HOW CARBON CAPTURE AND STORAGE CAN BE USED

Carbon capture and storage (CCS) has a role to play in bringing down greenhouse gas emissions across Scotland – from large industrial sites to individual homes and cars.

Renewable energy in Scotland has achieved a great deal in reducing Scotland's greenhouse gas emissions by producing electricity with minimum carbon dioxide (CO_2) emissions. In future, renewable electricity could play an even greater part, replacing fossil fuels to provide heat and transport and thus removing millions of small sources of CO_2 that add up to around 50% of our total emissions. However, electricity isn't the only option, and in some cases it isn't an option at all.

- Hydrogen could be used to replace gas for home heating, and hydrogen fuel cells could replace fossil fuels in transport.
- Some industries, such as steel manufacture, need such large amounts of heat that electricity just couldn't provide it.
- And there are some industries, such as cement, that will produce CO_2 as part of the process, regardless of which fuel is used as an energy source.

In all of these cases, CCS is needed to remove and store the CO_2 that would otherwise be vented to the atmosphere.

The development of CCS has evolved from the need to limit or reduce the amount of carbon being emitted. But what if CCS could remove excess carbon from the atmosphere as well? This is the concept of "negative emissions," where capturing and storing CO_2 from materials derived from plants and animals, or directly from the air, permanently removes it from the planet's carbon cycle.

SCCS is the largest CCS research partnership in the UK. We work with industry, government and academic partners worldwide to unlock the potential of CCS. Our track record includes research collaborations, joint projects with industry, knowledge exchange, international projects and a world-leading education programme.

Our partner institutes are British Geological Survey, Heriot-Watt University, the University of Aberdeen, the University of Edinburgh and the University of Strathclyde.

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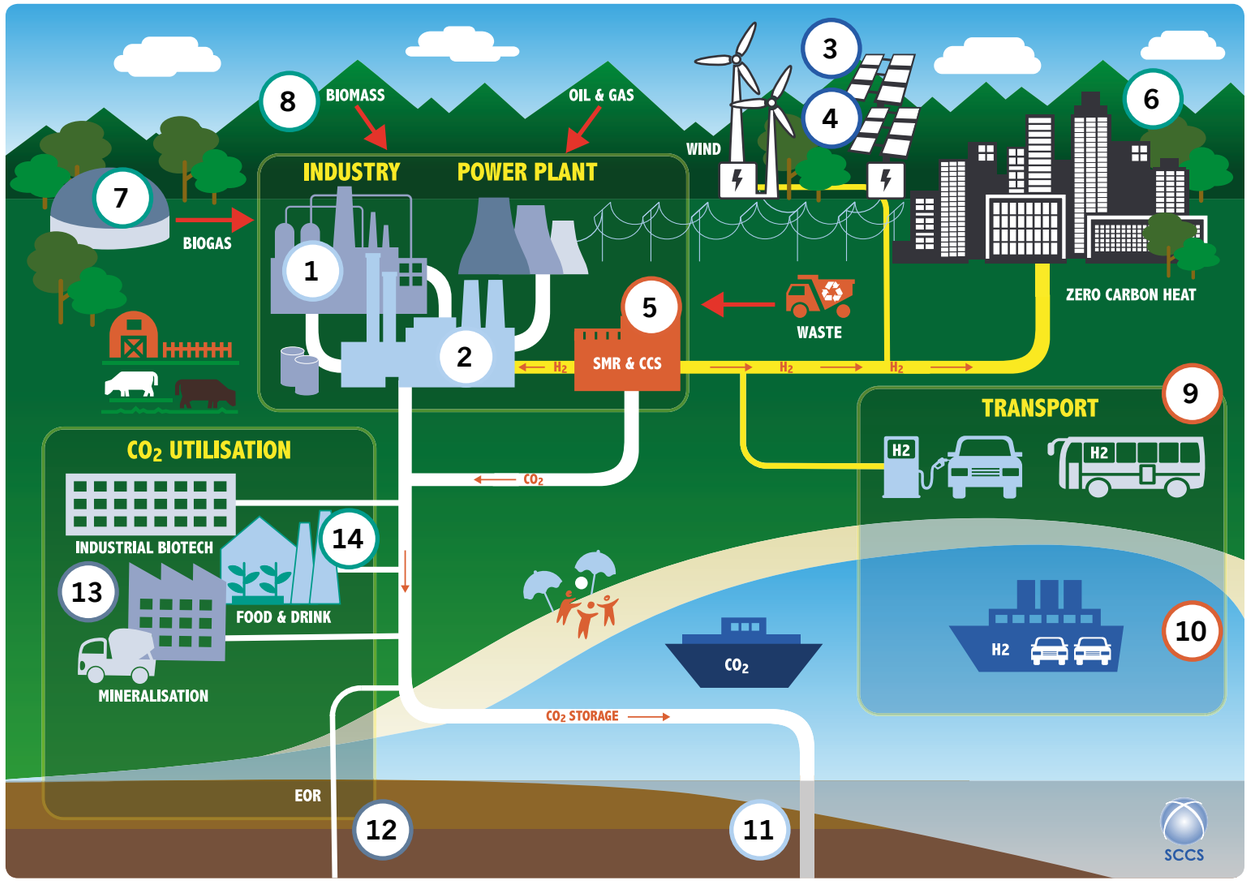
1 CCS is needed in industries that use fossil fuels to provide high levels of heat, which cannot be replaced with electricity. It is also needed for industries that produce CO_2 as part of their processes, such as steel, cement, and some chemical and refinery processes. CCS is currently the only way to reduce emissions from these industries, other than ceasing production or moving abroad – which would lead to job losses and the same emissions being produced in another country.

2 CCS can reduce carbon emissions from electricity generation at power plants using fossil fuels. Despite the move to renewables, this source of power may still be needed to balance out the variability of renewable energy production.

3 CCS is not in competition with renewable electricity: both are needed to reduce greenhouse gas emissions, along with global efforts on energy efficiency and significant changes in consumer behaviour.

4 CCS will bring down the lifecycle emissions associated with renewable energy by decarbonising the production of cement and steel, two materials that are essential for building and installing renewable electricity systems.



5 Hydrogen, which burns without emitting CO_2, can be produced from natural gas using a process called steam methane reforming (SMR). This produces CO_2 which can be captured and stored through CCS, thereby creating a clean and sustainable fuel for heat and transport.

6 It is also possible to capture CO_2 from the air, thereby creating negative emissions. This is more costly than capturing CO_2 from more concentrated point sources, but it can be carried out anywhere. Deploying this technology close to CO_2 storage sites would reduce its CO_2 transport costs.

7 Biogas and landfill gas are the result of anaerobic digestion – organic matter breaking down without oxygen – which produces CO_2 and methane. Capturing the CO_2 from this contributes to negative emissions. Methane can be used as a fuel or to produce hydrogen, with CCS.

8 Wood and waste products from biological sources can be burned to generate heat, electricity or both. Capturing the CO_2 from this contributes to negative emissions.

9 CO_2 is produced when we burn fossil fuels in vehicle engines and for heating domestic, commercial and public buildings. It isn't feasible to capture CO_2 from these dispersed sources. However, CCS can be used in the production of low-carbon hydrogen, which can replace gas, oil, petrol and diesel for these uses.

10 Hydrogen can be produced by electrolysing sea water, which does not produce CO_2 but requires a great deal of energy. This process is only worthwhile if there is surplus energy from renewable sources. As renewable electricity generation increases in future, the potential for making hydrogen through electrolysis will increase – until then, SMR with CCS can produce the hydrogen needed to enable us to quickly convert our heating and transport systems to low-carbon fuel.

11 In order to have a beneficial impact on climate change, captured CO_2 must be stored permanently so that it doesn't reach the atmosphere. The UK is fortunate that its geology is well-suited to secure offshore CO_2 storage – very few countries have this option, and this means that the UK has the opportunity to provide a CO_2 storage service to other countries in future, allowing a valuable service industry to develop.

12 CO_2 can be injected into oil fields to increase the amount of oil produced – known as enhanced oil recovery (EOR). If CO_2 injection continues after the oil has been recovered, the amount of CO_2 stored can more than offset the CO_2 resulting from the increased oil produced.

13 Instead of being stored, captured CO_2 can be used to make new products, such as building materials, fizzy drinks, fuels and the fire retardant in fire extinguishers. However, in most instances, the CO_2 will sooner or later be released to the atmosphere, where it will contribute to climate change.

14 Brewing and distilling as part of the drinks industry depend on fermentation to produce alcohol, and this releases CO_2, which can be captured and stored. This is another opportunity for negative emissions.