Björn Windén is a Ph.D. candidate at the University of Southampton. He received his Master of Science degree in 2009 from the Royal Institute of Technology (KTH) in Stockholm, Sweden. His interests lie within the field of Naval Architecture and especially ship-wave interaction.

Mingsheng Chen is a Ph.D. candidate at the National University of Singapore (NUS). He received his Bachelor degree of engineering from Shanghai Jiao Tong University (SJTU) in 2009. His research interests focus on hydrodynamics and dynamic simulation of marine structures.

Naoya Okamoto was born in 1986. He received a Master of Science degree in Marine Engineering from Yokohama National University in 2011. He is currently working at the Universal Shipbuilding Corporation's Research Centre. His research area is hydrodynamics, ballast free ship, sloshing and ship hull form etc.

Do Kyun Kim is a Ph.D. candidate at Pusan National University (PNU), Korea. Born in 1984, he received his Bachelor Degree of Engineering in 2008 and his Master Degree of Engineering in 2010 at the same institute. His interests lie in Strength Analysis of Ship and Offshore Structures.

Elizabeth McCaig graduated with a MEng degree in Naval Architecture from the University of Newcastle upon Tyne in 2007. She subsequently joined Lloyd's Register as a Graduate Trainee. She is now based in plan approval and is a member of the Lloyd's Register Ship Emergency Response Service on-call team.

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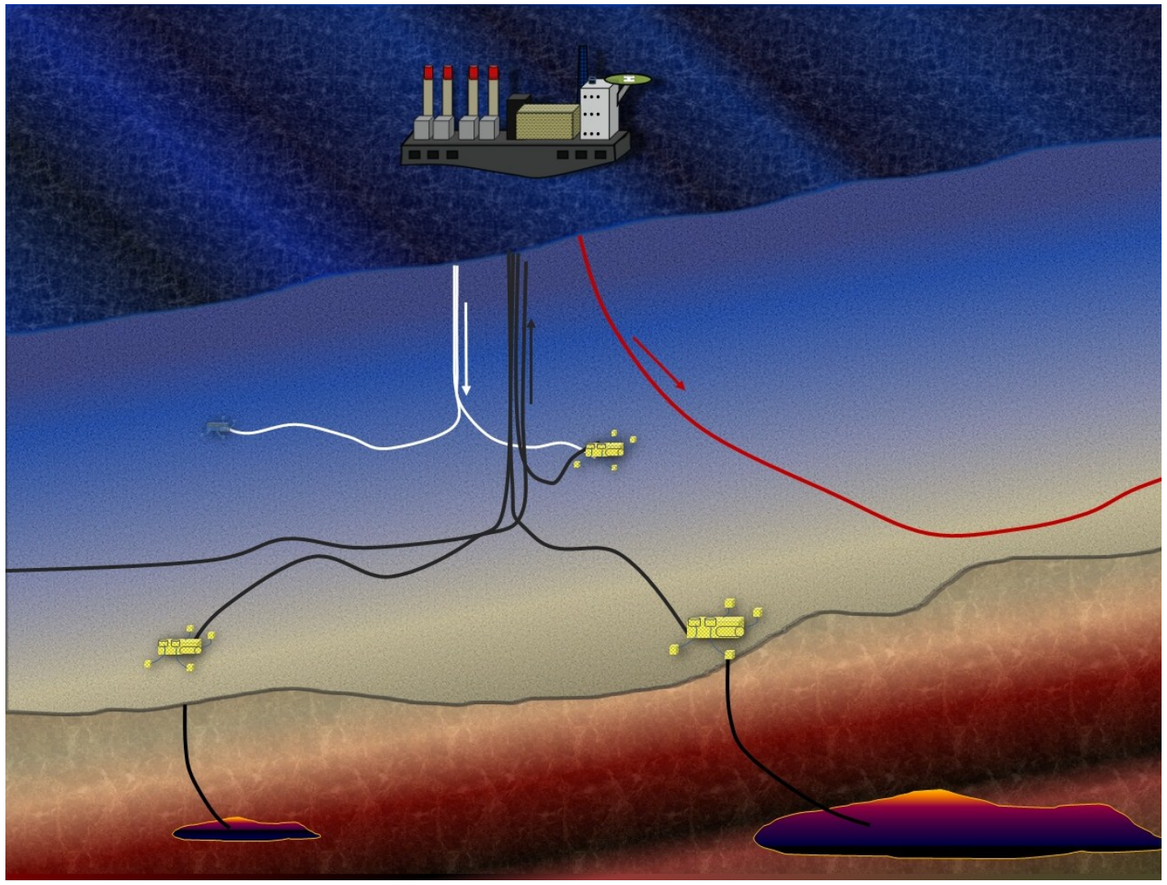
Offshore Thermal Power with CCS

An Alternative to CO_2 Transportation



BJÖRN WINDÉN, MINGSHENG CHEN, NAOYA OKAMOTO,
DO KYUN KIM & ELIZABETH MCCAIG

Lloyd's Register Educational Trust

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One of the main problems facing the world at the moment is Global Warming. This is where the global air and water temperatures are increasing, possibly leading to a rise in sea levels. This could cause flooding in low lying areas such as Norfolk or the Netherlands. One of the main reasons why this is happening is because there are more greenhouse gases in the air. Greenhouse gases include carbon dioxide (CO_2), methane, and ozone and are called greenhouse gases because they make the earth act like a giant greenhouse. The more of these gases there are in the air, the warmer the earth gets. One way to stop global warming is to lower the amount of these gases we put into the air. The main gas that needs to be reduced is CO_2 which is produced when oil, natural gas and coal are burnt. There are a few ways in which we can reduce the production of CO_2. Governments tell us to use less heating in our houses, switch off televisions and lights when we don't need them and switch to electric cars. The problem is that none of this is enough. It is thought that the amount of energy we require will double by 2035 and the amount of electricity we need will triple. More of our electricity could be produced using renewable energy such as wind, water and solar power. However, renewable energy will not be enough for our needs. We could use nuclear power but this would be an unpopular choice and we don't know what to do with the radioactive waste. As we will not be able to obtain enough electricity through renewable or nuclear energy, we will be forced to continue using fossils fuels (oil, gas and coal) to produce our electricity. This means that increasing amounts of CO_2 will be released into the atmosphere. One solution to prevent the increase in CO_2 levels could be to capture the CO_2 after it is produced and store it. This is known as Carbon Capture and Storage or CCS for short.

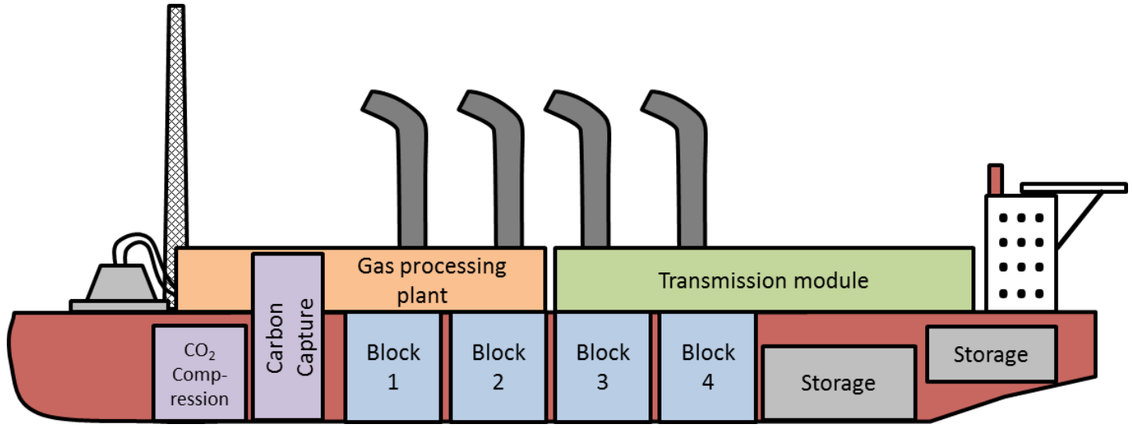
There are two main ways to capture carbon dioxide; before the fuel is burnt and after the fuel is burnt (post-combustion). The method that is most likely to be used in the near future is post-combustion. Using this method it is possible that between 80% and 95% of the carbon dioxide produced by a single source could be captured and stored.

There are four main sources of carbon dioxide production. These are power stations, transport (cars, planes, ships etc.), industry (steel mills, factories etc.) and heating our homes. The biggest source is power stations so it makes sense to focus on this area. A single power station can produce millions of tonnes of carbon dioxide every year and if most of this captured, then that's millions of tonnes that doesn't get into the air.

Once the carbon dioxide is captured, it needs to be stored. This is done by pumping it thousands of metres below ground into empty oil or gas fields or in underground lakes. It is also possible to store carbon dioxide in the oceans. It is more likely that storage sites offshore will be used because companies won't have to worry as much about what people think. It is also more likely that carbon dioxide will be stored below the seabed as using the ocean could kill fish.

Before the carbon dioxide can be stored, it needs to be transported. If the storage site is offshore, then pipelines or ships can be used. When the storage site is less than 1000km from land then will be cheaper to use a pipeline. The cost of transporting carbon dioxide is quite low compared to the cost of capturing carbon dioxide but it one of the most complicated parts of CCS. One way of removing the need to transport the carbon dioxide is to move the source of the carbon dioxide to the site where it will be stored.

Offshore thermal power with CCS is one way to do this. Thermal power is where electricity is produced using coal, oil or gas and in this case, natural gas is the most suitable option. Moving a gas power station offshore has several advantages. As well as there being no need to transport carbon dioxide, there is no need to transport the gas either. Instead, the electricity is transported back to shore using cables. The power station can be moved to where it is needed and can also be used in deep water. This allows gas that couldn't be pumped out before to be used. The question now is whether the offshore power station with CCS is cheaper than a power station with CCS on land.



So that this question could be answered, a case study was created. In this case study a site was selected and costs of the offshore power plant were worked out. Costs were also worked out for an onshore power plant. The country chosen for the case study was Australia. This is because Australia has both gas fields that are not being used and possible carbon dioxide storage sites close to these gas fields. The Australian government is also very keen to use CCS. This is important because for a CCS project to work, there needs to be support for it.

The offshore power plant with CCS has several different parts. First, there is the power plant itself. This is a combined cycle gas plant which uses gas turbines to produce electricity. Heat is also produced and this heat is used to drive steam turbines which also produce electricity. There are eight gas turbines and four steam turbines which split into four blocks. Each block produces 135 MW of electricity and the total amount of electricity produced is 540 MW. Using both gas and steam turbines allows more electricity to be produced from the same amount of natural gas.

This natural gas comes from a gas field that has a pipe drilled into it. The gas is then pumped up to the power station. Before the gas can be used, it needs to be cleaned.

This is done in a gas processing plant which is also on board the offshore power plant.

These parts are inside a ship-shaped structure. There are a few different options for the type of floating structure that could be used. The ship-shaped structure was chosen because it was the best type for the location and also the cheapest.

As well as producing heat, the gas turbines also produce exhaust fumes. Some of this exhaust is carbon dioxide which is taken out of the exhaust using carbon capture. The carbon dioxide is then compressed so it takes up less space and is then pumped below the seabed where it is stored.

The electricity produced by the power plant is sent ashore using cables which are laid on bottom of the ocean on the seabed. The site that was finally chosen is 285 km from the coast which means that 285 km of electricity cable is needed. The onshore power plant needs 285 km of natural gas pipeline and 285 km of carbon dioxide pipeline instead of the electricity cable.

When all the different costs were added together the cost of offshore power plant with CCS was between 7.3 and 7.7 cents per kWh which is the standard unit of electricity. The cost of the onshore power plant was between 8.5 and 8.9 cents per kWh. This means that putting power stations offshore is cheaper so long as CCS has to be used.