GLOBAL CCS INSTITUTE

Global CCS Institute - Key Messages

1. Paris climate change targets cannot be reached without CCS

CCS is a pivotal climate change technology. It is probably the most versatile and vital climate mitigation technology that exists.

It is not possible to reach net zero emissions in the required time without CCS.

Internationally recognised evidence by specialist climate change bodies concur that international climate change targets cannot be achieved without CCS.

IEA findings maintain that to reach Paris climate targets of 2 degrees by 2060, 14 per cent of cumulative emission reductions must derive from CCS. In a Beyond 2 Degrees Scenario (B2DS), this rises to 32 per cent. Additional modelling in the IEA's Sustainable Development Scenario finds that seven per cent of cumulative CO_2 emissions reductions must derive from CCS by 2040[1].

Despite this proof, for the need of CCS, there are not nearly enough facilities coming onstream. To reach the new Sustainable Development Scenario, more than 1000 facilities need to be operating by 2040 (based on a facility with capture capacity of 1.5 Mtpa).

2. CCS is the only clean technology capable of deeply decarbonising major industry (steel, cement, fertiliser, pulp and paper, petrochemicals, natural gas processing, oil refining)

CCS is endorsed by the highest echelons of science and academia which confirm that it is the only mitigation technology able to deeply decarbonise large industrial sectors. CCS is the only technology capable of reducing large-scale emissions from myriad industrial sources, particularly the gigantic steel, cement and petrochemical industries.

It is the only clean technology able to address emissions across major industrial sectors (including steel, chemicals, fertiliser, pulp and paper, petrochemicals, natural gas processing, oil refining).

A shining example of CCS application in industry is the Al Reyadah Carbon Capture Storage and Utilisation (CCUS) facility in UAE. This is the world's first CCUS installation in the steel sector.

[1] https://www.iea.org/topics/carbon-capture-and-storage/

GLOBAL CCS INSTITUTE

3. CCS is the conduit to a new energy economy of hydrogen production, Bioenergy with CCS (BECCS), Direct Air Capture (DAC) and Carbon to Value (C2V) representing a raft of CO_2 re-use applications

Hydrogen

CCS applied to hydrogen generated from coal and methane (natural gas) creates no CO_2 emissions. Several CCS clean hydrogen initiatives are active at the planning and feasibility stages in Europe (Magnum in the Netherlands, Leeds City Gate Project, Cadent in Liverpool/Manchester), Scottish Gas Networks, HyDeploy in the UK).

In Australia, a recently launched project called the Hydrogen Energy Supply Chain (HESC) will pilot turning Australian brown coal into clean hydrogen for export to Japan for use in heating, cooking and transportation.

Other Products (C2V)

CO_2 is also being innovatively used to manufacture new carbon to value (C2V) products including fertiliser feedstock (SABIC in Saudi Arabia), soda ash (Carbon Clean Solutions in India), foams used in mattresses and upholstered furniture (Cavestro in Germany), bricks and cement (Australia's Mineral Carbonation International). These game-changing attributes create jobs and preserve communities.

BECCS

BECCS or Bioenergy with Carbon Capture and Storage refers to the application of CCS to bioenergy production. BECCS offers large scale negative emissions when CCS is applied to the transformation of trees and crops into energy fuels. The Institute supports BECCS alongside organisations including the Royal Society, the International Energy Agency, Stanford University and Imperial College London (amongst others). However, we are cognisant of the impact BECCS has on countries where crops need to be prioritised for food. Similarly, for BECCS technology to be truly effective in reducing CO_2 emissions, massive tracts of arable land need to be cultivated and these are not always available, or easily utilised[2].

For that reason, the Institute sees BECCS as a proven and important complement to CCS – as long as it uses sustainably sourced biomass-which sits within the portfolio of carbon capture technologies. There are a number of commercially successful BECCS facilities in operation including Japan's Saga City Waste Incineration-To-Energy, Illinois Industrial CCS and Kansas Arkalon.

DAC

DAC is a technology that captures CO_2 from the atmosphere rather than from point sources. Similar to BECCS, DAC can also be a Negative Emissions Technology if it permanently removes the CO_2 by either placing it in geological storage or permanently trapping and utilising it in products.

[2] Carbon Sequestration Leadership forum 2018 BECCS report states that "BECCS has the technical potential to mitigate up to 3.3 GtC per year. However, deployment of BECCS at the technical potential as a major climate mitigation solution will necessitate planting bioenergy crops on approximately 430-580 million hectares of land. This is approximately one-third of the arable land on the planet or about half of the U.S. land area."

CCS technology underpins Direct Air Capture (DAC) whereby CO_2 is removed directly from the atmosphere through the use of chemicals that bind or "stick" to CO_2.

DAC enables CO_2 to be stored or recycled into CO_2 re-use applications.

Like BECCS, the Global CCS Institute does not consider DAC a "silver bullet" to reducing CO_2 emissions but it must be considered part of the arsenal of technologies that need to be deployed to beat climate change. Cost is still considered to be DAC's biggest challenge with cost estimates ranging from $100-600 per tonne of CO_2.

It is anticipated that costs may fall with the passage of California's Low Carbon Fuel Standard (LCFS) which is designed to give investors credits for employing DAC.

There are three notable DAC facilities in operation: Zurich-based Climeworks, Canadian based Carbon Engineering (funded by private investors including Bill Gates, as well as corporates including BHP) and New York based Global Thermostat.

4. CCS creates jobs, sustains communities and builds nations

The clean energy revolution can create new employment and economic opportunities for entire communities through the provision of services including project management, engineering, finance, legal and environmental roles. Additionally, it is adding value through the manufacture of CCS componentry such as boilers and turbines, construction (of new CCS facilities), and CO_2 infrastructure development, notably CO_2 pipelines and related transport facilities.

Early deployment of CCS, especially retrofits, could avoid potential early retirement of productive assets, thus keeping people in employment.

5. CCS is one of the most effective options available to reduce emissions and meet international climate change targets, and there are abundant storage resources to support widespread CCS development

With abundant underground storage resources at our disposal, storage remains the easiest and most logical CO_2 mitigation solution. Most of the world's key CO2 storage basins have been well assessed and almost every high-emitting nation has demonstrated substantial storage potential.

Detailed surveys have been undertaken in many countries, including the US, Canada, Australia, Japan, China, Norway and the UK, where potential storage sites are well defined and well documented. Many other countries are progressing storage studies.

Underground storage remains a common-sense solution, as the late Columbia University Professor, and founder of the phrase "global warming" Wallace S. Broecker said: "Garbage brought disease to the streets. We learned to dispose of it. Sewage poisoned our waters. We learned to treat it. CO_2 threatens to change our climate. Hence, we must learn to capture and bury it."

6. On a like-for-like total system cost basis, CCS is cost effective and costs continue to decrease as more facilities commercialise

Often, CCS is criticized as being high cost compared to wind or solar because the comparison uses the levelised cost of electricity (LCOE) as its measure. This is an incomplete and inaccurate comparison.

LCOE comparisons only address the cost of generation (e.g. what it costs to produce electricity from coal or gas). What matters most is the total cost which includes transmission, distribution, system reliability and resilience. To illustrate, in 2015 Australian generation costs comprised only 28 per of the total cost of a typical eastern Australia Electricity System (the National Electricity Market) electricity bill. LCOE does not include the full system costs, notably the remaining 72 per cent of electricity costs.

Another major influence of cost is the kind of carbon-emitting industry it is being applied to, and where it located (i.e. whether it is in close proximity to an underground storage site or if it is geographically stranded). Other CCS cost determinants are:

- The concentration of CO_2 in the gas stream from which CO_2 is being captured
- The distance to and quality of the storage reservoir;
- The cost of capital and labour in the location where the plant is being constructed.

It is significant to note that CCS costs continue to decline. For instance, since the Boundary Dam CCS facility in Canada began operations (in 2014), savings of more than 30 per cent have been identified for construction of a like (or follow-up) facility.

As a simple law of economics, costs will continue to fall as more facilities come onstream. What is most expensive is not doing anything at all.

7. CCS has been working safely and effectively for 45 years. It is real and happening with 18 large-scale facilities in commercial operation around the world. These facilities are already capturing almost 40 million tonnes of CO_2 per annum and a total of 220 million tonnes of CO_2 has been safely injected underground to date

CCS is real and happening. Currently, there are 18 large-scale CCS facilities in commercial operation with hundreds of others at various stages of development around the world.

In China alone, there are eight CCS facilities poised to come onstream in the next 12-18 months and myriad others in development.

In Saudi Arabia and the UAE, its application to industry is being embraced by large industrial facilities, and in the Netherlands, Norway and the United Kingdom, CCS “hub and cluster” developments are progressing.

Monitoring undertaken since the Val Verde CCS Facility began operating in Texas in the 1970s demonstrates that CO_2 can be safely stored deep below ground. Oil, gas and naturally-occurring CO_2 reservoirs have proven that fluids can be safely sealed underground for millions of years. CCS projects target the same geologies.

8. CCS is the only technology capable of effectively eliminating all fossil fuel emissions

CCS is a pragmatic technology with wide application enabling it to bridge the gap between our current fossil fuel dependence and a future which is fossil free.

CCS is the only technology able to curtail emissions from the more than 500 new coal plants currently being built around the world (and the additional 1000 in planning). In the IEA's Sustainable Development Scenario, around 210 gigawatts of coal plants are fitted with CCS globally, 150 GW of which are in China.

CCS' ability to retrofit aged coal plants keeps jobs and economies alive as the world transitions to a low carbon future. Even critical and supercritical coal technologies like HELE technology need CCS to mitigate CO_2 emissions.

The Institute does not consider fossil fuel energy technologies including HELE coal and gas generation as truly 'low carbon emissions technology' unless they are fitted with CCS.

9. CCS complements renewables by decarbonising industries which renewables cannot penetrate – notably, steel, chemicals, fertilisers, petrochemicals, paper and plastics, and flexible natural gas

International climate change bodies (IPCC, IEA) confirm that CCS is the only mitigation technology able to deeply decarbonise large industrial sectors.

CCS and renewables are partner technologies working towards the same decarbonised objective.

CCS is also demonstrating its suitability to industrial "hubs and clusters" where it can decarbonise a swathe of diverse industrial facilities within the same geographic location. Notable Hub and Cluster projects are in early development in the Netherlands (*Rotterdam Backbone*), the United Kingdom (*Teesside Collective*) and Norway (*Northern Lights*).

10. Policy confidence is needed to sustain investment in CCS

CCS requires clear timeframes, a carbon value and an understanding of how carbon values' change over time. It also requires clarity regarding eligibility (who can access it).

Specific policy confidence apparatus/mechanisms are:

- Economy-wide market reduction targets including nationally determined contributions (NDCs);
- CCS-specific legal and regulatory regimes which address all aspects of the project lifecycle
- Removal of CCS barriers such as the London Protocol;
- Introduction of a carbon value in countries where none exists (e.g. Norway's carbon tax, and the recently introduced US 45Q legislation);
- Policy predictability that ensures that large capital investment and long gestation/asset life of CCS facilities are not jeopardized by overt changes in political direction;
- Transparent public engagement which continues to build support across all stakeholder echelons; Robust research and development support.