

What Can CO₂ Capture and Storage Deliver ... and When?

An interview with

Eur Ing Harry Audus, General Manager, IEA Greenhouse Gas R&D Programme¹

For fifteen years, the authoritative website and studies of the IEA Greenhouse Gas R&D Programme ([IEA GHG](#)) have been keeping readers abreast of advances with technologies for combating greenhouse gases. The programme's efforts have focused strongly on technologies for CO₂ capture and storage (CCS).

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Technologies for CO₂ capture and storage (CCS) are attracting much attention in the ongoing debate about how to address climate change and security of energy supply while also safeguarding economic growth. Could you explain this heightened interest in capturing and storing CO₂ associated with fossil fuel combustion?

Harry Audus

I think the heightened attention is a response by policymakers to growing public acceptance that the threat of climate change is real. The Summit of G8 leaders in July 2005 gave a high profile to the policy issues but one should not ignore the early lead taken by several major energy companies. For example, Norway's Statoil, with its partners, have been demonstrating injection and storage of CO₂ under the seabed at the Sleipner platform in the Norwegian section of the North Sea for over 10 years. Also, recent concerns about the security of energy supplies have focused attention on the availability of fossil fuels and, in particular, on the widespread availability of coal. Indeed, it has also put the nuclear power option back on the agenda.



Eur Ing Harry Audus, General Manager, IEA Greenhouse Gas R&D Programme

It is clear that there is no single global solution to the need to reduce greenhouse gas emissions whilst maintaining energy security and economic growth. The options include: increased efficiency in both the production and use of energy, increased use of renewables, more nuclear power, and CCS. A portfolio approach to these options enables policymakers to best meet their energy and security needs, while also reducing the emission of greenhouse gases into the atmosphere. Whilst CCS would be a key component in many energy strategies, I would always expect it to be accompanied by other options.

¹ The [IEA Greenhouse Gas R&D Programme](#) is one of some forty international energy technology R&D programmes operating within the IEA's collaborative framework.

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Is it realistic to believe that this technology can significantly reduce greenhouse-gas concentrations in the atmosphere?

Harry Audus

Completely. The widespread availability and increasing use of fossil fuels make CCS a crucial component in most policy portfolios. Under any reasonable projection, it is clear that increased demand for power and transport fuels will result in a huge global increase in the emission of CO₂ into the atmosphere, unless CCS is widely adopted. We have to find ways of reducing CO₂ emissions from the industrialised world and those developing nations that are rapidly reaching similar emission levels. CCS could be widely deployed geographically. It has been estimated that potential global storage capacity possibly exceeds several hundred times today's annual global CO₂ emissions. CCS is applicable, moreover, to the two fastest growing energy sectors: electricity production and transport fuels. Electricity production is the most obvious application; some 40% of global CO₂ emissions come from this source and CCS can be applied only at stationary points of emission.

On the latter, the use of CCS as a major option to reduce emissions from transport may not be immediately obvious. It can be used to produce 'carbon-lite' electricity for both commercial and private transport. CCS can also be used to produce hydrogen for use in vehicles fitted with reciprocating engines or fuel cells. It would seem indispensable in production of liquid fuels from coal.

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How does CCS actually function, technically?
What are the best points for capturing CO₂ today?

Harry Audus

CCS has been described as a 'carbon management' solution. In principle it is quite simple. The carbon bound up in fossil fuels is burnt to produce energy and then put back underground in the form of CO₂. I think this explains much of the CCS activity among energy suppliers, who are aware that they have a responsibility for their product and its use.

IEA Greenhouse Gas R&D Programme (IEA GHG)

Founded in 1991, IEA GHG is an Implementing Agreement within the international collaborative framework of the International Energy Agency. It provides informed assessments of technologies capable of achieving deep reductions in greenhouse gas emissions and facilitates practical RD&D. Wide-ranging reference material and details on IEA GHG conferences can also be found on its [website](#). IEA GHG participants are: Australia, Canada, Denmark, Finland, France, Germany, India, Japan, Korea, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States and the European Commission. Sponsors are Alstom Power Technology AG, BP International Ltd., Chevron Corporation, Electric Power Research Institute, ENITecnologie ApA, ExxonMobil Corporation, RWE Aktiengesellschaft, Shell International BV, Total, Repsol YPF, Statoil, Vattenfall AB and E.ON UK.

The 'best point' to capture CO₂ in a technical sense is where it is most easily done; this usually means when CO₂ is at its most concentrated. In fact, there are industrial processes where high-purity CO₂ is captured as part of the process and not for climate-change reasons. The most obvious example is in the purification of raw natural gas, which often has a significant CO₂ content; this CO₂ would normally be vented into the atmosphere but, in a few locations, it is injected underground as part of projects to demonstrate CO₂ storage.

In terms of reducing emissions, the most effective point for capturing CO₂ is, without doubt, at power stations because they are globally the major source of emissions, and where large quantities are emitted from a single point. We are lucky to have at least three technology options for the capture of CO₂. Two of them are at the stage where large-scale demonstration is needed, and the third is not far behind. However, the capture of CO₂ is only part of the story. The CO₂ then has to be stored in a secure place. The main underground storage options are in depleted parts of oil and gas fields that have demonstrated their isolation from the environment over geological timescales, and in deep saline formations. Saline formations offer the largest capacity, believed to be more than adequate to cope with needs resulting from the availability span of fossil fuels. Unfortunately, these are not as well documented as oil and gas fields because there has been no previous commercial interest in them.

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We've been talking largely about power plants. What about industrial applications? And what can we learn from enhanced oil recovery projects, which have made extensive use of CO₂, or from gas storage?

Harry Audus

There are certainly instances where CO₂ from fossil fuels is captured and put to use. For example, CO₂ is captured during the production of ammonia and then generally used to produce urea, which is most commonly destined for agricultural fertilisers. Today, CO₂ emissions from industries such as cement production, refineries, petrochemicals and the iron and steel industry total some 10% of global energy-related CO₂ emissions.

One of the major uses of CO₂ is in enhanced oil recovery (EOR) where it is injected down the oil well and sweeps out additional oil through what is referred to as a 'miscible flood'. Roughly half the CO₂ injected stays in the oil field, so it is essentially stored. CO₂-EOR is widely used in the south eastern United States and in a few other places. Its adoption relies on suitable financial conditions and a source of large quantities of cheap CO₂. The IEA GHG Weyburn CO₂ Monitoring and Storage Project is a very successful example of using this technology and learning from doing, which is generally one of the best ways to help bring down costs. This project added an R&D component to a CO₂ flood underway at EnCana's Weyburn oilfield. The project was a major international co-operative exercise involving 15 industry and government sponsors, together with 25 research and consulting organisations. The conclusions are too

many to list here but, in summary, it was established that EOR works well as a storage mechanism for CO₂.

Where natural gas is concerned, it is stored in underground formations as a means of balancing demand. This has helped establish the credibility of CO₂ storage underground as it has demonstrated the safe operation of such facilities and resolved various regulatory and legal issues.

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How can we generate confidence that CO₂ can be stored sufficiently safely? What is the role here of current projects that monitor storage?

Harry Audus

Confidence about CO₂ storage in underground formations is not only to do with how safe the practice is but also about ensuring that the CO₂ is stored for sufficient time to be effective as an option for reducing greenhouse gas emissions into the atmosphere. A key requirement on both these issues is selecting suitable safe stores and ensuring effective monitoring of the storage site. There is much global activity in this area; I have already mentioned the Sleipner, and Weyburn projects, and if we include the In Salah demonstration in Algeria this brings the current total amount of CO₂ safely injected and monitored to some 25 million tonnes. We at IEA GHG are heavily involved in this area, running research networks on well integrity, for example, and carrying out measuring, monitoring and verification, along with risk assessment.

But we also need a public debate about safety. People need to understand the fundamentals of storing gases like CO₂. While monitoring and research requirements remain significant, a great deal of relevant experience has already been accumulated through EOR and acid-gas injection activities.

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How would you briefly summarise the current status of research and development? What about demonstration projects?

Harry Audus

I think the present R,D&D status is very encouraging. Both government and industry are putting a lot of effort into establishing CCS technology. Interestingly, the demonstration of CO₂ capture is lagging behind that of storage. The reason for this is probably a combination of two factors: the active role taken by the oil companies, who have the necessary expertise in subsurface activities; and then the high cost of demonstrating CO₂ capture at a power station. I am happy to say that there has been a recent surge in initiatives aimed at demonstrating the integrated operation of CO₂ capture (at a power station) and storage. Such schemes are expensive, involving something like 1,000 million US\$, and securing funding for them is not easy. Within the IEA community and the IEA GHG network we are discussing how we might

help facilitate the formation of demonstration projects through the Implementing Agreement mechanism.

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So what does that mean in terms of timelines for CCS coming into widespread use? What do you see as the main hurdles to be overcome if CCS is to become a reality for the future?

Harry Audus

I am less sanguine here. The costs involved are very large and there is at present no financial incentive to capture and store CO₂. We have had difficulty getting CCS accepted as a Kyoto 'Instrument', specifically in the Clean Development Mechanism, and CCS is not at present used within the EU Emission Trading Scheme. But the Intergovernmental Panel on Climate Change is considering CCS as a viable option to mitigate CO₂ emissions, as noted in its special report presented last year. In another important step, the countries that are contracting parties to the London Convention recently adopted a proposal that sub-seabed storage of CO₂ will be permissible under the terms of their 1996 Protocol. This means that, as from 10 February 2007, sub-seabed CO₂ storage will be legal. Meanwhile, a lot hangs on the outcome of discussions about global incentives for the post-Kyoto period beyond 2012. It is not realistic to expect any major reduction in global emissions without involving the United States and China.

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What role can government play here?

Harry Audus

Individual governments are limited by budgetary constraints but they can be pro-active in forming international agreements and they can selectively lead by example if they encourage developments. Some governments have been very active. And joint initiatives like the Gleneagles G8 Plan of Action and the Carbon Sequestration Leadership Forum help focus attention on what is needed.

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You may have heard that some parties are claiming that commitment to CCS and action might wane once the promise of its greenhouse-gas mitigation potential has given coal-fired power generation a more climate-friendly image. Can we be sure that today's momentum will be sustained and lead to real action in future?

Harry Audus

Actually, this is the first time I've heard this suggestion and can only assume that it comes from a source opposed to use of fossil fuels per se.

In fact, as I mentioned earlier, the fossil fuel industry in general takes the responsibility for its products seriously and has largely led developments, which means that industry is close to being in a position to adopt CCS technology. However, this will not be done without wide-ranging international agreement by governments on the necessity and the means. I do not see why anyone should think that governments might be interested in developing an image for coal-fired power generation that they are not prepared to support.

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Thank you, Mr. Audus, for answering our questions. We wish you well with the continued work of the IEA Greenhouse Gas R&D Programme.

Harry Audus

It has been a pleasure to tell your readers about the importance of CCS in the future energy policy portfolio. We hope they will visit the [website](#) of the IEA Greenhouse Gas R&D Programme regularly.