'Is clean coal the best way to meet spiralling energy needs and save the planet?'

Malcolm Wicks
Energy minister

Yes

Climate change is one of the biggest challenges we face this century, with global warming starting to take its toll. We know one of the greatest contributing factors is CO_2. And we know CO_2 emissions are set to rise. Many scientists and economists, including Sir Nick Stern, have singled out CCS as a crucial technology in the battle against climate change.

Currently, we have to use a mix of energy sources to power our country – fossil fuel, renewable energy and nuclear power. Together they provide us with a reliable electricity supply. And although the use of low-carbon energy sources is growing, fossil fuel will continue to generate power, not just here but around the globe.

Last year's World Energy Outlook predicted global demand for coal will rise by over 70% by 2030. China and India will account for most of the increase – China built the equivalent of one new 1GW coal-fired power station every four days in 2006.

With a 40-year life span, it's unlikely these and other power stations around the world will be decommissioned, so it's essential we tackle the problem realistically and with an international focus.

Carbon capture and storage (CCS) could cut CO_2 emissions from fossil-fuel power generation by up to 90%. The International Energy Agency predicts the technology could contribute up to 28% of the global CO_2 reductions needed by 2050 to stabilise temperature rises at 2C.

The agency also estimates CCS costs could halve as technology develops. And models – including that in the Stern review – show that including CCS in our climate mitigation plans could reduce the cost of cutting CO_2 emissions by up to 60%. It's for these reasons that the government is investing in CCS technology.

A government-supported competition to demonstrate the post-combustion CCS chain on a commercial-scale coal power plant highlights the UK's leading role. Due to be operational by 2014, it opens up huge opportunities. The winners will share their experience and knowledge with others in the UK and internationally. The technology can be retro-fitted to existing plants, so it will be vital in helping countries like China and India become low-carbon economies.

We're well placed to take the lead. Geographically we have some of the best offshore areas in the world to store CO_2. Depleted oil and gas fields in the North Sea can safely contain the gas, with little chance of it leaking. Research by the Intergovernmental Panel on Climate Change predicts that, with appropriate measures, 99% could still be stored after 1,000 years. Strict criteria for selecting storage sites and rigorous monitoring will meet these measures.

We cannot rely on CCS alone. Our power companies already operate under the EU Emissions Trading Scheme, which caps emissions and provides a range of low-carbon technology to invest in. And the Energy Bill includes measures for renewable energy and nuclear power, both low-carbon technologies, as well as a regulatory framework for the safe offshore storage of CO_2.

If passed, the new legislation will support the development of CCS, nuclear and renewable technology – underpinning our long-term energy and climate change strategy. This is not an either/or choice. We need to use every technology in our fight to cut CO_2 emissions.

As part of a secure energy mix CCS is, in my opinion, a valuable technology in the fight against climate change.

ILLUSTRATION TO COME

John Sauven
Greenpeace

No

I agree with our energy minister, Malcolm Wicks. Well, OK, not on everything. But I nodded along when he told the Fabian Society that "the climate is changing, and we have to act," and on energy, "here in the UK we are at a crossroads ... it falls to us to make some very big decisions now, which will have implications for the next 50 years."

He was spot on: today's decisions will make or break our efforts to tackle climate change far more than those taken

CCS technology must not become an excuse for a new generation of conventional coal-fired power stations

decades from now. Which means that the biggest energy issue in Britain today isn't carbon capture and storage (CCS), it's coal. CCS is being used as a smokescreen to cover up the fact that the power utilities and the Department for Business want to build a new generation of coal-fired power stations – whether CCS is shown to be practical, safe and affordable or not.

The application for the first of these new plants, at Kingsnorth in Kent, is with Gordon Brown now. Kingsnorth is not proposed as a CCS power plant, and nor is there any promise from the company that it ever will be. One of the world's top climate scientists, James Hansen, the head of Nasa's Goddard Institute, makes clear what is at stake: "The only practical way to prevent CO_2 levels from going far into the dangerous range ... is to phase out use of coal except at power plants where the CO_2 is captured and sequestered."

Hansen went so far as to write to Brown appealing to him to block Kingsnorth, not only because of the threat it poses to the UK but also due to the negative signal it would send to the rest of the world. That's why Greenpeace, Friends of the Earth, the RSPB and the WWF all think that action needs to be taken to prevent the utilities from gambling on new coal while making only a vague promise of CCS sometime in the future.

The groups have jointly proposed that a new standard be introduced in the UK, based on a now well-established law in California. This would set a limit on the emissions levels of any new power station, whatever the type, and would outlaw the most polluting. In California, the law has led to the promotion of renewable energy, combined heat and power plants, and the most efficient gas plants.

The government has been irresponsible by conflating several issues in the energy debate. They distract attention from the climate implications of Kingsnorth by promoting a tiny CCS competition that may never deliver results and may not affect the Kingsnorth plant anyway. They also claim that the technology could be sold to emerging economies like China and India in the future.

But the new energy system being built from scratch in China could be highly efficient and use much more decentralised energy – meaning ultra-efficient power plants that generate both heat and electricity close to where it's used, as well as a higher degree of renewable energy.

Yet with the UK's risible delivery of renewable energy and efficiency and its limited engagement with China on these issues, we are not setting a good example. Last year the Chinese wind industry installed more capacity in China in just 12 months than the UK has installed over the whole history of its efforts.

Efficiency, decentralised energy and renewables are proven, can deliver now and could make all the difference within the next eight years. Climate scientists say we have to achieve a dramatic turnaround in global emissions within this short timeframe if we are to win the battle against climate change.

So what should be the number one focus for government discourse, policy and will? Let the power industry prove whether CCS works or not, but this technology must not become an excuse for a new generation of conventional coal-fired power stations. The priority for government must be the urgent delivery of efficiency, decentralised energy and renewables. These are the real solutions to climate change and energy security.

Does more energy, less waste add up?

The claims made for carbon capture and storage are impressive, but a closer look reveals several grey areas

Terry Slavin

It's not hard to see why environmentalists are suspicious of carbon capture and storage (CCS). Can it really be true that a technology can mop up 80% to 90% of the CO_2 emissions from coal-fired power plants – the dirtiest source of power going?

The energy industry maintains it can and, what's more, advances in CCS technology could allow coal- and gas-fired power plants to become carbon neutral or even carbon negative – mopping up more CO_2 than it generates. The biggest challenge for the technology to overcome will be the "energy penalty". It takes between 20% and 40% more energy to run a plant equipped with current CCS technology. So along with the capital outlay, CCS raises operating costs by between 25%-60%.

One fear raised here is that, even if European energy companies were forced to equip new power plants with CCS after 2020, operators would only use them during daily peak periods when they are paid more for the electricity. They would then use the older power plants without CCS for the rest of the time. Without regulation to prevent this, what looks good on paper in terms of the EU meeting its climate targets may do little to save the polar bears.

Europe has plans for 10 to 12 full-scale CCS plants to be operating by 2015, but one senior European Commission official says he has no expectation that they will be running around the clock at the outset – just long enough to show that the full chain of capture, transport and storage works.

In the UK, major electricity producer E.on hopes it can assuage green concerns over its proposed Kingsnorth coal-fired power plant by winning the UK competition to build a demonstration CCS plant. But the CCS component of the 1,600MW-plant would only be 300MW, and according to government rules for the competition, only 50MW of it would have to be operating with CCS by the end of 2014.

The Drax plant, in Yorkshire, plans to replace 10% of the coal it uses with biomass

ILLUSTRATION: LEE WOODGATE

Compare that with the CO_2 that Drax, owner of the UK's largest coal-fired power plant, will save with its plans to replace 10% of the coal it uses at its 4,000MW Yorkshire plant with biomass (wood) – equivalent to 400MW of carbon-neutral power. Biomass is considered carbon neutral because the CO_2 that is released when it is burned was absorbed by the plant when it grew.

One advantage of burning a portion of wood with coal is that it takes no more energy than a conventional power plant. Another is cost: in Drax's case it will cost a relatively small sum (£50m) to fit the equipment to co-fire the biomass. But biomass can also be used in conjunction with CCS.

Norwegian energy company Aker Kvaerner says the carbon capture process can be made much more energy-efficient, and the remaining energy penalty can be removed – and even negated – by generating part of its energy from biomass.

At the end of next year, Aker will open a CCS demonstration facility at Karsto in Norway that will be powered 10% by biomass and 90% by gas. Aker says emissions from the power station will be 116% less than from a conventional plant.

Less talk, more action needed

Jeffrey Sachs
Comment

Sachs: 'It is hard to see how greenhouse gas emissions can be stabilised by mid-century without a decisive adoption of CCS technologies in coal-fired plants around the world'

The key to climate change mitigation is new technology. If the world were to attempt to control greenhouse gas emissions with the ones we've got, we would have to rely on devastating cuts in energy use, with crippling effects on the economy.

Moreover, the developing countries, which today account for roughly half of global carbon emissions and far more in the future, would not agree to kill their economic development to reduce emissions.

Rather than arguing incessantly about the details of carbon trading, we should be focusing on public policies to speed the research, development, demonstration, and diffusion of low-emission technologies.

Carbon capture and storage (CCS), in which coal-fired and gas-fired power plants capture their carbon dioxide, transport it by pipeline, and then store it in a long-term geological deposit, is likely to be one of the transformative technologies.

Indeed, with coal-fired plants accounting for 40% of worldwide electricity production, and on a trajectory to account for 50% by mid-century, it is hard to see how greenhouse gas emissions can be stabilised, much less reduced, by mid-century, without a decisive adoption of CCS technologies in coal-fired plants around the world.

The importance of CCS was recently under-scored by the International Energy Agency in its important report, Energy Technology Perspectives 2008, which provides the most comprehensive map of technological possibilities for a low-emission future.

In this report, the agency examines the costs and scalability of a dozen or so major emission-reducing technologies of the future, including low-emission automobiles (eg plug-in hybrids), green buildings, renewable energy sources (such as solar and wind power), and CCS. In its assessment, CCS would play the largest role of any single new technology in reducing emissions.

The problem with public policy until now is that the incessant focus has been on getting countries to agree on emissions targets, and on implementing the European Emissions Trading System, rather than on developing new technologies. While putting a market-type incentive on reduced emissions is important, its importance has been greatly exaggerated.

Countries such as China will not agree to limit emissions nor to adopt a carbon tax or permit system unless there is a much clearer technological pathway to

A deal on CCS is a high-priority goal for a world long on talk but desperately short of meaningful action

combining rapid economic growth with lower emissions.

Moreover, a carbon permit system or carbon tax is only part of the incentive framework for the research, development, demonstration, and diffusion needed for the successful, worldwide, rapid uptake of new and transformative technologies like CCS.

Consider various barriers to worldwide deployment of CCS. First, some of the basic engineering required to make it work at reasonable cost is not yet in place. CCS is likely to depend on new types of high-efficiency, coal-fired power plants, of which the most promising is the so-called integrated gasification combined cycle (IGCC) plant. This technology is still at an early stage, meaning there is the need for considerable learning about the design and optimisation of such plants.

Early movers will pay a high price, but it will be for worldwide benefit of later adopters. That is, early adoption of IGCC is a kind of "public good", the benefits of which will be reaped by the world, not by the early adopter.

Public goods require public financing to bring about the needed scale of effort. Even after the proper power-plant design is demonstrated using public funds, the power sector will continue to achieve significant cost reductions as the industry "moves down the learning curve". Once again, these economic gains of widespread diffusion will be enjoyed worldwide and, therefore, require a significant nudge of public-sector financial support.

Safe storage

Other components include the transportation of the carbon dioxide in a network of pipelines for its safe geological storage, and then the storage itself.

Both will also require significant public policy support. The pipeline sector is likely to require massive regulations (eg on right-of-ways over private and public lands), though the technology itself is quite mature.

The storage phase is the least proved of all. There are massive challenges of monitoring the storage to ensure that the carbon dioxide doesn't leak to the surface. There are liability challenges in case accidents occur. There are regulatory challenges as to the ownership of underground sites for sequestration.

Last but not least, there is the massive challenge of public acceptability. Sound technologies can be killed because of misplaced public fears and opposition. CCS already engenders many public doubts. Some sceptics want to end the use of coal entirely. This is naive, since China is not about to turn off its economic growth on such ideological positions. Yet the viewpoint could frustrate the actual deployment of technologies in Europe and the US, with dire spill-overs to other parts of the world.

In any event, the public has the right to be fully informed, and to feel secure against unknown risks. CCS is hardly understood yet by the broad public, and the technology will face major obstacles unless it is convincingly monitored, demonstrated for safety, and put into a suitable regulatory framework. And while this is true for Europe, the US, and other high-income countries, it is even more starkly the case in China and India.

There is now a widespread buzz around CCS in policy circles and the power industry. More than a dozen demonstration plants are on the drawing board, and smaller-scale carbon sequestration experiments (not linked to power plants) are under way in many places.

Yet the overriding truth is that the public sector has not yet stepped up to the challenge, and many or most (perhaps all) of the announced projects will be long-delayed or never see the light of day. Till now, there is not a single, large-scale coal-fired carbon capture storage demonstration plant actually in operation anywhere in the world, despite years of workshops, plans, projects and announcements.

The timely demonstration and diffusion of CCS in all major coal-using economies will require around $3-5bn per year of public funding from the G8 countries, an investment bargain that can potentially head off trillions of dollars of disaster if climate change is left unchecked.

The world has committed itself to negotiating a new arrangement on climate change mitigation by the end of 2009, yet it will certainly be unable to do so if there is no practical advance in creating the technological conditions for success.

Next month's G8 summit in Japan is the next stop on our continuing global saga to secure our future. A deal on CCS is a high-priority goal for a world long on talk but desperately short on meaningful action.

Jeffrey D Sachs is director of the Earth Institute at Columbia University in the US and author of Common Wealth: Economics for a Crowded Planet (Penguin, 2008)

Q&A What is carbon capture and storage and how does it work?

What does carbon capture and storage (CCS) involve?
Separating out the carbon dioxide (CO_2) emitted by power stations (or industrial processes), and transporting it to a place for indefinite storage. In the energy producing sector, the purpose of CCS is to reduce emissions from burning fossil fuel by some 85-90%, which many see as the only way to avert devastating climate impacts from coal-fired electricity production.

Does the technology exist?
Different stages have been used or demonstrated but the whole process has not yet been applied in power stations on a commercial scale.

So what's "carbon capture ready"?
It is an imprecise term used to describe the design of new power station projects, especially coal-fired ones, without which they would stand no real chance of approval in the UK. It should mean they have space and access for retrofitting carbon capture equipment once it is developed, plus access to suitable geological storage underground, and a feasibility study giving reasonable confidence that it would work. Critics say that in the absence of legislation to make it compulsory there is no obligation to retrofit CCS techology – and that it encourages a "build now, capture later" mindset that is extremely risky while the technology remains unproven.

Why might an operator not want to retrofit later?
It entails a capital expense and high running costs. Carbon capture could well absorb a quarter of the power station's generating capacity. Uncertainty about this and other costs is one of the big question marks over the viability of the whole CCS enterprise. Current estimates suggest costs of between 40 and 90 euros per tonne for capture, plus the (lesser) costs of transport and storage.

Can you take out carbon dioxide from the waste gas of a power station as you do for other pollutants such as sulphur dioxide?
Yes, this is what happens in one form of the technology known as "post-combustion". Using known industrial techniques, flue gases are diverted through an absorber, where the CO_2 is taken up by a solvent. The next stage, heating the CO_2-rich solvent to 120C in a reformer, releases the CO_2 for capture.

What are the other methods of removing CO_2 from a power station?
Instead of removing the CO_2 after the fuel has been burnt, the fuel is turned into a gas made of carbon monoxide and hydrogen. This gas, known as syngas, is combined with steam to turn the carbon monoxide into CO_2, which can be extracted and captured before the remaining hydrogen is burned to produce electricity. This method is known as pre-combustion.

Environmental concerns have ruled out disposing of CO_2 deep at sea

Are there any other methods?
There is a third technology called oxy-fuel where the fossil fuel is burned in 95% pure oxygen instead of in air, resulting in a flue gas that consists of high CO_2 concentrations and water vapour. The two can be separated just by cooling and the CO_2 is then condensed and compressed for storage.

Once you've captured your CO_2, how do you transport it?
Pipelines are generally the cheapest way, with costs depending on distance and the availability of suitable existing networks. However, there are questions that need to be answered about how the pipelines are going to work.

What are the main prospective storage sites?
The most important potential sites for storage are saline acquifers deep underground – porous rock formations that contain saline water. Before it is injected, the CO_2 is compressed to a dense fluid. This density increases as the CO_2 goes deeper underground until, below 800m, it becomes so dense that it should not rise to the surface. Other options for storage are depleted gas and oil reservoirs and seams of coal that are no longer mined.

What makes a good site?
To safely store CO_2, a site needs three things: enough storage space, a layer of rock, such as clay stone or shale, that seals the site and prevents gas from rising to the surface and a sufficiently stable geological environment. Under such conditions the UN's scientific expert Intergovernmental Panel on Climate Change considers it likely that 99% of the CO_2 will still remain safely sequestered after 1,000 years.

Are there other storage alternatives?
Disposal deep at sea has been considered, because of the heaviness of CO_2 at great depths, but this has been largely ruled out because of concerns about CO_2 changing the ocean environment.

Is there enough space underground to store all the CO_2?
There is an estimated capacity of at least 2,000 gigatonnes of CO_2, or 65 years of man-made global emissions at the rate the world is currently putting CO_2 into the atmosphere.

What happens if we run out of storage space?
CCS is not a licence to continue business as usual. Its proponents say CCS simply buys us time to switch to a more sustainable energy path, investing in renewable energy and energy efficiency to bring CO_2 emissions down.
Compiled by Roger East