Environmental impairment liability insurance for geological carbon sequestration projects

I Introduction

For some decades now experts have argued about availability, cost and feasibility of climate change mitigation options that bring about stabilization of atmospheric greenhouse gases at less than a doubling of pre industrial concentrations within the next half-century.[1] The portfolio of potential greenhouse gas mitigation opportunities range from options currently employed such as efficiency gains or the adoption of renewables to more prototype technologies such as fusion or space-based solar electricity.

Carbon sequestration refers to the provision of capturing and long term storage of carbon in the terrestrial biosphere, underground or in the oceans. Carbon dioxide can be captured at the emission source (e.g. combustion processes) or directly from the atmosphere, transported and injected into deep underground geological formations where it is expected to dissolve with fluids in the aquifer and hence sequestered.
The injection of carbon dioxide into the ground is not in itself a new idea. The oil and gas industry has been pumping certain gases, including carbon dioxide, into wells of aging oil fields for more than thirty years in order to extract more oil (Enhanced Oil Recovery, EOR).
The injection of carbon dioxide into geological formations for the sole purpose of isolating carbon dioxide from the atmosphere is occurring at a few places currently, among them Sleipner West in Norway (Statoil), Weyburn in Southeastern Saskatchewan (US Department of Energy), Salah, in the Algerian Sahara (BP).

As Carbon Capture and Sequestration (CCS) technology is being more widely demonstrated in numerous ongoing research projects and acknowledged by some as indispensable in a carbon-constrained world, the option also gains recognition from international political bodies. The Conference of the Parties (COP) to the Kyoto Protocol in its last meeting in November 2006 in Nairobi, for example, encouraged Parties to enhance capacity building on carbon dioxide capture and storage technologies[2].

In essence, the main problem around sequestration is the uncertainty around the level of leakage, which might occur over very long time scales and how this uncertainty can be accounted for. Whereas more attention has been paid to technical and economic issues[3], major legal questions related to sequestration remain unsolved and overarching regulatory frameworks in particular related to the issue of permanence and long-term liability are lacking.

[1] According to the current scientific consensus this goal which is equivalent to approximately 500 parts per million (ppm) is assumed to prevent most damaging climate change
[2] FCCC/KP/CMP2006/L.8 „Further guidance relating to the clean development mechanism“, MOP2
[3] E.g. IPCC Special Report on CCS

Given the above, the International Risk Governance Council (IRGC) has initiated a research project on the regulation of deep geological sequestration of carbon dioxide and commissioned several authors to prepare brief outlines of what they believe „constitute an appropriate regulatory framework“ to guarantee that "the sequestration of carbon dioxide in deep geologic reservoirs is regulated in such a way as to protect ecological and public health and ensure that overarching climate objectives are met"[4].

This paper is written with the support from Swiss Reinsurance Company (Swiss Re) and draws upon practical experiences from the insurance industry. The author hopes to contribute some useful point to the ongoing discussion.

This paper
1. addresses basic issues to be clarified for transferring the risks to insurers or capital markets.
2. introduces a risk transfer model, which tackles long-term liabilities based on the experience of environmental liability insurance.
3. points at areas where further research and refinement are crucial.

II Basic Principles & Considerations

This section of the paper
First discusses *economic incentive structures* driving sequestration projects because they will determine if and how sequestration is conducted.
Second, looks at the *definition of damage* and *type of harm* that can occur when the sequestered carbon dioxide leaks from the geological trap. Damage prevention constitutes the objective of a regulatory framework and defines the legal possibilities.
Third, considers *mechanisms and ownership structures*, which are suitable to tackle *long-term project liability*.
The *risk transfer model* subsequently outlined evolves around long-term liability. It guarantees that sufficient funds are set aside for damage compensation in the near and longer term future and that clear responsibilities are assigned.

Economic incentives:

Unlike other greenhouse gas mitigation options that generate electricity or save energy and therefore reduce costs, carbon dioxide sequestration does not yield any direct revenues. With the exception of EOR, the sole purpose and motivation to sequester carbon dioxide in deep geological formations is to remove the gas from the atmospheric cycle.
Hence, if projects that use other than taxpayers money are to be conducted, there need to be monetary or regulatory (e.g. penalties) incentives in place for the project owner or developer to engage in CCS activities. Incentives being tax breaks, requirements as part of a license to operate and/or income from certified carbon

[4] Stated goal in the IRGC project proposal

savings (e.g. certified emissions reduction under the Kyoto Protocol or marketable credits under other domestic or global schemes). Economic gains are even more vital if the owner or developer of the project is legally obliged to pay for damage or remediation occurring from the project activity. As with any commercial undertaking, the overall benefits from the sequestration activity need to exceed expected costs.

Definition of damage and harm:

Carbon dioxide is non-toxic. However, if inhaled in concentrations higher than 5%-10% by volume, it is immediately dangerous to life and health of plants, humans and animals. Hence, direct and measurable physical damage to humans, animals and the environment can result from releases of large quantities of carbon dioxide from sequestration projects. Sudden releases are related to site failure or storage site breach caused by e.g. unexpected tectonic movements or unforeseen large-scale migration. Gradual release is related to gas migration over time.

Legal guidance managing release of carbon dioxide from project activity can be drawn from environmental protection legislation, specifically related to environmental impairment leading to third party bodily injury, property damage and pure economic losses (environmental liability).

Within the environmental protection legislation strict liability regulation is occasionally supplemented by a presumption of liability in order to prevent undue disadvantage to injured parties where it would otherwise be very difficult to prove a link between cause (emission of pollutants), and effect (bodily injury, property damage or pure economic loss). Alternatively, law can alleviate the burden of proof falling to the injured parties. Even more stringent, legal action is also initiated against the real property holder being a different person from the site operator in addition to the operator of a site as the actual perpetrator of the pollution. Furthermore, legislation increasingly makes the party, which originally produced the waste/pollutant, or the party delivering the deposited materials jointly liable with the site operator.

The crucial element in the discussion about the release or deposition of carbon dioxide is the definition of pollutants or waste, i.e. the question if carbon dioxide is deemed a pollutant/waste and if the injection or storage is considered a dangerous activity. The regulator is responsible for such classification.[5]
If classification is in place there are many situations to which environmental protection legislation could apply, such as subsurface contamination, disposal in general, damage to freshwater resources or damage from high concentrations of carbon dioxide to humans, plants and animals.

Damage resulting from the contribution of carbon dioxide to global warming if gradual AND/OR abrupt leakage occurs is more difficult to measure and almost without predecessor. There is hardly any legal foundation on which to base

[5] See e.g. current discussions within the Environmental Protection Agency (EPA)

"indirect" damage on humans, animals and the environment resulting from abrupt AND/OR gradual release of carbon dioxide from sequestration projects resulting in the increase of greenhouse gas concentrations in the atmosphere.
However, there are examples from current risk transfer practices[6] where no proof of loss is required (i.e. no direct linkages to the basis risk exists), but where instead responsibility and compensation are based on measured indexes with predefined damage payments per unit change.
In the case of sequestration projects with the potential for release of carbon dioxide into the atmosphere a price would need to be assigned per unit of measurable concentration increase from a predefined source (project boundaries), measured at predefined stations (monitoring space), payable over a predefined time horizon at certain points in time or when certain thresholds are reached. Payment schemes can be linear (fixed price per unit change), non-linear (variable price per unit change) or variable (mark-to-marked at the time of observed release). Prerequisites to that scheme are either carbon price tags or a carbon price that is determined by the market; the ability to measure concentration increases and means to conduct third party verification.

Since gradual increases are difficult to measure (if at all), the paper suggests that thresholds are defined in advance upon which payments are being made. There needs to be reassurance about the ability to detect small quantity releases, otherwise they cannot be subject to a risk transfer scheme. The graph below depicts the threshold idea assuming linear release.

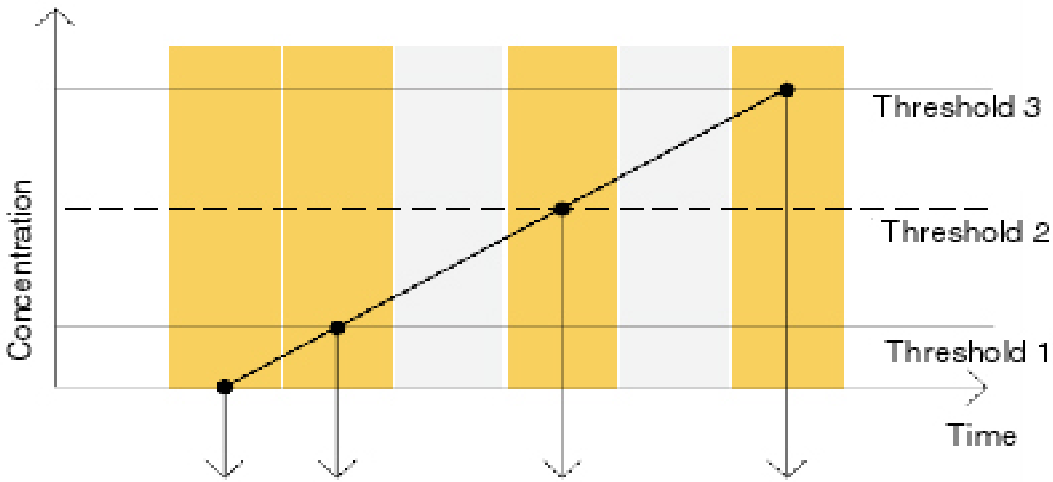

Figure 1: Definition of thresholds upon which payments are made

Long-term project liability and ownership structure:

Assuming (long-term) liability for any damage from leakage from sequestration projects over time requires clear ownership structures and mechanisms that ensure that financial resources for remediation and compensation purposes are available (similar to decommission funds in energy projects).

[6] E.g. a weather derivative that helps mitigate a farmer's risk of a lower than expected harvest with compensation payments according to temperature or precipitation indices.

It is proposed that project operators and owners are subject to legal obligation of providing financial safeguards in form of capital adequacy or risk transfer to third parties via insurance or capital market instruments to cover costs during project execution phase and any costs arising related to long term monitoring, remediation and potential damage payments.

For example, traditional engineering coverage is available to cover third party liability occurring during construction and operation (e.g. damage caused by injection activity or erection of machinery).

One of the main challenges arising in the context of financing for permanence is that damage might occur long after there is any further income from the storage activity and long after the site has been closed and possibly abandoned by the operator. That is why it is suggested that governments handle the site after sufficient funds have been built up.

III Environmental impairment liability insurance for geological carbon sequestration projects

The feasibility of any risk transfer solution relies on the idea that policy holders and (re)insurers collaborate closely and openly to achieve the mutual goal of preventing losses. Among the prerequisites for any long-term relationship with an (re)insurer are full information disclosure and the willingness to report any incidents.

The proposed model outlined below addresses the issues mentioned in the last section as follows:

Economic incentives: The model is centered on the idea that revenues generated by the activity can be used to build up and set aside sufficient contingency funds to manage future project damages without entirely compromising on the income earned.

Definition of damage and harm: The model assumes that the definition of damage is clarified, i.e. the applicability of environmental impairment legislation is granted in cases of direct and indirect damage to humans, plants, animals and property.
It furthermore assumes that a price has been attached to any (incremental) increase in carbon dioxide concentration in the atmosphere resulting from project leakage. In addition, for the sake of having to deal with only one compensation scheme, the model requires that in case of leakage compensation payments are the sum of the price for gradual release of carbon dioxide resulting in indirect damage related to global warming and – if applicable – direct damages that result from dangerous concentrations of carbon dioxide for plants, animals, humans and property caused by abrupt and/or gradual release of carbon dioxide.

Long-term project liability and ownership structure: The model designs a scheme where the operator holds the liability during the active project period and a predefined period beyond closing (passive period). It then transfers funds to the government. Second it yields a scheme where insurance cover is secured over a relatively long period of time. Third it presents a combination of financing solution and traditional risk transfer, which is tax optimized and flexible enough to facilitate the accumulation of sufficient funds to pay for losses occurring in the future.

Key elements to the model are the **sum insured**, the **policy period** and the **premiums**.

The **sum insured** sets an upper limit to the indemnity. It consists of two parts, a basic sector, which is a combination of insurance and financing elements, and an excess sector, which is a traditional risk transfer element.

The limit for the basic sector is the sum of the fund that upon contract termination, i.e. after the passive period will be handed over to the government. The basic sector will be filled by the financing premium that solely contributes to the fund and a traditional risk premium that covers the differential between accumulated funds and basis sum (which decreases over time).
The excess sector is the difference to the total sum insured. It is funded by regular premium payments during the active phase and interest income from the funds during the passive phase.

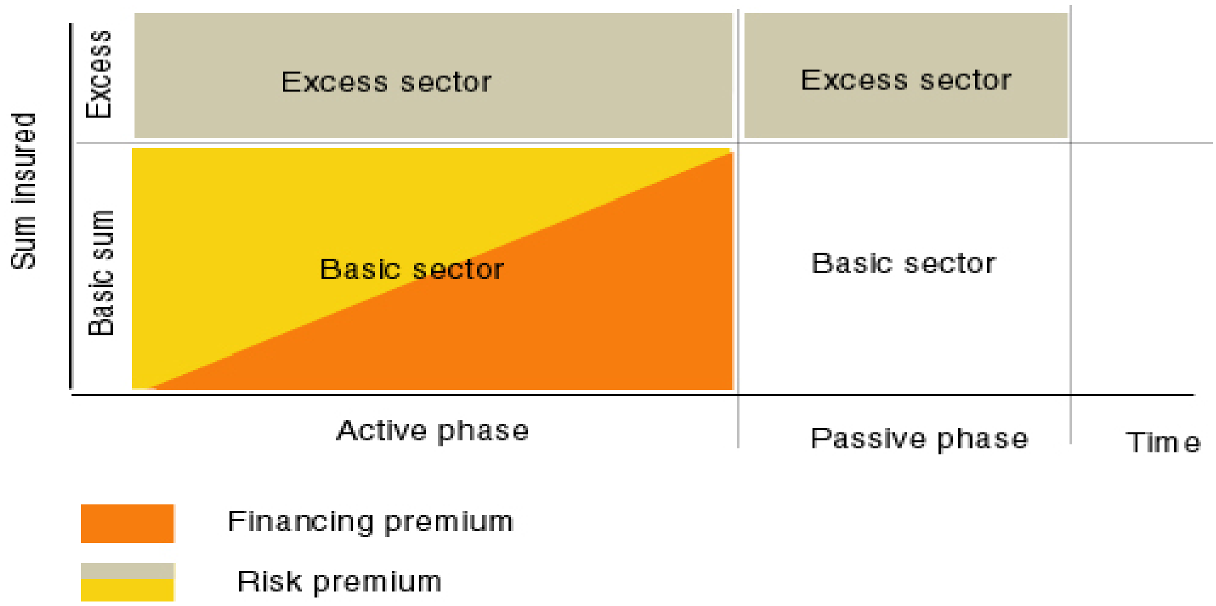

Figure 2: The insurance model comprising basic and excess sector

The value of the sum insured should be a conservative estimate comprising the combined potential losses from indirect (global warming penalty, or MTM carbon prices) and direct (harm to life and property) damage as explained under principles. It is an aggregate amount, which will be reduced each time a loss is indemnified (depreciative sum insured).

The initial sum insured at the start of the policy period might be higher than the discounted combined profit from the project activity. However, the return on equity of the financing premiums paid during the insurance period (i.e. active and passive phases) will make up for that difference given that good site management keeps losses at a minimum.

The **policy period** should consist of an active phase or filling period where premiums for the basic sector are actively managed and accumulated until the basic sum is reached and a passive phase where premiums will only contribute to the excess sector.
The end of the insurance period depends on the CCS-contracts respectively insurance contract and is finally reached with the legal transfer of the liability to the government. It is feasible to propose liability transfer time periods of 10 to 30 years after closing the C02 storage operation. Depending on the CCS-contract the funds should be transferred to the government. The government subsequently manages the funds and uses them for potential damage coverage.

The **premiums** paid depend on the sum insured, the length of the policy period, the sequestered volume and the assessment of the risks for the storage site.
Premiums that contribute to the basic sector will be returned as part of the return on equity as soon as the insurance contract is terminated. Upon indemnification the basic sector sum decreases as described earlier which means that the value of the funds will decrease by the same amount.
Premiums that contribute to the excess sector are fixed since they are the risk premium for the (re)insurer. This premium is paid with a portion of the return on equity.

The total sum insured should correspond to the aggregated direct and indirect expected damages as described earlier.

There should be flexibility in regards to coverage via different instruments supplementary to insurance.
The model described here assumes that the operator is the sole contributor to risk financing and the insurance industry is the ultimate risk taker. Yet, there are scenarios under which the contribution towards indemnity funding is split between operators, governments or investors.

One scenario embraces the option that the government asks the operator for a deposit or usage fee (similar to a lease or rent). In turn, the government would utilize part of the income generated to build up own funds on which it could draw when it assumes liability. This fact will automatically lead to an overall decrease of the legally commanded sum insured that the operator needs to find coverage for.

Another scenario relates to purely alternative risk transfer instruments such as, for example, "carbon leakage bonds" which would be based around an index that measures leaked carbon dioxide and which could be sold to capital markets. Unlike the operator/government built funds, however, those bonds would have rather limited durations. In addition there will be no certainty that investors show enough appetite for full coverage. Carbon bonds therefore should only be used to cover part of the excess sum over a defined amount of time. Funds to fill the basic sector would need to be accumulated by other means to ensure coverage.

Since under the model proposed, liability is handed to the government as the ultimate project owner at some point in time, governments should be interested in proper risk assessment, risk monitoring and control standards.
In cases where the authorities receive no direct benefits from sequestration projects they will ensure that they engage only in activities that are considered low risk and best practice and which will yield adequate cost coverage.
In cases where the government receives additional income from leasing ground to project operators, joint liability could be assumed during the active and passive project phase.
In both cases the regulator would want to enforce good site selection, rigorous standards and hence act in the interest of the public.

In particular authorities and project operators would need to clarify and validate any factors that determine risk quality among them specific on-site conditions, such as geological specificities of the site; monitoring and control standards, such as protective measures and control equipment; type and extent of potential damage, such as surrounding population, values, water bodies; conditions related to potential carriers of the gases. They will furthermore want to consider any risk related subjective aspects geared to the policyholder himself and the technical and political conditions under which he operates.
The same is true for insurance companies, which together with operators and governments would want to develop a comprehensive risk assessment process, which guarantees that highest standards are employed, and continuous improvement and monitoring takes place to prevent any damage related to the project activity.

IV Summary & Conclusion

The portrayed model can only serve illustration purposes. Any solution derived from such a scheme would need close examination on a case-by-case basis incorporating national regulation (e.g. taxes or solvency regulation, legal frameworks) and site-specific risk assessment.

In addition, there are many overarching and fundamental issues, which are not addressed in this paper, but which need clarification for the model to be implemented. Among them are project boundaries and projects involving more than one country, monitoring, accounting options, ability to define thresholds, acceptable leakage rates, trans-boundary migration, ground water, international waters, good site selection, risk management best practices or the regulation of project applicability and many more.

Some of the issues are of normative nature, some of which depend on safety standards and risk appetite. Overall, regulators, operators, investors and society as a whole will have to determine if CCS is to be widely exploited and approved within emission reduction schemes.

Furthermore, the insurance model described is derived from a solution of a somewhat similar problem – that of waste disposal facilities – where Swiss Re offers an innovative risk transfer concept for landfills.
Although carbon sequestration projects have some unique features, especially in regards to the global warming aspect of the problem, the idea that sufficient funds need to be set aside for any future damage from leakage is common to both cases.

The feasibility of any risk transfer solution relies on the idea that policy holders and (re)insurers collaborate closely and openly to achieve the mutual goal of preventing losses. For the proposed model to work there are a variety of pre-requisites that need to be met among them:
The installment of appropriate economic incentives
Definition and measurement of harm
Clear ownership structures and definitions of who is liable

Public – private partnerships will be key implementing the proposed scheme.

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Climate change has been designated a Swiss Re Top Topic, which means that it is recognized as an issue of Group-wide strategic importance. Swiss Re therefore invests into exploring the insurance industry's contribution to mitigating climate change. This paper would not have been written without the immense institutional knowledge and support of Swiss Re.

For the Swiss Re publication "Environmental impairment liability insurance for landfills" please refer to our web site at http://www.swissre.com/