The development, demonstration and deployment of low carbon technology – the case for CCS

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He became a Group Managing Director in 2002 and Executive Director of Exploration & Production in 2004.

He is a Fellow of the Institutions of Civil and Mechanical Engineers and a Council member of the Royal Academy of Engineering. He was appointed CBE in 2002 for services to the UK oil and gas industry.

He is a member of the Nigerian President's Honorary International Investor Council, a Trustee of the Emirates Foundation, The Shell Foundation and the International Business Leaders Forum.

CO_2 Capture and Storage (CCS) is a key technology in reducing greenhouse gas emissions from fossil fuels, in particular from coal-fired power. But open up the early negotiating text now being prepared for the climate conference in Copenhagen, and CCS barely gets a mention. In this speech, Malcolm Brinded lays out the case for CCS. To move CCS from demonstration to deployment, CCS should get specific mention in the overarching statement in the overall Copenhagen agreement. In addition, we need a sector-specific "satellite-agreement" for coal-fired power, aimed at enabling funds to flow from existing carbon markets in OECD countries to CCS-projects in developing nations, especially China, India and South Africa.

Intro

I think we're all agreed on the importance of Copenhagen delivering something really meaningful, given the scale and urgency of the greenhouse gas challenge.

And I hope we agree that there isn't a single technology or policy answer – a silver bullet – that will solve all our problems at once.

We need a comprehensive, balanced set of policy measures and technologies – and we need them all.

Let me list five things we need to do:

The first priority must be: energy efficiency and conservation – for both producers and consumers.

Second, the world needs to grow the share of biofuels, wind and solar power, as well as nuclear power.

Third, we need urgent and large-scale deployment of CO_2 Capture and Storage, to reduce emissions from coal-fired power stations and other large industrial CO_2-emitters.

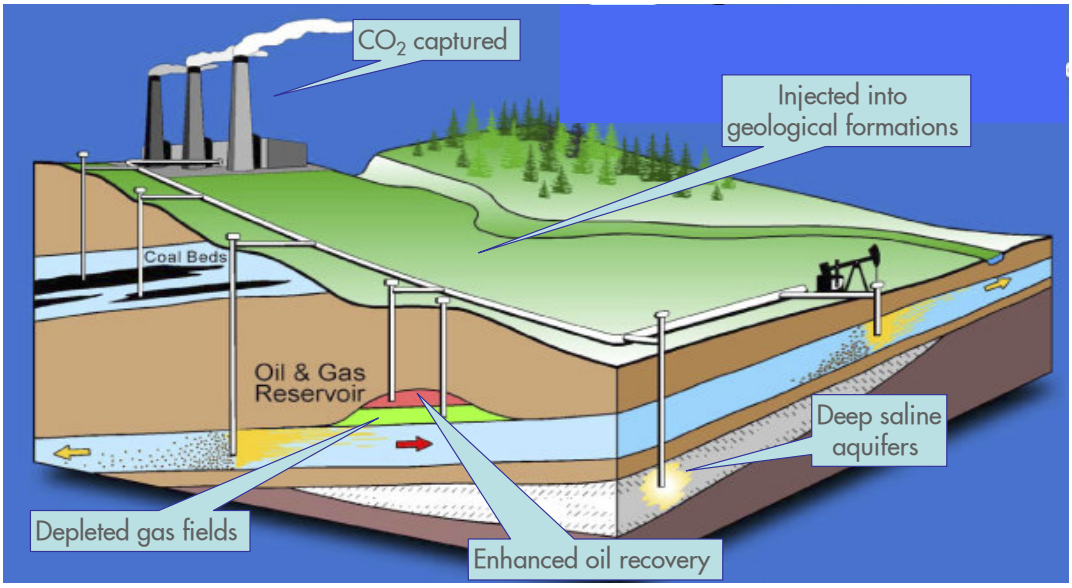
Fourth, society should address *non*-CO_2 emissions - other greenhouse gases - including methane, nitrous oxide and chemicals such as sulphur hexafluoride.

Fifth, we must address man-made CO_2 emissions from sectors other than energy, such as those caused by deforestation and land degradation.

And let's not forget the cement industry, which is a carbon-based industry based on converting limestone at high temperatures. Across the industry globally, every tonne of cement that gets produced, results in around 800 kilogrammes of CO_2 emissions. If you add that up, a continued high-growth unabated cement industry could emit as much this century as the full use of current proven natural gas reserves.

There are abatement possibilities for the cement industry. For instance, at Shell we have developed a concrete enhanced by sulphur, called Shell Thiocrete. Studies have shown that Shell Thiocrete could reduce the lifecycle CO_2

Figure 1:
CO_2 Capture and Storage



impact of concrete by 30-50%. The reduction level depends on the specific nature of the application – think of sea walls, pavements and road barriers. Research is currently underway to further extend its applicability and maximise potential CO_2 reductions.

So, five things we need to do. They need to be done, and they need to be done urgently.

But open up the early negotiating text now being prepared for Copenhagen, and nearly half of this doesn't get a mention. Apart from land use and forestry, the remainder gets scant mention. Even the notion of a carbon market to drive large-scale deployment is barely touched upon.

I think it is time to replace arcane wording and abstraction with clarity , focus and above all, action. With just 4000 days available to reduce developed country emissions by 20% and see emissions plateau in most developing countries, we no longer have the time for anything less than clearly specified large-scale demonstration and deployment programmes, with matching funding and financing to ensure implementation.

The case for CCS

Today I'd like to zoom in on one of the clean energy options on the table: CO_2 Capture and Storage, or CCS.

According to the Intergovernmental Panel on Climate Change (IPCC), CCS could potentially deliver around half of the total emissions reduction needed to stabilise global CO_2 levels by the end of the century.

I hope that climate negotiators will give CCS high priority in the draft texts being negotiated as the basis for a Copenhagen agreement.

So let me discuss the following questions:

- What's the case for CCS?
- What are the key deployment challenges for CCS, and what would be possible solutions?
- How would CCS fit into a broader climate policy framework?

We all know energy demand will increase during the first half of this century, and that tackling climate threats is an urgent task.

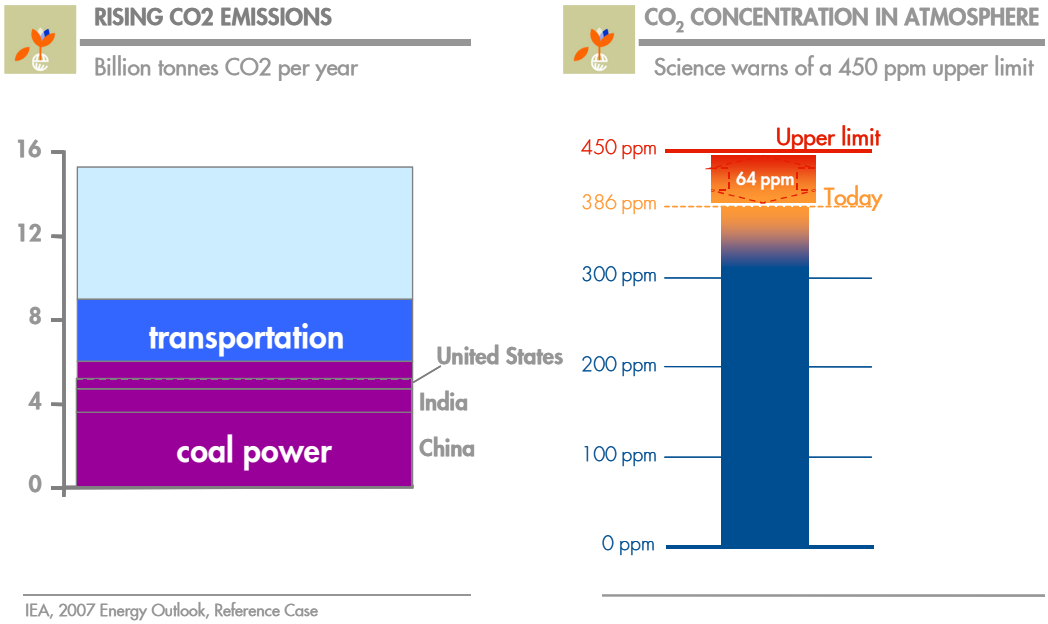
What is very striking is how urgent the task is, how little carbon space there is left, and how much of that space will be taken up by coal-fired power alone!

If we want to limit atmospheric concentrations of CO_2 to 450 parts per million, we have only around 64 ppm left.

Around 40% of that space will get taken up with existing and new-build coal power generation in just three countries- China, India and the United States - between now and 2050, if no measures are taken to abate emissions.

What's more in the period to 2030, according to IEA statistics, the *growth* in CO_2 emissions from *new* coal fired power generation in these same three countries would be *double* the growth in emissions from *all* the transport in all

Figure 2: The CO_2 Challenge



countries worldwide.

In that period, just over a thousand new power stations will be built in these three countries.

So it's crucial – and it should be feasible – for at least the *new* plants to be fitted with CCS technology.

While that presents a major challenge, it's a really important opportunity to reduce emissions through CCS. It should also be much easier to regulate and influence 1000 or so new power stations in 3 countries than several billion transportation vehicle purchase decisions across the entire world.

But to capture this opportunity we have to be ambitious. For CCS to fulfil its abatement-potential, we should have it installed at 90 per cent of all the coal and gas-fired power plants in OECD countries by 2050, and at half of those in non-OECD countries.

The result of such an aggressive CCS deployment would be around 230 gigatonnes lower CO_2 emissions by 2050 – that's more than 5 years' worth of total global CO_2 emissions by 2050. And according to the climate experts at Massachusetts Institute of Technology (MIT), deploying CCS at this scale would result in around 60 ppm lower atmospheric CO_2 concentrations by the end of this century.

There are people who believe that we should not do CCS at all, and focus only on growing renewable energy instead.

But such an approach would just not get us to where we need to be nearly fast enough .

If we wait for alternative energy to reach material scale, we will simply find it impossible to curb CO_2 emissions in time.

Historically, it has taken decades for new energy sources and carriers to obtain a 1 percent share of the global market following commercial introduction.

Shell's scenario experts believe that renewable sources could provide around 30% of the world's energy by the middle of this century, from around 3% today.

That would be impressive growth, - much faster than previous new energy sources have grown, but it also means that it will take forty years to get there, and that fossil fuels and nuclear will supply the remaining 70% even then.

To illustrate the challenge, in the case of wind, the world will need another 1-1.5 million turbines covering an area nearly the size of France in order to reach just 10% of global electricity generated by 2030. That means expanding today's worldwide turbine production of around 15,000 a year to just under 100,000 a year by 2030.

In other words, if we are serious about addressing climate risk, we must also address emissions from power stations and other large industrial facilities that emit CO_2 today, and from the new ones that are planned, that will together continue to emit for many, many years, unless we do something about it.

And, realistically, there's only one

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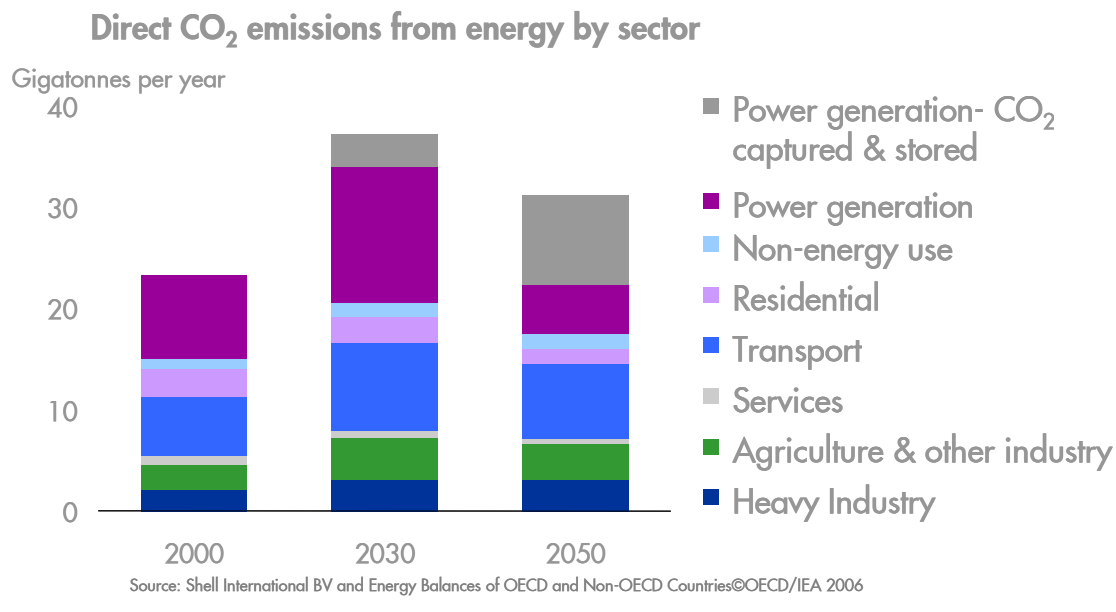
Figure 3:
CCS abatement potential



technology available today to help us do that: CO_2 Capture and Storage.

Demonstration to Deployment

For now, CCS is still in the demonstration phase.

There are some small-scale CCS projects – and we are in several ourselves as Shell including CO_2 SINK in Germany, Mongstad in Norway, Westcarb in the US, Weyburn and Quest in Canada, and the Otway Basin project in Australia. But with a total CO_2 storage rate of around 3 million tonnes per year globally, there's still a huge gap between where we are today and realising the full potential of CCS.

To fix that gap, we need to scale up.

We need more and bigger demonstration projects, so we can select the best and most-cost effective solutions, develop a business model, and address public concerns about storing CO_2 underground.

But not many large-scale demonstration projects see the light of day. Why?

CCS technologies in operation today

The problem is not the technology itself. All elements of CCS – capture, transport, re-injection and underground storage – are in operation today.

For instance, Shell's Rotterdam refinery already collects around 400,000 tonnes per year of pure carbon dioxide and pipes it to Dutch greenhouse-owners to boost the growth of vegetables in the summer; a smaller amount gets transported, by truck, to the soft drinks industry to put the fizz into their drinks. Interestingly, I believe that Coca Cola is currently the only company in the world that owns ships that were purpose-built for shipping carbon dioxide – proving the point that where there's a will there's a way.

CO_2 transportation overland by pipeline is very straightforward and well established. For example, in the United States, the Cortez pipeline transports CO_2 for 800 kilometres (500 miles) from Colorado to oilfields in Texas.

In sequestering CO_2 we would be replicating what we have been doing with natural gas for many years in hundreds of different locations around the world as short-term reserves for cities – for example right underneath the Olympic Stadium in Berlin.

And let's not forget that we have been re-injecting CO_2 for decades to enhance oil recovery from ageing oil fields. Currently, in North America, the industry is re-injecting approximately 30 million tonnes of CO_2 per year – ten times the amount the world is storing through the CCS projects I mentioned earlier.

What still needs to be put into practice is the joining up and operation of the various technologies, and especially their large-scale incentivisation and implementation.

Public acceptance

Lack of regulatory frameworks for issues like liability and rules for storage, as well as public acceptance, do constitute challenges. The EU directive on CCS adopted last December provides a sensible model that splits liability between storage operators, for the duration of the sequestration operations, and governments for the long term, once storage stability has been demonstrated.

But outside of Europe, progress has been slow. And we should not underestimate the challenge of public acceptance for a technology, which is known by experts to be safe, if responsibly executed, but to the layman is novel and to some may even potentially seem alarming.

Public concern focuses on CO_2 leakage from the storage sites.

In most cases this seems to stem from misplaced concern that CO_2 itself might be dangerous - even explosive, which is clearly not the case.

The IPCC believes that a 1% leakage of CO_2 from storage points over a thousand-year period would be what a well-designed storage scheme might emit.

Let's apply that to a real-life example. At the Barendrecht project in the Netherlands, our aim is to store 10

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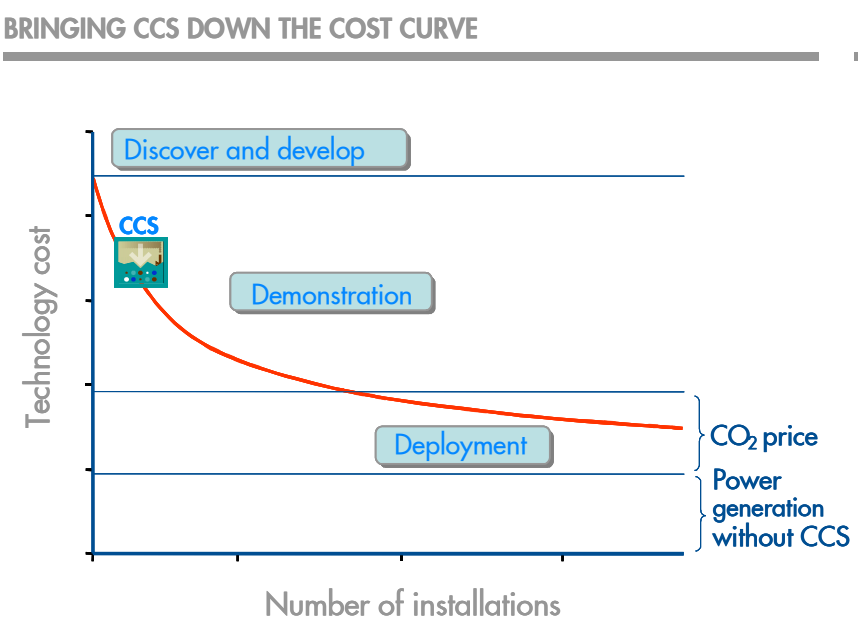

Figure 4: CCS cost curve

million tonnes of CO_2 over a twenty-five year period. Once filled completely, that would give a leakage rate - using the IPCC estimate - of about 100 tonnes per year, or 270 kilogrammes per day.

Yet the average European emits around 10 tonnes of CO_2 each year through direct and indirect use of energy. This means the Barendrecht leakage limit roughly equals the CO_2 generated by just ten human beings.

As is often the case, it is clear that we as industry need to get better at getting our messages across on CCS more simply and effectively If we manage to explain the facts to regulators and citizens, then I am confident these liability and public acceptance issues can be resolved – as they have been over many decades for natural gas storage and pipeline transport.

The CCS cost curve

Really the dominant factors holding us back are cost and the present lack of a source of revenue for CCS .

Bringing zero emission power plants down the cost-curve is far more difficult than for, say, the next generation of mobile phones, where early buyers partly fund the demonstration and improvement of a new technology.

CCS has no obvious early customers.

Remember, CCS projects of themselves don't bring in revenues. You need to have a CO_2 price, a value for reducing emissions, for CCS to take off.

But if we want to even reach the point where CCS projects sustain themselves on the basis of a strong CO_2 price, we will need careful shepherding and help of the technology in these early days.

Demonstration will not be completed without decisive public support in the form of direct funding and incentives to support industry initiative.

And this is where I think the European Union has done a good job.

The EU has created a framework for the demonstration phase, with an ambitious flagship programme of 10-12 Zero Emission projects up and running by 2015, putting industry and governments to work together to achieve this via a technology platform.

And it has addressed the funding issue with incentives, both through the ETS - by recognising CCS and making available allowances for demonstration projects - and through direct allocation of public funds (1.25 billion Euros agreed by the European Council on 19 March).

But for CCS to fulfil its potential, efforts must spread beyond Europe and the OECD and also involve the developing world.

Sectoral coal agreement

We cannot reach 450 ppm unless we take action outside of the OECD.

So the EU approach must be mirrored internationally.

Basically, a framework is needed that allows companies to reduce emissions at the lowest cost, based on the principle that a tonne of CO_2 stored through CCS in India or South Africa is as good as a tonne of CO_2 avoided by, say, a wind power project in the United States or a solar project in Germany. And the world needs all these solutions together to meet the climate challenge.

This means we would see a flow of funds from established carbon markets to developing countries; and a reverse flow of CO_2 certificates back into the carbon markets.

For that to happen, we need the following elements:

First, agreement on an international "flagship" programme which would enable some 25 1GW coal-fired power plants across China, India and South Africa to be fitted with CCS.

Second, CCS is recognised as a mitigation option within the CDM or a new Clean Technology Mechanism, and is supported by an agreed CO_2 storage certification approach. The Clean Technology Mechanism would exist next to the CDM, and would focus on the more complex, more expensive mitigation projects in the electricity and heavy industry sectors.

Third, the EU – and the same would be the case for other existing carbon markets in e.g. the US or Australia – needs to set aside the necessary space within the Emissions Trading Scheme to absorb the flow of CCS credits.

In the case of the EU, the objective to move from a 20% to a 30% reduction by 2020 – in case of an agreement in Copenhagen – would provide that space, because the extra 10% translates into 25 power plants.

Fourth, CCS should be included in multilateral technology funds that focus on the needs of developing countries, such as the World Bank's recently established Clean Technology Fund and Strategic Climate Fund, which the G-8 countries have said they would support.

Conclusion

In summary, CCS is a vital technology in our battle against greenhouse gas emissions, and its implementation needs to be accelerated. Deploying it aggressively is actually doable, but only provided the right policy frameworks are put in place.

Address coal-fired power in just the top 10 coal consuming countries, and you're addressing 90 percent of coal-related CO_2 emissions.

I think that's an important prize - worth a focused, collective effort.

So I hope that CCS will be at the top of the agenda as governmental negotiations intensify in the run-up to Copenhagen.

Having said that, I fully realise and wish to underscore that CCS can only be one component of a comprehensive climate mitigation strategy, which absolutely must include energy efficiency and conservation, as well as growth in renewables, addressing non-CO_2 greenhouse gas emissions, and addressing emissions from sectors other than energy.

Thank you.

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