside deep and rapid cuts to emissions.

Carbon Capture and Utilisation or Storage (CCUS) must therefore play three vital but limited roles in the energy transition:

1. To decarbonise those sectors where alternatives are technically limited (i.e. industrial processes which by their nature produce CO_2 such as cement);
2. To deliver some of the carbon removals that are required in addition to rapid decarbonisation if global climate objectives are to be achieved;[1]
3. And to provide a low-cost decarbonisation solution in some sectors and geographies where CCUS is economically advantaged relative to other decarbonisation options locally.

[1] For the purposes of this report, we treat Direct Air Carbon Capture (DACC) and Bioenergy with carbon capture and storage (BECCS) as subcategories of carbon capture and storage technology.

How much of the report is constituted of new analyses vs. integration of previous publications, and who has carried out the analysis?

The report integrates past analysis published by the ETC in its *Making Mission Possible* and *Keeping 1.5°C Alive* series. It also draws on peer-reviewed journals to complement the ETC's energy-based transition scenarios.

Our 2020 Making Mission Possible report laid out the building blocks to achieve a net-zero emissions energy and industry system globally by mid-century. Our clean electrification and hydrogen reports provide i) a refined view of the long-term role of each zero-carbon energy source, ii) more detailed information on the feasible pace of that transition from now to mid-century, and iii) how precisely to accelerate progress in the 2020s to ensure mid-century goals are attainable, providing more precise guidance to policymakers and business leaders.

In addition, the report integrates findings from detailed literature analyses published in peer-reviewed journals to assess the potential for CCUS scaling up over the next three decades. The conclusions related to CCUS potential are based on a comparison across these studies and white papers and were tested with a diverse group of stakeholders from both industry and NGOs.

The report draws upon analyses carried out by ETC knowledge partners SYSTEMIQ and BloombergNEF, alongside analyses developed by the International Energy Agency, Intergovernmental Panel on Climate Change, Global CCS Institute, Rocky Mountain Institute and the Mission Possible Partnership. We warmly thank our knowledge partners and contributors for their inputs.

Is this paper overly ambitious in its portrayal of CCUS potential?

This paper scopes an ambitious yet feasible take on CCUS potential. For each CCUS solution analysed, the maximum technical potential determined by peer-reviewed literature has been scaled down, taking into account various factors such as cost-effectiveness, limits to the sustainable supply of raw materials and other resources (e.g. clean power) and the practical barriers to deployment, including maximum feasible pace of scale-up of new technologies, and the work required to coordinate the actions of many inter-linked stakeholders. Taken together, this report presents a plausible but ambitious pathway for the scale up of CCUS.

Overall the report suggests that by 2050, the world will likely need to capture and either use or store 7-10 Gt/year of CO_2 (equivalent to 18-25% of today's CO_2 emissions), but this will not perpetuate the 'business as usual' development of today's fossil fuelled world:

- Of this 3-5 GtCO_2/year will be needed to achieve net zero emissions in industrial and energy applications (such as cement, steel and hydrogen production) where the use of electricity, hydrogen, or sustainable bioenergy doesn't provide a complete solution to decarbonisation. This use of CCUS would offset the continued consumption of 7 million barrels per day of oil (90% lower than today) and 2,700 BCM of gas per year (over 30% lower than today) while still achieving a zero-emission economy.

- Another 4-5 GtCO_2/year will be needed to achieve engineered carbon dioxide removals.

What about the risk of 'moral hazard' by relying on CCUS instead of decarbonising?

There is a valid and widespread concern that the commercialisation of CCUS solutions will slow efforts to decarbonise by other means, sometimes referred to as a 'moral hazard'.

Some published scenarios have in the past proposed a far larger role for CCUS than appropriate or required and have therefore seemed to justify a far greater than optimal future role for fossil fuels and delaying action today. While rejecting that approach, the ETC believes that CCUS will need to play a vital but limited role in transition to a net zero economy. Other means of decarbonisation such as electrification, hydrogen, sustainable bioenergy and energy productivity improvement can deliver the bulk of emissions abatement, but CCUS will be necessary in some specific sectors and applications. There is now room for greater confidence that CCUS deployment can be targeted to ensure its optimal use to deliver decarbonisation and avoid 'locking in' unnecessary, on-going oil and gas use.

Will DACCS be unrealistic because of the costs and energy requirements?

DACC will always require large energy inputs due to the low concentration of CO_2 in the air. But plausible assumptions on technological progress, renewable energy cost declines, learning by doing and economies of scale, suggests that DACC costs could fall from today's $300+ per tonne to below $100 by 2050. Sufficient land, solar and wind resources are available to support at least 3.5 Gt of DACC per annum by 2050.

How do the ETC's analysis of Gt estimates needed compare to other estimates?

The ETC has developed two scenarios for modelling the uptake of carbon capture capacity, "High Deployment" (10 Gt/year by 2050) and "Base" (7 Gt/year by 2050). High Deployment is based on the ETC's illustrative "supply side decarbonisation only" pathway where it is primarily supply side measures that drive the transition to net zero. The Base Scenario additionally assumes significant energy efficiency and materials circularity improvements. Both are intended to outline bold yet credible pathways for the technology deployment.

The ETC's numbers are consistent with a range of other estimated published by respected global institutions such as the IPCC, the IEA, BNEF and RMI, for scenarios which limit global warming to 1.5-2°C by the middle of this century. It should be noted however that a wide range of pathways for achieving this outcome exist and different approaches lead to varying sectoral volumes of CO_2 capture estimates.

Can carbon storage really be permanent?

Under the right conditions and if well-regulated, CO_2 can be safely, permanently stored in geological formations with minimal risks of significant accidental CO_2 release. Geological assessments indicate that there is plentiful storage capacity to absorb the quantities of CO_2 capture envisioned in our scenarios. Although the risk of leakage is small, it is not zero. Effective management and strong regulation will be vital to good project design, accurate monitoring and effective maintenance – all ensuring stored CO_2 remains trapped underground.

What actions are required by government, corporate and finance players?

Collective action by government, corporates and investors is crucial to achieving the scale of CCUS needed in the next decade. Six critical actions in the 2020s are:

1. **Overcoming the green premium to make CCUS deployment economically viable** through e.g. carbon pricing, early-stage financial support where needed - scaled through a combination of government and industry mechanisms (e.g. low-carbon product standards, buyer coalitions, procurement mechanisms).
2. **Developing enabling infrastructure** such as shared transport pipelines and storage sites at CCUS hubs. Cooperation between government and industry is critical to accelerating the delivery of CCUS hubs, thereby lowering costs and fostering scale up.
3. **Targeting R&D and deployment support towards high capture, next-generation CCUS technologies**, as well as developing innovative business models, such as Carbon Capture as a Service.
4. **Regulating and managing risks to ensure responsible and secure CCUS development** by assigning long-term responsibility for storage sites and meaningful penalties for leakage.
5. **Setting standards and regulation to ensure high CO_2 capture rates,** alongside developing transparent, best-practice **monitoring** of CCUS
6. **Building public support for CCUS' appropriate role as a low-carbon technology** by articulating a clear strategic, but limited role for CCUS, and transparency on performance

How much CCUS will need to be deployed and how fast do we need to go?

By 2050, the world will likely need to capture and either use or store 7-10 Gt/year of CO_2:

- Of this 3-5 Gt/year will be needed to achieve net zero emissions in industrial and energy applications (such as cement, steel and hydrogen production) where the use of electricity, hydrogen, or sustainable bioenergy doesn't provide a complete solution to decarbonisation. This use of CCUS would offset the continued consumption of 9 million barrels per day of oil (90% lower than today) and 2,700 BCM of gas per year (over 30% lower than today) while still achieving a zero-emission economy.

- Another 4-5 Gt/year will be needed to achieve engineered carbon dioxide removals.

By 2030, 0.8 Gt/year of capture will be required across a suite of technologies, including carbon dioxide removal, cement, blue hydrogen, iron and steel, petrochemicals and fossil fuel processing, and power generation. Active carbon capture will need to take place at around 300 large industrial, energy production or carbon dioxide removal facilities. This compares with 37 million tons per annum (mtpa) of CO_2 capture capacity today, with 30 facilities currently operating worldwide. Projects already under development, if fully implemented, will only take this to 160 mtpa by 2030.

How much will CCUS cost and who will pay for it?

The total investment in CCUS infrastructure is estimated at around $5 trillion by 2050. This is less that 5% of the total cost of the energy transition and equivalent to 0.1% of projected global GDP over this period. Total investment in CCS projects has been only $7 billion over the last decade compared to $3.4 trillion in renewable energy.

In the next decade, the bulk of the investment (90%) will be spent on point source capture, transport and storage, only c.10% will be DACC related. In the late 2030s and 2040s, DACC CAPEX requirements become more prominent.

The majority of CCUS costs are in CO_2 capture and typically reflect the concentration of CO_2 in the gas stream, with more diffuse sources (e.g. air) requiring more energy to isolate the CO_2 than higher concentration sources (e.g. fossil industrial processes). The private sector can finance most of the costs with both industry and governments playing a role in developing incentives (e.g. carbon pricing, low-carbon products), and developing shared transport and storage infrastructure via industrial hubs.

Section 3: Net-zero targets and negative emissions

The term "Net-Zero" is used a great deal – but what is "Net-Zero" and why should we set "Net-Zero" targets?

The concept of "net-zero emissions" is based on the climate science and what we must do to limit global warming. The IPCC's illustrative pathways for limiting global warming to 1.5°C indicate that CO_2 emissions need to be reduced to net-zero globally by around 2050. In this expression, the "net" reflects the fact that there may still be a small amount of residual emissions by 2050 – the ETC estimates that 2-4 Gt of CO_2 might still be emitted by the energy system – and those should be compensated by negative emissions, obtained via carbon removals (for instance from afforestation or DACCS).

We must therefore aim to decarbonise the economy by mid-century, reducing CO_2 emissions from energy, industry, transport and buildings to as close to zero as possible. Net-zero goals and targets are powerful, because they give us this galvanising clarity of action for government, business, and civil society, focusing the minds on a tangible objective associated with a clear timeline. They are a vital step in accelerating progress and urgency as we must act now to deliver them.

But achieving net-zero in these sectors alone will be insufficient to limit global warming to 1.5°C for three reasons.

- First, as CO_2 accumulates in the atmosphere, it is the total cumulative amount of emissions between now and 2050, and therefore the pace of emissions reduction, that will matter for global warming; this carbon budget is currently estimated at 500 Gt from 2020 by the IPCC. Cutting emissions fast in the next decade will be necessary to avoid an "overshoot" of the carbon budget - given potential feedback loops and tipping points within the climate system, it is unacceptably risky to rely on large scale negative emissions later in the century. IPCC pathways which avoid such reliance show that CO_2 emissions need to be cut from today's 40 $GtCO_2$ to below 25 $GtCO_2$ by 2030.
- Second, beyond the energy, industry, transport and buildings sectors, emissions from waste, agriculture, food and land-use should also be taken into account
- Finally, non-CO_2 emissions, in particular nitrogen oxide and methane emissions, also contribute to global warming effects and need to be cut.

Section 4: Geo-politics and the energy transition

How has the current situation (war in Ukraine and gas crises) impacted the energy transition?

The ETC addressed this subject in *Building Energy Security Through Accelerated Energy Transition* (May 2022) which explored how Europe, and other regions, can build energy security while also accelerating the required energy transition.

This paper focused on the medium-term actions that could improve energy security, strengthen stability of supply and limit the impact of future fossil fuel price shocks by 2030. The analysis finds that the response should be anchored around accelerated investment in renewable energy and economy wide electrification, together with improved energy efficiency.

The same paper also highlights tricky trade-offs and choices that have to be made. For example while imports of Liquified Natural Gas (LNG) from secure suppliers could also play a role, these must be combined with measures to reduce CO_2 and methane leak emissions in gas production in order to be viable. Actions which could seriously delay or imperil the energy transition are unnecessary and undesirable. These include any dilution of 2030 emission reduction targets or of commitments to phase out coal generation, or any large scale new oil and gas developments