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Why carbon capture should be in Singapore's green toolkit

A "Southern Lights" project will not only help stash away carbon emissions, but also develop a hydrogen fuel industry

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As a responsible nation, Singapore is doing its part to help global efforts in bringing down carbon emissions.

The options in its toolkit are many and varied – they include enhancing energy efficiency, ramping up solar energy adaption, electrification of transport, and reforestation. The Republic is also exploring the potential of green hydrogen and importing renewable electricity via the regional power grid.

But there is a less-often mentioned technology that should not be overlooked by Singapore – carbon capture and storage, more commonly referred to as CCS.

Capturing carbon dioxide (CO_2) from industrial sources and then storing it permanently in underground geological formations is one of the few mature technologies capable of preventing millions of tonnes of industrial CO_2 from being emitted into the atmosphere each year.

According to the Global CCS Institute, there are currently 28 large-scale projects operating worldwide, storing away 41 million tonnes of CO_2 a year. More are being planned.

One such project is in Norway. Last September, the Norwegian Parliament decided to invest up to US$1.8 billion (S$2.4 billion) in the Longship CCS project, which will come onstream in 2024. The project, also known as "Northern Lights", will capture 0.8 million tonnes of CO_2 a year from two industrial sources (a cement factory and a waste-to-energy plant) on the south coast of Norway.

The captured CO_2 will be shipped by tankers over approximately 1,000km to Norway's west coast, from where it will be permanently stored beneath the seabed. There are plans to expand the amount stored to five million tonnes per year by accepting CO_2 from other European countries.

Singapore could potentially launch its own "Southern Lights" project to decarbonise petrochemical and power plants located on Jurong Island.

How will it work?

The CO_2 from different plants could be directed to a central processing facility. By using a technology known as post-combustion carbon capture, the central plant will use liquid solvents, solid sorbents, semi-permeable membranes or a combination of them to capture CO_2 from the flue gas. The captured CO_2 can then be compressed into liquid form to be transferred to a nearby terminal for shipment to a suitable location for permanent storage.

Post-combustion CO_2 capture is a relatively mature technology although research is being done to increase the capture efficiency to reduce the cost. The liquified natural gas terminal on Jurong Island may be modified to handle loading of liquid CO_2 into tankers.

Potential locations for permanent CO_2 storage include saline offshore aquifers and depleted onshore gas reservoirs within a 1,000km to 1,500km radius from Singapore.

There is potential to expand the project on a regional scale to an Asean "CCS corridor".

By mapping regional industrial CO_2 sources and sinks, Singapore, together with other Asean member states, could build the foundations of such a corridor that will collect CO_2 from more than one country and store it in a common geological location.

By relying on economies of scale, an Asean CCS corridor can reduce the cost of CO_2 shipment and storage. Such a project will be a first for Asean. It will likely require the cooperation of multiple companies and governments. But a successful "Southern Lights" project has potentially substantial benefits for Singapore that go beyond slashing its carbon emissions.

An additional benefit is the creation of a hydrogen industry for Singapore.

Here's why – imported natural gas can be converted into hydrogen by a chemical process called methane steam reforming. By mixing natural gas with steam at a high temperature with the help of a catalyst, this process converts natural gas into hydrogen and CO_2.

The hydrogen may be sold as a clean energy carrier for use in hydrogen fuel cell vehicles, as well as for heating and as feedstock for industrial use. The CO_2 produced may be removed by CCS. This process will allow Singapore to become a producer of hydrogen for both domestic consumption and export.

Already, countries such as Japan and South Korea are planning to import hydrogen from overseas and include it in their future energy mix. It is estimated that the global market for low-carbon hydrogen will grow from 87 million tonnes today to over 200 million tonnes in 2030.

There is much for Singapore to benefit if it can become a regional hub for exporting hydrogen. CCS will be a key enabling technology for this to happen. New industries such as CCS and hydrogen may well become one of the new growth engines for the Singapore economy.

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