

Valuation of Carbon Capture and Sequestration under Greenhouse Gas Regulations: CCS as an Offsetting Activity

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She explored the topic of carbon capture and sequestration's valuation in greenhouse gas markets as a part of a grant given to Camco International by the Strategic Programme Fund of the UK's Foreign and

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When carbon capture and sequestration is conducted by entities that are not regulated, it could be counted as an offset that is fungible in the market or sold to a voluntary market. This paper addresses the complications that arise in accounting for carbon capture and sequestration as an offset, and methodologies that exist for accounting for CCS in voluntary and compliance markets.

Elizabeth Lokey

This article is the second of a two-part series covering how carbon capture and sequestration (CCS) could be valued under greenhouse gas regulation. The first article covered the implications of different types of regulation such as standards, a tax, and cap-and-trade schemes with various types of allowance allocation for CCS (*Electricity Journal*, May '09). This article covers the way in which

CCS could be counted as an offset and the implications thereof.

I. Offsets Background

Greenhouse gas offsets are emissions reductions derived from projects that reduce or absorb greenhouse gas emissions that would not have occurred in a business-as-usual situation. The number of tons of reductions that

result from these projects can be counted, checked by independent third parties, and sold to entities that must meet compliance obligations. The money that can be earned through the sale of these emission reductions often provides the extra revenue necessary for the project to exist. In this way, the argument can be made that the project would not have occurred in a business-as-usual situation without the benefit of the carbon revenue.

This criterion is called financial additionality, and is often required for crediting of offset projects. Also, any project that is required by a law that is enforced cannot earn carbon revenues under most recognized programs because the project would have been implemented regardless of the carbon revenues available. If a project can prove that it was not mandated by law, it passes a regulatory additionality test.¹

Offsets have a long history in various air pollution regulations. In 1994, Pennsylvania introduced Emission Reduction Credits (ERCs) for pollutants like volatile organic compounds and nitrogen oxides under the New Source Review and Ozone Transport Region. Activities like the shutdown of a polluting facility or installation of more efficient equipment could generate fungible credits for volatile organic compounds and nitrous oxide reduction obligations in Pennsylvania's program.² Now, this same principal is applied to offsets in greenhouse gas

markets; a project that reduces or absorbs greenhouse gases somewhere else can generate credits that can be purchased by a regulated entity for fulfillment of its reduction targets. Offsets can be fungible in greenhouse gas markets that use a tax, cap-and-trade system, or a regulation as long as the market rules allow a reduction in a metric ton of carbon dioxide (CO₂) equivalence from a qualifying project to count

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towards the mandatory reduction targets.

Offsets are sold in terms of CO₂ equivalence in order to have only one unit of trade in the market. So, greenhouse gases that have a higher warming potential are put in terms of their CO₂ equivalence for warming purposes. For example, methane is considered by the 2007 Intergovernmental Panel on Climate Change (IPCC) report entitled "Climate Change: The Physical Basis" to be 25 times as potent as CO₂. Therefore, reduction of one ton of methane yields 25 offsets in programs that recognize this most recent IPCC report.³

The goal of offsets in this and current greenhouse gas regulation has been to reduce the cost of compliance for regulated entities. For example, if it is cheaper to capture and flare methane from animal waste than to install a more efficient boiler in-house at a power plant, then the owner of the power plant that needs to comply with regulation may choose to purchase offsets for compliance. It should be noted that capturing and flaring or using the natural gas must be a practice that is not business-as-usual or required by law in the agricultural sector in order to be considered a qualifying offset. Also, most greenhouse gas regulation includes a supplementary clause for offsets which stipulates that compliance obligations cannot be met entirely through offsets and some in-house reductions must occur. The Kyoto Protocol stipulates that at least 50 percent of reductions are met domestically, and many countries have chosen even more stringent targets like the UK, which only allows 8 percent of its compliance obligations to be met through offsets.⁴

Given estimates of the potential geologic storage for CO₂, CCS from both regulated entities and entities outside of regulation for offset credit may comprise a large portion of the emission reductions that occur. A 2007 ICF International study estimates that the continental U.S. alone has 3,375 billion tons of storage. The IPCC has even more optimistic estimates, predicting there is

675–900 billion tons of CO₂ storage in oil and gas reservoirs, 3–200 billion tons in unmineable coal seams, and 1,000–10,000 billion tons in deep saline formations.⁵ Considering that the U.S.'s most stringent climate change legislation in 2007 called for just 7 billion tons of reductions by 2050, it is clear that CCS has the potential to make up a huge amount of the requisite reductions.⁶ However, some fear that CCS has the potential to flood the current market, lowering the price of offsets and out-competing other offset activities. All of the registered offsets under the Kyoto Protocol's Clean Development Mechanism (CDM), the largest offset program worldwide, have only been issued 267 million tons of CO₂ reductions.⁷

Before CCS is at danger of flooding the offset market, technical as well as regulatory hurdles must be overcome. Only then does it have the potential to allow future carbon markets to operate more efficiently and make reductions for the cheapest possible price. While owners of other offset projects are wary of CCS for its possible implications of flooding the market, industries like electrical power producers, natural gas processors, fertilizer manufacturers, and ammonia producers, who could participate in CCS, are hopeful about obtaining these carbon credits because of their economic value.

The compliance carbon offsets track the price of emission

permits (European Union Allowances-EUAs) in the EU's European Trading Scheme and can be sold for about 30 percent less than the EUA price at any given time. Carbon markets, like other markets, fluctuate and in July 2008, an offset in this market reached a high of \$24. By February 2009, an offset was only worth \$8.⁸ Whether or not this price would provide a steady enough price signal to incentivize

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the development of CCS can be debated.

The exact way in which CCS is valued, either as an offset or as tons not emitted from a regulated entity, has a large bearing on the role it will play in future markets. Therefore, before one can ascertain whether or not the price of CO₂ will be high enough to incentivize CCS, whether offsets from CCS will dominate an offset market, and whether regulated entities will be limited in their use of these offsets, it is essential to consider from which sectors CCS offsets would be eligible. The next section considers this point.

II. Offsets in Various Industries

A. Regulated entities

Australia and the EU have determined that CCS will reduce an emitter's greenhouse gas liabilities and count as emissions that are simply "not emitted" in their cap-and-trade schemes.⁹ However, CCS from regulated industries could alternatively be considered an offset activity.

Australia considered this form of valuation during the creation of its greenhouse gas legislation. In this situation, emitters that employ CCS would quantify the emissions coming out of their stacks even if these emissions are immediately piped to sequestration sites. The amount of emissions that leave the stack at the facility would be used for baseline accounting and inventory purposes. Then, as the CO₂ is sequestered underground, the regulated entity would earn offsets for this activity. These offsets could then be counted against the CO₂ they are emitting or sold to other market participants.¹⁰

No countries have thus far adopted this choice of carbon accounting for CCS perhaps in part because it creates a negative image for a polluting entity, as its emissions are shown to be much higher than they would be without CCS. This form of carbon accounting also adds a level of unnecessary complexity to the market as regulators must inventory emissions, generate

offsets, and then track the trade of offsets.¹¹

B. Other industries

The vast majority of federal cap-and-trade proposals and nascent U.S. regional and state regimes propose to instigate a carbon market that would cover large point-source emitters. Many sectors may not be covered by a cap-and-trade for political reasons or because monitoring and reporting may be difficult or costly. For some of these sectors like transportation with non-point-source pollution, CCS may never be a realistic CO₂ reduction option. However, there are many other industrial sectors that could engage in geologic CCS but may not be regulated in the first phase of the market. For instance, the Regional Greenhouse Gas Initiative, which covers 10 states in the Northeastern U.S., only regulates power producers in its first phase from 2009 to 2012.¹² If a national scheme is designed in a similar way that only covers power producers, then some major producers of CO₂ that may not initially be regulated include oil and gas processors, fertilizer plants, and ethanol and ammonia producers. For these industries, which have a nearly pure stream of CO₂ emissions from their plants, investment in the most expensive portion of CCS, the capture and separation technology, may not be required. CCS may be financially viable for these producers, especially if a CO₂ pipeline that they can use

runs close to their operations. Other emitters like oil and gas processing facilities may also be candidates for CCS, especially if co-contaminants like hydrogen sulfide can be sequestered with the CO₂ as they are at 43 sites in British Columbia and Alberta, Canada.¹³

None of the existing or proposed greenhouse gas markets have provided provisions for offsets generated

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by CCS activities in industries outside of the cap or regulated market. The subsequent section will describe how efforts to undertake CCS before an industry is regulated should be counted as offsets and why future regulation should explicitly address offsets in unregulated industries.

III. Early Action by Regulated Entities

Large point-source CO₂ emitters that are not required to account for and reduce their emissions in the first phase of the market, but most likely will be

required to in subsequent stages of the market have the potential to benefit from CCS in two ways: through counting the sequestration of tons as “early offsets” or as “early action.” Early offsets are offsets generated by a sector that will eventually be regulated and have the future stream of offsets from a given activity disappear as the sector will no longer be eligible for generation of offsets but instead required to make reductions. Early action is when emitters that are initially not covered by the cap or other regulation make reductions before they are regulated and receive credit for these actions taken in a future market. This type of action can also be taken and documented by regulated entities in advance of a cap-and-trade program commencing.

It is important to encourage early action for sectors that are initially not covered by the market to incentivize cost-effective early reductions and ensure that facilities are not penalized for reducing CO₂ emissions in advance of regulations. A facility would be penalized by early action if it received fewer allowances when it was eventually covered by the cap or other regulation because of the early action measures it put in place ahead of the regulation. Early action is often mentioned in proposed greenhouse gas legislation, but usually does not mention CCS as an approved mitigation strategy that would earn early action recognition.¹⁴

Because early action has not been recognized in all climate change legislation, especially for industries that will not be the first ones capped, there may be a perverse incentive for emitters either to do nothing to reduce their emissions or to increase their emissions until there is regulatory certainty about early action. If these emitters increase their emissions, then there is the possibility that they may earn more allowances in a cap-and-trade system where emissions are freely distributed based on the historical emissions of emitters.¹⁵

Most measures to implement early action through CCS may be used strictly in the accounting of a company's emissions. In this scenario, the company assumes that it will be regulated in the future and that emissions that are sequestered through CCS will be credited towards the emission permits of (allowances) that it is either given or does not have to purchase in an auction. However, whether or not this activity is recognized depends on the details of the greenhouse gas regulation. Generally, a baseline year is selected and any early action activities taken before this year will not be recognized. The further in the future a given sector is regulated, the greater the chance that this baseline year will be one in the future instead of the past.

A. Early offsets

If a non-regulated entity does not think that it will be regulated

in the near term or even perhaps at all, it may decide that instead of simply reporting its reductions in emissions due to CCS, it will earn offsets for each metric ton sequestered and forego any early action crediting it would receive when it was actually covered by the regulation. In this way, the offsets generated are referred to as "early offsets" because they are offsets that can be generated only up to the point when that entity is

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regulated. For example, if an ammonia producer that is outside of the greenhouse gas regulation implements CCS in 2010 and early action for ammonia producers is recognized only for activities completed during the years of 2012 and beyond in future legislation, then the ammonia producer that engaged in CCS fails to benefit from these activities except through the offsets it generated before the market began. In fact, if offsets are not generated in this situation, the CCS activities may even hurt the ammonia producer as its baseline of emissions would be quite low or nothing at all when its industry

is capped. In an allocation system where allowances are given to emitters based on historical emissions, the ammonia producer's competitors would receive allowances that have value - while it would not. These allowances would most likely have more value than the early offsets.

IV. Complications with Earning Carbon Credits for CCS

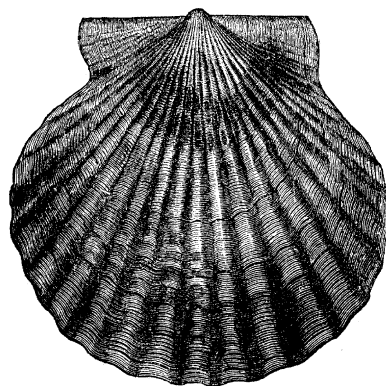
Despite the potential for deriving offsets from CCS for electrical and non-electrical sectors, there are many complications to earning credit for CCS activities as offsets or as allowances. For many of these reasons, CCS has not been approved as valid offsets by the UNFCCC for use in the Kyoto Protocol's Clean Development Mechanism (CDM). CDM offsets, known as Certified Emission Reductions, allow countries with Kyoto reduction targets to meet a portion of those targets with qualifying offsets. Participants of the Kyoto Protocol's Conference of Parties in 2008 feared that incorporation of CCS into the CDM would make developing countries a testing ground for CCS trials. Using an immature technology in developing countries could lead to health violations and abuse since environmental and industry standards are usually more lax in developing nations. Also, using CCS often causes emerging

economies to rely on finite fossil fuel resources like coal that incur extraction externalities like land disturbance. Finally, the technical complexities of CCS have not yet been proven to a commercial level in developed countries.

Therefore, this technology could have unforeseen problems when implemented in developing countries.¹⁶ And, as previously mentioned, other critics of having CCS in the CDM claim that it could flood the market with offsets, causing all other emission reduction projects to lose value and be overshadowed by CCS. This reliance on CCS projects could cause an unequal distribution of projects based on where there are opportunities to implement CCS. Also, the issue of how to provide long-term monitoring and liability for these projects was raised. Therefore, many oppose CCS implementation on the grounds that it is not an appropriate energy future for developing nations.¹⁷

Despite the fact that CCS has not yet been approved for the CDM, two CDM projects in Malaysia and Vietnam have submitted methodologies for CCS projects under the CDM, and Shell and the International Energy Agency (IEA) have created proposed methodologies for CCS.¹⁸ The American Carbon Registry is in the process of creating a methodology, which should be finished by December, for carbon crediting from CCS in voluntary markets.¹⁹ Also, the United Nations Framework

Convention on Climate Change (UNFCCC) has authored several documents considering some of the challenging issues related to quantifying emission reductions from CCS. The obstacles identified in these documents are methodological, technical, legal, and policy-related. Some of these challenges include reducing the energy penalty associated with



CCS, decreasing physical leakage, ensuring permanence of storage, long-term liability, and monitoring, understanding and predicting sub-surface CO₂ behavior, preparing remediation options, and defining the project boundary.²⁰

A. Energy penalty

Because separating CO₂ from a stack, transporting it, and injecting it requires significant inputs of energy, a metric ton of CO₂ stored through CCS is not equal to a metric ton of CO₂ mitigated through other methods. The energy for CCS is estimated to be between ~11 and 40% of the fuel required for a fixed output of

work.²¹ Because of this energy penalty associated with CCS, credit for CCS activities must take into account the energy and emission intensity of the steps necessary to sequester the CO₂. Creating a standardized equation to account for this energy penalty is difficult because of the variety of locations such as fertilizer plants, power plants, and ethanol refineries from which CO₂ can be derived, and the distinct separation technology and transport requirements necessary to conduct CCS for each of these situations.²²

B. Physical leakage

From a carbon credit generation standpoint, the issue of physical leakage from the site would present an obvious complication for the allocation of carbon credits. If the site cannot hold the carbon expected, then it should not receive carbon credits. How then, should the carbon credits be discounted to accurately reflect the amount of CO₂ that escapes, and how can one predict the amount of leakage over hundreds or thousands of years? One option to resolve this problem would be to take allowances out of future allocation pools for tons of leakage that occur. However, how to allocate discounted credits is unclear since leakage could occur over hundreds or thousands of years.

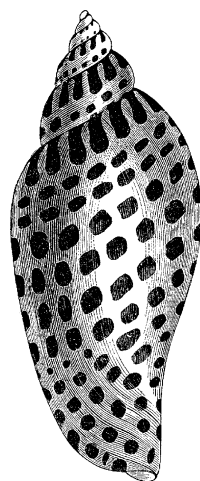
The issue of the physical plume size has been flagged by the UNFCCC and is an important one when considering

how to allocate the carbon credits.²³ Since science has not yet defined with 100 percent accuracy the extent of plume migration, it is possible that the injected CO₂ could invade pore space that belongs to others such as landowners, mineral rights owners, or the state or federal government. The owners of this other pore space would probably own the right to the carbon credits for the CO₂ stored in their property. The patchwork of ownership rights in reservoirs could cause a complicated allocation of carbon credits to owners or involve payouts to these entities for the right to inject in their land. For instance, injected gas in one reservoir diminishes the ability of the injector's neighbors to inject and hence, to benefit from carbon credits.²⁴ In this case, would the neighbors earn a portion of the carbon credits that is equal to their reduced capacity to inject? It would probably be impossible to determine the exact amount of CO₂ injected in individual plots with complete scientific certainty, and doing so may lead to complicated litigation between neighbors as each tries to maximize their carbon credit portion.

C. Crediting lifetime

Another issue of concern for carbon credit generation is the lifetime of the project. A typical CDM project has a lifetime of up to 21 years after three crediting periods,²⁵ and generates CERs which have expiration dates and

which need to be replaced after they expire. However, such short crediting periods do not accurately reflect the near permanent sequestration of CO₂ and may not provide a sufficient financial incentive to employ CCS.²⁶ The Intergovernmental Panel on Climate Change has high expectations for the permanence of geologically sequestered CO₂



saying "the fraction retained in appropriately selected and managed geological reservoirs is likely to exceed 99 percent over 1,000 years."²⁷ However, the key consideration in this assumption is that the site where the CO₂ is injected is appropriately selected and managed. This assumption is, of course, subjective and depends on the regulatory structure in place. If the sequestration is truly permanent as the UNFCCC predicts, then perhaps a longer time horizon for CCS could be proposed. The idea of issuing these carbon credits as geologic sequestration units (GSUs) has been proposed.²⁸ It is possible that these GSU offsets would have an implicitly lower value than

other, less risky forms of emission offsets or, on the contrary, perhaps these GSUs would have a higher value since the sequestration is more permanent than other types of offsets. However, introducing credits that are not fully fungible and must be sold at a discount into the global trading schemes would greatly complicate the markets and tracking systems.

V. Existing Methodologies for CCS as Offsets

Despite all of the complexities inherent in awarding carbon credits for CCS, several programs described in this section have designed methodologies which give carbon credits for geologically sequestered CO₂. It is important to note that no methodology exists for CCS in its purest form, without the ancillary benefits of acid gas injection or enhanced extraction of a resource such as enhanced oil recovery (EOR) or enhanced coalbed methane recovery (ECBM).

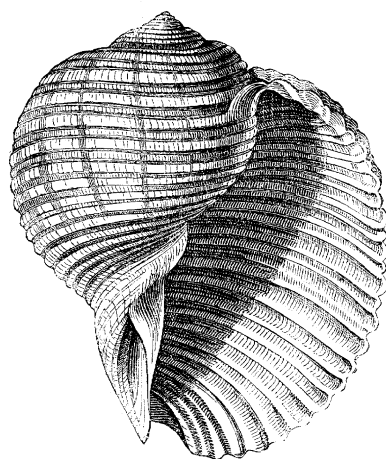
Injecting CO₂ into these reservoirs forces more of the commodity out of the ground. Some of the CO₂ returns to the surface, is separated from the oil or gas, and then reinjected to force out more of the oil and gas. During this process, about 50 percent of the injected CO₂ stays embedded in underground pore space.²⁹ During natural gas extraction, hydrogen sulfide (H₂S) and CO₂ is often found in the

same reservoirs as the natural gas. During natural gas processing, this H_2S and CO_2 must be stripped from the natural gas and disposed of. The H_2S can either be remediated at the ground level or injected, along with the CO_2 , into underground reservoirs.³⁰ This section will discuss the carbon crediting that occurs for these EOR, ECBM recovery, and acid gas injection activities.

A. Blue Source

A carbon consultancy called Blue Source developed a methodology for the creation of carbon credits in voluntary markets for EOR activities that use anthropogenic CO_2 from industrial processes that would have been off-gassed.³¹ In this way, the CO_2 from natural gas processing used for EOR is replacing CO_2 from underground reservoirs that would have been used in a business-as-usual situation. The companies like PetroSource and Merit Energy using this protocol are large processors and most likely will be regulated at some stage in a future compliance regime. Also, Anadarko Petroleum Corporation modified the Blue Source methodology slightly for the qualification of several enhanced oil recovery projects. They may have implemented the projects in part to reduce their greenhouse gas liabilities, hoping that they may earn early action credit in addition to the offset credit they are now earning for their sequestration activities.

As of May, the only project developers to use these methodologies were Blue Source and Anadarko. In the U.S., Blue Source used the Environmental Resources Trust's GHG Registry, which became the American Carbon Registry, as the standard and registry, for acceptance of the methodology and issuance and tracking of credits from the



project. Verification for Blue Source's EOR projects is done by firms such as Ruby Canyon Engineering, ICF International, and URS Corporation.³² Some of Blue Source's customers include Dell, Delta, AEP, Google, Pacific Gas & Electric, Yahoo, and Nike. As of November 2008, 10 million tons of voluntary or verified emission reductions (VERs) had been created and sold from these projects.³³

B. Alberta Environment

Alberta Environment of Canada worked closely with Blue Source to develop EOR methodologies, which are similar to the one described in the section

above. These methodologies are used for offset crediting in the Alberta intensity-based greenhouse gas system. In total, there are three CCS-related methodologies that are eligible for use in Alberta. Two of these methodologies allow offsets to be generated from EOR projects that use CO_2 that would have otherwise been vented into the atmosphere. One of these takes into account EOR that creates emissions as CO_2 is separated from other waste gas streams while the other does not.³⁴ A third CCS methodology involves geologic sequestration of H_2S , CO_2 , and other airborne contaminants from natural gas processing facilities. Industries in Canada that use any of these methodologies are able to sell the offsets from these projects to entities that need them for compliance purposes.³⁵ Offsets earned for these activities are registered with the Canadian Standards Association CleanProject Registry and Alberta Emissions Offset Registry.

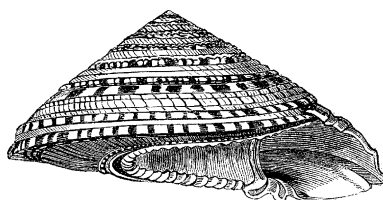
If a company is regulated within the Canadian market because it emits more than 100,000 tons of CO_2 equivalence, then it can engage in these EOR and acid gas activities and earn credit for doing so if the company surpasses its reduction goals. This credit is commoditized into Emission Performance Credits (EPCs) that are fungible among regulated entities. Two companies had earned EPCs for acid gas injection activities, and

one has earned offsets for it as of May.³⁶

C. Oklahoma Conservation Commission

During the summer of 2008, the Oklahoma Conservation Commission drafted a methodology for verifying carbon sequestered during EOR activities in the State of Oklahoma. The goals of this verification program include assuring Oklahoma offsets meet a standard, encouraging the capture of anthropogenic CO₂, and providing a mechanism for carbon sequestered as a result of EOR to be recognized as a credible offset. A co-benefit of the program is that it will likely encourage more EOR activities in the state. The program rules are still in development, and many details of the program will be finalized in the next year. Like the Blue Source methodology described above, EOR projects that use anthropogenic CO₂ from the stack of natural gas processors and other industrial activities that would have otherwise been off-gassed are eligible for verification. Since EOR involves the injection, extraction, and reinjection of a known amount of CO₂ several times, a mass balance equation that takes into account the total CO₂ that is injected and not recovered can be used to quantify and verify annually the amount of CO₂ to be counted as offsets. Projects must follow applicable EPA Underground Injection Control Program's rules for

permitting and monitoring. In Oklahoma, ex-post verification of these projects will occur by the state or state-approved verifiers. The verified credits will be posted on a state-created offset registry with the sale of credits solely at the discretion of the project operator. At this time the program is not affiliated with other, recognized greenhouse gas



programs like the Voluntary Carbon Standard, the Chicago Climate Exchange, the Gold Standard, and the California Climate Action Reserve.³⁷

VI. Conclusion

Given that the Intergovernmental Panel on Climate Change estimates for the potential geologic storage of CO₂, CCS has the potential to play a huge role in climate change mitigation.³⁸ CCS will certainly have a role in helping regulated entities meet their reduction targets, but may also be instrumental in helping facilities that are initially or permanently

not covered by regulation reduce global levels of greenhouse gases. Allowing tons sequestered from entities outside of regulation to count towards reduction targets in the market would make CCS a valid form of an offsetting activity.

However, there is not yet certainty that sectors outside of regulation will earn credit for sequestration activities, and there is an urgent need to clarify which sectors can earn early action credit for CCS activities to incentivize CCS among electric power producers and other industrial sectors that may implement CCS before the regulation or fall outside of the regulation once it has begun. Without these provisions, there is a perverse incentive for emitters to do nothing to reduce their emissions in an attempt to avoid jeopardizing the allocation of allowances they may receive. No countries have fully designed these early action rules. In the absence of such rules, entities that may in the future be regulated may choose to either not implement CCS or earn early offsets for CCS.

Most compliance and voluntary offset programs have not yet adopted CCS as a valid offsetting activity because of the inherent challenges in accurately counting offsets from CCS. These groups point to difficulties in accounting for the CO₂ that may leak from the reservoir in future years, considering complexities for the baseline calculation, deciding how long the life of the issued

offset should be, determining who is liable for the injected gas years in the future when the present institutions may be non-existent, and assigning carbon credit ownership. And, CCS, in the opinion of the UNFCCC, is not yet ripe to be counted as offsets derived from developing countries because of its unproven status.

However, some methodologies that do offer credits for these activities have been developed by the Conservation Commission of Oklahoma, Blue Source, and Alberta Environment. These projects may help push the market for CCS, and the methodologies created for these projects may serve as the beginning of a template for future

CCS offset protocols, as future greenhouse gas regulators find they must turn to CCS to mitigate climate change.■

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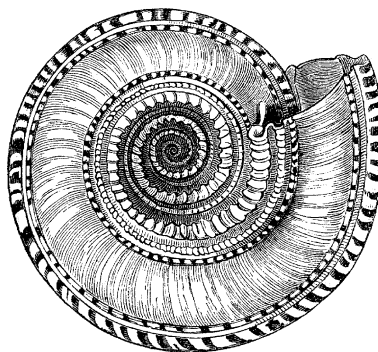
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