Environmental Finance: the rise of environmental markets and opportunities for actuaries

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1. Environmental Finance

1.1. Policy options for environmental problems

1.1.1. Introduction

Australia's natural environment is experiencing a range of serious problems arising from increased demands placed on natural resources, population growth and lifestyle choices. These problems include soil degradation, loss of biodiversity, salinity, local air and water pollution, water shortages, ozone layer depletion and climate change. There is growing recognition that our current way of living is not sustainable and that our economic system does not adequately take into account environmental damage.

Human civilisation has always had a local environmental impact, but since the industrial revolution that impact has become global with problems such as climate change and ozone depletion. These are problems that cannot be resolved by individual nations – international cooperation is needed.

Human-related environmental problems generally arise from economic activities that produce unintended impacts. Typically the economic benefits from the activity will accrue to one party and the damage will be suffered by another party, although this is not always the case. This injured party is often remote in location and/or time from the original activity.

There are different views on what constitutes an environmental problem. An individual's view is typically related to the amount of damage or loss they suffer personally. Often one party will reap substantial economic benefit from a particular activity but the damage will be spread across a large number of individual who each suffer a relatively small loss and consequently may not find it worthwhile to act against the polluter.

For all these reasons it is usually necessary for a government to deal with environmental problems. Solutions usually involve difficult political judgements and sophisticated government policy that seeks to balance economic growth with community well-being.

The scale of the environmental issues currently facing us is such that traditional policy solutions alone are unlikely to succeed. Increasingly governments are turning to the private sector to develop commercially viable technologies and strategies to combat environmental problems. A new class of environmental policy that uses financial incentives and market-based mechanisms to direct capital and encourage commercial innovation to deal with environmental problems on a wide scale is emerging.

The three principal classes of policies are available to manage environmental problems are set out below, together with a comment on voluntary agreements. These are explained in terms of polluters or emitters of a particular pollutant.

1.1.2. Command and control regulation

Command and control is the traditional method of regulating environmental behaviour. In this case the regulator defines particular minimum environmental standards and all polluters are required to meet these irrespective of the cost of doing so. There are typically civil or criminal penalties for failing to meet standards, but no financial benefit for over-complying. For example, the regulator may place a maximum limit on the annual sulphur dioxide emissions for a particular power station.

1.1.3. Taxation/fiscal measures

Taxation and fiscal measures apply financial penalties or provide financial incentives for polluters to undertake activities desired by the regulator. For example, the regulator might apply a tax of $10 per tonne on the emission of a particular pollutant. Emitters of this pollutant have an incentive to reduce emissions up to this cost. Fiscal measures include financial subsidies in the form of government grants or tax deductions in respect of particular investment, for example, the government may subsidise the purchase of energy efficient equipment.

1.1.4. Market-based mechanisms

Market-based mechanisms are where the regulator sets overall environmental targets (for example, the desired economy-wide level of emissions of a particular pollutant) and allows market forces to determine, in the most economically efficient manner, where the reductions in the pollutant occurs. Typically a tradable instrument is created whose market price is used to communicate price signals to polluters as to whether they should reduce their emissions or pay for someone else to undertake the reduction.

The regulator controls the overall volume of the pollutant emitted but not the “per unit cost”, which depends on the abatement cost curves for individual polluters, the overall economy-wide target and the efficiency of the market. The advantage for the regulator is certainty of volume, the regulator can be certain that the desired economy-wide target will be met (provided that all polluters comply). A number of examples of market-based schemes are discussed in the following sections.

1.1.5. Other approaches

Polluters may also agree to voluntary commitments to meet certain targets or standards. For example, car manufacturers might agree to increasing fuel efficiency of motor vehicles. Elements of the three mechanisms identified above will be used, however these measures will not have the force of law. Polluters will agree to and abide by voluntary agreements in order to forestall mandatory measures, which are likely to be more costly.

For the rest of this paper we will be concentrating on market based mechanisms.

1.2. Environmental finance

Environmental finance refers to the application of finance techniques and practices to environmental issues. This includes:

- the use of market mechanisms to ration environmental goods (such as water) or environmental bads (such as the right to emit harmful pollutants);
- the creation of environmental commodity instruments that place a value on beneficial environmental activities; and
- the use of financial instruments to manage risk arising from natural events such as weather.

Environmental markets are created by legislation[1]. It is recognised that individuals and profit making firms will not necessarily act in the most environmentally responsible way simply for altruistic reasons. Market mechanisms place a value on environmental behaviour that previously did not have a value thereby altering the financial incentive structure and encouraging the flow of capital towards environmentally desirable activities or away from environmentally damaging activities. Environmental markets are artificial constructions and rely on legislation to maintain this incentive structure.

An important concept in environmental finance is the idea of offsetting. That is, recognising that while you may not be able to change your environmentally damaging behaviour cost-effectively, you may be able to pay someone else to do this for you. This is based on the economic concept comparative advantage where any two parties who produce two different goods can benefit from trade because each will have a comparative advantage in the production of one of the goods and if the two parties cooperate in their production decisions, overall economic wealth will be maximised. Market mechanisms allow this to occur.

With the growth in environmental markets sophisticated financial and commercial techniques are being transplanted to this new field. A key element of many environmental markets is the creation of new commodity instruments such as carbon credits or renewable energy certificates. Market infrastructure soon emerges, this includes brokers, trading platforms, clearing houses, standardised contracts, derivative instruments and speculative traders. This is the application of existing financial market techniques and practices to a new market.

[1] Aside from weather derivatives, where participants bet on the outcome of natural events for risk management or speculative reasons

1.3. Environmental markets

There are a range of environmental markets operating and under consideration around the world. Environmental markets are becoming an increasingly popular mechanism to control environmental problems. This section provides a brief description of a selection of these markets.

1.3.1. Climate change and emissions trading

Climate change is a serious global environmental concern. Excess greenhouse gas (GHG) emissions primarily produced through the combustion of fossil fuels such as coal, oil and gas are thought to be responsible for global warming due to the heat-trapping properties of GHGs such as carbon dioxide (CO_2) and methane. A series of international and national initiatives have been established to control GHG emissions. Many of these schemes use a market mechanism, emissions trading, to provide a financial incentive to reduce GHG emissions.

Emissions trading involves government imposition of an economy-wide target for a particular pollutant. Tradable allowances are allocated that give the holder the right to emit unit quantities of the pollutant. Fines are imposed on companies that fail to hold sufficient allowances to cover their emissions. Companies that can reduce emissions more cheaply will do so and sell their excess allowances to companies that face a higher cost of reduction.

The market price for allowances will equal the economy-wide marginal cost of reducing emissions, thereby achieving the target at the lowest possible cost. A much publicised aspect of emissions trading is carbon sequestration, where carbon dioxide is removed from the atmosphere and stored in (for example) forests or underground.

The foundation of emissions trading relies on the idea that one party will be able to reduce GHG emissions more cheaply than another. If the two parties cooperate in deciding who reduces emissions then a greater reduction can be achieved for the same cost. The typical emissions trading scheme covers a closed universe of emitters. A variation on this is ability to purchase emission offsets from parties outside the scheme who may be able to sequester emissions or avoid emissions more cheaply than participants in the trading scheme.

Climate change and greenhouse gas (GHG) emissions trading is discussed in detail in the next section.

1.3.2. US pollutant trading schemes

A variety of pollutant trading schemes have been implemented in the USA. The largest and best known is the Acid Rain programme which controls emissions of sulphur dioxide

from power stations and other large scale combustion facilities nationally. Under this scheme emitters are allocated a quantity of emission allowances for free and then buy or sell allowances depending on their level of production and their ability to reduce emissions cost effectively. The Acid Rain programme has achieved excellent results, with sulphur dioxide emissions from power plants 41% below 1980 levels by 2002. This reduction was achieved at a cost of $US1-2 billion per annum, one quarter of the original cost estimated by the US EPA.[2]

Emissions trading encouraged innovation in pollution control equipment because it allowed firms to generate financial benefits by over-achieving emission reductions and selling the excess "emission allowances" to competitors. The success of the Acid Rain programme encouraged the development of numerous market-based pollution control schemes at the state, regional or city level which seek to improve local or regional air quality. These schemes cover a range of pollutants including nitrogen oxides, sulphur dioxide, VOCs and wastewater.

1.3.3. Renewable energy certificate trading

Electricity is largely generated from non-renewable fossil fuels such as coal, natural gas and oil and is therefore a major source of GHG emissions. In recent years governments have moved to encourage the generation of electricity from renewable sources such as wind, solar, biomass and run-of-river hydro. Historically much of the government support for renewable energy has come in the form of tax concessions, above-market electricity tariffs arrangements and direct subsidies.

More recently the use of market mechanisms to incentivise renewable energy has become widespread. The typical approach is for the regulator to set an overall renewable energy target for all electricity suppliers, create a new commodity (often termed a renewable energy certificate) that specifically relates to the "green" component of the renewable electricity and allow this instrument to be traded separately from the underlying electricity. This creates a market in renewable energy certificates (an additional revenue stream for green power producers) thereby boosting their revenue and encouraging additional renewable energy. The market value of the renewable energy certificates sends price signals to developers of new renewable power projects.

1.3.4. Water trading

Various water trading systems have always existed in Australia, however there has never been a coherent national strategy. Recent water restrictions in our cities and shortages of water for irrigation have caused considerable economic and social costs.

The Wentworth group of concerned scientists in their report "Blueprint for a national water plan" point out that current systems of access rights to use water lack clarity and in many

[2] Cap and Trade: Acid Rain Program Results, US EPA. www.epa.gov/airmarkets

cases are not consistent with natural processes (ie water allocation rights are higher than the water available). They recommend the establishment of a new nationally consistent water entitlement and trading system that provides security to both water users and the environment. Two types of trade are recommended:

- 'Permanent' trades involving the sale of an access entitlement (to receive a specified share of any future allocations); and
- 'Temporary' trades involving the sale of a water allocation for a season (a specific volume that is available for use in a specific location).

The national water initiative was signed in 2004 between the states (excluding WA) and the federal government enabling a national water trading market to be set up. It includes a $A500 million rescue plan for the Murray-Darling River system, which runs between the states of Victoria and New South Wales, and aims to establish a national system of compensation for land-owners who relinquish their water rights.

1.3.5. Salinity trading

In some areas of Australia salinity is a natural phenomenon in the landscape (for example, in inland salt pans, brackish streams and coastal salt marshes). In other areas, increasing salinity is often the result of particular land use practices, such as over-clearing, urban development, river regulation, irrigation or cultivation of crops and pastures.

Dryland salinity occurs in non-irrigated areas and is the build up of salt in the soil, usually as a result of a rising watertable and often caused by the loss of deep-rooted perennial trees, shrubs and grasses. Irrigation Salinity is caused by over-irrigation of farmland, inefficient water use and poor drainage leading again to water tables rising. River salinity is where water running from areas of dryland, irrigation and urban salinity may flow into creeks and rivers, raising their salinity. Industrial salinity is where waste water from industry fed back into the rivers has high levels of salt, for example in coal-fired power stations water used for cooling is partly evaporated, which concentrates the salt in the water discharged from the coolers.

Salinity trading aims to use a market based mechanism to reduce salinity levels. The NSW Government's Hunter River Salinity Trading Scheme has been responsible for restoring the waters of the Hunter to an unprecedented level of freshness. The central idea of the scheme is to only discharge salty water when there is lots of low salt fresh water in the river. Salinity credits are used to determine who can discharge salty water. These credits can be bought or sold online daily. Other salinity trading schemes could involve the selling of credits associated with the new planting of trees.

1.3.6. Biodiversity

Although there are no current examples of biodiversity trading, it is easy to see a future scenario where rural landholders receive payments, not only for the commodities they produce but also for the environmental services that they provide (managing their properties in a particular manner). This could be achieved by either Government funded stewardship payments or by market mechanisms whereby landholders could trade biodiversity credits (as well as carbon sequestration credits and salinity control credits).

If such markets were to exist, landholders could choose to protect an endangered ecological community, plant trees on a critical recharge area or establish perennial native grasslands. They would do so, not because of regulation, but because it was financially attractive when compared with traditional enterprises such as sheep or cattle.

State Forests recently negotiated an initial trade incorporating biodiversity values with Integral Energy whereby five hectares of Cumberland Plains Woodland, an endangered ecological community, will be re-created on State Government land in Western Sydney. In return for their investment, Integral Energy will receive the benefits associated with carbon sequestration from the plantings whilst the community will benefit from increased salinity control and biodiversity enhancement. The driver behind this trade is not direct financial return to the investor but the desire on the part of the company concerned to project an image of environmental responsibility.

One of the most effective drivers of a market in biodiversity credits would be the setting of biodiversity targets. One of the main difficulties lies in the definition of the units by which biodiversity would be traded. Any unit definition would have to take into account such issues as connectivity, diversity of species, rarity etc, and attach a relative value to each of these parameters.

Whilst the development of a market for biodiversity credits is still in its infancy, this type of approach is capable of delivering real returns both to landholders and to the environment.

1.3.7. Weather derivatives

Weather derivatives are financial contracts where the pay-out depends on weather related events such as temperature or rainfall. The primary users of weather derivatives include:

- Energy companies who use weather derivatives as hedging mechanisms to protect their revenue.
- Insurers and reinsurers who write weather risk (either through weather derivatives or weather insurance policies).
- Banks and traders who use the weather market to provide liquidity by taking speculative positions for profit, just as they do for commodity markets.

Temperature is the main form of weather measure that is traded. This is because energy utilities are the main purchasers of these derivatives as a result of their high exposure to

temperature changes. The most common temperature index is heating degree days (HDDs) in winter and cooling degree days (CDDs) in summer. This measure correlates with the fact that energy volume starts to increase only above a certain temperature (where air conditioning units are turned on and conversely electric heaters in winter).

The second most common temperature index is the use of event days (for example, an event can be defined as a sequence of 3 days when the maximum daily temperature is greater than 35° or a day where the maximum temperature is greater than 40°.

Rainfall is the second most common form of weather measure that is traded. The weather market shows how risks that were previously consider unhedgeable can now be priced, transferred and managed.

2. Case study: climate change and emissions trading

2.1. Background

2.1.1. Climate change – the science

The natural greenhouse effect relates to the absorption of solar energy by the earth's atmosphere. Part of the long-wave infrared radiation emitted by the sun is not reflected back into space by the Earth's surface but is absorbed by greenhouse gases naturally occurring in the atmosphere thereby maintaining a stable average temperature of 15°C in the earth's atmosphere. The continued release and accumulation in the atmosphere of greenhouse gases since the industrial revolution is likely to result in a wide range of climatic changes.

There is a very strong case that human-induced climate change is a genuine phenomenon and will have a damaging and far-reaching impact on human civilisation. Australia has warmed by 0.7°C since 1910, the Earth is the warmest it has been for at least 2000 years and most alarmingly atmospheric concentrations of the primary GHG, CO_2, are now 30% higher than they have been for at least 400,000 years. Natural climate change has wiped out human civilisations in the past, and complex civilisations like ours are often the most vulnerable.

Despite the record of observed changes, there remains a large amount of uncertainty regarding the future dynamics of climate change, particularly on the precise nature, scale and location of impacts, as well as future emission trends. Nevertheless, the risks, particularly that of catastrophic events, such as the collapse of the ice-sheets and large-scale discontinuities such as the disturbance of the Gulf Stream suggest that scientific uncertainty should not constitute an obstacle to action.

The six greenhouse gases regulated by international agreements are carbon dioxide, methane, nitrous oxide, hydrofluoro-carbons, perfluoro-carbons and sulphur hexafluoride, with carbon dioxide being the most abundant.

2.1.2. The Kyoto Protocol

Climate change is a global problem and requires a global solution. To this end the Climate Convention was signed at the Rio Earth Summit in 1992 with the aim of the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The 1997 Kyoto Protocol is an instrument of the Climate Convention that requires industrialised countries to meet quantified emissions reductions targets corresponding to an aggregate reduction of 5.2%, to be met over the first commitment period of 2008-2012, relative to the 1990 base year. National governments have given up sovereignty by agreeing to these targets. While the initial targets are small, the key element of Kyoto is the establishment of a framework and infrastructure that will allow much greater reductions in the future.

For the Protocol to enter into force, it must be ratified by 55 countries and countries that account for 55% of Annex I (industrialised countries) CO_2 emissions. By October 2004 the major industrialised countries not to have ratified are the USA, Russia and Australia. Russia has indicated it will ratify, leaving Australia and the US isolated.

The Kyoto Protocol is unique as a global environmental treaty that incorporates market-based mechanisms to help achieve emission reductions at least economic cost. These "flexibility mechanisms" are:

- International Emissions Trading: this provides for the creation of a market in greenhouse gas instruments, known as Assigned Amount Units or AAUs which are tradable between Annex I countries.
- Joint Implementation (JI): this allows credits (known as Emission Reduction Units or ERUs) from emissions reduction projects in an Annex I country to be transferred to another Annex I country.
- The Clean Development Mechanism (CDM): this is a project-based mechanism where emission reduction credits (known as Certified Emission Reductions or CERs) generated by projects in developing countries may be transferred to industrialised countries. CDM projects must meet specific development and sustainability criteria to be eligible.

The Kyoto Protocol creates a number of new internationally-accepted commodity instruments that will play an integral part in environmental finance, each equivalent to the emission of one tonne of CO_2. AAUs are instruments that are issued by sovereign governments and may have the same or higher credit-standing than debt issued by that country, which creates some interesting opportunities for financial engineering for poorly rated countries. This will result in the shift of capital between nations as those who face a high cost of reducing emissions will pay low-cost nations to reduce emissions on their behalf.

The Kyoto Protocol also recognises and rewards the sequestration (storage) of CO_2 through a variety of mechanisms including forestry (a growing forest absorbs CO_2) and geosequestration, (where CO_2 is stored underground in geological structures such as depleted gas reservoirs). These type of projects generate "carbon credits", either under the Clean Development Mechanism (CERS) or if they are forestry-based, they generate a "Removal Unit" (RMU).

Carbon credits create a range of complex technical, business and financial problems. These include measurement of the volume of CO_2 sequestered, permanence (could the forest burn down or the CO_2 leak from the underground reservoir) and financing (often a key value stream arising from a project is the stream of carbon credits generated, will a lender accept the risks associated with these instruments?). Carbon credit projects encompass a wide range of environmental finance issues.

2.1.3. How are governments planning to meet Kyoto targets?

While Kyoto provides an international framework individual countries must implement their own national solutions to meet national targets. These will consist of a variety of measures ranging from command and control regulation (for example, building efficiency standards), to tax and fiscal measures (for example, tax concessions for low-emission energy equipment) to emissions trading.

Most industrialised countries that have ratified the Kyoto Protocol have decided to use national or regional emissions trading as the primary mechanism for meeting their targets. For example, a comprehensive emissions trading scheme that covers the majority of CO_2 emissions by volume will commence in the 25 countries of the European Union in 2005.

Canada and Japan have indicated that they will implement emissions trading schemes in the next two or three years. Russia is likely to be a seller of emission instruments for the foreseeable future and its main focus will be in developing a framework to allow it to sell these instruments to international buyers. Developing countries are also moving to take advantage of the Clean Development Mechanism, which allows genuine emission reduction projects to be recognised and sell “carbon credits” to industrialised countries.

There is considerable activity at the state level in the US and Australia, the two industrialised countries who have not ratified Kyoto. Numerous US states have introduced GHG control schemes, including a number who are developing state-based emissions trading schemes. In Australia, NSW has introduced a state-based emissions trading scheme that covers the electricity industry and allows forestry sequestration.

This confusing patchwork of emissions trading initiatives makes it difficult to understand what is happening and the legislative and financial impact. For example, is the scheme binding, does it apply at a state, national or regional level, what are the penalties, what is the likely price of emission instruments, how does it link to other schemes, etc?

2.2. Emission trading markets

2.2.1. EU emissions trading scheme

<u>Description</u>

The EU emissions trading scheme (EU ETS) is critical to meeting the EU’s Kyoto Protocol commitment of an 8% reduction of 1990 greenhouse gas (GHG) emissions by 2008-2012. The EU ETS will creates the world’s largest market for GHG emission instruments, is likely to have a capitalisation of tens of billions of euro’s, and will drive billion of euro’s of investment in low carbon technology.

Scheduled to commence on 1 January 2005, the EU ETS is a cap and trade[3] scheme that requires emitters of CO_2 in the energy and industrial sectors to hold and surrender tradable allowances equal to their direct CO_2 emissions during the compliance period, or face financial and environmental penalties.

The EU Allowance (EUA) is the tradable instrument used in the EU ETS. Each EUA is equivalent to 1 tonne CO_2, and a quantity of EUAs will be allocated to each regulated site (installation) that emits CO_2 for free based on historical emission levels and a range of economic and political considerations.

Each installation covered by the scheme must monitor and report their CO_2 emissions on at least an annual basis. In order to comply with the EU ETS an installation must surrender a number of EUAs equal to its annual emissions for the calendar year. In practice companies are likely to measure, monitor and forecast emissions on a near continuous basis in order to effectively manage their position. CO_2 emissions will be treated like any other physical input/output because they have a financial value.

Installations may trade EUAs at any time, and there is a four month reconciliation period after each compliance year where an installation may continue to buy or sell EUAs to ensure it achieves compliance for the prior year. EUAs may be banked for use in subsequent years (with some restrictions).

If an installation fails to surrender EUAs equal to its verified emissions, it faces a fine of €40/tCO_2 during 2005-07 rising to €100/ tCO_2 during 2008-12 per tonne of its shortfall. The installation will also be required to make good this shortfall in EUAs in the next compliance year (ie, paying the penalty does not erase the obligation to surrender EUAs equal to emissions).

The EU ETS legislation provides for international linkages.

- Kyoto Protocol project-based mechanisms – properly approved "carbon credits" created outside the EU may be used for compliance under the EU ETS from 2008 onwards. However, limits have been placed on volumes and quality of such credits.

- The EU ETS legislation allows mutual recognition of allowances from other national trading schemes. This will be assessed on a case-by-case basis. It is not clear whether EUAs will be directly convertible to Kyoto emission instruments or how this would happen in practice. This may limit free trading between the EU ETS and other national schemes.

[3] There are two principal types of emission trading schemes, "cap and trade" and "baseline and credit". A cap and trade scheme requires emitters to hold and surrender tradable allowances equal to or greater than their direct emissions during the compliance period. The target for each emitter is equal to the quantity of emission allowances allocated to it. Emission allowances, the currency of the scheme, are created by the regulator. A baseline and credit scheme assigns a particular target to each emitter. The target may be based on absolute or relative emissions (for example per unit of output). Emission credits - the currency of the scheme - are created by emitters who over-comply with their targets, and once verified may be sold to emitters who fail to meet their target.

Observations

The EU ETS will create the world's largest market for GHG emission instruments and Europe will become the global focus for emissions trading. London is already the principal centre for GHG emissions trading.

The EU ETS will impact many thousands of companies across Europe and effectively impact every citizen through increased prices for electricity and other CO_2 intensive goods. This represents a massive internalisation of an environmental externality.

The emission of CO_2 is no longer a free good. Firms must now factor the cost of emissions into any commercial decision ranging from long term capital investment to short term operational decisions.

The EUA market is rapidly becoming more sophisticated. This is evidenced through the increasing number of speculative traders and the increasing number of brokers, many of whom offer the technology to execute trades on-screen in real-time. Standardised contracts have been developed to aid liquidity and a range of standard contract types have emerged. For example, most trading to date has related to the forward delivery of EUAs at a specific time during future years. Derivatives contracts have also emerged, largely call options. While some exchange have indicated they will list EUAs, none have done so far and for the foreseeable future EUAs may be transacted through brokers rather than infrastructure-heavy exchanges.

Firms need to measure and forecast CO_2 emissions from their own facilities, and forecast future EUA price levels. Within corporations, traders are working with treasury staff and environmental staff to understand the firm's position and use a combination of internal investment and trading to ensure compliance. New problems include:

- How to measure, monitor and report CO_2 emissions in an effective, timely and accurate manner. Accuracy is particularly important because any measurement error, particularly if corrected later, could have a significant financial impact.

- How to factor the cost of emissions into long term investment decisions. This is an incredibly complex problem because the cost of emission in the future depends on a wide range of technological, economic and political factors. For example, future economic growth determines overall emission levels (assuming no technology improvements). However, technology improvements are inevitable, but to what extent? How much will new technology reduce emission levels? And if new technology does dramatically reduce emissions will this simply mean will this simply mean even tighter targets? This requires well-thought out, long term modelling and analysis that factors in the uncertainties associated with economic, technological and political change.

- How to factor the cost of emissions into short-term operational decisions. In order to do this decision makers must know the emission intensity of production, the cost

of EUAs and the second and third order cost impacts (for example, will the price of inputs such as electricity change). This also involves a shift in business culture, taking into account a previously non-existent issue.

2.2.2. UK emissions trading scheme

Description

The UK emissions trading scheme (UK ETS) was the world's first cross-industry, national greenhouse gas emissions trading scheme. Scheduled to run for five calendar years from 2002 to 2006, the key objectives of the scheme were to achieve a significant volume of absolute emission reductions at a reasonable cost, enable business to gain practical experience of emissions trading and position London as a global centre for emissions trading.

The scheme was voluntary, and some £215 million of government incentive money was provided to encourage participants to accept binding reduction targets. Only 34 companies joined the scheme via the direct (auction) route, although several thousand other companies participated indirectly (through voluntary agreements).

The scheme is highly complex, with two (originally three) categories of participants. It combines elements of "cap-and-trade" and "baseline-and-credit" emissions trading and is integrated with a number of other policy mechanisms, including the Climate Change Levy (CCL) and renewable energy policy. Unusually, the UK ETS covered both direct emissions (for example, from combustion of fossil fuels on-site) and indirect emissions from electricity generated elsewhere but consumed on-site.

The UK ETS covers all greenhouse gases and is open to all sectors of the UK economy except electricity generators, land and water transport and the household sector. The penalties relating to not meeting targets largely related to the withdrawal of benefits (for example, incentive payments).

The UK ETS does not incorporate linkages to foreign trading schemes and does not permit the use of international emission credits. There was a proposal to add a provision in the UK ETS for project-based credits, but this was abandoned when the EU ETS emerged.

Observations

On a strict cost-benefit basis, the UK scheme was less successful than was hoped. There were less participants than expected and many of the emission reductions bought by government may well have happened anyway.

However, it did give UK emitters a significant head start over competitors in the wider EU because they were forced to consider emissions trading earlier. It established London as

a global centre for emissions trading and it gave a huge boost to the emissions trading service sector with numerous brokers, verifiers and other professional services gaining valuable skills and experience.

The UK ETS continues to be a valuable learning experience for participants, traders and government.

2.2.3. Chicago Climate Exchange

Description

The Chicago Climate Exchange (CCX) is a US-based private sector, self-regulated exchange that administers a voluntary, binding pilot greenhouse gas emission reduction and trading program where private entities agree to meet certain emission reduction targets. Members may meet targets through internal action (reducing GHG emissions from their facilities) or through the purchase of emission allowances, or emission offsets. Participating emitters are drawn from a wide range of industry sectors including automotive, chemicals, power generation, manufacturing and transportation. Other market participants include emission offset provides, traders and brokers.

Trading infrastructure has been created to allow the exchange of various types of emission instruments. This includes Exchange Allowances ("emission allowances" issued to CCX Members in accordance with that Member's emission target) and Exchange Offsets ("emission credits" generated by eligible emission reduction and sequestration projects).

CCX members who accept binding reduction targets do so without government legislation requiring them to do so, which raises the question of why a company would voluntarily accept additional costs over and above legislated requirements. Companies accept relatively minor additional costs for a host of reasons, including to avoid more onerous government regulation in the future and for reasons of public perception and social responsibility. However, typically companies do not accept significant additional costs unless forced to do so by legislation. The CCX demonstrates this as it has attracted limited participation and only requires relatively light emission cuts, as demonstrated by the low prices for CCX instruments of around US$1 per tonne of carbon dioxide equipment (around 10-15% of the price of EUAs).

The CCX is part altruistic and part commercial. It has developed highly sophisticated trading infrastructure, well beyond the short to medium term requirements of this relatively small, illiquid market. This suggests that the owners and technology providers anticipate significant upside for this marketplace. The CCX has recently announced that it will list EUAs and the long term plan is to become a global exchange for environmental instruments. In this sense it is no different to a host of other brokers and exchanges who hope to facilitate the trading of environment instruments.

Observations

Sufficient interest has been shown amongst large companies in the US and Canada to accept voluntary GHG emission targets in the absence of government action. This is highlighted by a successful private placement (in late 2003) that raised US$15 million for the company that owns the CCX concept.

It is difficult to see how a strictly voluntary initiative like the CCX could ever generate substantial emission reductions. No company would voluntarily accept tough and expensive emissions targets without legislative prodding. At best the CCX might raise awareness and enthusiasm to control GHG emissions amongst corporate America. The CCX appears to be positioning itself as the "exchange of choice" for environmental instruments, with GHG instruments being the first step.

The CCX blurs the line between commercial enterprise and a quasi-public, altruistic market that seeks to control GHG emissions. This shows that where there are gaps in a perceived need for government action, the private sector will develop solutions to bridge the gap. Many consider GHG emission constraints to be inevitable, and in the absence of government action private companies have taken steps to develop standards of behaviour at a short term cost to themselves. Typical reasons for participating centre around the idea that the benefits of organisational change and preparedness for possible future legislation outweighs the cost.

2.2.4. Carbon credit projects

An important element of the international emissions trading framework is the concept of carbon credits. Carbon credits represent the environment benefit from projects that either avoid the emission of GHGs or that permanently store CO_2 in some fashion. An example of an emission reduction project is a renewable power facility, such as a wind turbine, that produces emission-free electricity. The electricity produced by this project will displace the electricity from emission-intensive sources (such as coal or gas) and therefore reduce system-wide GHG emissions. A project that stores CO_2 could do so through forestry or geosequestration (storage underground in depleted oil and gas reservoirs).

Carbon credit projects have been embraced by the Kyoto Protocol and represent the primary way in which developing countries contribute to reducing GHG emissions (under Kyoto, developing countries have no binding targets). Kyoto's Clean Development Mechanism allows projects that lower emissions below an agreed "baseline" to earn carbon credits.

The most critical issue for a carbon credit project is additionality, that is, to demonstrate that the project would not have occurred anyway (in the absence of the cashflow from carbon credits). In practice this is almost impossible because it is rare that any one single factor will be significant enough to affect the decision to proceed with a project. A pragmatic view is taken that balances additionality against the encouragement of environmentally beneficial projects.

Most carbon credit projects occur in developing countries and are typically based in the renewable energy, waste and forestry sectors. These projects face the same business problems that any project will have to deal with. In addition they must find a buyer for their stream of carbon credits. In 2003 the CDM Executive Board was established. This international authority is part of the Kyoto framework and its role is to approve carbon credit projects under the Kyoto rules.

The official imprimatur of the CDM Executive Board means that carbon credits are much more valuable because the buyer knows they will be accepted under the Kyoto regime. The development of the EU ETS has created demand for carbon credits. As a consequence the level of activity in the CDM market has increased dramatically over the past two years with numerous multi-million tonne transactions being announced this year.

2.3. Australian environmental markets

It is worth noting that the non compliance penalties in each of the Australian schemes are not intended to be tax deductible, while the cost of the certificates purchased under each scheme is intended to be deductible, thereby creating an incentive to purchase certificates.

2.3.1. Mandatory Renewable Energy Target

On 1 April 2001 Australia became the first country to introduce a national renewable energy certificate regime, known as the Mandatory Renewable Energy Target (MRET). The aim of the scheme is to increase generation from renewable sources. MRET requires all licensed electricity retailers to hold a defined number of Renewable Energy Certificates (RECs), each of which represent 1 MWh of electricity, in proportion to the total volume of electricity sales.

These tradable RECs are produced by qualifying renewable energy sources and the price of RECs fluctuates according to supply and demand factors, with a price cap equal to the amount of the fine for non-compliance. A key benefit of this type of scheme is the ability to separate the renewable benefit (the REC) from the underlying electricity so that the maximum price can be obtained on aggregate, leading to a more economically efficient outcome.

The Australian Government's renewable energy target places a legal liability on wholesale purchasers of electricity to proportionately contribute towards the generation of an additional 9,500GWh of renewable energy per year by 2010.The measure will apply nationally, with all electricity retailers and wholesale electricity buyers on liable grids in all States and Territories contributing proportionately to the achievement of the measure.

Non compliance penalty is $40 / MWh. The REC market has been evolving since MRET commenced in 2001. There are still a lot of direct over the counter REC trades but broker involvement is increasing and liquidity and market discovery are on the move.

Numerous similar schemes have been emerged in the UK, Europe and a number of US states. Each scheme is subtly different and very specific to the requirements of the individual jurisdictions in respect of targets, penalties and types of renewable energy that qualifies.

2.3.2. NSW Greenhouse Gas Abatement Scheme

The NSW Greenhouse Gas Abatement Scheme commenced on 1 January 2003 and remains in force until 2012. The Scheme imposes mandatory greenhouse gas benchmarks, on all NSW electricity retailers and large electricity users to abate the emission of greenhouse gases from the consumption of electricity in NSW.

The Scheme sets a State greenhouse gas benchmark expressed in tonnes of carbon dioxide equivalent (tCO2-e) per capita. The initial level set for 2003 is 8.65 tonnes and the benchmark progressively drops to 7.27 tonnes in 2007 which represents a reduction of five per cent below the Kyoto Protocol baseline year of 1989-90. The 7.27 tCO2-e benchmark level will then be maintained until 2012. The State greenhouse gas benchmark is multiplied by the total State population to produce the annual electricity sector benchmark. This represents the total amount of greenhouse gas emissions allowable for the consumption of electricity in NSW.

Benchmark participants, are required to reduce their emission of greenhouse gases to the level of their greenhouse gas benchmark by off-setting their excess emissions through the surrender of abatement certificates. These certificates are created by accredited abatement certificate providers and can be traded to benchmark participants.

At the end of a compliance year benchmark participants must submit an annual greenhouse gas benchmark statement to the Tribunal. Excess emissions remaining after the surrender of abatement certificates is called a greenhouse shortfall and currently attracts a penalty of $10.50 per tCO2-e.

Abatement certificate providers can be accredited to carry out the following abatement activities:

- Low-emission generation of electricity (Generation).
- Activities that result in reduced consumption of electricity (Demand Side Abatement).
- The capture of carbon from the atmosphere in forests (Carbon Sequestration).
- Activities carried out by elective participants that reduce on-site emissions not directly related to electricity consumption (Large User Abatement).

The market for NGAC's has some level of transparency via brokers, although broker trades are relatively limited compared to direct over the counter deals between sellers

and buyers. The size of the market is expected to increase as the emission target becomes more stringent by 2007.

2.3.3. Gas Fired Electricity Scheme

The aim of the Queensland gas fired electricity scheme (GEC scheme) is to reduce greenhouse gas emissions by encouraging gas fired generation. The scheme is Queensland based and applies to electricity retailers and direct purchasers and will start on 1st Jan 2005. The Scheme requires electricity retailers and other liable parties to source at least 13% of their electricity sold in Queensland from gas-fired generation from 1 January 2005. An $11 non-compliance penalty applies per GEC.

Greenhouse gas emissions will be reduced by more than one million tonnes in the first year of operation of the Scheme. The Scheme is also aiming to diversify the State's energy mix towards a greater use of gas and encouraging new gas infrastructure in Queensland.

GECS is a strange market with two major sellers and two major buyers and a number of fringe players. Some trades have gone through already, although the GEC instrument is not yet gazetted in legislation.

3. Characteristics of a good trading scheme

A trading scheme needs to balance cost, efficiency and simplicity. Key characteristics of a successful trading scheme have been set out below. This list is based on work published by Origin Energy[4], with some additions.

- **Effectiveness** – The scheme needs to actually achieve its targeted objectives for example, reduce GHGs. This refers to the certainty with which it can be expected to deliver the desired target.
- **Least cost** – The extent to which the scheme is efficient in delivering the required objective at least cost. Costs must also include transactions costs associated with implementing and operating the scheme as well as the actual abatement costs themselves.
- **Administrative simplicity** – The scheme needs to be simple and transparent in order to minimise the associated administrative costs and to improve engagement.
- **International compatibility** – Any scheme developed should be compatible with any international schemes to aid a global response. In this way costs should again be minimised by taking advantage of international opportunities.
- **Distributional equity** – The trading schemes needs to help to distribute the cost across society. The competitiveness of business relative to interstate and international competitors is a key consideration.
- **Political feasibility** – The scheme needs to be placed in the context of the political environment and assessed for its acceptability in the electorate.
- **Mandatory** – The scheme force polluters to account for their activities.
- **Maximum sectoral coverage** – The scheme should seek to maximise the coverage, but balance the administrative cost of including small polluters against the cost of doing so.
- **Environmental integrity** – A strong compliance and verification regime is required to maintain confidence in the scheme.
- **Penalties for non-compliance** – Penalties must be proportionate and dissuasive, set at a level that encourages compliance in vast majority of cases but not catastrophic in case of non-compliance.

Many practical problems must also be solved to facilitate the smooth functioning of the market. For example, market infrastructure, standardised contracts, market practices and accounting standards. Participants must deal with special problems associated with a new market such as the government changing the rules, inexperienced counterparties not used to dealing in financial markets, liquidity problems and lack of data. These problems can only be solved over time as participants gain experience.

[4] Origin Energy presentation at AETF conference 20/4/2004: Criteria for assessing a multi-state or national GHG emissions trading scheme.

4. Future developments and opportunities for actuaries

4.1. Future developments in environmental markets

More and more environmental problems are becoming apparent due both to greater pressure on the environment and a richer, better educated society that is less willing to accept the health and lifestyle impacts of environmental problems. As societies get wealthier they tend to place more importance on the environment.

Society is more willing to tackle environmental problems through political pressure and legal action which in turn puts pressure on governments to deal with environmental issues. Governments want policy mechanisms that reduce pollution at the lowest cost and produces better environmental outcome for less money. In many situations (but not all) market mechanisms deliver the most economically efficient outcome.

The concept of emissions trading has caught the imagination of business, environmental organisations and consequently government. Business appreciates market mechanisms because they turn an environmental problem into a business opportunity and typically provide the polluter with more flexibility compared to command-and-control regulation or a tax.

Environmental organisations appreciate market mechanisms (provided they have appropriate compliance controls and penalties) because they deliver a better environmental outcome for a given cost and also mean that business interests align with environmental interests. This attitude represents a sea-change for environmental groups, who used to be anti-market mechanisms for ideological reasons.

There has been an overall trend towards increasing the efficiency of economy through competition policy, privatisation of government enterprises, free-trade, etc. Market mechanisms fit in with this general trend.

The use of market mechanisms in Australia to deal with environmental problems is likely to increase for all these reasons. Areas where this will continue to occur in the future in Australia include GHG emissions, salinity and water. There are likely to be greater international linkages for environmental markets that deal with environmental global issues such as climate change and biodiversity.

4.2. Professional services in emerging environmental markets

At the early stages of development of environmental markets most of the consulting work emerges from government (who are attempting to craft policy solutions) and sometimes from industry associations and stakeholder (who seek to influence policy). Typically this work is relatively poorly paid and is undertaken by economists and consultants with a background in economics.

As the policy become more clear, work starts to come from companies and stakeholders who will be impacted by the policy. This will initially be general questions about how the policy will affect me and what should I do to influence the policy or prepare myself. As the market is defined, the work shifts so that companies want to know what risks they face, what their competitors are doing and what they should be doing.

The development of environmental markets creates a range of complex and fascinating questions both for governments and companies who are affected. Issues include:

- How serious is the environmental problem, what are the risks it poses to civilisation and the natural environment and how much should be spent to fix it?
- Is a market mechanism the optimal solution for this environmental problem?
- If so, what type of scheme is most appropriate?
- What sectors of the economy should it cover?
- How are different stakeholders affected, and how should the negatives impact be spread across the economy?
- How should environmental commodity instruments (for example, emission allowances) be allocated to scheme participants? (This is usually a highly data intensive exercise)
- How should the scheme be implemented? For example, trading rules, market infrastructure, regulator, etc.
- What is the likely market price of the environmental commodity?
- How should companies incorporate this in their investment and operational decision making?
- What new data systems are required by companies to measure and monitor their environmental performance and emissions?
- How should environmental commodities be treated for tax and accounting purposes?
- How should the financial markets regulator treat environmental commodity instruments?

4.3. What type of professionals are needed in this field?

Environmental markets are new and no one group of professionals have a natural claim over this field. At this stage most problems are multi-disciplinary and require the cooperation of different experts. A number of different professions tend to be involved, for example:

- **Economists**
  specialise in developing economic policy and market structures.
- **Environmental engineers and consultants**
  focus on technical issues and working within defined policy structures.
- **Lawyers**
  legal and policy issues.
- **Strategy consultants**
  high level implications for industries and companies.

- **Accountants and financial analysts**
  focus on optimising financial outcomes for business.
- **(Financial) Traders**
  apply financial market tools and techniques.
- **Commodity analysts**
  understand market dynamics.
- **IT specialists**
  developing systems to measure, monitor and report environmental performance.

4.4. Where can actuaries apply their skills?

None of the professionals listed above have all the answers. Rather they have specialist skills that can be applied to particular problems.

It may not be immediately apparent where actuaries can contribute. However, this is a new field and there are no experts. Actuaries, particularly consulting actuaries, have dealt with a wide range of new problems over the past decades and have proven they can deliver innovative solutions.

Actuaries have particular skills in the following relevant areas:

- Quantitative analysis and decision making where data is scanty and unreliable
- Recognising the impact of uncertainty and considering alternative scenarios
- Combining technical analysis with financial analysis
- Complex modelling exercises that combine financial and technical factors with uncertainty
- Determining capital required for long term viability or sustainability

Practical work that actuarial consultants could undertake includes long term modelling and valuation of environmental services/markets, developing greater understanding of areas of uncertainty, market supply/demand analysis and exploration of the impact of alternative scenarios on business and the environment.

In practice, actuaries would work with other professionals in a multi-disciplinary team. This is unlikely to ever be more than a niche area for actuaries, however it is fascinating and will be a growing part of our economy.

5. References

Cap and Trade: Acid Rain Program Results	US EPA www.epa.gov/airmarkets
Chicago Climate Exchange	www.chicagoclimateexchange.com/
Climate Change Solutions for Australia	The Australian Climate Group 2004
Criteria for assessing a multi-state or national GHG emissions trading scheme	Origin Energy AETF Conference 20/4/2004
Greenhouse gas issues within Australia's Electricity Industry	Richard Cumpston & Andrew Burge 2003
Hunter River Salinity Trading Scheme	http://hits.nsw.gov.au/salinity_trading.html
EU emissions trading scheme	http://europa.eu.int/comm/environment/climat/emission.htm
NSW Greenhouse Gas Abatement Scheme	www.greenhousegas.nsw.gov.au
Overview of the Mandatory Renewable Energy Target	www.orer.gov.au/overview.html
Queensland Department of Energy	www.energy.qld.gov.au
UK emissions trading scheme	www.defra.gov.uk/environment/climatechange/trading/index.htm
United Nations Framework Convention on Climate Change	www.unfccc.int
Weather Derivatives	Raymond Yeow 2001