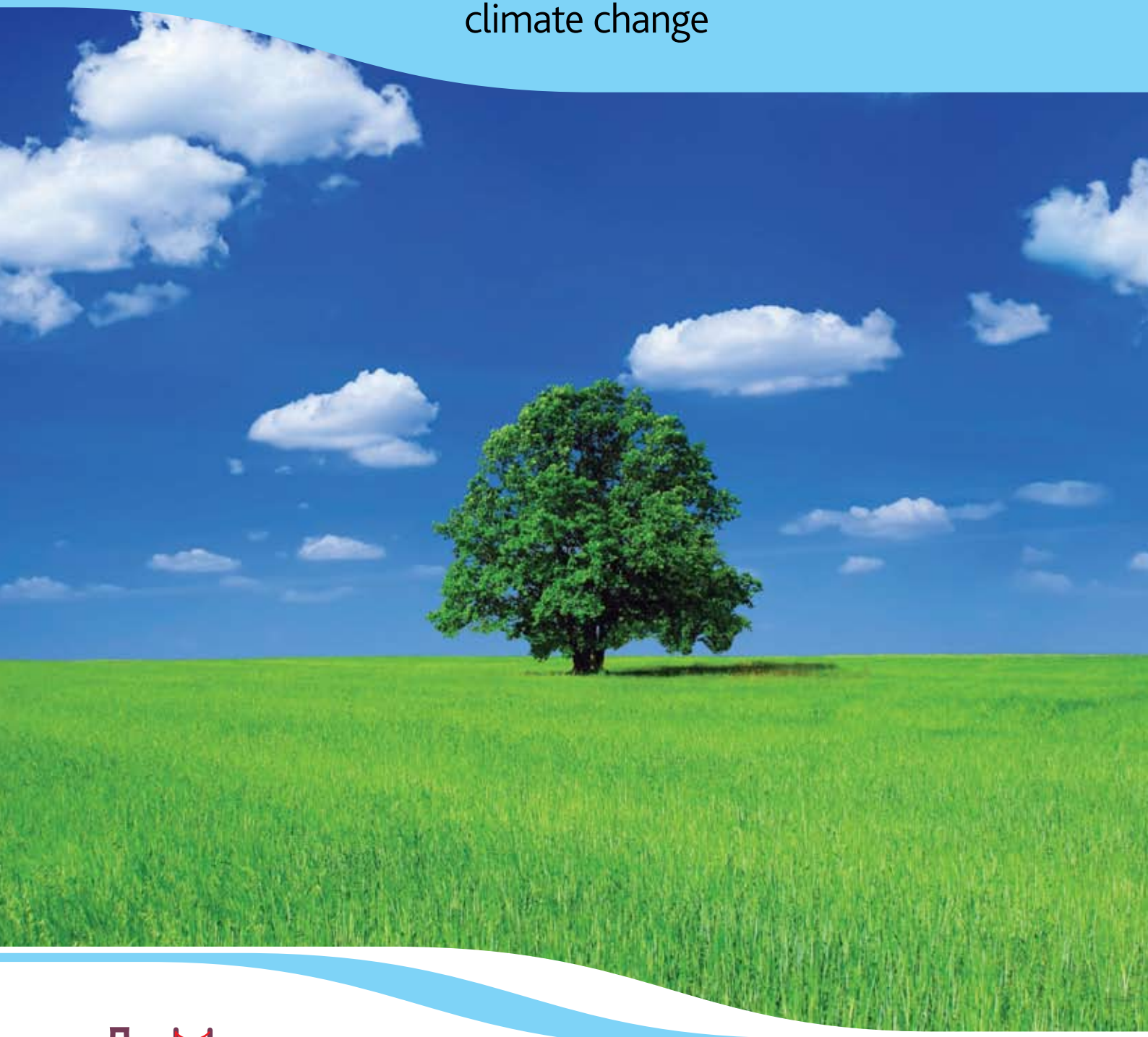
European Technology Platform for
Zero Emission Fossil Fuel Power Plants (ZEP)

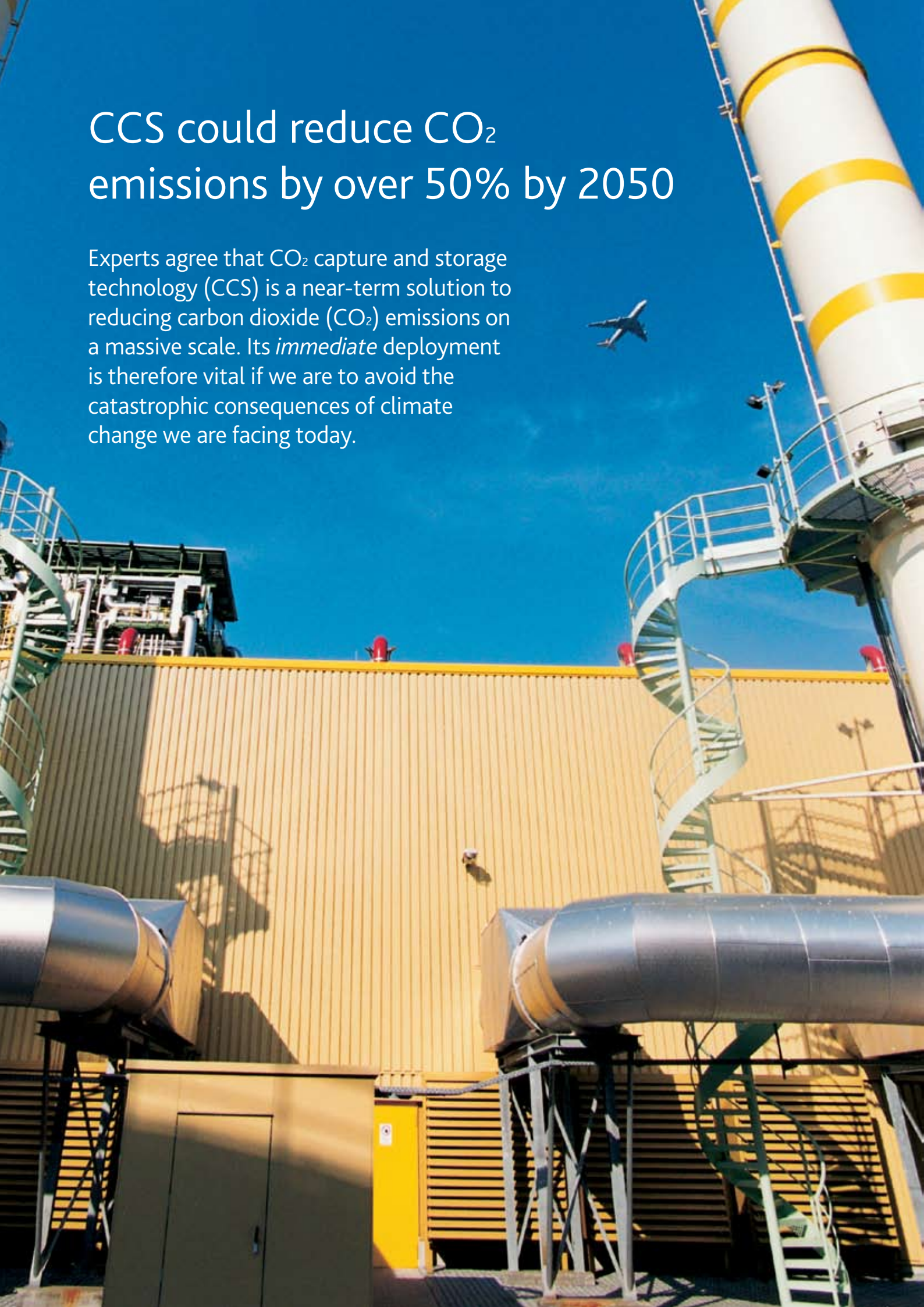
CO_2 Capture and Storage (CCS)

A key solution for combating climate change



CCS could reduce CO_2 emissions by over 50% by 2050

Experts agree that CO_2 capture and storage technology (CCS) is a near-term solution to reducing carbon dioxide (CO_2) emissions on a massive scale. Its *immediate* deployment is therefore vital if we are to avoid the catastrophic consequences of climate change we are facing today.



The IPCC[2] has confirmed that unless we reduce CO_2 emissions by 50%-80% by 2050, the impact on global warming will be disastrous. Yet with world energy demand predicted to increase by 60% between 2002 and 2030[3], and renewable energies to make up only a third of the energy mix by 2050[4], the immensity of the challenge becomes clear. Improving energy efficiency will help enormously, but in itself will not solve the problem.

As a safe and efficient method of capturing and storing billions of tonnes of CO_2 underground for thousands of years, CCS represents the bridge to a sustainable energy system. Indeed, if deployed to its full potential, it could reduce CO_2 emissions in the European Union by over 50% by 2050, compared to today[5]. This includes all industry and transportation sectors, with a reduction of around 30% from the power sector alone.

It means power plants equipped with this technology will emit *only around 10%* of their produced CO_2 when fired with hard coal, lignite or natural gas[6]. They can also be fired with biomass, paving the way for net *negative* emissions (because biomass also draws CO_2 down from the atmosphere while it is growing). CCS can even produce clean hydrogen as a by-product, which can then be used for electricity or fuel, thus also facilitating a hydrogen economy.

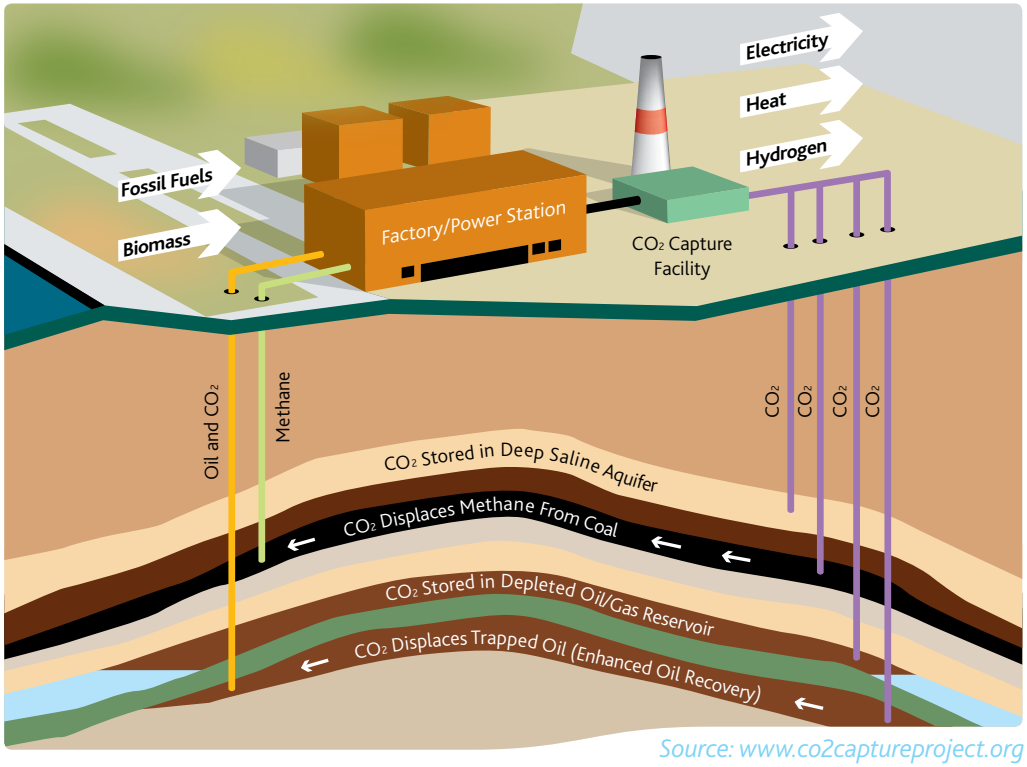
In 2005, the European Commission, European industry, NGOs[7], scientists and environmentalists therefore united to form the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP). Its Vision? To enable zero emissions from European fossil fuel power plants by 2020. This involves implementing a complete CO_2 value chain – from the capture of CO_2, its transportation to storage sites, to its storage in geological formations deep underground.

Zero emissions from European fossil fuel power plants by 2020

It is an ambitious goal, but an entirely feasible one. After all, the technology has been practised within the oil and gas industries for decades. However, a significant scale-up will be required – 20-50 times – including full process integration and optimisation.

Indeed, substantial R&D is needed, not only to drive down the cost of CO_2 capture technologies, but to demonstrate the safety and feasibility of large-scale CO_2 geological storage.

No shortage of suitable storage sites is anticipated – on land or offshore. These include deep saline aquifers (saltwater-bearing rocks), depleted oil and gas reservoirs (including the possibility of enhanced oil and gas recovery) and deep unmineable coalbeds.



Source: www.co2captureproject.org

There is a wide range of options available for CO_2 geological storage

2 Intergovernmental Panel on Climate Change, "Third Assessment Report - Climate Change 2001", Cambridge University Press
3 The IEA World Energy Outlook, 2005
4 Shell's Long-Term Energy Scenarios
5 Bellona Paper, August 2006, http://bellona.no/artikler/notater_stangeland_solomon
6 Although several CO_2 capture technology developments for coal also apply to oil, it is not considered an economically preferred fuel for future power generation (except for niche applications)
7 Non-governmental organisations

"With the right incentives, the private sector can deliver solutions. Delay would be costly or dangerous."

Sir Nicholas Stern, *The Stern Review, October 2006*

We therefore need to initiate the immediate large-scale deployment of CCS, starting with 10-12 industrial-scale demonstration projects. These should be ready for commissioning by 2015 at the latest – *but many will be ready before this date.*

At this stage, it is imperative that we "learn by doing" – in parallel with R&D projects into advanced concepts. This will require substantial investment, a burden which industry cannot take on alone, with each project costing as much as €500-€1,000 million apiece and all the risks such a commitment involves. Indeed, it is why such a step change has not already happened.

It means taking an integrated approach, with the cooperation of both industry and government – at national and EU levels – and a combination of funding sources. It also means kick-starting the CO_2 value chain with a range of fiscal incentives and a clear regulatory framework that goes beyond 2012. Only then will investors have the long-term certainty they require to commit their funds and resources.

CCS *complements*, not replaces, renewable energy

Yet all will be to no avail without the approval and consent of regulators and the public. It is therefore essential that it is understood that CCS is not only safe and reliable, but a vital and complementary solution to our longer-term goal for renewable energy. It is a challenge we can most certainly meet - but only if we begin that process now.

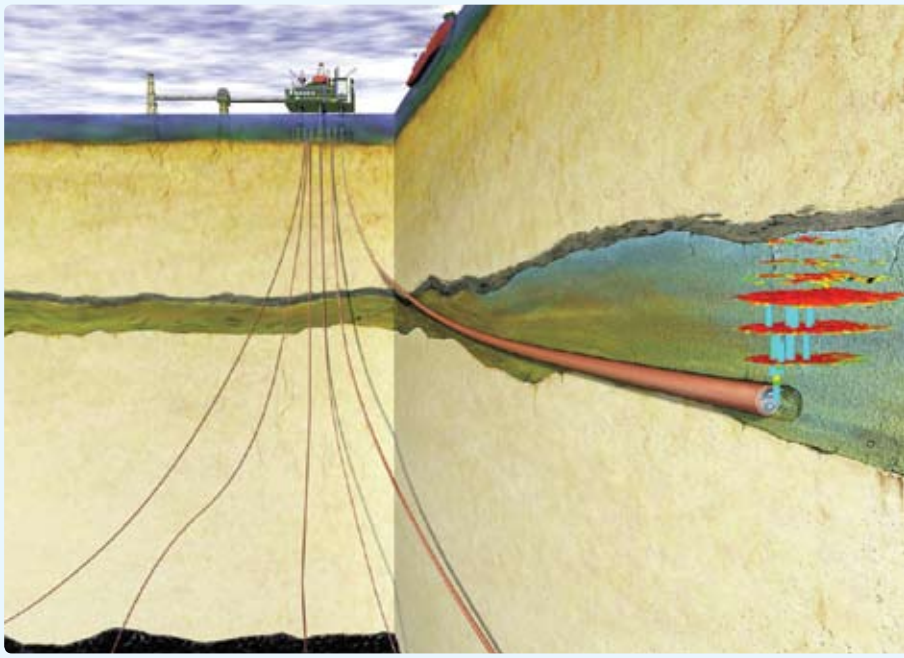
Europe can afford to wait no longer.

Zero leakage from the Utsira storage site

Experts agree that storing CO_2 underground should pose no health, safety or environmental hazard – either in the short or long term.

In fact, many large natural accumulations of CO_2 have already been discovered underground, trapped there for millions of years in exactly the same way as we now store it. CO_2 also occurs naturally in the atmosphere; will neither burn nor explode and even comprises 8% of human breath!

Nevertheless, we do not anticipate leakage of CO_2 at any significant level. Indeed, experts agree that it is very likely that the fraction of CO_2 retained will be more than 99% over the first 100 years and likely that the fraction of CO_2 retained will be more than 99% over the first 1,000 years (IPCC Special Report on Carbon Dioxide Capture and Storage, 2005).



Since 1996, one million tonnes of CO_2 from Statoil's Sleipner gas field has been stored successfully every year in the Utsira deep saline aquifer – 1,000 metres beneath the North Sea. Since then, sophisticated monitoring equipment has not detected any leakage of CO_2.

Key recommendations

Despite most of the technology elements being available, CCS is still not deployed for two key reasons:

1. **The costs and risks still outweigh the commercial benefits**
2. **The regulatory framework for CO_2 storage is not sufficiently defined.**

The European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) has therefore proposed a clear way forward: the *Strategic Research Agenda* describes a collaborative programme of technology development for reducing the costs and risks; while the *Strategic Deployment Document* outlines how we can accelerate the market to achieve zero emission power production by 2020. A *Strategic Overview* summarises the two documents.[1]

ZEP recommends (under the Seventh Framework Programme, FP7):

ZEP Deployment Strategy

1. **Kick-starting the CO_2 value chain with urgent short- and long-term commercial incentives:**
   - By the end of 2007, clarify the conditions under which the geological storage of CO_2 qualifies for the European Union Emissions Trading Scheme (EU ETS) and other incentive mechanisms
   - By the end of 2007, clarify CCS status under EU guidelines for State Aid
   - By the end of 2007, create early mover funding mechanisms to support the development of 10-12 large-scale CCS projects which demonstrate a diverse range of infrastructure, technologies, fuels and storage locations
   - Establish long-term, sustainable mechanisms to supplement the EU ETS, informed by experience gained in demonstration projects.
2. **Establishing a regulatory framework for the geological storage of CO_2:**
   - By 2008, amend existing EU legislation (concerning waste and water) in order to clarify the conditions under which CO_2 is stored underground
   - By 2010, implement new EU guidelines for Member States permitting geological storage projects (including risk management, site selection, operation, monitoring, reporting, verification, closure and post-closure).
3. **Gaining public support via a comprehensive public information campaign:**
   - Generic EU-wide outreach via multi-media (TV, Internet, print)
   - Local, focused outreach in support of early mover CCS projects.

1 See www.zero-emissionplatform.eu/website/library/index.html

ZEP Research Agenda

1. **Urgently implementing 10-12 integrated, large-scale CCS demonstration projects Europe-wide:**
   - Improve the cost-effectiveness and availability of current CO_2 capture technologies; optimise energy conversion efficiency when integrated into a power plant; and bring to commercial readiness by 2020
   - Assess the full potential for CO_2 geological storage, demonstrate its safety to the public and understand/respond to their concerns
   - Resolve all technological uncertainties and establish a critical mass of data for exploitation in parallel R&D projects.
2. **Developing new concepts already identified, but not validated, for demonstration by 2010-2015 and implementation beyond 2020, e.g.**
   - Advanced new materials and combustion systems
   - Storage in onshore, deep saline aquifers and CO_2 for Enhanced Oil Recovery in the North Sea.
3. **Supporting long-term exploratory R&D into advanced, innovative concepts for implementation of next-generation technology, e.g.**
   - Innovative CO_2 capture technologies (membranes, adsorption etc.)
   - Innovative concepts for CO_2 storage
   - Simple, reliable tools for long-term modelling and monitoring of CO_2 storage.
4. **Maximising cooperation at national, European and international level:**
   - Mobilise national and European funding and explore new options for launching large integrated projects, such as Joint Technology Initiatives
   - Further promote international cooperation, especially with emerging countries such as China and India.

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For more information, please contact the ZEP Secretariat on
Telephone: +31 6426 25727
E-mail: info@zero-emissionplatform.eu
Website: www.zero-emissionplatform.eu