Environmental & Marine Law

An overview of international and national law issues arising from the development of Carbon Capture & Storage (CCS) in South Africa

by
Tom Herbstein
HRBTOM001

22nd October 2007

Supervisor: Prof. Jan Glazewski

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.
2. I have used the footnote* convention for citation and referencing. Each contribution to, and quotation in, this essay from the work(s) of other people has been attributed, and has been cited and referenced.
3. This essay is my own work.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.
5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and declare that this is my own work.

Signature: ………………………………

TABLE OF CONTENTS

Chapter I - Introduction

If the growth in greenhouse gas (GHG)[1] emissions continues unabated, the atmosphere is heading towards trebling its stock of GHGs by the end of the century.[2] This is the view of the 2006 British government commissioned Stern Report. Amongst many other equally serious changes to the climate, there is a 50% risk that temperatures will rise by up to 5 ^{o}C around the planet.

At the current rate, according to the Stern Report, a rise of 2-3 ^{o}C is foreseeable within the 'next fifty years or so'. This would lead to increased flooding, decreased water supplies, increased pressure on coastal areas, hundreds of millions of people displaced and unable to produce or purchase sufficient food, and an estimated 15 – 40 % of the world's flora and fauna would be wiped out.[3]

A number of mitigation options have been implemented to lessen the impact of carbon emissions and ultimately to lower their output. These include

- improving energy efficiency;
- switching to less carbon intensive fuels;
- nuclear power;
- renewable energy sources;
- the enhancement of biological sinks;
- the reduction of non-CO_2 GHG emissions,[4] such as methane and HFC-23.[5]

But many of these options are expensive or have social and/or political implications that are slowing down the speed with which they need to be implemented.

---

[1] Includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) as defined by the Kyoto Protocol

[2] N Stern 'Stern Review The Economics of Climate Change' (2006) HM Treasury at i. The Stern Report aimed to outline the economic damage that the continued release of GHGs into the atmosphere would have on the world's economy.

[3] Ibid at vi.

[4] B Metz 'Carbon Dioxide Capture and Storage - Summary for Policymakers and Technical Summary' (2005) IPCC at 2.

[5] (Note 1).

There is one option, however, that has been identified by the Intergovernmental Panel on Climate Change (IPCC), which could significantly address the problems faced by the increased release of GHGs. This is known as Carbon Capture and Storage (CCS).

CCS is essentially the practice of capturing CO_2 from the exhaust gas of power stations and other 'point-sources' such as cement production plants and storing it, compressed and liquefied in carbon reservoirs. A number of storage options have been identified that include *inter alia*:

- geological storage in depleted hydrocarbon reservoirs;
- storage in saline aquifers;
- direct injection into the deep ocean;
- the fertilisation of the ocean to increase the growth of carbon digesting phytoplankton.

Although a number of pilot projects have experimented with the storage of CO_2, only a few are achieving the volume of carbon removal or sequestration that would be necessary if any benefit were to arise from the development of the technology.

These projects have been undertaken in Europe, North America and Australia, but to date there has been no significant CCS in South Africa, or for that matter in most of the developing world.

It has been identified on both an international and domestic level, that given the unique characteristics of carbon sequestration, a solid and rigorous legal regime is necessary to regulate the potential long-term risks that the artificial storing of significant amounts of anthropogenic CO_2 underground may carry.

No significant study has yet been undertaken into South Africa's current domestic and international legal regime, and how CCS might fit into it. As a result this paper seeks to examine the current legal framework for CCS in South Africa and discuss under which regime (if any) it may fall and what changes (if any) would be required to satisfy both international and domestic concerns.

Most of the international discussion into CCS has occurred over the past five to six years, as the international community has woken to the reality of climate change and the benefits that sequestering CO_2 could have on the atmosphere.

Many significant agencies, including the International Panel on Climate Change (IPCC), International Energy Agency (IEA), Tyndall Centre and the National Energy Technology Laboratory (NETL), have published papers examining the current international legal framework and undertaken extensive studies into the reality of implementing the technology on a commercial level.[6]

As a result, extensive literature exists, produced by the various stakeholders. It is felt the current international framework is well understood and defined by these studies available.

As analysis of the South African framework is less forthcoming, this paper will turn to Australia for some indication of the legislative environment necessary for regulating CCS. In 2003, the Australian government published the "Guiding Principles" a comprehensive study into the regulation of CCS under domestic Australian law and the criteria that would need to be satisfied.

Their principle legal concerns are long-term liability and who would be held responsible for the gas in the event of future leakage. The unique aim of CCS in sequestering CO_2 for hundreds, if not thousands of years, makes the issue of liability a complex one, as it requires suitable and novel methods of monitoring and verifying the stored gas. This also relies on clearly defined access and property rights.

---

[6] Ibid.

In South Africa, a document similar to the Guiding Principles is yet to be produced. The country is only at the stage of analysing the physical suitability for implementing CCS domestically. A report commissioned by the Department of Minerals and Energy in 2004[7] investigates South Africa's technical capacity and forms the basis of this study, by helping to narrow down the various CCS options available.

Thus Part A of this report introduces the various possible applications of CCS, highlighting the technologies available for capturing, transporting and sequestering CO_2. An idea as to the most likely form of sequestration in the early stages of the development of CCS in South Africa is provided.

Part B examines the international legal environment, outlining the major legal challenges facing CCS, as raised by international organisations, followed by an introduction to the relevant conventions that currently play a role in regulating it.

Part C examines the domestic application of CCS in South African law, beginning with an introduction to the key pieces of legislation. In the main body of the study, a detailed discussion examines the issues to be faced in the legislating and regulating of CCS, with references to some of the steps Australia, a country with one of the more advanced regulatory regimes for CCS, has taken in accommodating carbon sequestration.

Finally, current South African law is examined in detail and suggestions made as to the best possible means for developing an adequate CCS regime for the country.

[7] A Engelbrecht et al. 'The Potential for Sequestration of Carbon Dioxide in South Africa' (2004) CSIR at 16.

Part A - What is Carbon Capture & Storage (CCS)?

Chapter II - The Technology

Capture

It is the capture and not storage of CO_2 that poses the greatest challenge to developers of CCS.

This is because the efficient storage of CO_2 underground requires a CO_2 stream of not less than 95%. However, in conventional fossil fuel power stations where coal is burned to produce electricity, flue gases emitted contain only between 10-15% CO_2,[8] the rest comprising a mixture of mainly nitrogen, together with oxides of sulphur and nitrogen. A secondary process therefore has to be employed to raise the purity of these emissions to a level where it can be stored efficiently.

However, in synthetic fuel plants, where coal is processed into oil or gas, exhaust emissions contain between 90-98 % CO_2, so this type of fuel plant lends itself particularly well to carbon capture because the gas has the potential to be sequestered without the need for further treatment.

A number of possible capture options exist. These include “post-combustion”, “pre-combustion” and so-called “oxy-fuel combustion”.

Post-combustion

The post-combustion process is when CO_2 is removed from the final flue (exhaust) gas of power stations and other ‘furnaces’.[9] The best-proven process to date involves the scrubbing of the flue gas using a solution to

[8] A Engelbrecht et al. (note 7) at 16.
[9] Ibid at 11.

which CO_2 readily binds.[10] The solution is then heated with steam to release the purified CO_2 before being recycled once again through the system.

While post-combustion is relatively straightforward, the large volume of flue gas that needs to be scrubbed means that it must occur on a relatively large scale.

Current examples of post-combustion capture are present in the natural gas processing industry,[11] where the technology is utilised to separate the high levels of CO_2 naturally found with gas. This being the case, the technology is classified by the IPCC[12] as 'operating in a mature market'.[13]

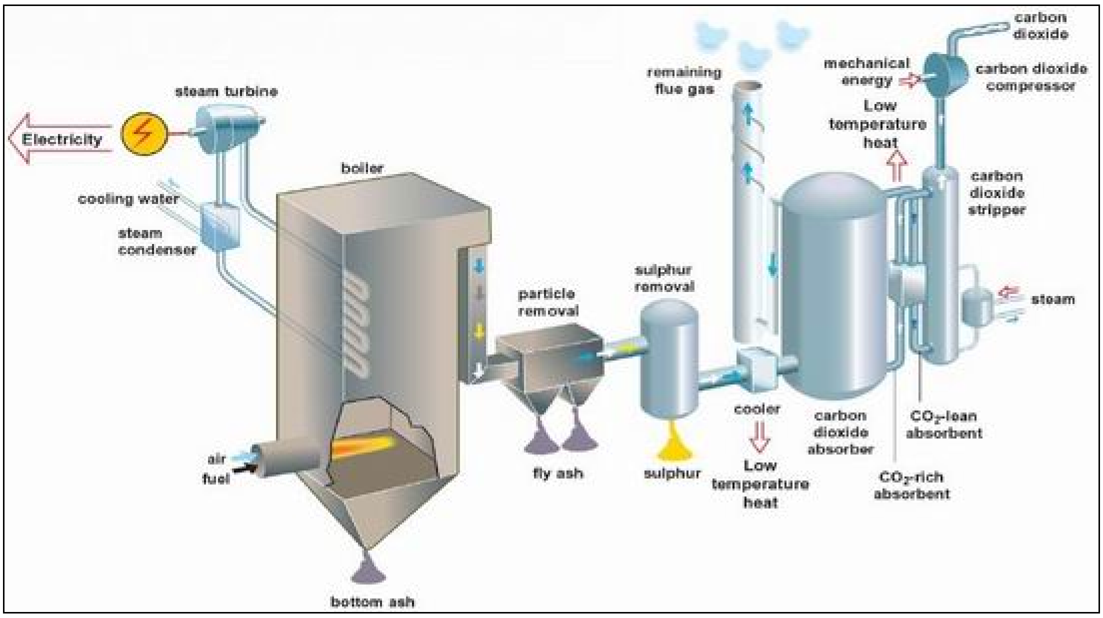

Figure 1 - Post-Combustion Process
www.f-e-e.org/.../fee/cal/event.cgi?ActID=3029 [Accessed 18th August 2007]

[10] Ibid. A mono-ethanol amine (MEA) solution is generally used in this.
[11] Natural gas extracted from the ground contains on average 1% CO2. Available at http://www.eia.doe.gov/oiaf/1605/87-92rpt/appd.html [Accessed 7th August 2007]
[12] The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). It is charged with assessing the most up to date scientific, technical and socio-economic research in climate change.
[13] B Metz (note 4) at 4.

Pre-combustion

This method converts fuel - in most cases coal - to a gas, before combustion, by subjecting it to oxygen, steam, heat and pressure. The gas is then cleaned to remove impurities[14] before being chemically altered to create methane and hydrogen - used to produce energy - and the waste products carbon monoxide (CO) and CO_2.

The exhaust gas is now concentrated to 25-40 % CO_2,[15] and is further separated using the 'post-combustion' process.

While the initial process of gasifying the fuel is complex and expensive, the high concentrations of CO_2 produced and the resulting low volume of flue gas that needs to be processed mean the final separation stage is both easier and cheaper than in pure 'post-combustion'.

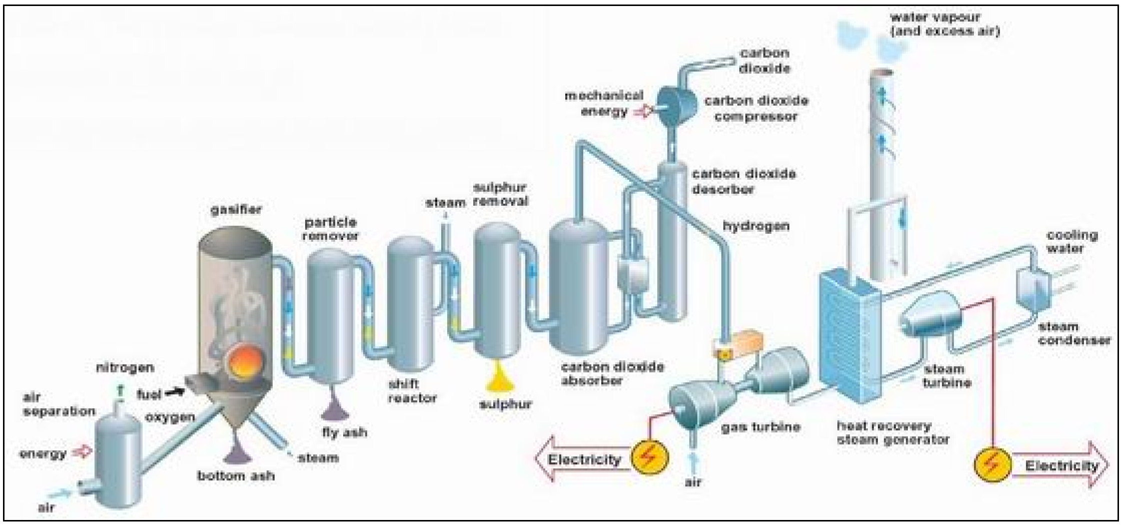

Figure 2 - Pre Combustion Process
www.f-e-e.org/…/fee/cal/event.cgi?ActID=3029 [Accessed 18th August 2007]

"Pre-combustion" is currently used to produce fertiliser and in manufacturing and synthetic fuel production.[16] Thus the technology has been classified by the IPCC as 'operating in a mature market'.[17]

---

[14] Includes hydrogen sulphide (H_2S), ammonia (NH_3) and other particulates.
[15] M Gupta, I Coyle, and K Thambimuthu 'CO_2 Capture Technologies and Opportunities in Canada' (2003) CANMET Energy Technology Centre at 7.

Oxy-fuel combustion

In this process instead of normal air, the initial fuel source is burned in pure oxygen, extracted from the air before the combustion process begins. The result is an exhaust gas high in CO_2 (> 80 %),[18] and free of nitrogen, achieving a large reduction in the overall volume of the exhaust gas by around one fifth to one third.[19] Like 'pre-combustion', this makes the final separation simpler and cheaper.

As yet no industrial application of 'oxy-fuel combustion' exists, principally because, unlike 'post-combustion' used by the natural gas industry and 'pre-combustion' for the synthetic fuel industry, the technology creates no additional benefits, other than the CO_2 produced. The technology is therefore reliant primarily upon the widespread development of CCS projects before it is likely to become a serious consideration.

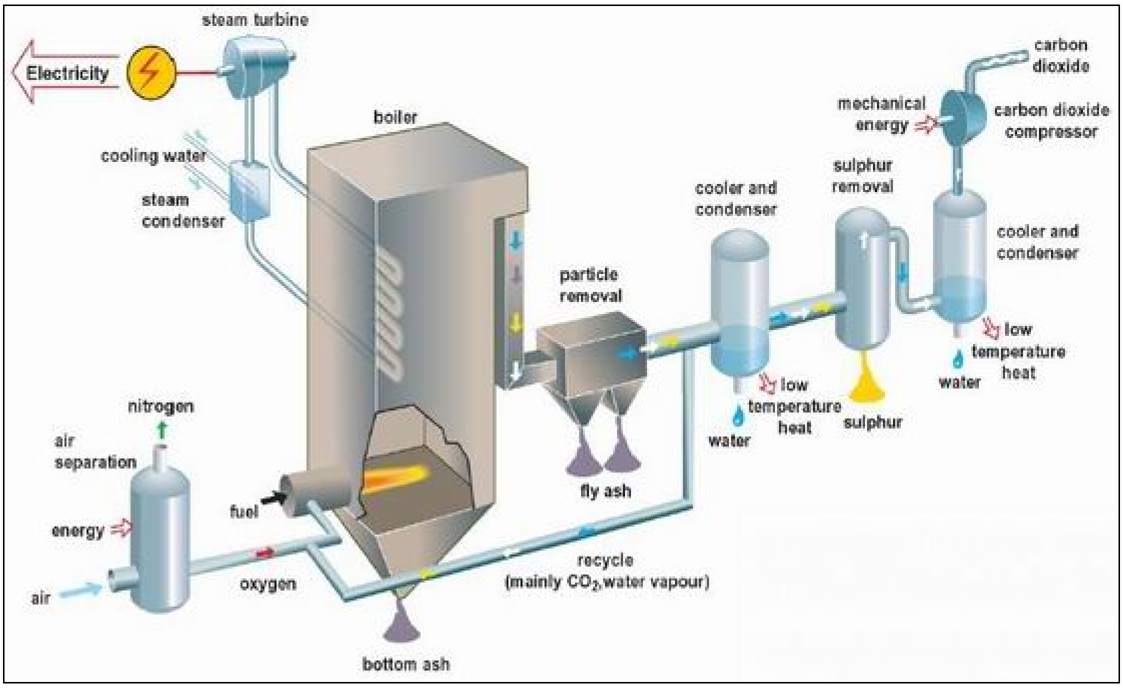

Figure 3 - Oxy-Fuel Combustion
www.f-e-e.org/.../fee/cal/event.cgi?ActID=3029 [Accessed 18th August 2007]

---

[16] B Metz (note 4) at 4.
[17] B Metz (note 4) at 4. 'Mature Market' means that the technology is now in operation with multiple replications of the commercial-scale technology worldwide.
[18] M Gupta, I Coyle, and K Thambimuthu (note 15) at 16.
[19] Ibid.

For this reason the IPCC has classified 'oxy-fuel combustion' as operating at the 'demonstration phase'.[20]

Capture Conclusion

At best, these available technologies capture between 85-95 % of the CO_2.[21] However, in order to achieve this level of separation a high input of energy is needed. Some estimates indicate that between 10-40 %[22] more energy is required for the separation process, which in turn requires proportionally more fuel to be burned in the first place.

While both post- and pre-combustion are currently widely applied to the natural gas and synthetic fuel industries respectively, oxy-fuel combustion is only at the very earliest stages of development due to dependence on the roll out of CCS.

Transportation

For transportation, the gas will generally need to be both cooled and compressed to decrease its net volume, making it easier and cheaper to move.[23]

The current preferred mode of transportation is by pipeline,[24] particularly for distances up to 1,000km from the source and for projects that produce high quantities of gas. Other possible modes of transport include ships, road and rail tankers.[25]

---

[20] B Metz (note 4) at 4. "Demonstration Phase" means that the technology has been built and operated at the scale of a pilot plant but that further development is required before the technology is ready for the design and construction of a full-scale system.
[21] Ibid at 3.
[22] Ibid.
[23] 'Carbon Capture and Storage (CCS)' (2005) 238 Postnote Parliamentary Office of Science and Technology at 2.
[24] B Metz (note 4) at 5.
[25] Ibid at 4.

Use of pipelines already exists widely in the hydrocarbon industry, where many thousands of kilometres of pipelines are in operation today. As the risk of transporting CO_2 is significantly lower than that currently faced by the oil and gas industry,[26] pipeline transportation is widely regarded as operating in a mature market posing no real challenges to its application under CCS.

Storage

Geological Storage

Depleted Oil/Gas reserves & Enhanced Oil Recovery (EOR)

Contrary to popular belief oil reservoirs are not underground caves filled with oil or gas but rather areas of permeable (sedimentary) rock that allow fluids to seep through. Sealing the reservoir and ensuring that the oil and gas may not escape is due to a non-permeable 'cap rock' surrounding the reservoir. The cap rock could for example be of granite or shale.

CO_2 in liquid form is pumped to a minimum depth of 800 m where the ambient pressure and temperatures maintain the CO_2 in a liquid - or 'super-critical' - state.[27] While stable in this form, the density of the gas is still only 50-80 % that of any water that may be present and this buoyancy forces the CO_2 upwards.

Thus the need for a well-sealed, non-permeable 'cap-rock' that is sufficient to trap the CO_2 and prevent it rising above 800 m below the surface. If the CO_2 rises closer to the surface than 800 m it will return to its gaseous state, and increase pressure on the surrounding rock structure.

Given that depleted oil and gas reservoirs have already contained fluids successfully for millennia, the IPCC believes that a secure reservoir - one that

[26] Ibid at 11.
[27] Ibid at 28.

has a proven 'tightness' - is 'very likely' to exceed a 99 % retention of CO_2 over 100 years and 'likely' to exceed 99 % over 1,000 years.[28]

It is also possible that, over time, the injected CO_2 may even dissolve, chemically reacting with the water in the reservoir and minerals in the rock to become immobilized as a solid carbonate, a process known as 'geochemical trapping'.[29]

Although this process occurs over hundreds if not thousands of years,[30] the process could trap CO_2 for many millions of years more, indicating that CO_2 could actually become more secure with time.

Furthermore, as a result of past use, many depleted reservoirs have already undergone the intense geological surveying and mapping needed to satisfy a reservoir as a suitable storage site, and it is felt that in many instances only limited additional analysis would be necessary.

This would include confirming that the 'cap-rock' is 'tight', the reservoir's minimum depth uniformly below 800m and the risk of extraneous events such as seismic activity or the corrosive effects of CO_2 on the surrounding rock, understood and taken into account.

Since the 1970s the hydrocarbon industry has been routinely pumping CO_2 back into operational oil reservoirs as a means of increasing output, a process known as Enhanced Oil Recovery (EOR).

When in contact with oil, CO_2 acts as a solvent, dissolving into it and causing it both to expand and thin. This in turn allows the oil to seep more easily through the sedimentary rock, towards the pumps, and ultimately increasing operational output.

[28] Ibid at 13.
[29] Ibid at 29. Most commonly occurring carbonate is limestone. YOU NEED TO REFERENCE THIS
[30] Ibid.

While much of the injected CO_2 used by industry originates from the extraction of the hydrocarbons in the first place, it has been found that most of the injected CO_2 remains sequestered as a result.

It is for these reasons that geological storage is one of the 'most viable and environmentally acceptable forms of sequestration to date. [31]

Deep Saline Aquifers

Deep Saline Aquifers are similar in structure to oil and gas reservoirs except that instead of trapping hydrocarbons, they contain a highly mineralised water, or brine, that has so far been considered not 'fit for human, industrial or agricultural use.'[32]

The verification process, used to confirm that saline aquifers are adequate for storage, is similar to that used in validating the suitability of depleted oil and gas reservoirs. Many of the risks and concerns discussed with regard to the use of depleted hydrocarbon reservoirs are also similar, as too is the positive potential for both long-term storage and geochemical trapping.

The global distribution and vast capacity of these aquifers has led geologists to predict that, even with today's level of anthropogenic GHG emissions, saline aquifers have the potential to store all anthropogenic CO_2 for hundreds of years.[33]

[31] Postnote (note 23) at 1.
[32] A Engelbrecht et al. (note 70) at 38.
[33] Ibid at 39.

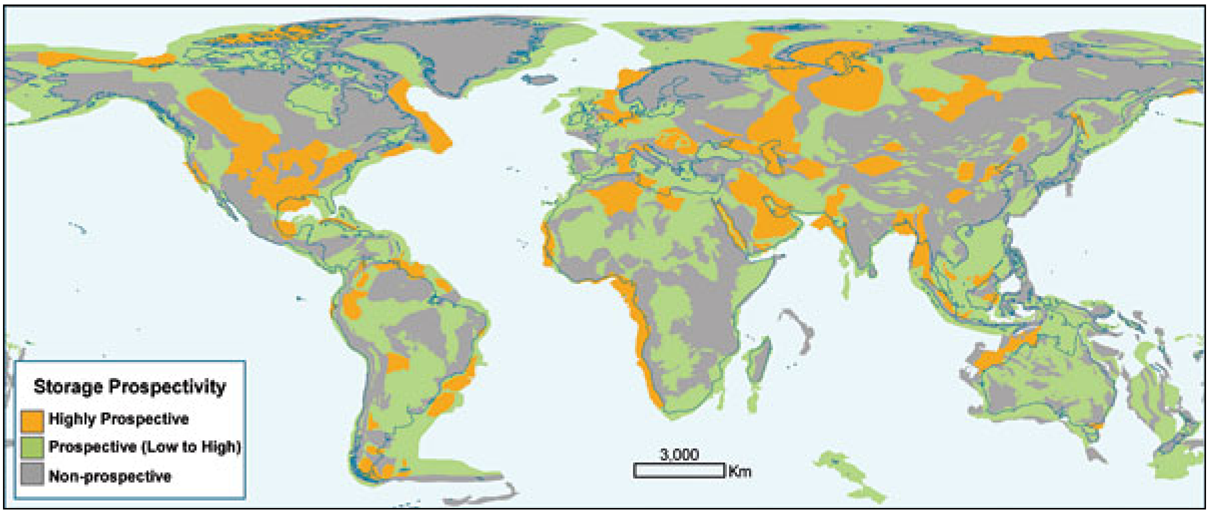

Figure 4 - Global Carbon Dioxide storage potential
(http://news-service.stanford.edu/news/2007/june13/carbon-061307.html)

In addition, their proximity 'to existing large-point sources',[34] such as high capacity fossil fuel power stations, would reduce the need for extensive transportation between areas of capture and storage, helping to reduce the overall cost of the CCS project.

While many aquifers will be found to be geologically unsuitable, where the 'cap rock' is not 'tight' enough, the aquifer shallower than 800 m or the site located in an area of high seismic activity, the scale of the 'storage potential'[35] nonetheless remains significant.

When compared with the data available for depleted oil & gas reservoirs, knowledge of 'saline formations is quite limited'.[36] However, many of the techniques developed for the oil and gas industry could be easily applicable for the validation of aquifers.

Mines & Enhanced Coal Bed Methane Recovery (ECBM)

CO_2 'sticks better to coal than the methane'[37] found naturally bound to it. Therefore by injecting CO_2 into coal seams it displaces the methane leaving

[34] Ibid.
[35] CO_2net 'A "Down-to-Earth" solution to Climate Change' (2005) European Carbon Dioxide Network at 2.
[36] B Metz (note 4) at 30.
[37] CO_2 net (note 35) at 3.

the CO_2 securely sequestered.[38] The displaced methane can then be captured, and sold as fuel thus offsetting some, if not all, of the costs of sequestration

Although ECBM has undergone limited field-testing in the United States over the past 20 years, this has been small scale, and more work is required to determine if it is both feasible and economically viable.

There are concerns that once CO_2 has displaced methane, the coal bed might become unusable, thus eliminating a potential fuel source. In addition, the amount of CO_2 that could realistically be sequestered onto the coalface is relatively small which makes the potential return from investment in ECBM unattractive.

Marine Sequestration[39]

<u>Deep Ocean Sequestration</u>

CO_2 pumped to a depth greater than 1,500 m will be dense enough to become absorbed into the water column, limiting its return to the surface layers. Pumped to below 3,000 m, even greater storage potential is achieved as the 'density of CO_2 exceeds that of water'[40] and the liquid CO_2 sinks to the bottom of the ocean and is sequestered 'for [a] very long time'.[41]

It has even been suggested that an ice-like combination of water and CO_2 could form between the gas lake and the surrounding sea water, 'preventing the dissolution'[42] of the GHGs yet further.

[38] A Engelbrecht et al (note 70) at 44.
[39] 'Why is the Atmospheric Carbon Reservoir so Small?' Available at http://earthguide.ucsd.edu/virtualmuseum/climatechange1/05_2.shtml [Accessed 10th August 2007].
[40] A Engelbrecht et al. (note 70) at 48.
[41] Ibid.
[42] Ibid.

Ocean storage, however, while ‘technically feasible’,[43] is yet to be deployed or even demonstrated at a pilot level.[44] There are concerns over what effect dumping even a small amount of CO_2 into the water column may have on the local and widespread marine ecosystems[45], as it lowers the pH of water, increasing its acidity.

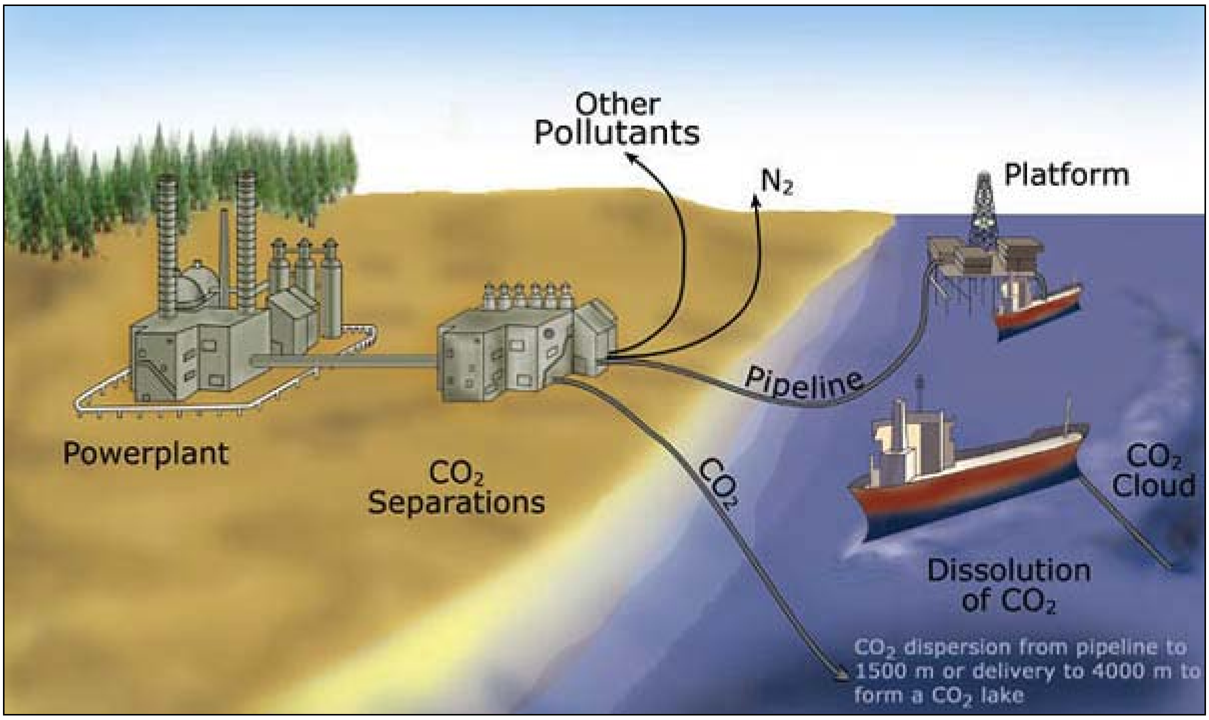

Figure 5 - Carbon Sequestration into the deep ocean
http://www.princeton.edu/~chm333/2002/fall/co_two/oceans/ [Accessed 18th August 2007]

Nonetheless the oceans have been naturally absorbing anthropogenic emissions for the past 200 years. To date they contain well over 140 Gtc of the total 350Gtc released by man since the start of the industrial revolution. The current natural uptake of anthropogenic emissions stands today at around 2 Gtc/year, indicating the mammoth storage potential that exists should the scientific concerns ever be satisfied.

The IPCC is confident that between 65-100 % of CO_2 could be retained after 100 years and between 30-85 % after 500 years.[46] However, the reliability of

---

[43] Ibid.
[44] B Metz (note 4) at 34.
[45] Ibid at 6.
[46] Ibid at 13.

storage is heavily dependent upon which site the CO_2 is pumped in at, as local currents, vertical water movement and other variables will all be a significant factor.[47]

Marine Fertilisation

This is a process which propagates enlarged colonies of phyto-plankton in the ocean. As the microbes grow, they digest CO_2 from the surrounding seawater manufacturing calcium carbonate to build their shells. When they die they sink to the seabed and the CO_2 is locked away indefinitely. Iron is required in the reaction however, and there a limited supply of naturally available iron in the ocian so iron would have to be artificially introduced to enhance the propogation rate of phyto-plankton.

However, the amount of iron needed to sequester any significant quantity of CO_2 would be enormous. In addition, concerns over the effect that fertilisation may have on other areas of the ocean have been raised, as the artificial propagation of phyto-plankton in one part of the ocean may lead to a significant drop in productivity in another as the flow of available nutrients is reduced.

Other forms of sequestration

Biological sequestration

Biological sequestration involves the removal of carbon dioxide from the atmosphere through the encouragement in the growth of plant biomass, in particular forests. Its inclusion in the Kyoto Protocol's Clean Development Mechanism,[48] is highly contentious as the quantity of the carbon sequestered by this method is hard to calculate accurately and the potential storage time

[47] A Engelbrecht et al (note 70 at 47.
[48] Kyoto Protocol to the United Nations Framework Convention on Climate Change 1998 (2005) 37 ILM 22.

is highly unpredictable. Estimates range from 'between weeks' to 'centuries'.[49]

Mineralisation

Mineral carbonation involves enhancing a chemical reaction between the acidic CO_2 and 'silicate rocks such as serpentine and olivine'. The result is a neutral compound such as calcium carbonate - or limestone.[50]

The quantities of these silicate rocks far outweigh the amount needed to fix all anthropogenic CO_2 emissions and would produce carbonates that are very stable over long time scales. This would trap the CO_2 indefinitely from being released into the atmosphere and as a result require little monitoring.

However, the technology is now only at the 'research stage'[51] so there is much ground to be covered before it becomes a viable option. The expected energy consumption is also a concern, as the energy needed to force the reaction is expected to equal 30 to 50 % of a power plant's output.

When combined with the equally energy-hungry capture process, this could require as much as 60-180 % more energy per kilowatt hour (kWh) produced than a conventional fossil fuel combustion generator.[52]

The Current Cost Inhibitor of CCS

The cost of implementing a CCS project and the lack of political incentives are the most significant inhibiters to the widespread application of CCS today. As things stand, lack of subsidies mean that the capture, transportation and

[49] A Engelbrecht et al (note 70) at 24.
[50] B Metz (note 4) at 36.
[51] Ibid at 36.
[52] Ibid at 37.

storage of CO_2 will raise the cost of producing each kWh of electricity by between 25-160 %.[53]

Estimates suggest that retrofitting existing power plants will be more expensive than incorporating the technology in new build plants and that the application of CCS becomes more economical the more large-scale the project.[54]

Capture - and compression - is currently the largest cost component, but it is believed that over the next decade this could be reduced by up to 20-30 %,[55] and even more as development of the technology progresses.

The cost of transporting CO_2 by pipeline, from the point of capture to the point of storage, has been estimated at around US$ 1.5 - $ 5.5/tonne CO_2 per 100 km.[56] As many point-sources are 'within 300 km of areas potentially holding formations suitable for geological storage',[57] transportation costs are felt to be a relatively negligible component of CCS. Shorter transportation distances, however, will still, no doubt, be favoured.

Nonetheless it is 'unlikely that industry will be encouraged to invest in CCS'[58] under current market conditions. It is estimated CCS may only become economical once CO_2 prices on the international carbon markets reach US$ 25-$ 30/tCO_2 which makes the cost of emission reductions through CCS similar to developing offshore wind farms and photovoltaic plants, technologies themselves struggling to get off the ground.[59] As of September 2007, the value of carbon credits on the open market stood at just US$ 21/t CO_2.[60]

---

53 Ibid at 9.
54 Ibid at 9.
55 Ibid at 10.
56 CO_2net (note 35) at 3.
57 B Metz (note 4) at 7.
58 Postnote (note 23) at 3.
59 Ibid.
60 Available at www.pointcarbon.com [Accessed 18th September 2007].

While there is no reason why CCS could not contribute between 15-55 % of the cumulative GHG mitigation effort worldwide by 2100,[61] it is estimated that several 100,000 CO_2 capture systems would need to be installed over the next century - each capturing between 1 and 5 Mt/year[62] - to achieve this.

In the absence of government incentives or emission taxes, the best means of encouraging CCS could well be through its initial application as an EOR or ECBM project.[63] In certain circumstances this could have the financial benefit of reducing the cost of storing CO_2 to a point which may even turn a profit.[64]

But assessing the current cost of carbon emission reductions through CCS is complicated and is governed by a number of factors, including:

- the type of power station or other plant involved;
- the technology with which costs are compared;
- economies of scale;
- transportation distances;
- in the case of EOR - future oil prices.[65]

Current CCS case studies

Norway - Statoil - Sleipner:

The earliest example of a carbon sequestration project, by storing CO_2 in a saline aquifer, was introduced by Statoil, Norway's largest oil company. The Norwegian government threatened to impose a daily fine of Kr 1,000,000 (+/- R 1,272,406)[66] if the company continued to emit into the atmosphere which CO_2 which had been separated off from natural gas extracted from its Sleipner oil fields in the North Sea.

---

[61] B Metz (note 4) at 11.
[62] Ibid.
[63] Ibid
[64] Ibid
[65] Postnote (note 23) at 3.
[66] Available at www.XE.com [Accessed 19th September 2007].

In 1996 the company started injecting CO_2 into a sandstone saline aquifer, close to Sleipner, at a rate of 2,800 tonnes of CO_2 per day.[67] While the gas is sequestered to an aquifer above the production wells, the depth of storage (below 800 m) and non-permeability of the 'cap rock' have proved so far that CO_2 can be stored securely.

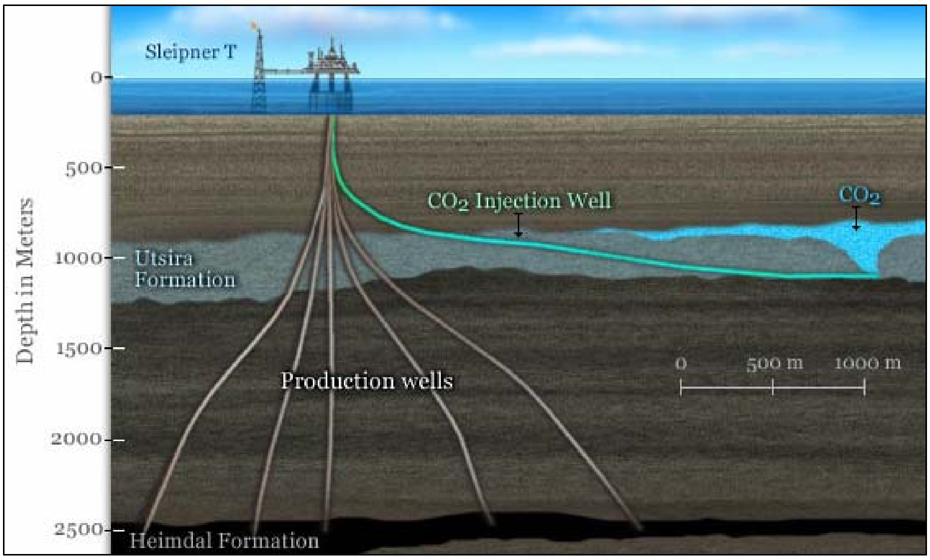

Figure 6 - Carbon Dioxide injection at Sleipner
http://www.seed.slb.com/en/scictr/watch/ 1 [Accessed September 5th]

It is the 'first example of an industrial scale storage project in the world' and to date remains the longest running private sector demonstration project.[68] As a result it has pioneered the design of storage technology while developing methodologies for monitoring the long-term security and stability of the sequestered gas.

Canada - EnCana - 'Weyburn':

The Weyburn oil field was discovered in 1954, containing an estimated 1.5 billion barrels of oil. Production peaked at 47,200 barrels a day in 1966 and for the next 20 years this declined steadily to a low of just 9,400 barrels a day.

[67] 'Carbon dioxide storage prized' Available at http://www.statoil.com/statoilcom/SVG00990.NSF?OpenDatabase&artid=01A5A730136900A3412569B90069E947 [Accessed 1st September 2007].
[68] K Robertson, J Findsen, S Messner 'International Carbon Capture and Storage Projects Overcoming Legal Barriers' (2006) National Energy Technology Laboratory at 33.

By 1998, barely 330 million barrels had been produced, an estimated 23 % of the reservoir's entire capacity. In 2000, a 330 km high-pressure pipeline, linking Weyburn to a synthetic fuel plant over the US border in North Dakota, was opened.

The plant began transporting 13,000 tonnes of waste CO_2 daily to Weyburn where it was pumped into the field merging with the oil, thinning it and thus enabling it to be extracted - oil which would have been impossible to extract otherwise. This is a successful example of an (EOR) programme.

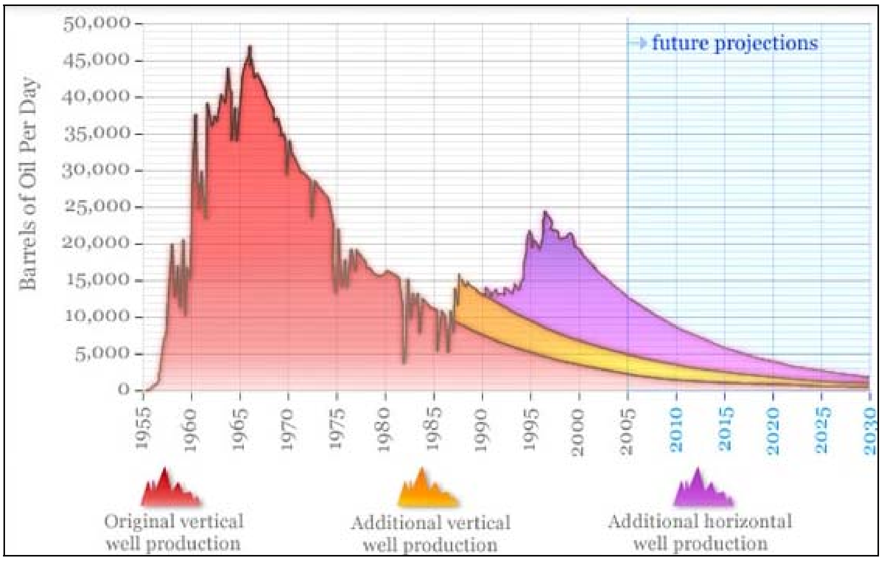

Figure 7 - Increase in hydrocarbon production at Weyburn through after the application of EOR.
http://www.seed.slb.com/en/scictr/watch/climate_change/weyburn.htm [Accessed September 5th 2007]

The increase in recovered oil is expected to reach an additional 130 million barrels over the next 20-30 years, significantly extending the life of the oil well, while in the process sequestering an estimated 20 $MtCO_2$ successfully over that period.[69] The value of the oil is likely to be greater than the cost of capturing and transporting the CO_2 so, in this case, the project pays for itself.

[69] 'The Weyburn Oil Field – Enhanced Oil Recovery' Available at http://www.seed.slb.com/en/scictr/watch/climate_change/weyburn.htm [Accessed 18th August 2007].

United States - Future Alliance - 'FutureGen'

While yet to be constructed, 'FutureGen' is an example of one of the few pilot schemes set up to test a commercial scale example of a 'cradle-to-grave' CCS project. A result of a US$ 1.5 billion partnership between the US government and an 'alliance'[70] of leading international energy companies,'[71] the aim is to 'design, build and operate a nearly emission-free, coal-fired electric and hydrogen power production plant'.[72]

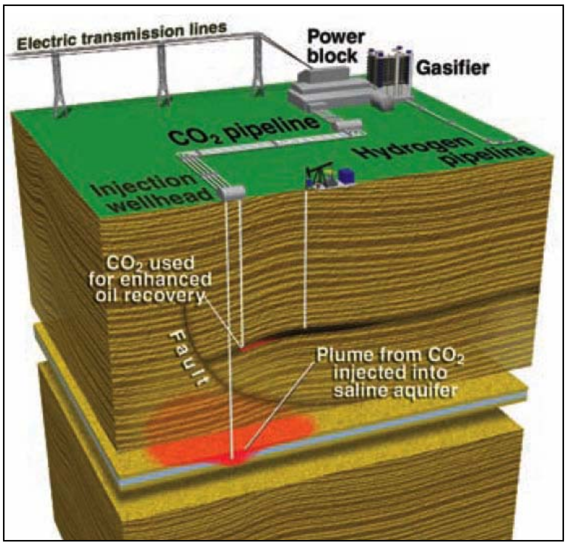

Figure 8 - FutureGen CCS design
http://www.aapg.org/explorer/divisions/2006/08emdfigure.jpg [Accessed 7th September 2007]

The technology will employ pre-combustion (or gasification) technology to produce hydrogen (and CO_2) from the coal prior to firing. The hydrogen will then be separated and used as fuel for power generation, achieving a 275 megawatt (MW) output, while the CO_2 will be sequestered in a 'geologic formation' close to the plant.[73] The sequestered gas will be 'intensively monitored'[74] over the future years for any leakage.

[70] A non-profit consortium of some of the largest coal producers and users in the world. The group includes American Electric Power, Anglo American, BHP Billiton, China Huaneng Group, E.ON Group, Rio Tinto and Peabody. A full list of partners is available at http://www.futuregenalliance.org/alliance/members.stm.
[71] 'Frequently Asked Questions: FutureGem Management, Budget, and Oversight' Available at http://www.futuregenalliance.org/faqs.stm [Accessed 5th September 2007].
[72] 'FutureGen - A Sequestration and Hydrogen Research Initiative' Available at http://fossil.energy.gov/programs/powersystems/futuregen/futuregen_factsheet.pdf [Accessed 15th August 2007].
[73] 'Coal and Power Systems' Available at http://www.netl.doe.gov/technologies/coalpower/futuregen/index.html [Accessed 15th August 2007].
[74] Ibid at 1.

Due for full-scale operation by 2012,[75] 'FutureGen' will aim initially to sequester a minimum of 90 % of the CO_2 produced, with future potential rising to almost 100 % or one to two million tons of CO_2 a year.[76]

Australia - Chevron - "'Gorgon'"

Located between 130-200 km off the north-west coast of Western Australia is the country's 'largest known undeveloped gas reserve'.[77] It contains an estimated 482 billion cubic metres of natural gas.

While similar to the Sleipner project, Chevron and its partners plan to sequester over 5 Mt CO_2 per year, that will be separated from the natural gas. The CO_2 will be stored in a deep saline aquifer beneath Barrow Island, in close proximity to the gas fields.

What makes this project interesting is that the unique combination of natural gas extraction and CO_2 sequestration in Australia has meant that a gap appeared in the controlling legislation. As a result the Barrow Island Bill[78] was enacted in 2003. It deals specifically and exclusively with the legislative requirements of the Gorgon project and the development of a CCS project in the area. This forms a useful means of comparison between what Australia has already achieved in legislating for CCS and the options available to South Africa. For this reason it is outlined and discussed in further depth later on in this study.

[75] 'Timeline' Available at http://www.futuregenalliance.org/about/timeline.stm [Accesses 6th August 2007].
[76] (note 73) at 2.
[77] 'The Gorgon Project' Available at http://www.gorgon.com.au/01gp_project.html [Accessed 6th August 2007].
[78] Barrow Island Bill (Western Australia) of 2003. Available at http://www.parliament.wa.gov.au/parliament/bills.nsf/6ECF866731F4656148256DA3000D5763/$File/EM-Bill230.pdf.

What is the most likely development of CCS in South Africa

Capture

Of the 427 Mt of CO_2 that South Africa releases into the atmosphere each year, 249 Mt[79] - or 58 % - is from sources that are considered point-sources, and deemed 'sequesterable' as it is feasible to capture CO_2 at these sites.

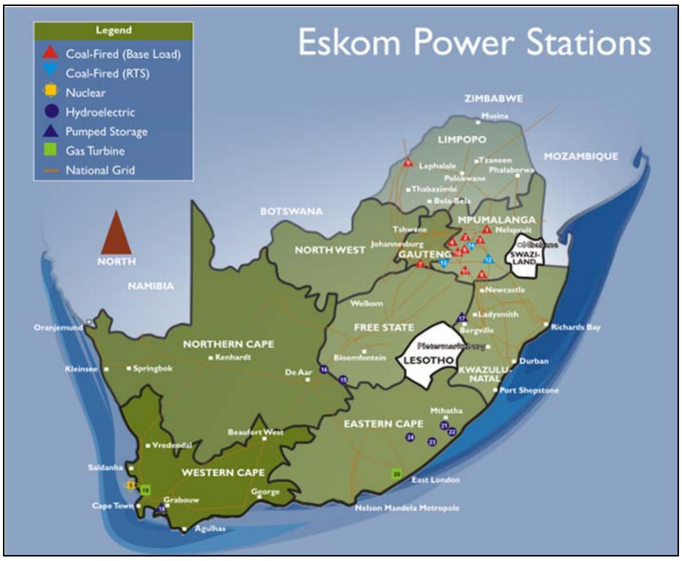

Figure 9 - Distribution of Eskom Power Stations
http://www.eskom.co.za/live/content.php?Item_ID=4673 [Accessed 7th September 2007]

Of this 'sequesterable' CO_2, almost 65 % is generated from the energy sector alone and the majority of these power stations located 'within a 100 km radius of each other in the Mpumalanga Province,[80] north of Johannesburg and close to the coal mines that supply them.

What is of even more interest at the moment are the Sasol synthetic fuel plants at Sasolburg and Secunda that produce 30 million tonnes CO_2 ($MtCO_2$) per annum at a concentration of 90-98 % pure CO_2. In addition this CO_2 is already compressed, so that the need for a costly capture process is all but removed.[81]

[79] A Engelbrecht et al. (note 70 at 13.
[80] 'Energy and Environment' Available at http://www.deltaenviro.org.za/resources/envirofacts/energy.html [Accessed 18th August 2007].
[81] C van der Merwe 'Carbon Capture & Storage' (2007) Mining Weekly at 9.

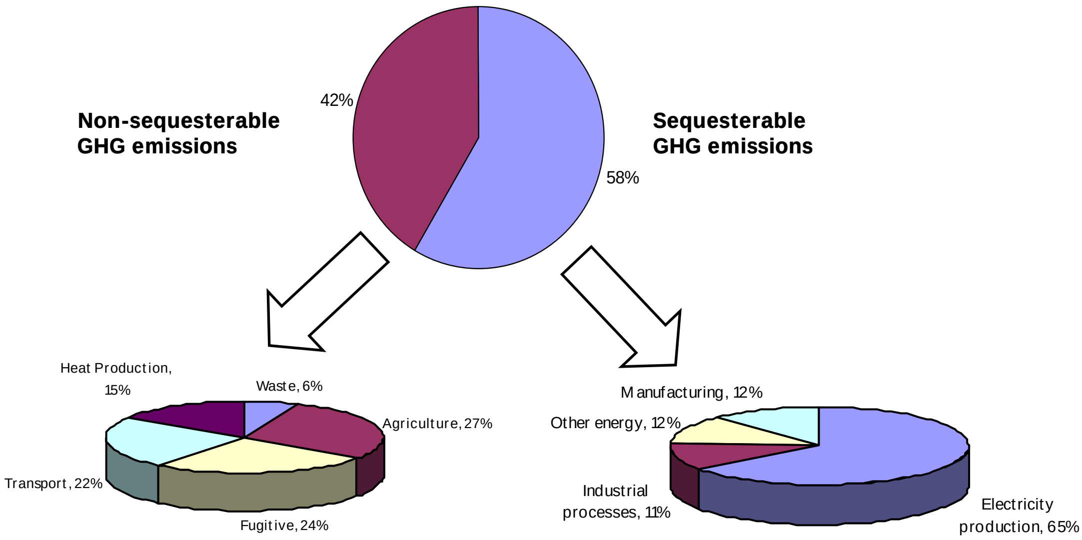

Figure 10 - South Africa's 1990 CO2 emissions by industry sector.

Eskom and Sasol produce 87.5 % of the South Africa's total sequesterable CO_2 which is why there is of little surprise that the high emission concentrations recorded around Johannesburg and the Northern Transvaal correlate to the locations of both the Sasol synthetic fuel plants and principal Eskom power stations. [82]

Transportation

In South Africa, like other areas of the world, pipeline transportation is already widely used by the hydrocarbon industry and as a result the technology is expected to be easily transferred to cater for the transportation of CO_2.

While South Africa still has a significant road and rail network that could facilitate transportation, the scale of the expected CO_2 from the Eskom or Sasol plants would be far higher than existing capacity in either of these transport systems.

[82] Ibid at 10.

However, the plans to sequester the gas in close proximity to the major point-sources would render the use of rail transportation superfluous.

Sequestration

Given that the majority of large-point emitters are situated towards the centre of South Africa, close to myriad saline aquifers, coal faces and mines, geological sequestration is expected to be the likeliest method of storing CO_2 in the near future. The industrial infrastructure easily adaptable to facilitate this form of sequestration is, for the large part, either already present or widely available on the open market. The extensive history of research and geological surveying, a result of mining activities, further encourages the likelihood of development in this area.

While it is possible that CO_2 will at some stage be used for Enhanced Oil Recovery (EOR) in the oil fields off Mossel Bay, its potential as a significant sink for CO_2 is limited, due to the fields' relatively small size and considerable distance from the main sources of emissions.

The oceans offer an almost unlimited storage capacity and South Africa's positioning is unrivalled in its access to prime locations for sequestration. But there are many concerns that still need to be addressed so some time will still be needed before it becomes a serious option.

In addition, only a relatively small number of 'large-point' systems exist 'close to potential ocean storage locations',[83] so the cost of transporting the CO_2 will be significant.

[83] C van der Merwe (note 82) at 7.

Part B - The International Environment

Chapter III - The Key International concerns

While CCS technology has developed and progressed, so too has the understanding of the legal challenges that face the widespread rollout of the industry. The National Energy Technology Laboratory (NETL), the Tyndall Centre and the International Energy Agency (IEA) have all completed studies examining the legal challenges that face CCS.

These issues include

- the definition of CO_2;
- access and property rights;
- transportation of the gas;
- the development of suitable guidelines;
- monitoring and verification of the sequestered gas;
- the liability attached to the handling and storing of the gas.

Definition of CO_2

Before any legislation can be introduced a legal definition of CO_2 as a component of a CCS project needs to be established. At its simplest, this is whether CO_2 should be defined as an 'industrial product', or a 'waste product'. The former definition, if adopted, would subject projects to less stringent regulation than the latter definition.[84]

Classifying CO_2 simply as a 'waste product' in 'applicable instruments'.[85] is inadequate as factors such as its 'degree of purity', 'concentration of any contaminants', its origins and even under what method it will be sequestered[86] will need to be established from the outset, if a secure and stable governing regime is to be successfully created.

[84] K Robertson et al (note 77) at 7.
[85] A Engelbrecht et al (note 8) at 35.
[86] A Flory 'Legal Aspects of Storing CO_2' (2005) International Energy Agency at 37. Ray Purdy and Richard Macrory 'Geological carbon sequestration: critical legal issues' (2004) Tyndall Centre for Climate Change Research at 21. K Robertson, J Findsen and S Messner (note 68) at 7.

For instance, if CO_2 is sequestered 'solely for the purpose of CO_2 storage' it would most likely be classified as a 'waste product', yet should that CO_2 be used instead for EOR, where a primary focus is on increasing the extraction of hydrocarbons, it is instead likely to be considered as an 'industrial product'.[87] This is the case for most of the EOR projects in North America, including the Weyburn project in Canada outlined in Chapter II.

In the case of EOR, further questions are raised over what would happen to this classification of CO_2 as an 'industrial product' should primary operations ever shift from EOR to one of long-term storage. A shift like that would certainly cause 'complications' in the definition of the CO_2, particularly during the process of negotiating contracts between contracting parties and the state. It would be very likely that developers would need to obtain permits under multiple project categories to cover the storage of CO_2, as an industrial product (in EOR) and as waste (in long-term storage).[88]

As a result of the increased control under international law, associated with classifying CO_2 as a 'waste product', it is of little surprise that industry has tended to advocate its classification as an 'industrial product' while those concerned with the long-term environmental and health impacts of CO_2 lean towards its definition as a 'waste product'.[89]

[87] K Robertson, J Findsen and S Messner (note 68) at 7.
[88] Ibid.
[89] Ibid.

CO_2 definition at Weyburn

The United States and Canada bypassed the problem of classifying CO_2 during the planning stages of Weyburn by creating a bilateral agreement which outlined their respective obligations with regard to the movement and storage of the CO_2.

However, this project was based within the national borders of the two countries, avoiding regulation under the more stringent international agreements, and was an EOR project, which meant the CO_2 escaped the definition as a waste product and the restrictive associations that it carried.

Access and property rights

Issues relating to access and property rights also need to be clearly defined in both national and international law in order to foster trust in the industry and to 'clearly identify relevant parties' rights and obligations'.[90]

The three main areas of property rights have been identified as the surface (injection); sub-surface (reservoir); and the CO_2 itself.[91]

At the heart of this is the question of liability which could impact on any relationship between the public and private sectors - such as the use of public land for carbon storage as is happening at the Gorgon project - and the fact that reservoirs and injection sites may be subject to 'competing claims from other users'.[92] The potential of having multiple players in a project, from the producer of the CO_2, to the transporter, injector and land owner, makes the situation even more challenging.

---

[90] MCMPR 'Carbon Dioxide Capture and Geological Storage Australian Regulatory Guiding Principles' (2005) Ministerial Council on Mineral and Petroleum Resources at 29.
[91] K Robertson, J Findsen and S Messner (note 68) at 10.
[92] MCMPR (note 91) at 26.

While off-shore storage is primarily framed by the international legal framework, on-shore storage falls largely within the scope of national, state or provincial legal frameworks.[93] With regard to property rights, there is an almost total lack of case law covering CCS, and this suggests that rights for individual projects will - at least in the near future - be developed on a case-by-case basis.[94]

NETL has outlined two principal 'schools of thought', one focusing on the ownership of the commodity - the CO_2 - and one that places greater emphasis on the rights associated with the service - injection and storage - provided.

The former suggests that greater liability will be placed on the holder of the property rights, while the latter suggests that rights, similar to current disposal processes, could be applicable. The application of a fund similar to the Superfund, established by the US to locate and clean up hazardous waste, has been proposed. However, critics have questioned the negative effect that this may have on public perception, as the relatively low risk CCS may become associated with high-risk activities such as the handling of nuclear and hazardous waste, thus ultimately inhibiting its development.[95]

In the majority of cases it is believed that property rights issues will be addressed by specific contracts at the start of the development of projects, where parties decide on the laws applicable and how.[96] Nonetheless CCS remains a novel concept and standards for addressing it are poorly defined. This makes the issue of property rights - particularly over the long term - hard to determine.[97]

---

[93] A Flory (note 87) at 9.
[94] K Robertson, J Findsen and S Messner (note 68) at 10.
[95] Ibid at 15.
[96] A Flory (note 87) at 9.
[97] Ibid.

Clear titles and transferable rights are vital to help promote a regularised operating environment and establish a chain of both liability and responsibility.[98]

Transportation

There are two potential safety hazards associated with transporting a high pressure CO_2 stream. These are the safety of workers and the general public, as well as the potential impact of leakages on the environment.[99]

As has been discussed, pipeline transportation is likely to be the most favoured and practical choice for most CCS projects. High pressure natural gas has been transported via pipeline by the hydrocarbon industry for many years and there have been few associated safety and environmental incidents.

Given the low risk of CO_2, it is felt that there will be no 'major concern' for the use of pipelines as part of a CCS project, and many of the regulations applicable to the transportation of hydrocarbons will be simply interchangeable.[100] Although associated with asphyxiation, the amount of CO_2 that would need to be released, to cause a significant threat to life, would far outweigh the amount that could escape from even the highest capacity pipelines.

The only considerations that need to be taken into account when referring to potentially applicable hydrocarbon legislation is that while both CO_2 and natural gas are heavier than air and odourless, CO_2 is not flammable and becomes acidic once mixed with water.

---

[98] Ibid.
[99] MCMPR (note 91) at 32.
[100] Ibid.

Guidelines

What could be potentially more controlled are the guidelines regarding the selection of storage sites and the design of injection wells. Site selection criteria would need to include storage potential, its likely integrity as well as its ability to store CO_2 over significant periods of time.[101]

The design of the actual storage well is fundamental to the long-term success of a CCS project, as its failure at any point of the project's lifetime could be devastating for the long-term sequestering of CO_2.

While current oil and gas design standards are well tested, outside the US, Canada and the North Sea there is only limited experience with high pressure CO_2 well design, so that some international CCS-specific standards may be required.[102]

The largest challenge faced is likely to be the successful long-term sealing of the well, identified as a significant weak point in a CCS reservoir.

Monitoring and verification

While the probability of leakage from a storage reservoir is believed to be very low, the 'costs of such an incident could be very high'.[103] Thus measurement, monitoring and verification (MMV) is a vital component of the CCS project and crucial to any regulatory and legal framework.[104] In addition, MMV will be needed to verify the amount of CO_2 that is actually sequestered, and help minimise any potential risks associated with the process.

[101] A Flory (note 87) at 37.
[102] K Robertson, J Findsen and S Messner (note 68) at 9.
[103] S Bode and M Jung 'Carbon dioxide capture and storage (CCS) – liability for non-permanence under the UNFCCC' (2005) Hamburg Institute of International Economics at 37.
[104] A Flory (note 87) at 11.

One of the challenges is that the individual components of CCS occur over differing time spans: injection from years to decades while storage is measured over hundreds to thousands of years.[105]

While many techniques and guidelines could be adapted from those used in the storage of natural gas or liquid and hazardous waste injection - particularly in the pre-injection and injection stages - the main legal and regulatory gaps identified internationally in CCS appear to lie in the long-term monitoring of the sequestered gas.

This focuses on 'two dimensions': first, the lateral migration and second, the vertical leakage of CO_2 outside of the storage area. There is a number of techniques currently being applied and reviewed in active CCS projects, such as Sleipner and Weyburn, but consensus on which is the most suitable has yet to be reached.[106]

Part of the challenge is that for CCS to gain public acceptance and ensure some degree of continuity and uniformity, standards will need to be set. But therein lies a 'Catch 22', because as monitoring and verification is 'site specific', it would be equally inappropriate to develop a single 'framework with a uniform set of requirements.'[107]

Nonetheless, the flexibility required for such a framework will need to oblige industry to provide accurate and relevant information that is easily available and open for independent verification.[108]

One suggestion is to adapt the verification process applied to the Kyoto Protocol's Clean Development Mechanism (CDM).[109] This currently provides

[105] A Flory (note 87) at 17.
[106] K Robertson, J Findsen and S Messner (note 68) at 11. These include time lapse 3D seismic imaging, seismic profiling, injection well pressure and rate monitoring, surface and sub-surface geochemical and geophysical surveys and the possible use of tracers.
[107] Ibid.
[108] MCMPR (note 91) at 37.
[109]See Chapter IV.

guidelines and methodologies to facilitate accurate monitoring and verification of CO_2 mitigated by its participant projects.[110]

This could also help in resolving issues over how to account for any leaked CO_2 in situations where the sequestered gas is used to offset national GHG inventories or sold as carbon credits (CERs) on the open market. It is likely that some degree of reassignment would have to be done between the GHG inventories of the country that sequestered the CO_2 and the country that experienced the leakage.[111]

Liability

Liability is without doubt 'one of the most essential regulatory issues facing CCS projects'[112] as it not only affects the cost of projects, but is also fundamental in advancing public confidence and protecting the environment.

Essentially, liability for a CCS project can be divided into two categories; short and long-term.

Short-term liability refers to aspects of CCS that include operational liability, in particular the immediate 'environmental, health and safety risks'[113] associated with a project. These include the capture, transportation and injection stages. However, the operational liability required by a CCS project has already been sufficiently established by the oil and gas industry.[114]

The uncharted area is that of long-term liability. This is principally concerned with the damaging effects that any 'leakage and migration'[115] of CO_2 from a

[110] 'Technologies, Policies and Measures for Mitigating Climate Change - IPCC Technical Paper' Available at http://www.ipcc.ch/pub/IPCCTP.I(E).pdf [Accessed 18th September 2007].
[111] K Robertson et al. (note 106) at 13.
[112] K Robertson, J Findsen and S Messner (note 68) at 12.
[113] Ibid.
[114] A Flory (note 87) at 38.
[115] Ibid at 39.

reservoir may have on the environment and ecosystems. It is a challenging concept given the huge time-frames involved in carbon storage.

Potential damage is wide ranging. Sub-surface damage could lead to spoiled hydrocarbon resources or contaminated water supplies while surface leakage could do severe environmental damage to the 'air, soil, water, and overall ecosystem'.[116]

Trans-boundary liability involves potential damage across national borders or to the global climate in general. For instance, while CO_2 may be injected and stored in one country, what would happen if leakage should occur in another country or in international waters? No international instrument currently satisfies these concerns and it seems clear that some framework for determining 'which party is liable' will at some point have to be established.[117]

Other concerns include the need for clarity over what time frame comprises 'short' and 'long-term' and at which point and to what extent, if any, public liability by one of the contracting parties should lie.

Furthermore, determining where the boundaries of local, national and international liability lie [118] is necessary, but opinion is heavily divided. The UK's Department of Trade & Industry (DTi) for instance, claimed in 2004 that it believed long-term liability should lie with the state 'as companies may go out of existence in the long-term'.[119] On the other hand, environmental lobbyists Greenpeace have argued that as the risk of reservoir failure is only 1 in 1,000, operators should be forced to retain liability and be held accountable in the event of any leakage, thus ensuring that initial sound storage techniques are maintained.

---

[116] E Wilson 'Liability and Accounting for CCS' (2006) WRI Carbon Capture and Storage Project Available at http://powerpoints.wri.org/ccs_wilson.pdf [Accessed 16th August 2007].
[117] Carbon Sequestration Leadership Forum (CSLF) 'Considerations on Legal Issues for Carbon Dioxide Capture and Storage Projects' Report from the Legal, Regulatory and Financial Issues Task Force, 13th August 2004.
[118] K Robertson et al. (note 68) at 13.
[119] B McKee 'Summary of Outcomes form Taskforce Workshop 14-16 July 2004, London, UK' (2004) Carbon Sequestration Leadership Forum at 5.

The most likely scenario will be a cocktail of liability shared by the relevant industries, specific firms and governments in a combination with financial 'guarantees' that include insurance, special funds, financial guarantees and 'caps' to cover any potential future damage.[120]

Framing long-term *in situ* liability

Delano de Figueiredo summarises a number of case studies in the United States that provide legislators with potential options for long-term storage of carbon.

He defines *'in situ'* as referring to the point at which the CO_2 'exits the injection well and enters the geologic formation'.[121] It is from this point that he identifies the principal issues regarding liability in CCS and assesses the potential options for liability. These are:

Negligence:

Essentially, this is when a person or corporation fails to exercise reasonable care' as a result of which the plaintiff suffers harm.

Negligence is generally applied to day-to-day activities of the natural gas industry, now regarded as 'routine' activities. Guidelines and regulations outline what is meant by 'reasonable care'[122] and only leakages that result from a breach of these regulations render the operator accountable.

Figueiredo argues that CCS will need to be accepted as a 'routine' activity before it can be adequately covered by the liability regime of negligence.

Strict Liability

[120] A Flory (note 87) at 38.
[121] M Figueiredo, D Reiner and H Herzog 'Framing the Long-Term In Situ Liability for Geologic Carbon Sequestration in the United States' (2005) *Mitigation and Adaptation Strategies for Global Change* 647-657 at 649.
[122] Ibid.

This is where a person or entity is held liable for harm, regardless of whether 'reasonable care' was used or not.[123] This is usually imposed on particularly dangerous activities involving high levels of risk, potentially causing harm and a general inability to minimize the risk through 'reasonable care'.

In the US, strict liability is applied to the operators of hazardous waste storage and disposal facilities, managed through a 'Superfund' financed by those participating in the contract to carry out the work.[124] However, applying strict liability to CCS could be burdensome and unnecessary given the low risk of significant leakage and the non-toxic nature of CO_2. In the same way, the reluctance of companies participating in CCS projects to finance a Superfund would hold back development and be damaging to the public perception of CCS who may then associate carbon sequestration with far more hazardous activities such as the recycling of nuclear waste.

Implied Warranty

This is when a service or goods fails to deliver what is expected by the client. For example, a leakage of CO_2 would be contrary to public expectation and therefore the participating company could be held liable.[125]

But this form of liability is normally associated with 'goods' and not 'services' and thus its relevance to CCS has been questioned.

Product Liability

This refers to liability arising from 'manufacturing' 'design defects' or a general failure to 'warn of a potential danger'.[126] This though would be much harder to apply to CCS than other forms of liability as the risks associated with CCS are well documented and understood beforehand.

[123] Ibid at 650.
[124] Ibid.
[125] Ibid at 652.
[126] Ibid.

Other concerns

Other international concerns which have a potential bearing on CCS projects include the question of intellectual property rights (IPR), as well as the effect that the precautionary principle[127] on the development of the technology.

Although primarily an American-led concern, the protection of intellectual property rights would come into play in the development of any new technology that might be developed for CCS projects. It is felt that a 'robust IPR regime' will be 'crucial for encouraging developed countries to invest in CCS technologies'[128] in developing countries and protect the value of the technology.

As CCS is 'technology-intensive'. The capture process in particular requires considerable development and therefore funding which needs to be recouped. Therefore, legal haggling over IPR might prove to be a common feature of contract negotiations in the absence of a stringent regulatory framework.[129]

The World Trade Organisation's Trade-Related Aspects of Intellectual Property Rights (TRIPS)[130] attempts to address general IPR issues, but national governments still need in many cases to draft regulations for national legislation.[131] This leads to concerns that some countries with weak enforcement of IPR may not benefit from a transfer of CCS technology. This is because companies which have invested considerable sums of money in R&D might fear their technology could be pirated and sold on cheaply elsewhere so they won't recoup their capital outlay. This would hinder the implementation of CCS in such countries.

---

[127] Part of the 1992 Rio Declaration - When there is an activity that could threaten human health or the environment, precaution should be taken, even before there is complete scientific proof that the activity is harmful.
[128] K Robertson et al. (note 68) at 10.
[129] Ibid at 11.
[130] Agreement on Trade-Related Aspects of Intellectual Property Rights 1994 (1999) 33 I.L.M. 1197 (1994).
[131] K Robertson et al. (note 68) at 11.

The role of the 'precautionary principle' is relevant as the concerns regarding the long-term effect of carbon sequestration are yet to be satisfied. Thus some suggest that the potential risk associated with storing such large quantities of CO_2 underground may disqualify the development of the technology under international and, in many cases domestic, legislation.

On the other hand, given our current understanding of the detrimental effects of climate change through the continued release of CO_2 into the atmosphere, failure to develop CCS could in fact be a breach of the 'precautionary principle' in itself.[132]

Conclusion

It is clear that the development of a legal framework adequately governing CCS will not be an easy undertaking as there are currently no 'clear, defined legal and regulatory frameworks' that could be adapted to attempt it.[133]

While offshore projects do currently appear more legislated, onshore CCS projects are governed by many conflicting and contrasting state, national and international laws.

Many guidelines and regulations, predominantly those in the hydrocarbon industry, could be adapted for use in CCS, in particular for transportation and short-term storage. However, guidelines still need to be developed to tackle important issues such as maintaining the long-term security of *in-situ* CO_2, and implementing MMV into the future.

What is clear is that national and international legal frameworks will have to be flexible enough 'to reflect [the] scientific and technological' developments,

[132] A Engelbrecht et al. (note 8) at 38.
[133] K Robertson et al. (note 68) at 5.

while at the same time satisfying the ultimate objectives of the international community.[134]

Primarily, a definition needs to be agreed for CO_2 intended for sequestration, and from this should flow consensus on the rights and obligations attached at each stage of a project.

Liability will prove a significant challenge as the international community and national governments will need to decide on who shoulders long-term responsibility for the stored gas and any leakage.

This will go hand-in-hand with the development of accepted guidelines and standards for the development of MMV, though it is felt that much could be transferable from the current oil and gas industries.

For CCS to become viable, this must happen quickly and at the very least governments 'should ensure that there is an appropriate national legal environment'[135] to at least encourage more pilot projects.

[134] Engelbrecht et al. (note 8) at 9.
[135] Gupta et al. (note 18) at 10.

Chapter IV - Relevant International Conventions

CCS projects will be principally located in two jurisdictions, the first on land or internal waters and principally governed by domestic law, and those projects in international areas of the high seas, which are primarily governed by international law.

However, crossover in legislation will occur where some domestic CCS projects are still influenced by international law, and vice versa. As a result, this chapter introduces the key international conventions that potentially have a bearing on the development of a CCS project.

United Nations Framework Convention on Climate Change, 1992 (UNFCCC) & the Kyoto Protocol

The UNFCCC opened for signature in 1992 and came into force on 21st March 1994. As of July 2007, 191 countries were party.

It opened for signature at the Rio Earth Summit, and was one of the more significant 'accomplishments' of the conference.[136] It was created to help tackle the problem of global climate change by achieving a:

> 'stabilization of greenhouse gas concentrations in the atmosphere at concentrations at a level that would prevent dangerous anthro-pogenic interference with the climate system.'[137]

In other words it seeks to prevent 'human-induced climate change by principally reducing the production and release of greenhouse gases.'[138]

---

[136] J Glazewski *Environmental Law in South Africa* 2ed (2005) at 586.
[137] United Nations Framework Convention on Climate Change 1992 (1994) *ILM* 1992:851-873 at Art 2.
[138] M Figueiredo (note 121) at 586.

The convention identifies a number of core principles that aim to achieve this objective that oblige Parties:

- to endeavour to protect the climate on an 'equitable basis';
- to acknowledge a 'common but differentiated responsibility';
- to highlight the needs and vulnerability of developing countries;
- to apply the 'precautionary principle';
- to encourage 'sustainable development';
- to promote an open 'international economic system' (trade) to advance economic growth amongst 'all Parties'.[139]

In order to achieve this required delegation of responsibility, Parties were to be divided between those that were developed or 'undergoing transition to a market economy' and listed in Annex-I, and those still developing, omitted from Annex-I and simply referred to as 'non-Annex-I Parties'.

Annex-I parties to the UNFCCC
(all countries omitted from this list are classified as non-Annex-I)

Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom & United States of America.

A non-binding commitment was placed on Annex-I countries to reduce their emissions to their 1990 levels by the year 2000, an obligation 'generally not complied with'.[140]

In addition, the convention obliges Parties to publish an inventory of their anthropogenic emissions, to maintain and promote carbon reservoirs and

[139] UNFCCC (note 138) at Art 3.
[140] Glazewski (note 137) at 588.

sinks,[141] to develop plans for resource management and impact assessment and to co-operate in both scientific and technical research.[142]

Finally, 'full consideration' was made of the special needs of small island countries, those with low-lying coastal areas or those prone to natural disasters, which would be hardest hit by climate change.[143]

The Kyoto Protocol

The Kyoto Protocol was the result of the first UNFCCC Conference of the Parties (COP), held in Germany in 1993 after the Rio Earth Summit, known as the 'Berlin Mandate'.[144]

It called for a Protocol to be drafted to develop post-2000 commitments by the Parties to the UNFCCC. These included the development of stronger policies and measures for developed countries and set quantified objectives for both reducing emissions and increasing carbon sinks, within a specified timeframe.[145]

Thus the Kyoto Protocol obliges developed countries - those in Annex-I - to reduce their emissions by a minimum of 5 % below their 1990 levels by the year 2012. Non-Annex-I countries, of which South Africa is one, are assigned no emission reduction obligations. This is because it was agreed that the developed world has not only released significantly more GHGs historically, but is in a far stronger economic position as a result.

[141] A 'Reservoir' is an area where carbon is stored, while a 'Sink' is a carbon reservoir that is increasing in size due to natural or human activities or mechanisms removing carbon dioxide from the atmosphere, such as the absorption by growing trees.
[142] UNFCCC (note 137) Art 4(1).
[143] Ibid at Art 4(8).
[144] P.W. Birnie and A.E. Boyle *International law and the environment* (2004) at 526.
[145] Ibid.

However, while economic and social development and the eradication of poverty have to be of top priority for developing countries ,[146] the seriousness of climate change is such that it is unlikely non-Annex-I participants will be exempt from emission reductions indefinitely.

To facilitate countries in Annex-I meeting their emission targets, Kyoto introduced a number of 'flexible mechanisms'. The first, 'emissions trading', simply allows Annex-I countries to buy and sell parts of their emission budget to another Annex-I country should the 'seller' achieve a domestic reduction below that of its commitment target.

The second is 'Joint Implementation' (JI), which permits Annex-I countries to 'transfer to, or acquire' emission credits from other Annex-I countries through investment in 'projects that aim to reduce anthropogenic emissions or enhance anthropogenic removal…of Greenhouse Gases in any sector of the economy.'[147] For example, an Annex-I country may invest in a solar energy plant in another Annex-I country because the economic conditions are more favourable in that country, but the reduction in 'carbon credits' reflect on the investor's GHG inventory rather than that of the host country.

The final 'flexible mechanism' is the 'Clean Development Mechanism' (CDM) which seeks to engage the principle of 'common but differentiated responsibility' a principle of the UNFCCC. Similar to Joint Implementation, the CDM aims to form partnerships between Annex-I countries and non-Annex-I countries where 'clean' technology and investment is exported to the developing world in exchange for 'carbon credits'.

Although it opened for signature in 1997, the Kyoto Protocol only came into force on 16th February 2005.

[146] C Warburton, A Gilder, S Shabalala and M Basterfield 'Options for Greenhouse Gas Mitigation Mechanisms in South African Legislation' (2006) Imbewu at 12.
[147] Kyoto Protocol to the United Nations Framework Convention on Climate Change 1998 (2005) 37 ILM 22 at Art 6.

Why is the UNFCCC and Kyoto Protocol relevant to CCS

Given their aims, the UNFCCC and Kyoto have proved to be the catalyst for the development of CCS internationally and provided an environment under which CCS technology is encouraged.

It is unfortunate then that the actual drafting of the UNFCCC fails to embrace the use of CCS. In the wording of the Convention, the 'removal' of CO_2 from the system is defined as 'any process, activity or mechanism which removes a greenhouse gas...from the atmosphere'.[148] Under this definition CCS would not be included as it involves the capture of CO_2 from the chimneys of power stations[149] rather than from the atmosphere.

As a result CCS is currently omitted as an emission reduction activity under Joint Implementation I and the Clean Development Mechanism and instead is considered an emission reduction process. Given the interest it has created among the international community, however, it is unlikely that CCS will be omitted from the Kyoto Protocol for long. When it is included, countries that have worked on the development of the industry are likely to benefit significantly from its deployment.

The United Nations Convention on the Law of the Sea, 1982 (UNCLOS)

UNCLOS, which opened for signature in 1982, seeks to deal with all aspects related to the international law governing the sea. Coming into force on 16th November 1994 it has to date (July 2007) attracted some 155 member States.

The Convention does not contain detailed regulations. Instead it provides a framework for issues relating to the governance of the maritime environment.

[148] UNFCCC (note 138) at Art 1(8).
[149] S Bode (note 104) at 7.

In this way UNCLOS encourages the development of 'more targeted' agreements aimed at filling 'in the gaps'.[150]

The principal components of UNCLOS are based on the division of the marine environment into a number of zones in which a maritime state's jurisdiction lessens as the distance from its coast grows. Up to 200 nautical miles (M) from a country's coastline, defined in the UNCLOS as the Exclusive Economic Zone (EEZ), a maritime state has the right exclusively to explore, exploit and generally utilize the sea's natural resources. Beyond that its exclusive rights are curtailed.

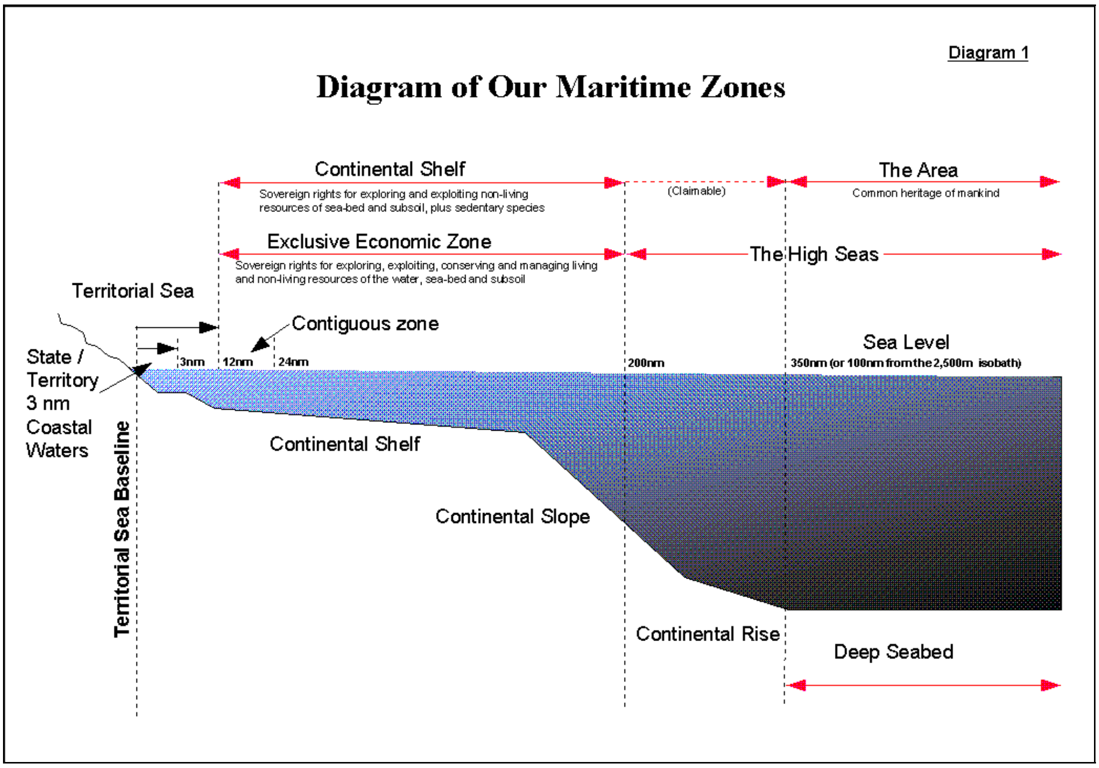

Figure 11 - UNCLOS Maritime Zones
http://www.environment.gov.au/coasts/oceans-policy/publications/images/maritime-zones.gif [Accessed 7th September 2007]

The Convention also deems the use of the high seas ('The Area') the 'common heritage of mankind',[151] and calls on signatories to take 'necessary

[150] A Flory (note 87) at 21.
[151] United Nations Convention on the Law of the Sea 1982 (1994) 21 I.L.M. 1261 at Art 136.

measures' to ensure that 'effective protection of the marine environment'[152] is upheld.

There are also stringent conditions on pollution and dumping in the marine environment, obliging coastal states to 'prevent, reduce and control'[153] such activities, both in waters under their jurisdiction and in the high seas.

Why is UNCLOS relevant to CCS?

A number of key sections of UNCLOS are potentially relevant to the application of CCS.

While it would be difficult to classify a full-scale CCS project as 'scientific research', sequestration is still in its infancy and as a result research is still needed to confirm its suitability for storing CO_2. Thus both marine sequestration and geo-sequestration under the sea-bed (such as the Sleipner project), at least in the near future, are likely to be classed as experimental and so classified as 'scientific research'.

As a result, Part XIII of UNCLOS is relevant in that it deals specifically with marine scientific research and permits all States to engage in 'scientific research', subject to the rights and duties of other States under the convention.[154] This is particularly the case in territorial waters, where maritime States have the exclusive right to regulate, authorise and conduct such research.[155]

The same rules apply to the Exclusive Economic Zone. However, coastal States are required, under normal circumstances, to grant relevant 'consents' to other States.[156]

[152] Art 145.
[153] Art 208(2) - 210(2).
[154] Art 238.
[155] Art 245.
[156] Art 246.

On the high seas, there is a general unrestricted freedom to engage in scientific research.[157]

In addition, the process of disposing of CO_2, the primary objective of CCS, could be governed by UNCLOS as the Convention requires States to adopt laws and regulations aimed at preventing, reducing and controlling 'pollution' from land-based sources, including pipelines,[158] as well as sea-bed activities within their jurisdiction or from artificial islands, installations and structures in their territorial waters.[159]

Finally, UNCLOS obliges States to control pollution effectively from any vessel or structure flying their flag or operating under their authority on the high seas or 'the Area'.

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 ('the London Dumping Convention')

Opened for ratification in 1972, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter came into force in 1975. As of August 2007, 82 states have signed up to the London Dumping Convention, as it is more commonly known.

The London Dumping Convention is widely regarded as 'one of the more successful regulatory Treaties of the 1970s'.[160] Its objective is to 'promote the effective control of all sources of marine pollution and to take practicable steps to prevent pollution of the sea by the dumping of wastes and other matter'.[161]

[157] Art 87(1)(f).
[158] Art 207.
[159] Art 208.
[160] P Birnie (note 144) at 427.
[161] 'London Dumping Convention 1972' Available at http://www.imo.org/home.asp?topic_id=1488 [Accessed 19th August 2007].

In principle, it aims to control 'ship and platform-based dumping activities'[162] and achieved a decrease in the dumping of hazardous wastes from 17 million tonnes per annum in 1979, to just 6 million tonnes by 1987.

Three categories of waste are outlined:

- The 'black list'. The dumping of substances on this list is totally prohibited. These substances include mercury, oil, radioactive wastes and material used for biological warfare;[163]
- The 'grey list'. This contains substances that require a specific authorisation or permit, issued by the national authority of the contracting party prior to dumping and include *inter alia* wastes containing significant amounts of toxic substances such as arsenic, lead, copper and zinc;[164]
- The final category is a list of any substances which are not on either the 'black' or 'grey list' and may be dumped freely with just a prior general permit.[165]

Annexure 3 of the London Dumping Convention outlines a number of 'factors and criteria'[166] which the 'national authority' must adhere to when processing both general and special permits. These are based on the characteristics and composition of the proposed waste, the characteristics of the dumping site, the method of depositing, together with a number of more general considerations and conditions.[167]

The London Dumping Convention has been amended often since coming into force, with controls being added to low-level radioactive waste in 1993 the incineration of hazardous wastes and in 1995 and, relevant to CCS, the dumping of industrial waste.

---

[162] R Purdy et al. (note 87) at 18.
[163] The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1996 (1997) 11 I.L.M. 1294 at art 4(1)(a).
[164] Art 4(1)(b).
[165] Art 4(1)(c).
[166] Glazewski (note 137) at 651.
[167] London Dumping Convention (note 163) Art 5.

The 1996 Protocol ('the Protocol')

The 1996 Protocol replaced the London Dumping Convention when it finally came into force on 24th March 2006. It 'represents a major change of approach'[168] in the regulation of the sea as a depository of waste material, particularly in its introduction of the 'precautionary principle', providing that:

> '...appropriate preventative measures are taken when there is reason to believe that wastes or other matter introduced into the marine environment are likely to cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their efforts.'[169]

By seeking further to 'protect and preserve the marine environment from all sources of pollution',[170] the Protocol adopts a tighter approach to dumping at sea than the London Dumping Convention. It now includes the deliberate disposal - and storage - of wastes in the sea, sea-bed and subsoil while the London Dumping Convention only regulates the disposal of waste into the water column. The Protocol also introduces a 'reserve list'[171] which, contrary to the Convention, prohibits <u>all</u> waste from being dumped unless it is specifically included in the list.[172] The list includes, amongst other forms of waste, dredged material, sewage sludge, fish waste and organic material of natural origin.[173]

However, the definition of 'sea dumping' under the Protocol fails to include discharges from pipelines connected to the land or operational discharges from vessels and offshore installations. It also excludes the placement of substances 'other than for the mere disposal of', unless it is contrary to the general aim of the Protocol.[174] In other words, if the intention of sequestration is only to store CO_2 temporarily, this would be permitted under

[168] Glazewski (note 137) at 183.
[169] Protocol to the Convention on the Prevention of Marine Pollution by Dumping of wastes and Other Matter, London 1996 (1997) 36 I.L.M. 1. at art 3(1).
[170] A Flory (note 87) at 25.
[171] Ibid.
[172] Art 4.
[173] Annex 1.
[174] Ibid.

the Convention. However, normal sequestration, with the intention to store CO_2 indefinitely, would not be permitted as this would fall under the definition of 'disposal'.

Currently 31 States are signed up to the Protocol.

Why is the London Dumping Convention and Protocol relevant to CCS

In north-west Europe a combination of substantial hydrocarbon reservoirs, the proximity of large power or fuel stations to the coast and favourable geologic conditions under the sea bed, makes marine geo-sequestration an almost inevitable option. This means that any discussion about CCS under international law must make reference to the marine conventions.

Both the London Dumping Convention and the Protocol deal specifically with the 'dumping of all wastes'[175] in the marine environment, unless they are excluded (from the three Annex's in the Convention) or listed (in the 'reverse list' of the Protocol) respectively.

However, the 'two treaties were drafted without CCS in mind.' This was because at the time of drafting CCS as an industry was in its infancy and was not yet considered by the international community as viable. It was for this reason that 'disposal of CO_2 in the water column was considered banned'[176] under the Convention.

An exception was made for EOR which is just as likely to occur in the marine environment as on land, as both Treaties made allowances for the 'placement of matter', so long as it was for a purpose other than 'mere disposal' of.[177] If

[175] Fact Sheet on Carbon Dioxide Capture and Storage (CCS) Available at http://www.gi.ee/co2net-east/failid/Factsheeteng.pdf [Accessed 18th August 2007].
[176] 'Carbon Dioxide Capture and Storage Offshore – International Legal Position' Available at http://www.cslforum.org/documents/UKpresentation.pdf [Accessed 21st August 2007].
[177] London Dumping Convention (note 173)

CO_2 was therefore used as part of the process of extracting oil as an EOR project, that was acceptable under the Protocol. But if CO_2 is being pumped into the bedrock for permanent storage this would not be permitted under the Protocol, which specifically prohibited 'the sea bed and subsoil'[178] for the storage of waste.

However, in November 2006 - a week after the publication of the Stern report highlighting the economic threat of climate change - and much to the delight of the proponents of CCS - an amendment to the London Protocol was approved, that permitted CO_2 to be dumped in geological formations under the sea.[179]

For many this was seen as 'removing one of the main legal hurdles' facing the implementation of large-scale CCS projects, indicating the seriousness with which the international community, or at least the developed world, views carbon sequestration.

In June 2007, seven months after this amendment to the London Dumping Convention, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR),[180] similar to the London Protocol, but a regional organisation for countries surrounding the North-West Atlantic, was amended to permit the storage of CO_2 in geological formations under the sea bed.[181] Both these amendments provided a green light to the international community's apparent eagerness to embark on large-scale sequestration projects.

---

178 Ibid.

179 'London Protocol Approves co2 Storage' Available at http://www.bellona.org/articles/London_protocol [Accessed 21st July 2007].

180 The Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR") 1992 (1998) 32 I.L.M. 1069.

181 'New Initiatives on CO_2 Capture and Storage and Marine Litter' Available at http://www.ospar.org/eng/html/press_statement_2007.htm [Accessed 18th August 2007].

Other treaties and conventions

While the principal Conventions and Protocols affecting the international development of CCS have been introduced, the following Agreements, which may also have a bearing, are described briefly below.

The Convention on Biological Diversity may affect the development of biological sequestration as it seeks to protect the development of large monoculture forests, while the Basel Convention puts restraints on the international transportation of hazardous waste, of which CO_2 may be included.

Convention on Biological Diversity, 1992 (CBD)

The CBD opened for signature at the Rio Summit in 1992 and came into force on 29th December 1993. As of July 2007, there were 190 parties to the Convention.

The CBD's objective is:

> '...the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding'[182]

It deals with the following issues

- sovereignty and ownership of genetic resources;[183]
- '*in situ'* and '*ex situ'* conservation;[184]
- access to genetic resources;[185]
- equitable return of benefits;[186]
- indigenous knowledge;[187]
- aspects dealing with the use of biotechnology.[188]

---

182 Convention for Biological Diversity 1992 (1993) 1992:822-841 at art 1.
183 Art 3.
184 Art 8.
185 Art 15.
186 Art 17.
187 Art 8(j).
188 Art 8(g).

Conflict with regard to biological sequestration could arise over potential development of large monoculture plantations that, while rapidly absorbing CO_2 and therefore meeting the requirements of climate change legislation, nonetheless, severely threaten biodiversity and cause complications with the CBD as a result.

The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 (Basel)

The Basel Convention regulates the international transport and disposal of hazardous and other waste. While it does not ban its movement, it imposes responsibilities on the transportation and disposal in the country of origin. It affords countries the right to prohibit the importation of any waste and promotes the ultimate aim of protecting human health and the environment from the dangers of hazardous waste.[189]

The general principles are:

- to encourage the production of hazardous waste to be kept to a minimum;
- to avoid pollution due to such waste;
- to prohibit the import or export of waste if either party believes the waste may not be treated properly.

Although not classified directly as a hazardous waste, it remains unclear whether CCS will be included as 'deep injection, (e.g., injection of pumpable discards into wells, salt domes of naturally occurring repositories, etc.)',[190] and as such be governed by the Convention.

It opened for signature in 1989, entering into force on the 5th May 1992.

[189] J Glazewski (note 137) at 47.
[190] Annex IV

South Africa and the International Conventions

The Climate Change Conventions

South Africa signed the UNFCCC in 1993, ratifying it on the 28th August 2007 and it entered into force on the 27th November 1997. South Africa ratified the Kyoto Protocol on 31st July 2002.

Significantly for South Africa it has been classified as a (developing) non-Annex-I country in respect of the climate change legislation. It is thus exempted from some of the 'more demanding commitments',[191] including emission reduction targets, a key aspect of the convention for the developed countries.

South Africa is, however, obliged to produce and submit annual reports to the secretariat. These include an inventory of GHG emissions and an update of the various 'policy initiatives' it has taken to reduce GHGs.[192]

This is specified in article 4.1(b) of the UNFCCC, and again in 10(b) of the Kyoto Protocol, providing that '(all) Parties... shall:

> Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montréal Protocol,...'[193]

Imbewu, a Johannesburg-based sustainable law consultancy,[194] recently reviewed South Africa's obligations under the UNFCCC and the Kyoto Protocol. It suggested that while article 4(1) appears to be an 'unequivocal statement of commitment,' creating a 'highly differentiated regime with no common

[191] 'Global Climate Change and Ozone Layer Protection - UNFCCC' Available at http://www.environment.gov.za/ClimateChange2005/UNFCCC_The_Convention.htm [Accessed 15th August 2007].
[192] K Ramakrishna, L Jacobsen, R Thomas, E Woglom, and G Zubkova 'Country Case Study: South Africa' (2003) The Woods Hole Research.
[193] UNFCCC (note 138) at Art. 4.1(b).
[194] See http://www.imbewu.co.za/ for further details.

standard, significant room is left for each Party to in effect, determine its own level of commitment.'

The definition of the term 'measures' could be viewed as referring to 'legislative, administrative or other means through which a predetermined course of action may be implemented.' It would therefore seem that while the government's active involvement in developing CCS is encouraged, failure to 'comply with the commitment' is unlikely to have any serious repercussions under the current regime.[195]

The Department for Environmental Affairs & Tourism (DEAT) has been charged with the implementation of the UNFCCC at a domestic level. It has established a National Committee on Climate Change to advise and oversee:

> '...capacity-building studies on greenhouse gas emissions accounting, mitigation and adaptation strategies, policy development, public communication, and the impacts of climate change on agriculture, water resources, biodiversity, human health, and other areas of national concern.' [196]

Unlike the rest of Africa, South Africa has the potential to benefit significantly from the policy mechanisms of the UNFCCC and Kyoto Protocol in particular the Clean Development Mechanism (CDM). This is because South Africa's relatively high dependence on fossil fuels, such as coal, in the energy sector, means that both the country's *per-capita* emissions and its carbon intensity[197] is higher than most other countries and thus easier - and cheaper - to clean up.[198] As a result this makes South Africa one of the more sought-after candidates for the development of 'clean coal'[199] CDM projects.

Negotiations are currently underway to include CCS on the list of eligible CDM projects in time for the follow-up to the Kyoto Protocal, scheduled for 2012. If

---

195 Warburton et a. (note 147) at 11.
196 C Warburton et al. (note 146) at 88.
197 The relative amount of carbon emitted per unit of energy or fuels consumed.
198 Ramakrishna et al. at 93.
199 Coal that has been sized, washed and dried in preparation for shipment to customers. Washing coal removes impurities such as rock and ash.

this does occur, South Africa could benefit significantly from income generated through encouraging the development of CCS.

The Marine Conventions

South Africa signed UNCLOS in 1994 and ratified it on 23rd December 1997. It signed the London Dumping Convention in 1972, acceding to it in 1978 and it remains in force today. South Africa is also Party to the Protocol to the London Dumping Convention and as such is bound by it.

Although it is unlikely that South Africa will undertake projects in the marine environment in the initial stages of CCS, the presence of the hydrocarbon reservoirs off the Mossel Bay coastline, as well as the extensive coastline and access to the nutrient rich Southern Ocean, means that UNCLOS must still be acknowledged.

This covers all aspects of scientific research as well as the rules governing pollution and dumping at sea. There may also be requests by other Parties to UNCLOS to conduct research related to CCS in South Africa's Exclusive Economic Zone. Under the Convention these must be considered.

Similarly, the rules relating to dumping under the London Dumping Convention and its Protocol are relevant if South Africa ever plans to sequester CO_2 offshore. However, the amendments to the Protocol, effectively permitting the storage of CO_2 under the seabed, have reduced its control significantly.

The Other Conventions

South Africa signed the Convention on Biodiversity on the 2nd November 1995, ratifying it on the 14th August 2003. It came into force on the 12th November that year. The country acceded to the Basel Convention on 5th May 1994 and it came into force three months later.

While these Conventions may only indirectly affect South Africa's development of CCS, they remain significant nonetheless.

South Africa has an impressively diverse ecosystem, one that in recent times has come under growing threat from climate change as a result of increasing demands on the land.

One of the concerns regarding biological sequestration in South Africa is that it may encourage the development of large monoculture forests, planted commercially and aimed at absorbing CO_2 through the trees growth. The requirement on Parties to ensure that adequate protection of their ecosystems be maintained may be a limiting factor on the development of biological sequestration projects in South Africa should they become a scientifically viable option.

The Basel Convention also limits the international transportation of hazardous waste and, while not specifically identified as such, CO_2 may still be controlled should South Africa ever be in a position where it seeks to trade CO_2, with other countries, for sequestration.

Initially, the most likely CCS development in South Africa will be the initial sequestration of CO_2 inland in geological formations, in which case the regulatory limitations posed by international agreements will be less relevant. However, in light of international concerns outlined in the preceding chapter, any such limitations need to be taken into account in any future legislation drafted by the SA government.

However, South Africa has neither ratified nor signed the Convention on the Ban of the Import of Hazardous Waste into Africa ("Bamako") an African regional agreement which attempts to extend further the control and limitations of transporting hazardous waste in the region, thus escaping its obligations.

Conclusion

The applicable international agreements include the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the United Nations Convention on the Law of the Sea (UNCLOS), the London Dumping Convention & Protocol, the Convention on Biodiversity(CDB) and the Basel convention.

However, the most applicable agreements for the initial development of CCS in South Africa is the UNFCCC and the Kyoto Protocol as they deal directly with the current and future development of CCS.

PART C - Towards developing a South African regulatory regime.

This study has so far completed a technological overview of CCS, discussed the key international concerns as well as introduced the relevant international instruments that may potentially regulate it.

It was concluded that the most likely form of CCS to occur in South Africa, at least in the near future, is the inland geo-sequestration of CO_2 in saline aquifers.

The key concerns, raised by international organisations include

- the need for a precise definition of CO_2;
- clarity on access and property rights;
- the hazards and legalities associated with transporting the CO_2;
- the development of suitable guidelines to ensure continuity in the governance of CCS;
- monitoring and verification of the sequestered gas to ensure its long-term *in situ* security;
- the liability attached to both handling and storing of the gas.

The international agreements relevant to CCS, both directly and indirectly, include the UNFCCC and Kyoto Protocol, UNCLOS, the London Dumping Convention and Protocol, the CBD and the Basel Convention.

The foundations have now been laid for the introduction of the concerns raised in respect to the regulation of CCS in South Africa.

Thus Part C will contain a review of the following:

- an introduction to the key laws in South Africa most likely to affect the regulation of CCS;
- an outline of the key issues relating to the domestic regulation of CCS;
- a comparative study of the current and possible future legislative regime South Africa might adopt.

Chapter V - An overview of South African law applicable to CCS

The SA Constitution

The Constitution is the supreme law of the land. Within the Bill of Rights in the Constitution which sets out the fundamental human rights is the 'environmental right'. This provides that:

24. Everyone has the right:

(a) to an environment that is not harmful to their health or well being;

(b) to have an environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.'

This mandates the government to enact legislation to achieve the goals of environmental protection and the prevention of pollution and ecological degradation.[200]

The Department of Environmental Affairs & Tourism (DEAT) has been empowered with the overhaul of South Africa's environmental laws. This involves the update of 'important general environmental legislation' while introducing 'new environmental legislation and policy documents that deal with 'important aspects relevant to environmental management'.[201]

[200] J Glazewski (note 137) at 87.
[201] Warburton et al. (note 147) at 20.

Other relevant components of the Constitution include the right of access to information,[202] the right to just administrative action[203] and an expanded *locus standi.*[204]

The Environmental Framework Laws

National Environmental Management Act (NEMA)

The most important of the new environmental laws has been the National Environmental Management Act 107 of 1998 (NEMA), which came into force on 29th January 1999. The first post-apartheid environmental law, it provides an overall framework for the broad management of the environment in South Africa under which almost all other environmental laws lie.

For the first time it introduced a suite of emerging international principles into South African law, including 'sustainable development', the 'polluter pays', 'preventative' and 'precautionary' principles, while 'entrenching "cradle-to-grave" responsibility'[205] for environmentally detrimental activities and confirming the state as the environment's legal guardian.

Key to NEMA's strength is that the principles contained in Chapter One of NEMA, apply 'to all organs of state',[206] thereby elevating the status of DEAT, its Minister and the environment to one in which other departments of government could be deemed subservient.

In fact, one of the requirements in NEMA, aimed at harmonising the very activities of the various governmental departments, is that environmental management plans (EMPs) and implementation plans (EIPs)[207] be published,

[202] Constitution of South Africa, 1996 at s 32 – the right of access to any information held by the 'state' or 'another person' that is required for the exercise or protection of any right.
[203] s 33 – administrative action that is lawful, reasonable and procedurally fair and the right to a 'written reason' for adverse decisions as a result of administrative action.
[204] s 38 – permitting legal action when acting out of own interest, on behalf of another who is unable, a group/class or in the public interest.
[205] National Environmental Management Act 107 of 1998.
[206] s 2(1)(e).
[207] NEMA (note 205) Chapter 3.

outlining the various considerations afforded to the environment by the policies of each department.

An improved environmental impact assessment (EIA) regime seeks to tighten controls on potential damage to the environment through 'listed activities',[208] while actual damage to the environment is managed through a suite of mechanisms including the 'duty-of-care' and 'emergency incidents', increased access to information and '*locus standi*' and the ability to engage in both 'private prosecutions' and 'criminal proceedings'.[209]

NEMA falls under the Department of Environmental Affairs & Tourism.

Environmental Conservation Act (ECA)

All but repealed in favour of NEMA, the Environmental Conservation Act 73 of 1989 is still relevant to the management of waste disposal.[210] This requires a permit to be sought from the Minister of Water Affairs for any person wishing to 'establish, provide or operate any disposal site'.[211]

The ECA falls under the Department of Environmental Affairs & Tourism.

The Air Pollution Laws

National Environmental Management: Air Quality Act 39 of 2004 (NEM:AQA)

NEM:AQA has revolutionised the way in which air pollution in South Africa is managed. It not only builds on the structures introduced by the Atmospheric Pollution Prevention Act, but introduces obligations to create planning frameworks that include emissions, air quality monitoring and air quality information management. At the same time it further enforces the principles and measures outlined in NEMA.

---

[208] s 24.
[209] s 30-34.
[210] Environmental Conservation Act 73 of 1989 s 20.
[211] s 20(1).

New to NEM:AQA is the concept of ambient air standards that places greater emphasis on the overall quality of the air rather than the amount of pollutants being produced at each point source and industrial site. However, greenhouse gases do not yet feature on this list of 'polluters'.[212]

In addition, NEM:AQA allows for the discretionary declaration of priority areas by the Minister of the Environment, permitting greater emphasis to be placed on particularly polluted areas.[213] Controlled emitters may be declared that oblige polluters to adhere to minimum standards of emissions, as well as 'priority pollutants' that compel the emitter to produce pollution prevention plans.

NEM:AQA falls under the Department of Environmental Affairs & Tourism.

Atmospheric Pollution Prevention Act 45 of 1965 (APPA)

Like the ECA, APPA has been all but repealed. What remains in force is the chapter dealing with 'Noxious or Offensive Gases' referring in particular to the 72 'scheduled processes'[214] that require a 'registration certificate' or permit under the Act.[215]

Requirements outlined for the issue of a licence, oblige applicants to adopt and outline 'the best practical means... for preventing or reducing to a minimum the escape' of pollutants at their premises.[216]

While DEAT has stated that APPA is due to be replaced 'in its entirety'[217] by the National Environmental Management: Air Quality Act, there is no timeline

[212] National Environmental Air Quality Act 39 of 2004 Schedule Two.
[213] The first priority area to be declared was the Vaal Triangle North of Johannesburg. This occurred in 2006 as a result of s 18(1) of the National Environmental Management: Air Quality Act 39 of 2004.
[214] Atmospheric Pollution Prevention Act 45 of 1965 Second Schedule.
[215] s 8-10.
[216] s 10(a).
[217] 'Atmospheric Pollution Prevention Act' Available at http://www.environment.gov.za/appa/about/about%20us.html [Accessed 18th August 2007].

or deadline for when this will occur; APPA is therefore included in this summary.

APPA falls under the Department of Environmental Affairs & Tourism.

Other potentially relevant Acts

Minerals & Petroleum Resources and Development Act 28 of 2002 (MPRDA)

Certainly, one of South Africa's better drafted and innovative pieces of environmental legislation, the MPRDA deals with the issues regarding mining and the extraction of minerals and petroleum products.

Taking over from the Minerals Act of 1991[218] and a product of a 1998 White Paper,[219] the Act tackles head-on almost all of the challenges faced by the various stakeholders. Acknowledging the State as legal 'custodian', it affirms that South Africa's mineral and petroleum resources are the 'common heritage of all the people'.[220]

A number of 'rights' are issued by the MPRDA. Essentially the two key rights include the 'prospecting right' which limits activities in an area to one of exploration and study, to determine whether it is suitable for mining,[221] while a 'mining right' permits the full-scale extraction of a specified mineral or petroleum product.[222]

While a maximum lifespan of 30 years is attached to a mining right, this is renewable on an unlimited basis, so long as the provisions of the Act are satisfied.[223] These include compliance with the MPRDA and other relevant

[218] Minerals Act 50 of 1991.
[219] 'White Papers' Available at http://www.info.gov.za/documents/whitepapers/index.htm [Accessed 19th August 2007].
[220] Minerals & Petroleum Resources and Development Act 28 of 2002 s 3(1).
[221] s 19.
[222] s 22.
[223] s 24(4).

Acts,[224] the production and compliance with an approved environmental management programme, the payment of royalties to the state and the submission of annual reports.[225]

Key to the MPRDA from an environmental perspective is the reiteration of the principles and integrated environmental management outlined by NEMA.[226] There are strict obligations places on parties involved in a project for the production of EMPs and the requirement fully to rehabilitate an area after the mine has closed, in order to qualify for a 'closure certificate'. The certificate permits the transfer of environmental liability to a 'competent person' and the return of the financial guarantee is obliged as part of the permitting process for a prospecting or mining right.[227]

The MPRDA falls under the Department of Minerals & Energy.

National Water Act 36 of 1998 (NWA)

Replacing the outdated Water Act of 1956,[228] the NWA abolished the notion of private and public water, instead appointing the State as 'public trustee'.[229] Unlike previous legislation the Act is geographically focused, based on actual catchment areas rather than municipal borders, thus offering a more pragmatic approach to water management.[230]

A 'reserve' must be determined for every 'significant water resource', comprising two components: the 'basic human need' and the 'ecological'

---

[224] These include *inter alia* NEMA, NEM:AQA, Mine Health & Safety Act, Mining Titles Registration Act and the National Water Act.
[225] s 25.
[226] s 37(1) & 38.
[227] s 37-41.
[228] Act 54 of 1956.
[229] s 3(1).
[230] Part 2.

component. Once the reserve is calculated the remaining water may be licensed for use.[231]

Importantly, Schedule 1 outlines the *de minimus* uses that are exempt from licensing requirements,[232] while general authorisations empower the Minister of Water Affairs and Forestry to permit some uses of water, thereby removing the need for individual licenses. Registration, though, is required.

The prevention of pollution is dealt with comprehensively, and while the Act embodies the environmental protection outlined in NEMA, it reiterates both the 'duty-of-care' and control of emergency incidents.[233]

The NWA falls under the Department of Water Affairs & Forestry.

Conclusion

South Africa's environmental legislation is widely regarded as one of the most progressive in the world. The inclusion of the environmental right in the Constitution is fundamental as it elevates the legal significance of the environment.

The presence of this Constitutional right, as well as the obligations outlined by NEMA, have afforded DEAT a hierarchical status above that of many other government departments.

NEMA effectively introduces the key international principles, broadly established at the Rio Conference, while providing scope for significant measures to be put in place in order actively to protect the environment. The overhauled EIA structure allows tighter control over land use and planning.

[231] Part 3 – The basic human needs reserve refers to the essential needs of individuals served by that particular water resource and includes water for drinking, for food preparation and for personal hygiene. The ecological reserve refers to the water required to protect the aquatic ecosystem.
[232] These include *inter alia* reasonable domestic use, emergency firefighting, use for recreational purposes and the runoff of water.
[233] s 19-20.

The State has not only been formally identified as custodian of the environment - a theme reflected through subsequent Acts[234] - but other government organs are now obliged not only to consider but accommodate the effect that their own policies and agendas will have on the environment.

The sector specific legislation seems to be moving from one of targeted control to one where an holistic approach is preferred. The ambient air standards contained in NEM:AQA and the idea of the 'water reserve' in the NWA are prime examples of this.

Finally, measures developed such as the duty of care, control of emergency incidents and ability to undertake both private prosecutions (in respect of environmental degradation) and criminal proceedings, have elevated the power of the government and the public to engage in active stewardship of the environment.

[234] MPRDA and NWA.

Chapter VI - Domestic Legal challenges facing CCS

As no previous study in South Africa has yet investigated the legislative environment for CCS, this section seeks to introduce the key concerns that have arisen from the comparative domestic study undertaken in Australia. This will be used to create a starting point for the discussion of the suitability of the current legislative regime in South Africa for regulating CCS.

The chapter deals with the issues raised by the international organisations, introduced in Part B but discussed with regard to their application under domestic law. This is followed by a discussion of the current position of South Africa in regard to CCS, and what legislative model - if any - could be adopted (or adapted) to satisfy these concerns.

The areas covered include

- access and property rights;
- the assessment and approval process;
- transportation;
- liability;
- monitoring;
- verification and financial issues.

Access and property rights

The Guiding Principles, commissioned to study the legislative environment for CCS in Australia, define property rights as 'an entitlement, or bundle of entitlements, that define the owner's right to use a resource and any limitations on its use'. This means that legislation for CCS needs to ensure that owners be required to manage access of others to a site, appropriate any benefits generated, prevent damage by others while being able actively to enforce these rights.

However, in CSS projects there are likely to be multiple owners as well as the differing rights associated with the 'surface and sub-surface', Both of these aspects need clarification, but this is no simple matter.

This is exemplified in that:

> '...sites may occur on freehold land, unallocated State land, unallocated State land which has been dedicated for use as a specific purpose, onshore or offshore or under State or Commonwealth jurisdiction.'[235]

In Australia, studies commissioned after publication of the Guiding Principles concluded that 'no existing' legislation existed [that] provid[ed] a clear regime establishing ownership of a CCS stream and clear 'identification' of the owner at each stage of the project.

Some regional legislation was identified that went some way to 'contemplate CCS' but it generally failed to provide for the fundamental legislative arrangements necessary for the storage of CO_2 over the long-term. [236]

The Principles reconfirmed that, vital to the development of CCS, proprietary rights and access for each stage of a CCS project relating to the surface and sub-surface needed to be defined.

Pipeline transportation will almost inevitably encroach on private and/or public property, but it was concluded that adequate comparable legislation from the hydrocarbon industry already existed to accommodate third party access rights.

What is less clear is whether the encroachment of a sub-surface reservoir on a third party's property could be included in this legislation.[237] These are

[235] MCMPR (note 91) at 27.
[236] Ibid at 26. Western Australia and South Australia as well as more recently the 'Queensland Petroleum and Gas (Production and Safety) Act 2004'.
[237] Ibid at 27. It is felt that Part IIIA of the Trade Practices Act 1974 may accommodate this in Australian legislation.

likely to become key considerations in respect of what extent they are applied within a CCS regime.[238]

To date no 'legal precedents' have been documented between owners of land, the operators of CCS projects and the suppliers of gas, so little is known about how the activities of a CCS project will be affected within the legislative regime.[239]

Simply to rely on common law was rejected by the Guiding Principles as this would place an onerous burden on industry which would be forced to clarify the law through the courts and this prospect could act more as a deterrent to the development of CCS than an encouragement.

Thus the 'point-of-change' in ownership needs to be clarified to permit the efficient transfer of responsibility between the various owners of the gas. Consideration will also have to be given to issues such as the multiple and sequential use of the surface infrastructure and sub-surface reservoirs, development of permits covering the exploration and utilisation of storage sites, duty-of-care considerations, compensation, the extent of the government veto and a cost recovery/pricing structure for both storage and access.[240]

On top of this, due consideration will have to be given to the rapid changes in technology and practices likely to be attached to such a young and dynamic industry.

In response, the Australian Federal government announced in June 2007 it intended using the Offshore Petroleum Act 2006 as a suitable model for creating a regulatory regime for CCS.

---

[238] Minter Ellison 'Carbon Capture and Storage - Report to the Australian Greenhouse Office on Property Rights and Associated Liability Issues' Available at http://www.greenhouse.gov.au/ccs/publications/pubs/ccs.pdf [Accessed 7th August 2007].
[239] Supra note 240 at 28.
[240] MCMPR (note 91) at 30.

Legislators argued that as it already had a proven track record in regulating offshore petroleum activities it could easily be adapted to apply to CCS because of the similarities between it and the mining industries.[241]

Furthermore, as petroleum and CCS will not only be likely to co-exist closely in the future, with determinable rights shared by both, control under similar regulation will go a long way to ironing out legislative conflicts. In turn, this should help to ensure legal consistency across jurisdictions.[242]

On a regional level, while a number of existing State laws generally embrace the storage of CO_2 underground[243] the Barrow Island Act 2003 (WA)[244] ('Barrow Island Act'), drafted specially for a CCS project currently underway off the coast of Western Australia, is by far the most progressive in outlining Party obligations towards permitting (rights) for the sequestering of CO_2 underground.

It came about as a result of the development of the Gorgon project, prior to the national government's decision to adapt the *Offshore Petroleum Act 2006* for CCS. The Act provides the legislative authority for the Western Australian Government to grant a lease on Barrow Island specifically for gas processing and CCS, while at the same time ratifying the Gorgon State Agreement.[245]

The Bill includes general prohibitions on the disposal of CO_2 without ministerial approval,[246] an outline of the application process as well as details of the information required upon submission.[247]

---

[241] J Bradshaw 'Development of Australia's Legislation and Regulatory Guidelines for CCS' (2007) Australian Government Department for Industry, Tourism and Resources at 7.
[242] Ibid.
[243] These include the Petroleum Act 2000 (SA) s 10(1)(d) and the Petroleum and Gas (Production and Safety) Act 2004 (Qld).
[244] A comprehensive regime to specifically facilitate the proposed Gorgon Project in Western Australia and is applicable to the Barrow Island area exclusively.
[245] Barrow Island Bill 2003 (WA).
[246] s 13(1).
[247] s 13(2) – must include the position, size, capacity and geological structure of the underground reservoir; the rate of proposed disposal, volume and composition of the CO_2 and the expected duration of the disposal; the injection and disposal methods; the capability of the reservoir to confine the CO_2; and the technical advice and data available in relation to the proposed disposal.

Assessment & Approvals process

In general Environmental law, Impact Assessments (EIAs) and the adherence to relevant 'occupational health and safety' are current mechanisms applicable to the approval process of almost all major projects that concern the environment.[248]

It is taken as a given therefore that a geo-sequestration project 'will require an appropriate environmental license and/or authorisation' in almost all jurisdictions.[249] This could include the requirement that plans for environmental management and ongoing monitoring of the stored gas be submitted.

Concern has been raised that a lack of consistency could occur under current approval frameworks. This is due to the sharp differences between individual components of an 'integrated CCS project', particularly when considering the unique goals when compared to other, more conventional, resource-based or industrial projects.[250]

These concerns are increased when the role that local laws may play is considered. There is a likelihood that projects will be treated differently according to the jurisdiction they fall within. Inconsistency may become evident, not only in how similar projects are treated in separate areas, but even between two geographically separate stages of the same project - for example between the point of capture and storage - that may fall under separate jurisdictions.

The Guiding Principles make it clear that to reduce the likelihood of long-term leakage, a secure site and sufficient plans for monitoring and verification are paramount. Clear and consistent regulations and a transparent guiding

[248] MCMPR (note 91) at 22.
[249] McLaren, J and Fahey, J 'Key Legal and Regulatory Considerations for the Geosquestration of Carbon Dioxide in Australia' (2005) 24 *ARELJ* 45-74 at 56.
[250] MCMPR (note 91) at 23.

framework, outlining the general criteria for CCS, will be vital in tackling both uncertainty of industry and negative public perception.

Returning to the Australian 'Barrow Island Bill', the Western Australian environmental minister is given powers to 'grant approval of an application' for geo-sequestration but can demand financial guarantees, to indemnify the state and to restrict transferability 'or otherwise' of the approval.[251]

The 'Gorgon State Agreement', drafted in conjunction with the 'Barrow Island Act' and published alongside it, outlines the contractual agreement between the government of Western Australia and the operators of the Gorgon project. Amongst other details specific to the Gorgon project is a time frame limiting submission of applications, for that project, to December 2008.[252]

Transportation

The Australian Guiding Principles foresaw few problems with the use of pipelines to transport high pressure CO_2 from the point of capture to the point of storage.

This is mainly due to the fact that high pressure natural gas pipelines are widely used across the world, and this is expected significantly to increase as more gas reserves are accessed.

In Australia, the pipeline owner is generally responsible for the safety of the public while the licensee has 'important responsibilities' in the event of any incidents.[253]

[251] Barrow Island Bill (note 257) s 13(6).
[252] Gorgon State Agreement 2003 (WA). Clause 7.
[253] MCMPR (note 91) at 32.

There is a current Australian Standard that controls oil and gas pipelines and there is no foreseeable reason why this cannot be co-opted for the transportation of CO_2.[254]

This Standard requires the identification of all risks, 'metre by metre' along a pipeline's entire length,[255] to ensure that a risk is as low as is reasonably possible. There are obligations to complete the assessment and approval process, requiring the submission of adequate EIAs and approval documentation.

Legislation dealing with the transportation of 'waste' may also affect the transportation of CO_2. In Australia this occurs both at the national environmental framework level, but also in more specific legislation.[256] These independently require that EIAs be completed and permits obtained. [257]

The 'Barrow Island Bill' has also 'effectively amended' the definitions of 'petroleum' and 'pipeline' in the Petroleum Pipeline Act 1969 (WA),[258] to include the transport of carbon dioxide by pipeline. However, this is limited to the disposal of carbon dioxide on Barrow Island in an 'underground reservoir or other sub-surface formation.'[259]

Liability

Given the risk to the environment, due to the large volumes of gas involved, worst case scenarios indicate that significant financial burden may occur in the event of a catastrophic leakage of CO_2.

[254] Ibid at 33. AS 2885 - The standard specifies requirements for the design and construction of steel pipelines and associated piping and components that are used.
[255] Ibid.
[256] McLaren et al. (note 251) at 54. E.g. Environmental Protection Act 1970 (Vic) ss4, 39(1), 41(1), 45(1); Waste Minimisation and Management Act 1995 (NSW) s 5.
[257] Ibid at 57. s 4, definitions or 'regulated substance' and 'pipeline' and s 10(1)(g).
[258] Ibid at 58. s 4.
[259] Note 257 s 11.

Some degree of liability may be dealt with under the common law of nuisance and negligence, particularly in respect of the capture, transportation and injection of the gas. However, common law requires both an element of fault to be proved and stands in perpetuity - in that liability only arises when an injury or damage actually occurs. Who, it has been asked, would be liable for a major gas leakage in a long term-storage site a hundred years from now?

While long-term liability is an onerous burden for the operators of a CCS project, as they effectively remain liable forever, the Australian Guiding Principles suggest that the 'overriding arrangements' should not be allowed to differ from the liability associated with other industries.[260]

Principles applicable to the decommissioning of petroleum and mine site operations, long-term management of hazardous waste disposal sites and contaminated site remediation may provide models for countries to assist in defining the relevant liability.[261] It is felt that 'in line with current industry practice', the operator would be responsible for managing all operational aspects of a project, including the decommissioning process.

It is, however, impractical, if not impossible, for liability to be held against an operator in perpetuity, primarily because the time frames involved with CCS are extensive. The Guiding Principles suggest therefore that should an operator comply with all Terms and Conditions attached to an approval process, the 'regulator' (or State) could bear long-term liability. The operator would then be relieved of responsibility unless negligence could be proven on its part.[262]

Nonetheless it was felt that the government should clearly develop an outline of all aspects of liability that may arise from a CCS project, while in operation and post-closure.

---

[260] MCMPR (note 91) at 42.
[261] Ibid.
[262] McLaren et al. (note 251) at 42.

In Australia, liability appears to be covered by the general environmental State laws that impose the all-encompassing duty not to cause 'environmental harm',[263] defined as any 'direct or indirect alteration of or impact on the environment which has an adverse effect on or degrades the environment, of whatever degree or duration.'[264]

Thus escaped gas - at any stage of the project - is likely to be classified as a 'pollutant' and 'waste'[265] and as such, associated remediation obligations would arise, under the environmental protection Acts, but also under the contaminated land legislation previously introduced.[266]

With regard to long-term liability, it remains unclear where responsibility lies for the sequestered gas. In Australia the 'Barrow Island Bill' provides a loose framework but is limited to permitting the Minister to demand financial surety, indemnify the government and limit general transferability of an approval.[267]

The 'Gorgon State Agreement' goes a little further in demanding a 'minimisation of environmental disturbance',[268] as well as contractually permitting the Western Australian government to claim against the 'joint venturers'.[269]

Monitoring, Measuring & Verification (MMV)

Australia's Guiding Principles stress the importance that must be placed on industry in providing 'accurate and relevant information' through the monitoring and verification of the storage reservoirs.

---

[263] Ibid at 54. E.g. Protection of the Environment Operations Act 1997 (NSW), s 116(1).
[264] Ibid.
[265] 'Waste' is defined by the Environmental Protection Act 1970 (Vic) as 'any substance which causes an alteration in the environment; discarded or unwanted matter, and any other substance as prescribed.
[266] E.g. *The Contaminated Land Management Act* 1997 (NSW).
[267] s 13(6).
[268] c 5 and14.
[269] Mclaren et al. (note 251) at 58.

Similar to the process involving transportation, this will likely be in the form of standards or objectives rather than set practices, and be clearly planned, outlined and undertaken at the pre-injection phase, continuously during injection and 'for an appropriate period thereafter.'[270]

As MMV is currently applied to the underground storage of natural gas, it is possible that many components of a CCS project could be monitored under various existing frameworks. These include pipeline, petroleum, mining or waste disposal, and only minor legislative amendments may be necessary.[271]

However, the Guiding Principles note that the concept of verification is not necessarily considered in all jurisdictions. Existing legislation and regulations would therefore need to be adopted or changed in order to apply to every stage of a CCS project.

Furthermore, as no adequate Standards or Guidelines currently exist to regulate the unique decommissioning process that a CCS site must go through, operators will need to prove conclusively that the stored gasses no longer pose a threat and that liability for the site could then be transferred to the state or government, as deemed suitable.

The Guidelines also indicated that additional powers may have to be legislated for Regulators or third party verifiers in order to satisfy both the public and private concerns that long-term storage is both safe and secure.[272] This suggests that a Designated National Authority (DNA) will most likely play a significant role in the development and regulation of CCS.

By not developing sound monitoring and verification processes, industry will be unable to provide the assurances to confirm that the injected gases can be consistently and accurately accounted for. This may result in inconsistencies

[270] MCMPR (note 91) at 39.
[271] Ibid.
[272] Ibid.

in the way CCS projects are regulated and affect public and private perceptions of the industry.[273]

But many of these risks and processes associated with the short-term aspects of CCS are similar to the hydrocarbon industry.

In Australia, general 'industry' 'codes, standards, rules and guidelines' enforcing the monitoring and verification of stored gas has been widely referenced and it is felt that such legislation could be satisfactorily transferred to the early stages of a CCS project.[274]

However, due to the failure of satisfactorily legislating for the long-term storage of *in situ* gas, much of the development of MMV is occurring as a result of the activities of the scientific community rather than legislators. Projects like Weyburn and Sleipner have been developing methodologies for monitoring and verifying stored CO_2 in these 'test projects' since 1990. It is likely that project reports from these activities will heavily influence the international approach to regulating the long-term storage of CO_2 in the future.

Financial Concerns

Australia has highlighted three key areas of concern in regards to financial issues relating to CCS; the general tax system applicable; insurance; and the provision of funding for any post-closure obligations or liabilities.[275]

While the long-term protection of the environment is important, these financial and regulatory measures 'must be subject to a least cost approach

[273] Ibid at 37.
[274] s 29 and 31.
[275] MCMPR (note 91) at 46.

that preserves international competitiveness, uses established regulatory principles and procedures and avoids fiscal burden.'[276]

The normal practice of industry is to take out insurance to cover any liability. While none of the processes in a CCS project, including construction, operation and short-term liabilities should have any problem in being insured,[277] insuring post-closure would be more problematic as underwriters may not want to take on the risk associated with such a unique and unknown storage procedure.

Ultimately the government may need to take on the role of insurer which would not only require a policy decision by the State but be seen as a form of 'special assistance' to the industry and maybe even contravene international trade agreements.[278]

Precedents for site rehabilitation and decommissioning already exist in the mining and petroleum industries - including the establishment of trust funds or bank guarantees - and their application could be considered for a CCS project. The cost of monitoring could be dealt with in the same way.

For liability during the post-closure stage, the situation was felt to be more complex. An arsenal of financial instruments may be required to accommodate the likelihood that common law will be unable to hold negligent parties accountable over the long-term.

Acknowledging the importance of this, the Guiding Principles have identified criteria that would need to be accommodated in any financial instrument in that it:

- must be compatible with the time frame of long-term storage;.
- needs to be flexible enough so as to be 'site specific';
- should promote 'leading practice' in CCS;

[276] Mclaren et al. (note 251) at 69.
[277] MCMPR (note 91) at 48.
[278] Ibid at 47.

- should be consistent with current law, especially in respect of regulatory, property lease and taxation requirements;
- should reflect the cost of the risk being undertaken.[279]

While the cost of adhering to these financial obligations may be significant for industry, they are ones which 'any responsible project operator would expect to face' anyway.[280]

Much can be learnt from this discussion on the activities and studies undertaken by other countries in developing a legislative regime for CCS. This report will now take these findings and apply them to South Africa and the development of CCS in the country.

Below is a table summarising the key areas of CCS that require legislating and the principle concerns regarding each.

[279] Ibid.
[280] Ibid at 48.

Access & Property Rights	Assessment & Approvals	Transportation
Need to ensure owners can manage access to sites, appropriate any benefits prevent damage and enforce rights Underground reservoir may encroach on third parties Potential for multiple owners/users of reservoirs Potential for sequential use of reservoirs and sub surface infrastructure Need for secure permitting regime	Needs to be able to deal with the wide ranging inconsistencies possible in a CCS project Needs to adequately cater for projects which cross over multiple jurisdictions	Must ensure that sufficient protection of human and environmental health is upheld

Liability	Monitoring & Verification	Financial Concerns
Needs to be able to deal with the potential risk of large gas leakage in the future Must cater for the transfer of long-term liability to the State/Government if deemed a suitable option	Need for CCS specific guidelines to be developed to cater for all stages of a project Must be consistent but allow for inevitable differences between CCS projects	Least cost approach to developing CCS desirable Should be based on established principles Avoids excessive fiscal burden by all parties Must deal with possibility that long-term aspects of CCS may be uninsurable Should be able to cater for trust funds of necessary

Chapter VII - The South African Solution

Access & Property Rights

In order to investigate the issue of access and property rights, or who is responsible for what parts of a CCS project, in South Africa, it is necessary to determine where CCS would be regulated within the current legislative regime - if anywhere.

The Provinces of South Africa have significantly weaker powers than the States of Australia, so that major legislative activities tend to be dealt with at national rather than regional level. While this implies it is not as flexible towards localised conditions as the Australian model, South African law is less fragmented, the jurisdiction more universal and the legislative system somewhat easier to analyse.

In determining governance the principal issue is whether CCS constitutes an environmental rather than an industrial activity.

Considering that the development of CCS is encouraged in international law by the climate conventions,[281] it would be understandable to assume that any domestic laws proposed would come under the remit of the air pollution legislation.

However, the ultimate process of CCS is not in removing CO_2 from the atmosphere and increasing air quality, but the physical processes involved in capturing, transporting, injecting and storing the gas.

While the aim of NEM:AQA is to minimise air pollution, there is 'nothing specific to CCS' aside from the Minister of the Environment being empowered to make Regulations that include 'the avoidance or reduction of harmful

[281] UNFCCC (note 48) and the Kyoto Protocol (note 147).

effects on air quality.'[282] This is not felt to be a significantly supportive argument for the control of CCS under the air pollution regulation.

As in the case of Australia, it appears that South Africa's mining and petroleum legislation would be better suited to regulating CCS. The Mining and Petroleum Resources Development Act (MPRDA), South Africa's foremost mining legislation, is the obvious candidate to be adapted to the needs of CCS. It deals succinctly with the issuing of permits, as well as access and property rights,[283] both for prospecting and mining, and with many of the similar stages that will be experienced by the CCS industry.

However, for several reasons the simple inclusion of CCS into the MPRDA may not be feasible. First, there needs to be clarity over whether the definition of 'mineral' meaning '*any* substance, whether in solid, liquid of gaseous form', could refer to a CCS stream, even though CO_2 is not a mineral. In addition, the requirement that the 'substance' be 'formed or subjected to a geological process'[284] further distances the Act from embracing a CCS stream.[285]

Second, the definition of 'mine', around which the Act revolves, is outlined as:

> '...any operation or activity for the purposes of *winning* any mineral on, in or under the earth, water or any residue deposit, whether by underground or open working or otherwise and includes any operation or activity incidental thereto.'[286]

The principal concern is that although CCS (and more likely EOR) could be loosely classified as 'incidental' activities, it is felt the reference to 'winning' currently disqualifies geo-sequestration as an eligible activity under the Act.

---

[282] NEM:AQA (note 212) s 53.
[283] Chapter 4.
[284] s (1).
[285] A Gilder and M Basterfield 'The SA law relating to Carbon Capture and Storage' Available at http://www.imbewu.co.za/publications/CCS_FFF_130606.ppt [Accessed 13th July 2007].
[286] s (1).

Third, although dealing with rights associated with prospecting and mining, the MPRDA fails specifically to regulate the transportation of 'minerals', with particular regard to the issuing of access rights for the construction and operation of high-pressure pipelines.

One alternative is the Gas Act 2001,[287] which regulates the 'transmission, storage, distribution, liquefaction or re-gasification' of gas',[288] and clearly outlines the application process necessary for obtaining licences. This includes *inter alia* the 'plans and abilities' of the applicant to adhere to 'all applicable labour, health, safety and environmental legislation.'[289]

However, like the MPRDA, the definitions of the Gas Act fail to embrace CCS, as 'gas' is limited to 'all hydrocarbon gases'[290] of which CO_2 is, by the absence of hydrogen, excluded. In addition, the Act fails to regulate the physical processes of mining gas - only the post-extraction handling - and is thus unsuitable for many stages of a CCS process.

So while the MPRDA does contains a number of related and topical issues pertaining to CCS - in particular its detailed regulations for the application and issuance of 'rights' - amendments will have to be made to its definitions and the lack of clear guidelines governing transportation of gas by pipeline will need to be addressed.

Therefore, it seems most likely that a marriage of the MPRDA and the Gas Act will go some way towards creating satisfactory legislation for the property and access rights associated with all components of a CCS project.

[287] Gas Act no 48 of 2001.
[288] s 15(1)(a).
[289] s 16(f).
[290] s 1.

Assessment & Approvals

As in the case of Australia, assessment and approvals are well catered for under South African law, and obligations exist right to the very top.

Section 24 (the 'Environmental Right') of the Constitution - that everyone has the right to 'have the environment protected'[291] - is reflected throughout the South African environmental regime and is felt to be one of the stronger general aspects of public law.

The National Environmental Management Act (NEMA), the most comprehensive piece of legislation dealing with the protection of the environment, embodies a range of measures aimed at ensuring a smooth, effective and consistent approach to the assessment and approval process.

The measures stem from the principles maintaining that '[pollution and degradation of the environment be avoided, minimised or remedied',[292] along with the disturbance of both 'landscapes'[293] and 'ecosystems'.[294]

An effective NEMA mechanism is the obligation it imposes on every government department to publish 'environmental implementation plans' (EIPs) and 'environmental management plans' (EMPs). These are required in accordance with each department's relative involvement in developing policies that may have a direct - or indirect - effect on the environment.[295]

This is critical because as CCS is likely to be governed by the mining and hydrocarbon legislation, it will fall primarily under the stewardship of the Department of Minerals and Energy (DME) rather than the Department of

[291] s 24.
[292] s 2(3)(ii).
[293] s 2(3)(iii).
[294] s 2(3)(i).
[295] s 11. EIPs are required from every department whose policies 'may effect the environment' and include DEAT, DLA, DoA, DoH, DTI, DWAF, DoT and DoD. EMPs are required from every department whose policies involve the management of the environment and include DEAT, DWAF, DME, DLA, DoH and the DoL.

Environmental Affairs and Tourism (DEAT).[296] As a result the obligation on the DME to produce EIPs and EMPs means they are required to accommodate environmental concerns in their policies and, ultimately, their assessment and approval processes.

Furthermore, NEMA is the home to South Africa's EIA regime, which requires any 'potential impacts on the environment... [to] be considered, investigated, assessed and reported on to the competent authority'.[297]

NEMA's associated EIA regulations,[298] published in 2006, outline the specific procedure for the implementation of NEMA's 'Integrated Environmental Management'.[299] Most importantly, it outlines the EIA process[300] but also consolidates the role that the public must play in the assessment and approval process.[301]

Though not specifically listed at the moment, there is no doubt that any future CCS activity will trigger an activity on the EIA regulations and require an EIA, for almost all of its component stages. The two sets of 'listed activities'[302] accompanying these regulations identify the activities that would trigger an automatic requirement for an EIA within NEMA.

Below is a table identifying each component stage of a CCS project and the likely activities it may trigger:-

---

[296] Both the MPRDA and the Gas Act are governed by the DME.
[297] s 24(1).
[298] NEMA Environmental Impact Assessment "EIA" regulations (GN No. R. 386 and 387 of 21 April 2006) produced as a result of s 24(5) of NEMA.
[299] NEMA (note 215) Chapter 5.
[300] No. R. 385 Chapter 3.
[301] No. R. 385 Chapter 6.
[302] No. R. 386 and No. R. 387 produced as a result of s 24(1) of NEMA.

CCS Stage	Potential triggered activity
Capture	R. 387 1(e). Release of emissions, pollution, effluent or waste.
Transportation	R. 387 1(f). Temporary storage of waste of more than 50 tonnes a day. 1(j). The bulk transportation of dangerous goods using pipelines.
Injection	R. 387 3. The construction of filling stations... or any other facility for the underground storage of a dangerous good...
Storage	--
General	R. 387 1(f). The recycling, re-use, handling, temporary storage or treatment of general waste. 1(g). the use, recycling, handling, treatment, storage or final disposal of hazardous waste. 2. Any development... where the total area is, or is intended to be, 20 hectares or more. 7. Reconnaissance, exploration, production and mining as provided for in the MPRDA... 8. ...any other right granted in terms of previous mining legislation...

But it is not just NEMA that requires the production of an EIA. The MPRDA is generally regarded to be as much about environmental protection as the encouragement of sustainable mining. It states that mining '...may not result in unacceptable pollution, ecological degradation or damage to the environment'[303] and that all mining applications must be accompanied by both an 'environmental impact assessment' and an 'environmental management plan'.[304]

A problem under the current South African environmental regime though, is the number of pre-constitution Acts yet to be repealed. As a result, several environmental Acts were drafted before the emergence of the current framework laws, in particular NEMA. Consequently, there is a high degree of fragmentation and overlapping, particularly in regard to the issuing of permits.

For instance, should the CCS stream be defined as a 'waste product', permits would potentially be required not only under NEMA and the MPRDA as

[303] s 23(d).
[304] s 22(4)(a).

discussed, but also *inter alia* for 'waste disposal' under the ECA,[305] and the 'intentional recharging of an aquifer' under the National Water Act (NWA).[306]

This has posed logistical difficulties for developers in the past as they have not only had to deal with permit requirements under several individual Acts, but also with numerous government departments. In the above example, NEMA lies within DEAT, the MPRDA under the DME and permits associated with the NWA and ECA are issued by the Department of Water Affairs and Forestry (DWAF).

It is clear that this overlapping must either be removed or the application process simplified to provide an efficient application process for CCS projects.

It seems clear from the above that South Africa's assessment and approval regime, while sometimes a little cumbersome, is broad, encompassing and effective. NEMA has been well drafted and clearly ensures that both past and future technological developments will be covered under the legislation.

However, methods for accommodating technically unique aspects of CCS, such as site selection, quantity of gas stored and the maximum amounts of foreign gas other than CO_2 in the stream, will need to be developed.

But so long as the supporting documents, submitted with applications, can both scientifically and technologically justify the planning decisions, there should be no reason why the current regime cannot be adequately adapted for CCS.

[305] s 20. 'Waste' is defined by the ECA as 'any matter, whether gaseous, liquid or solid...designated by the Minister... as an undesirable or superfluous by-product, emission... of any process or activity.'
[306] s 37(d).

Transportation

In South Africa, as in Australia, it is felt that the gas transportation legislation could be easily transferable for the transportation of CO_2. The Gas Act would thus be a suitable model, although the amendment of the definitions to expand its current governance purely of hydrocarbons would be required.

The Gas Regulator, introduced by the Gas Act, oversees, licenses and regulates the operators of gas transmission facilities. Again, this could prove beneficial to legislators.

There is also a number of local and international standards regulating the construction, operation and handling of gas transmission facilities. These, too, provide easily transferable models for legislators.[307]

Liability

General Liability

Liability under South African environmental law, like Australia, revolves around common law and is well catered for within legislation.

At the top, the Bill of Rights not only enshrines the Right to have the environment protected, but goes further in upholding both an 'access to information'[308] and a right to 'just administrative action'.[309] Significantly, *'locus standi'* has been extended to include:

- anyone acting in their own interest;
- anyone acting on behalf of another person who cannot act in their own name;

[307] South African National Standards (SANS) accreditation, Sans 329 ensures a standardised qualification for individuals involved in the handling, storage, and distribution of gas. Sasol Gas currently adheres to the American National Standard for Gas Transmission and Distribution Piping Systems as well as maintaining accreditation ISO 9002 quality management system and ISO 14001 (http://w3.sasol.com/annual2001/br_sasol_gas.htm).
[308] s 32. Enacted in legislation by PAIA.
[309] s 33. Enacted in SA legislation by PAJA.

- anyone acting as a member of, or in the interest of, a group or class of persons;
- anyone acting in the public interest;
- an association acting in the interest of its members.[310]

This means that through the Constitution alone, liability for harm to the environment can not only be upheld, but actively enforced.

NEMA deals extensively with liability and any activity involving the potential to cause harm to the environment. This would include CCS. The main mechanisms in NEMA are outlined in Chapter V, but principally include the 'duty of care and remediation of environmental damage'.[311]

Section 28(1) states that every person 'who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring.' In other words, any damage caused to the environment, be it present, in the past or in the future will be liable under NEMA.[312]

Short Term Transmission Liability

As it is likely that an operator of a CCS project will require a permit under the Gas Act, an adequate liability regime currently exists to govern this component of a project.

The objectives of the Act specify that it aims to ensure 'the safe, efficient, economic and environmentally responsible transmission, distribution, storage, liquefaction and re-gasification of gas'.[313]

---

[310] s 38.
[311] s 28-34.
[312] Some of the main enforcement mechanisms stemming from the duty of care, include the 'protection of workers refusing to do environmentally hazardous work' (s 29), the 'control of emergency incidents (s 30), 'access to environmental information and protection of whistle-blowers' (s 31), 'seizure of items', an increased 'legal standing' (s 32), the ability of the public to undertake 'private prosecution' (s 33), as well as significantly increased penalties, including fines and imprisonment (s34).
[313] s 2(c).

The importance in mitigating potential threats of transmission is reflected throughout the Act. The application process requires a review of the 'plans and ability of the applicant to comply with all applicable labour, health, safety and environmental legislation',[314] while the Gas Regulator is empowered to alter 'the plans for the proposed construction' in order to comply with the legislation if necessary.[315]

Reference to 'environmental legislation' would clearly encompass the range of framework environmental laws, in particular NEMA, and its duty of care, as well as the requirement for EIAs and the comprehensive management and impact plans.

Failure to comply with the obligations outlined in the license agreement may result in fines of up to 'R 2,000,000 per day for each day on which the contravention or failure to comply continues.'[316] Continued failure to adhere to licence requirements can result in the suspension or revocation of the licence, by the Gas Regulator.[317]

The obligations laid down by the Gas Act, and supported by the framework environmental laws, are considered more than sufficient to cover the short-term liability for the transmission of a CCS stream. Considering the relatively small volumes of CO_2 likely to be transported by individual projects, it is clear that transport of natural gas poses significantly more risks than that of CCS.

We can therefore conclude that the legislative framework governing the transmission of gas in South Africa is more than adequate to regulate the handling of CO_2.

---

[314] s 16(f).
[315] s 18(b).
[316] s 26(2).
[317] s 27(1).

Long-Term Transmission Liability

There is little concern over the long-term liability for the transmission of CO_2 as the standard obligations regarding the closure, removal and rehabilitation of industrial projects will apply. The CCS stream is not stored at the transmission stage for any significant period of time and therefore risks of leakage over the long-term are minimal.

Short-Term Injection Liability

The Minerals & Petroleum Resources and Development Act of 2002 (MPRDA) generally obliges parties to 'rehabilitate the environment... to its natural or predetermined state',[318] making them 'responsible for any environmental damage'.[319] There is little doubt that the intention of the drafters in the Department of Mines was to link the Act closely to the principles of NEMA and indeed frequently refers to it by name.[320]

A feature of the MPRDA of particular interest to CCS is the Act's requirement that the Minister oblige operators to provide financial guarantees for the 'rehabilitation or management of negative environmental impacts', prior to the issuance of a mining right. The operators are then required regularly to 'assess' their 'environmental liability' and report back.[321] These powers are further enforced by the right to 'recover costs in event of urgent remedial measures'.[322]

This reduces the liability shouldered by the State and obliges operators to give due diligence to the short - and possibly even long-term - effect that their activities may have on the environment, and plan accordingly.

---

318 s 38(1)(d).
319 s 38(1)(e).
320 s 38(1)(a) and s 38(1)(b).
321 s 41.
322 s 45.

The MPRDA thus goes some way to dealing with liability transfer and the unanswered question of exactly when short-term becomes long-term under a CCS project. The Act holds the operator 'responsible for any environmental liability' until a 'closure certificate' has been issued. This certificate is released once satisfactory completion of the 'closing plan' has been done.[323]

Once issued, the Act permits the Minister to 'transfer such environmental liabilities and responsibilities as may be identified in the environmental management plan or environmental management programme... to a person with such qualifications as may be prescribed.'[324] There is no limitation in the Act to indicate that this 'person' may not be the State or an entity thereof.

Long-Term injection liability

Given the MPRDA's focus on extracting minerals rather than sequestering them, it fails to address the long-term decommissioning process necessary for a CCS injection site. But it does require that operators must, 'as far as it is reasonably practicable, rehabilitate the environment... to its natural or predetermined state'.[325] This is considered sufficient to encourage good environmental practices during the final closure of an injection site.

But one key concern in the long-term decommissioning of a storage reservoir is that sufficient sealing, or 'capping', of the actual injection well - the physical hole drilled to inject the gas - is carried out, otherwise the threat of corrosion, and ultimate storage failure, is increased.

The injection wells, the point where the CO_2 stream is physically injected into the reservoir, have been highlighted as one of the weaker points of a storage reservoir as they often form the only breach of the cap-rock and thus their sealing post-injection could prove vulnerable to corrosion. The need for them

[323] s 43(3)(d).
[324] s 43(2).
[325] s 38 (1)(d).

to be securely constructed and properly decommissioned is vital if there is to public confidence in the industry's ability to sequester significant amounts of GHGs over a significant period of time.

Although the MPRDA fails specifically to refer to the 'capping' of wells, adequate arrangements made for decommissioning during the initial assessment and approval process would provide for the necessary security and safety of the stored gases. This is, however, dependent on an efficient, transparent and consistent Regulator (or assessor) to enforce these standards and develop guidelines.

Thus it is recommended that universal standards and guidelines be developed outlining the minimum requirements for the 'capping' of wells, while accommodating the differing requirements that exist between storage sites.

Under the licence conditions of the Gas Act no reference is made to the decommissioning process of an injection site or indeed any of the stages of transmission.[326] However, given the general obligations to 'comply with the applicable health, safety or environmental legislation',[327] this would also include sufficient plans for the decommissioning process of the injection site.

Long-term Storage Liability

As already mentioned, the most difficult component of a CCS project to legislate for under existing legislative models is the permanent storage of CO_2 underground.

This sort of activity was not anticipated in South Africa at the time of drafting the various potentially applicable laws, and as a result is not accommodated in the current legislative framework. However, there are several Acts that may provide options for legislatures. These are discussed below.

---

[326] s 21.
[327] s 16(f) and 18(b).

First: common law in South Africa. Many environmental Acts accommodate common law, in particular NEMA and its 'duty' to remediate environmental damage, past, present and future.[328] This includes broad obligations on an 'owner of land or premises, a person in control of land or premises or a person who has a right to use the land' and applies to 'any' act that has been performed or undertaken.[329]

It would seem evident that NEMA intends to hold accountable both operators of a CCS project and the holder of property rights to the land on which the ongoing gas storage would occur. However, the Act fails to specify a limitation period. This can be seen positively as it at least provides a liability fallback, by holding operators liable in perpetuity. In practice, however, the likelihood of being able to hold operators (and possibly even property rights holders) to account in the event of incidents occurring decades, or even centuries hence, is small.

The long-term liability regime therefore will need to take a different approach to the concerns expressed if both the public and private sectors are to be satisfied and trust built up.

Chapter 4 of the National Nuclear Regulator Act (NNRA) outlines the issue of liability in the nuclear industry. As in the MPRDA, it requires financial surety to be lodged with the Minister to 'fulfill any liability which may be incurred'[330] as a result of any incidents.

This is a result of 'strict liability' imposed on nuclear operators by the Act, holding them accountable for damage 'caused by or resulting from' their activities, 'whether or not there is intent or negligence proved'.[331]

---

[328] s 28(1).
[329] s 28(2).
[330] National Nuclear Regulator Act no. 47 of 1999 s 29(2).
[331] s 30(1).

The Act refers to any liability that may arise as being 'determined in accordance' with 'common law',[332] but significantly the Act limits any claims for compensation to a 'maximum liability'[333] where the government is bound to shoulder the additional financial burden that may be required in the case of a major accident.

Second: the Hazardous Substances Act (HSA).[334] The Act outlines the liability associated with the handling of hazardous substances, holding the employer, 'or principal', directly accountable for any damage caused by the handling of dangerous substances.[335]

Unlike the NNRA, however, the HSA does not impose strict liability upon operators, but states that 'no person, including the State, shall be liable in respect of anything done in good faith'.[336]

While neither Act provides a conclusive regime to satisfy the concerns of long-term liability of the sequestered CO_2, it is likely that a combination of provisions, drawn from current South African environmental legislation, could combine to form a regulatory regime.

Conclusion

Under the Constitution and NEMA, operators at the transmission and injection stages of CCS can be held liable for their actions in the short-term if they cause harm to the environment.

The similarity of many components of a CCS project to other mining or industrial activities means that existing 'environmental legislation' under the

[332] s 32(1)(a).
[333] s 33.
[334] Hazardous Substances Act 15 of 1973.
[335] s 16.
[336] s 28.

MPRDA and Gas Act would provide an adequate short-term liability regime for the processing of a CCS stream.

As to long-term liability, the question still to be resolved is whether or not a transfer of liability will occur at some point from the operator to the State. Given that CCS's ultimate objective is storing CO_2 in perpetuity it is impractical to impose long-term liability on the operator.

Linked to this is the vexed question of the time scale necessary to establish satisfactorily that the reservoir poses only marginal risk of leakage and the State's exposure to liability thereby minimised.

A balance needs to be found between the onerous liability conditions imposed on operators under the NNRA - seen as a deterrent to the development of CCS - and ensuring that adequate planning, monitoring and verification is undertaken by the Parties, to satisfy concerns over the long-term security of the stored gas and reduce the burden of risk to the State.

It would be proposed that only once conclusive proof is provided that a site is stable and secure should a transfer of liability occur. It is recommended that this be adapted from the regime of the MPRDA that requires financial guarantees, released upon successful application for a closing certificate.

Monitoring, Measuring & Verification (MMV)

Short Term

Given that the transmission and injection stages of CCS essentially involve activities already in use in other industries, it is believed that the Gas Act would provide the necessary framework for the regulation of MMV in the short-term.

Licence terms and conditions require 'plans' to be submitted supporting an applicant's capacity for operating a project. These 'must' address the concerns of the 'environmental legislation' and it would be logical that the inclusion of a clear outline for the monitoring of the project throughout its life cycle would be mandatory.[337]

Similar requirements are brought to bear under the MPRDA, reflecting Chapter 5 of NEMA, which enforce the obligation to undertake adequate monitoring and verification of the injection process.

The requirements incumbent on operators under existing legislation to conduct monitoring and verification associated with the transmission and injection stages of a CCS project may mirror those methods already employed by the hydrocarbon industries.

Long-term

As seems to be the case for most of the major issues raised about CCS, long-term monitoring and verification is significantly harder to regulate than the common activities associated with the transmission and injection stages.

Obligations to engage in MMV are encouraged with the requirement to obtain a closing certificate under the MPRDA that proves no significant threat to the environment remains. In particular, operators are required to 'annually asses his or her environmental liability',[338] *in lieu* of the financial surety provided to the State that their activities are not detrimental to the environment.

So, the problem lies not so much with the legal requirements to enforce MMV, but the methods and practices to be utilised by operators to satisfy the demands of the MPRDA and the Minister responsible.

[337] Gas Act (note 287) s 16.
[338] s 41(3)

No regime currently in operation in South Africa envisages the monitoring of stored gasses underground over the long-term. However, many examples are being developed in the range of test projects overseas and it is recommended that drafters of guidelines draw from the experience of Australia, Norway and Canada when clarifying for the CCS industry what checks would need to be undertaken.

Financial Concerns

Many similarities exist between the Australian model and South Africa. Once again the issue of financing breaks down into the differences between the short and long-term components of a project.

The role of tax breaks will be considered and it is likely that a situation similar to Australia's will emerge between that difference in burden between EOR and pure CCS. The system would reflect the difference between the use of CO_2 as a means of extracting further petroleum - and thus VAT deductible - and as an end product and thus not eligible for tax reduction.

Insurance in the short-term is unlikely to be a problem as policies already exist indemnifying the transmission of gas and petroleum. The transport of CO_2 has less risk attached to it.

As for the long-term storage, however, no provision is evident in South African law, aside from the demands of financial surety in the MPRDA and NEMA. While this is a possible solution to maintaining responsibility towards the sequestered gas, many industries prefer to take out insurance to satisfy the surety, rather than lodge a cash deposit with the Minister.

It is not felt that the insurance industry will be particularly open to insuring the storage of CO_2 in the immediate future due to the unknown nature of the processes involved and potential for liability over long time frames.

However, it is still possible that insurers will agree to indemnify industry on a year-to-year basis, thus reducing their liability over the long-term. This could be encouraged through legislation.

Chapter VIII - Conclusion

This paper has provided an overview of both international and domestic law considerations arising from the relatively recent adoption of CCS. It began by outlining the large variety of possible options for developers of the technology that included the various methods of capturing, transporting, injecting and storing CO_2. It then identified the potential legal issues that have arisen.

It was established that the most likely CCS development for South Africa, at least in its infancy, would include capture from the Sasol and Eskom plants in Mpumalanga, transportation by high-pressure pipeline and geological sequestration in either an EOR project, offshore from Mossel Bay, or more likely in saline aquifers located towards the centre of the country. This raises both terrestrial and marine issues both form a domestic and international perspective.

Following on, an outline of the international legal framework was undertaken to highlight its role in governing CCS. It was found that projects based offshore would fall under the jurisdiction of this legislation far more than projects on land. The principal applicable conventions included the London Dumping Convention & Protocol, UNCLOS, the UNFCCC and Kyoto Protocol.

The commitment by the international community to developing CCS was also framed by a brief discussion in regards to the recent amendments made to both the London Dumping Convention and OSPAR, that now permits the storage of CO_2 under the seabed.

After an introduction of the most applicable domestic environmental laws in South Africa, an overview of the key international and domestic concerns regarding the regulation of CCS was made.

In the context of domestic law, the question was raised as to whether a CCS stream should be defined as a ‘waste’ or ‘industrial by-product’. The different treatment each classification would receive under law was examined. Issues relating to property and access rights, including the surface, sub-surface and the sequestered CO_2 itself, were discussed. The need for clear definitions of these rights was highlighted as a major obstacle in regulating the industry and attaching liability to the various stages.

It was felt that transportation would not pose a significant concern as many of the activities were already sufficiently dealt with by the hydrocarbon legislation and could be amended easily enough to apply to CCS.

However, new methods for monitoring and verifying the stored gas must be developed to satisfy critics that the *in-situ* gas is secure. Much must be learnt from the activities of the various pilot projects that are currently experimenting with the sequestration of CO_2.

Liability has proven to be the greatest challenge to legislators. Short-term liability can be applied to the operator exactly as it is in the hydrocarbon industry. Long-term liability is a different matter. As it would be impractical to impose liability on the operator in perpetuity this mantle will need at some point to be transferred to either national or regional government. In terms of the South African legal framework it was concluded that the regulation of CCS would best be housed under the mining and hydrocarbon legislation, namely the MPRDA and the Gas Act, as opposed to the air quality Acts.

Alternatively, dedicated legislation or regulation could be developed, but it is felt that the similarities are so close between CCS and the hydrocarbon industry that this would be unnecessary.

In principle the Gas Act would deal with all stages of the transmission of the gas, from capture to the point of injection, while the MPRDA would regulate all aspects of injecting the gas and the rehabilitation of the site post-closure.

Definitional issues in both the MPRDA and the Gas Act will have to be ironed out through amendments, in particular to include CO_2 under the definition of a 'mineral' and 'gas' respectively.

However, it was felt that the combination of the two Acts would create an adequate legal framework for all stages of CCS up to the point of site closure. Post-closure obligations under the MPRDA will require the operator to secure a 'closure certificate' before transfer of liability may occur.

Little is known about suitable methods for monitoring and verifying that the gas will be secure. Guidelines must be drawn up to clarify the standards required in order to satisfy public concerns.

In addition, environmental law in South Africa is often fragmented, falling under the auspices of many different departments and regulating bodies. In an ideal world legislation governing CCS would be brought under one roof, governed by one department. Unfortunately this is unlikely to occur due to the diversity of components involved in CCS and thus the focus must be in streamlining the legislation for the smooth and effective development of the industry.

Indeed many acts still remain in force that were drafted during the Apartheid era. These fail to promote the progressive developments that appear in the more recently produced environmental legislation and will need to be fazed out in order to create a more consistent and effective regulatory regime.

CCS faces a tough challenge. In a world of increasing concern about climate change, it is clear that the laws of South Africa should be made ready for a rapid but safe implementation of a large scale CCS regime. However the South African legal framework is not yet ready for such a development, hindered as it is by the many government departments and regulatory bodies with a role in its future. Much work still needs to be done to create a system that is consistent and fair to all parties.

While CCS should by no means be seen as the ultimate solution to global climate change, it does offer mankind an opportunity to both safely and effectively store excess CO_2 that is produced within a global framework of energy conservation and reduction.

CCS must not be allowed to develop simply into yet another excuse to continue our love affair with fossil fuels.

Glossary

APPA	-	Atmospheric Pollution Prevention
CBD	-	Convention on Biodiversity
CCS	-	Carbon Capture & Storage
CDM	-	Clean Development Mechanism
CER	-	Carbon Emission Reduction
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
COP	-	Conference of the Parties
CSIR	-	Council for Scientific and Industrial Research
CSLF	-	Carbon Sequestration Leadership Forum
DEAT	-	Department of Environmental Affairs & Tourism (South Africa)
DME	-	Department of Minerals and Energy (South Africa)
DNA	-	Designated National Authority (Australia)
DTi	-	Department of Trade & Industry (UK) (now The Department for Business, Enterprise and Regulatory Reform.
DWAF	-	Department of Water Affairs and Forestry
ECA	-	Environmental Conservation Act 73 of 1989 (South Africa)
ECBM	-	Enhanced Coal Bed Methane
EEZ	-	Exclusive Economic Zone
EIA	-	Environmental Impact Assessment
EIPs	-	Environmental Implementation Plans
EOR	-	Enhanced Oil Recovery
EMPs	-	Environmental Management Plans
GHG	-	Greenhouse Gas
Gt	-	Giga tonne (billion tonnes)
Gtc	-	Giga tonne carbon
HSA		Hazardous Substances Act (South Africa)
IEA	-	International Energy Agency
IPCC	-	Intergovernmental Panel on Climate Change
IPR	-	Intellectual property rights
JI	-	Joint Implementation
kWh	-	Kilowatt hour
M	-	Nautical miles
MCMPR	-	Ministerial Council on Mineral and Petroleum Resources
MMV	-	Measuring, monitoring and verification
Mt	-	Mega tonne (million tonnes)
MPRDA	-	Minerals & Petroleum Resources and Development Act 28 of 2002 (South Africa)
MW	-	Megawatt (million watts)
NEMA	-	National Environmental Management Act (South Africa)
NEM:AQA	-	National Environmental Management Air Quality Act (South Africa)

NETL	-	National Energy Technology Laboratory
NNRA	-	National Nuclear Regulator Act
NWA	-	National Water Act 36 of 1998 (South Africa)
OSPAR	-	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAIA	-	Promotion of Access to Information Act,
PAJA	-	Promotion of Administrative Justice Act
t	-	tonne
TRIPS	-	Trade-related Aspects of Intellectual Property Rights
UNCLOS	-	United Nations Convention on the Law of the Sea
UNFCCC	-	United Nations Framework Convention on Climate Change

Bibliography

- Birnie, P and Boyle, A *International law and the environment* (2004) at 526.
- Bode, S and Jung, M 'Carbon dioxide capture and storage (CCS) - liability for non-permanence under the UNFCCC' (2005) Hamburg Institute of International Economics at 37.
- Bradshaw, J 'Development of Australia's Legislation and Regulatory Guidelines for CCS' (2007) Australian Government Department for Industry, Tourism and Resources at 7.
- Carbon Sequestration Leadership Forum (CSLF) 'Considerations on Legal Issues for Carbon Dioxide Capture and Storage Projects' Report from the Legal, Regulatory and Financial Issues Task Force, 13 August 2004.
- CO_2net 'A "Down-to-Earth" solution to Climate Change' (2005) European Carbon Dioxide Network.
- Engelbrecht, A et al 'The Potential for Sequestration of Carbon Dioxide in South Africa' (2004) CSIR.
- Figueiredo, M et al 'Framing the Long-Term In Situ Liability for Geologic Carbon Sequestration in the United States' (2005) *Mitigation and Adaptation Strategies for Global Change* 647-657.
- Flory, A 'Legal Aspects of Storing CO_2' (2005) International Energy Agency.
- Glazewski, J *Environmental Law in South Africa* 2ed (2005) 586.
- Gupta, M et al 'CO_2 Capture Technologies and Opportunities in Canada' (2003) CANMET Energy Technology Centre.
- Stern, N 'Stern Review The Economics of Climate Change' (2006) HM Treasury.
- McLaren, J and Fahey, J 'Key Legal and Regulatory Considerations for the Geosquestration of Carbon Dioxide in Australia' (2005) 24 *ARELJ* 45-74.
- McKee, B 'Summary of Outcomes form Taskforce Workshop 14-16 July 2004, London, UK' (2004) Carbon Sequestration Leadership Forum.
- MCMPR 'Carbon Dioxide Capture and Geological Storage Australian Regulatory Guiding Principles' (2005) Ministerial Council on Mineral and Petroleum Resources at 29.
- Metz, B et al 'Carbon Dioxide Capture and Storage - Summary for Policymakers and Technical Summary' (2005) IPCC.
- Postnote 'Carbon Capture and Storage (CCS)' (2005) 238 Parliamentary Office of Science and Technology.
- Purdy, R and Macrory, R 'Geological carbon sequestration: critical legal issues' (2004) Tyndall Centre for Climate Change Research at 21.
- Robertson, K et al 'International Carbon Capture and Storage Projects Overcoming Legal Barriers' (2006) National Energy Technology Laboratory.
- van der Merwe, C 'Carbon Capture & Storage' (2007) Mining Weekly.

- Warburton, C et al 'Options for Greenhouse Gas Mitigation Mechanisms in South African Legislation' (2006) Imbewu at 12.

Internet Sources

- 'Carbon Dioxide Capture and Storage Offshore - International Legal Position' Available at http://www.cslforum.org/documents/UKpresentation.pdf [Accessed 21st August 2007].
- 'Carbon dioxide storage prized' Available at http://www.statoil.com/statoilcom/SVG00990.NSF?OpenDatabase&artid=01A5A730136900A3412569B90069E947 [Accessed 1st September 2007].
- 'Coal and Power Systems' Available at http://www.netl.doe.gov/technologies/coalpower/futuregen/index.html [Accessed 15th August 2007].
- 'Energy and Environment' Available at http://www.deltaenviro.org.za/resources/envirofacts/energy.html [Accessed 18th August 2007].
- Fact Sheet on Carbon Dioxide Capture and Storage (CCS) Available at http://www.gi.ee/co2net-east/failid/Factsheeteng.pdf [Accessed 18th August 2007].
- 'Frequently Asked Questions: FutureGem Management, Budget, and Oversight' Available at http://www.futuregenalliance.org/faqs.stm [Accessed 5th September 2007].
- 'Global Climate Change and Ozone Layer Protection - UNFCCC' Available at http://www.environment.gov.za/ClimateChange2005/UNFCCC_The_Convention.htm [Accessed 15th August 2007].
- 'London Protocol Approves co2 Storage' Available at http://www.bellona.org/articles/London_protocol [Accessed 21st July 2007].
- Minter Ellison 'Carbon Capture and Storage - Report to the Australian Greenhouse Office on Property Rights and Associated Liability Issues' Available at http://www.greenhouse.gov.au/ccs/publications/pubs/ccs.pdf [Accessed 7th August 2007].
- 'National Dangerous Goods Framework' Available at http://www.ascc.gov.au/ascc/HealthSafety/HazardsSafetyIssues/HazardousSubstances/NationalDangerousGoodsFramework.htm [Accessed September 1st 2007].
- 'New Initiatives on co2 Capture and Storage and Marine Litter' Available at http://www.ospar.org/eng/html/press_statement_2007.htm [Accessed 18th August 2007].
- 'Technologies, Policies and Measures for Mitigating Climate Change - IPCC Technical Paper' Available at http://www.ipcc.ch/pub/IPCCTP.I(E).pdf [Accessed 18th August 2007]
- 'The Gorgon Project' Available at

http://www.gorgon.com.au/01gp_project.html [Accessed 6th August 2007].

- 'The Weyburn Oil Field - Enhanced Oil Recovery' Available at http://www.seed.slb.com/en/scictr/watch/climate_change/weyburn.htm [Accessed 18th August 2007].
- 'Timeline' Available at http://www.futuregenalliance.org/about/timeline.stm [Accesses 6th August 2007].
- 'White Papers' Available at http://www.info.gov.za/documents/whitepapers/index.htm [Accessed 19th August 2007].
- 'Why is the Atmospheric Carbon Reservoir so Small?' Available at http://earthguide.ucsd.edu/virtualmuseum/climatechange1/05_2.shtml [Accessed 10th August 2007].
- Wilson, E 'Liability and Accounting for CCS' (2006) WRI Carbon Capture and Storage Project Available at http://powerpoints.wri.org/ccs_wilson.pdf [Accessed 16th August 2007].

Statutes (International)

- Agreement on Trade-Related Aspects of Intellectual Property Rights 1994 (1999) 33 I.L.M. 1197 (1994).
- Convention for Biological Diversity 1992 (1993) 1992:822-841.
- Convention on the Prevention of Marine Pollution by Dumping of wastes and Other Matter 'London Convention 1972' Available at http://www.imo.org/home.asp?topic_id=1488 [Accessed 19th August 2007].
- Kyoto Protocol to the United Nations Framework Convention on Climate Change 1998 (2005) 37 I.L.M 22.
- The Convention for the Protection of the Marine Environment of the North-East Atlantic 1992 (1998) 32 I.L.M. 1069.
- Protocol to the, London 1996 (1997) 36 I.L.M. 1.
- The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1996 (1997) 11 I.L.M. 1294.
- United Nations Convention on the Law of the Sea 1982 (1994) 21 I.L.M. 1261.
- United Nations Framework Convention on Climate Change 1992 (1994) *ILM* 1992:851-873.

Statutes (Australian)

- Australian Capital Territory (Planning and Land) Management Act 1988 (Cth).
- Barrow Island Bill 2003 (WA).
- Contaminated Land Management Act 1997 (NSW).
- Development Act 1993 (SA).
- Environmental Planning and Assessment Act 1979 (NSW).
- Environmental Protection Act 1970 (Vic).
- Environmental Protection Act 1986 (WA).

- Environmental Protection Act 1993 (SA).
- Environmental Protection Act 1994 (Qld).
- Environmental Protection Act 1997 (ACT).
- Gorgon State Agreement 2003 (WA).
- Integrated Planning Act 1997 (Qld).
- Land (Planning and Environment) Act 1991 (Act).
- Minerals Act 50 of 1991.
- Operations Act 1997 (NSW).
- Petroleum Act 2000 (SA).
- Petroleum and Gas (Production and Safety) Act 2004 (Qld)
- Planning and Environment Act 1987 (Vic).
- Queensland Petroleum and Gas (Production and Safety) Act 2004
- Town Planning and Development Act 1928 (WA).
- Trade Practices Act 1974.
- Waste Minimisation and Management Act 1995 (NSW).

Statutes (South Africa)

- Atmospheric Pollution Prevention Act 45 of 1965.
- Constitution of South Africa, 1996.
- Environmental Conservation Act 73 of 1989.
- Gas Act 48 of 2001.
- Hazardous Substances Act 15 of 1973.
- Minerals & Petroleum Resources and Development Act 28 of 2002
- National Environmental Air Quality Act 39 of 2004.
- National Environmental Management Act 107 of 1998.
- National Nuclear Regulator Act 47 of 1999.
- National Water Act 36 of 1998.

Acknowledgements

Many thanks to Prof. Jan Glazewski, Andrew Gilder, Dr Tony Surridge, Denis Herbstein, Patricia Walby and MG for their input, patience and support. Their assistance was gratefully received.

Any mistakes herein are purely my own.

Tom Herbstein (2007)