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Global Governance of Carbon Capture and Storage: Role for the GCC?

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December 2017

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Executive Summary

- Carbon capture and storage (CCS) is an essential environmental technology, and particularly important for the Gulf Cooperation Council (GCC) countries in allowing them to make continuing use of their large oil and gas resources.
- CCS has advanced less than is required to meet global climate goals, according to the International Energy Agency,¹ and less than other climate-friendly technologies such as renewable energy.
- This is primarily due to a lack of suitable financial mechanisms to encourage its use, and hence an inability to implement projects at scale and bring down costs. In turn, this lack of financial support is partly the result of insufficient global governance.
- Numerous multinational and international organisations are engaged in CCS in different ways, including through research, advocacy, funding and deployment, either as part or the whole of their mission.
- The GCC states, with the UAE and Saudi Arabia taking the lead, could cooperate with a small number of key CCS partners, namely Australia, Norway and possibly Canada, and a wider group of interested parties, such as the US, UK, the Netherlands, China, Japan, South Korea and South Africa. This would be intended to lead to the formation of a CCS club, of countries with consistent and somewhat harmonised policies supportive of development of the CCS industry on a self-sustaining basis.
- To bring cooperation with major oil producers, OPEC, with mediation by the International Energy Forum and with CCS involvement via OPEC's role in the International Energy Agency's IEA-GHG, could be the appropriate venue. The GCC states' long-standing relationships with international oil companies, including through the Oil & Gas Climate Initiative, can be leveraged to give access to CCS technology, project management, financing and lobbying with their national governments.
- The GCC states would have to consider which concessions and trade-offs could be made with other countries to secure their support on CCS. A contribution to direct funding of CCS projects by major hydrocarbon exporters may be required.
- Of global organisations, the Global Carbon Capture and Storage Institute and the Carbon Sequestration Leadership Forum appear to have the most momentum and the GCC states could step up their involvement.
- This cooperation should further three aims:
 - to implement a suite of CCS demonstration projects to bring down costs and develop confidence in the required technologies;
 - to encourage adoption of a consistent mechanism to make large-scale adoption of CCS viable, most promisingly a carbon tax; and
 - to support a positive image for CCS, and avoid further disseminating the image that CCS is merely about rescuing the 'dirty' fossil fuel industry.

The Issue

This EDA Insight examines the global governance of carbon capture and storage (CCS)^a – specifically, how it operates today, how it may be strengthened to advance this important climate technology, and what role the UAE and other GCC states should play.

CCS is regarded as one of the key technologies for tackling climate change (see Box 1). Reports by the International Energy Agency (IEA), the Intergovernmental Panel on Climate Change (IPCC) and other bodies have given a prominent role to CCS in contributing to achieving the required mitigation of greenhouse gas emissions, alongside renewable energy, energy efficiency, nuclear power and other low-carbon technologies.

However, despite some recent successes, CCS deployment has advanced relatively slowly – much more slowly than foreseen in the IPCC's landmark 2005 special report,² and more slowly than required for it to play its required part in meeting global climate commitments, such as those agreed in the UN Paris Agreement of December 2015. These include two temperature goals (holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit this increase to 1.5°C) and long-term emissions goals (achieving a global peaking of greenhouse gas emissions as soon as possible and achieving net-zero emissions in the second half of this century).

The IEA's model from 2015 estimates that, to stay below 2°C, CCS would need to deliver 13% of the required global emissions reductions by capturing 6 billion tonnes of CO₂ annually by 2050.³ This is equal to 7,500 projects on the scale of the Al Reyadah Emirates Steel CCS facility, in operation in the UAE.

CCS is a key technology for the UAE and other GCC states, because it allows continuing consumption of oil and gas (and coal), and hence preserves the basis

of the regional economy. The GCC has ideal conditions for implementing CCS, but only two operating projects to date. Thus far, GCC states have achieved relatively little success in encouraging its global progress.

This Insight addresses the current global governance of CCS and its fit within the climate framework. It discusses the extent to which limited progress in CCS is due to inadequacies in the global governance framework, and suggests how governance can be strengthened and how interested parties can push for such improvements.

Relevance for the UAE and GCC

The UAE, and GCC countries generally, have a unique relationship to CCS, because of: the growing commitment by these governments to climate solutions alongside their economies' status as leading oil and gas producers and consumers; their ability to access the right technology and financing; as well as general public acceptance and technical conditions for large-scale CCS deployment.

It is in the interest of GCC countries to promote CCS internationally and strengthen its global governance framework because:

- CCS is a technology in which the UAE and GCC countries have a competitive advantage, and which, deployed domestically and internationally, allows them to continue the use and export of their large oil and gas reserves while meeting climate goals.
- At a time of uncertainty over the future of oil and gas, and attempts by hydrocarbon exporters to diversify their economies, it can create a whole new industrial sector and set of technologies and employment opportunities.

Box 1: What is CCS?

Carbon dioxide (CO₂), the main pollutant driving climate change (global warming) is produced by the combustion of fossil fuels (oil, gas and coal), biomass (wood and other biological materials) and waste, and by some industrial processes, particularly cement manufacture.

For electricity generation, a number of approaches are available to capture the CO₂, either before the combustion of the fuel or by processing the emissions (usually a mix of CO₂, water, nitrogen and some pollutants). For industries, the details of the capture mechanism vary, but some industries naturally produce concentrated streams of CO₂ which can be relatively easily captured.

The captured CO₂ is usually stored underground, in saline aquifers (rock formations containing unusable, highly salty water), depleted oil and gas fields, or in active oil-fields for enhanced oil recovery (EOR). Extensive research and geological analogues indicate that, in well-chosen sites, CO₂ can be safely stored in this way for hundreds of thousands or millions of years, with minimal leakage.

Beneficial use of CO₂ (carbon capture, use and storage, CCUS) to produce chemicals, ceramics, plastics and fuels, is still largely at a research stage, other than for EOR and some fertiliser production and agriculture.

^a The 'S' sometimes stands equivalent for 'sequestration', and a 'U' is occasionally added for 'utilisation'.

- Global advocacy for CCS is relatively weak. The UAE in particular has been a strong global advocate and leader of CCS, whose promotion has been an important part of its climate diplomacy, and hence there is space for its voice to make a significant difference.
- A positive contribution by GCC countries to global CCS governance can enhance the GCC states' reputation on climate change action, and advance the deployment of this important technology.

Current Status of CCS

Carbon dioxide (CO₂) for enhanced oil recovery (EOR), primarily using natural sources, has been employed in the US since the 1970s. At present, the technology required for CCS is generally well-understood and does not require any fundamental breakthroughs (although some advanced technologies are in development). What is mainly needed to improve its viability is the deployment of more large-scale projects to reduce costs, build skills and accumulate operational experience.

The first large-scale CCS project for climate mitigation began at the Sleipner oilfield in Norway in 1996, storing annually 0.85 million tonnes of CO₂ extracted from processing natural gas. Other notable projects were launched in North Dakota, US (2000), In Salah in Algeria with 0.5–1 million tonnes per year (2004), and Norway (2008).

However, a number of other large projects planned in the US, UK, Netherlands, UAE and elsewhere since have seen repeated delays and cancellations due to a variety of issues, primarily: indecision and changes in government policy leading to the withdrawal of financial support; the collapse in EU CO₂ emissions prices; the falling cost of natural gas and renewables; and mismanagement and cost over-runs at some projects.

Several important projects started operating in 2014–17 in the US⁴ and Canada. The Emirates Steel project in Abu Dhabi for EOR, operated by Al Reyadah (a joint venture of Abu Dhabi National Oil Company ADNOC and clean energy company Masdar), began operations in 2016, storing 0.8 million tonnes of CO₂ per year. Despite its importance to the region, there is only one more operating CCS project in the GCC: Uthmaniyah in Saudi Arabia, which also captures 0.8 million tonnes per year for EOR. The world's largest, Gorgon in Australia, expected to start operating shortly, will store 3.4–4 million tonnes annually.

Alongside these large projects are numerous smaller-scale pilots and field trials. There has also been a significant research effort across numerous countries, with focus areas including: lowering the cost and energy penalty of capture; ensuring safe long-term storage; characterising total available underground storage capacity in various areas; and gauging public attitudes.

Although CCS has made some progress in recent years, it remains well behind required levels. As of April 2017, 22 facilities worldwide were in operation or construction and storing 40 million tonnes of CO₂ per year, seven were in advanced planning and able to store 14 million tonnes per year, and 11 were in earlier stages of planning with potential for 19 million tonnes per year.⁵

However, in the IEA's '2 Degrees' scenario, 4,000 million tonnes would need to be captured and stored annually by 2040 and 6,000 million tonnes per year by 2050. Even if all current projects go ahead, CCS has to be scaled up by a factor of more than 50 over the next 20 years.

The Role of CCS in Climate Change Mitigation

CCS is an important pillar of climate policy for a number of reasons. It allows continuing use of fossil fuels (particularly coal and gas), and therefore helps bring countries with large fossil fuel resources on-board in climate efforts. Such countries include GCC countries and several other Middle Eastern states, China, the US, Russia, Canada, Australia and South Africa.

Ten countries mentioned CCS in their first Nationally Determined Contributions (NDC), the national climate change plans submitted as part of the Paris Agreement: Bahrain, China, Egypt, Iran, Iraq, Malawi, Norway, Saudi Arabia, South Africa and the UAE.⁶ Notably, three of these are members of the GCC, four are members of OPEC, five are Middle Eastern countries and five are major oil exporters. The EU and Japan also mentioned CO₂ transport and storage in their first NDCs.

Despite recent strong progress in reducing the cost of renewable energy and improving its integration into the electricity grid, variable renewables (wind and solar) still require some kind of back-up, energy storage or dispatchable power to meet demand reliably. The lowest-cost and most politically-achievable solution is likely to be a mix of renewables with other technologies, potentially including a large share of CCS.

Many industrial processes yield CO₂ as an unavoidable by-product, particularly the manufacture of cement and also ethylene oxide and direct reduced iron. These materials are essential and there is no obvious way to decarbonise their production without CCS. Production of such basic materials has been a large part of GCC countries' industrialisation in recent decades.

CCS is an important step towards 'negative-emission' technologies used actively to reduce the level of CO₂ in the air. This may become essential to prevent dangerous climate change if global emissions do not peak and start falling fast in the near future. It also permits the use of fossil fuels in certain sectors that are very hard to decarbonise, such as shipping and aviation, hence preserving a role for oil in the global energy mix.

Challenges of CCS Deployment to Date

The relatively limited progress of CCS so far has been the result of the intersection of economics, politics, public opinion and industry structure.

On the side of **economics**, CCS raises the cost of electricity (or industrial) production, as it has a large capital cost and lowers the efficiency of the plant. While CCS costs, in terms of US\$ per tonne of CO₂ mitigated, are comparable to those for other low-carbon technologies, the current incentive structures are unfavourable to it. Cheap (and relatively low-carbon) natural gas and the falling cost of renewable energy have also made CCS seem less urgent.

Traded carbon prices (as in the EU's Emissions Trading System or credits under the Kyoto Protocol's Clean Development Mechanism, CDM) have been very low and insufficient to make CCS projects – or indeed most low-carbon technologies – viable, while other countries, including in the GCC, do not have a carbon price, tax or economic incentive at all unless they make use of the CDM.

Mandates for a given (and rising) share of electricity or energy production from renewables, in force in the EU and in many US states and other jurisdictions, typically do not include CCS, though it could be included as part of a 'clean energy standard'.

In the absence of consistent sectoral policies, most large CCS schemes that have gone ahead so far have done so either as government-supported demonstrations, or by selling their CO₂ for EOR.

In **politics** and **public opinion**, CCS, associated with large oil and power companies, has been unable to muster the support given to renewable energy (a problem it shares with nuclear power). Individual CCS projects are large and, in the absence of comprehensive carbon pricing, require governments to write a large cheque. Even if total spending on renewables is larger, it is split over numerous individual projects, many of which may be owned by householders and hence generate widespread public support.

In some areas, the public has been opposed to underground storage of CO₂, fearing safety issues. This has encouraged the study of suitable storage sites offshore, in remote onshore areas, or in already producing oil and gas regions.

Political indecision, particularly in the US, UK and through several changes of leadership in Australia, have prevented the sustained multi-year support that CCS projects require.

Finally, on the topic of **industry structure**, CCS has lacked a natural champion. Power generation companies and industries emit CO₂ but are not skilled in subsurface storage. Oil companies have the subsurface knowledge and the experience of transmitting gases through pipelines, but not the majority of large-scale point sources of CO₂ emissions.

This partly explains why the successful early CCS projects have tended to focus on CO₂ from gas processing, where the gas company is required to separate the CO₂ to yield saleable gas, and does so in close proximity to a suitable geological storage site. The other set of successful CCS projects has been those involving EOR, where the oil company has a strong economic rationale to procure CO₂.

Current CCS Governance: Areas of Governance

National governance of CCS is reasonably well developed in countries that are deploying it, usually by adaptation of existing regulations, funded under climate change policy measures, and carried out under the ambit of the oil or energy ministry, supervised by the environment ministry or regulator.

In contrast, global governance of CCS is an emergent area, and spans a wide range of different disciplines and institutions. Among the five components of governance, typical organisations that are involved are described in Box 2 (see next page).

Box 2: Who Is Involved in the Different Components of CCS Governance?

Technology development and dissemination: universities; research institutes and government laboratories; think tanks; consultancies; and companies (petroleum, power generation, engineering/equipment, industry and entrepreneurs/start-ups).

Economics and financial support mechanisms: governments (regional, national and supra-national); environmental and CCS funds; 'green' investment banks; traditional investment banks; and investors.

Public knowledge and acceptance: governments (regional, national); media; NGOs, community organisations; project proponents; and industry advocacy bodies.

Regulation, permitting, standards, law and safety: governments (regional, national and supranational); standards and certification organisations; and international governing bodies and treaties.

CCS within the wider climate action framework: governments (regional, national and supranational); international climate/energy organisations; and international governing bodies and treaties.

Figure 1 below shows one possible view of CCS's global governance and its relation to industry structure. National governments negotiate climate treaties, and determine policies and funding mechanisms for CCS (a mix of national and international instruments and regulations). International organisations coordinate policies, monitor their results and try to deter non-compliance.

Governments fund research and development (R&D) into CCS, both nationally and as part of international consortia, along with private-sector funding mobilised by the prospect of an economic role for CCS. Funding can be a mix of direct funding, and a cost of carbon imposed as a tax, a traded emissions cap, or (implicitly) by a mandate to deploy low-carbon energy.

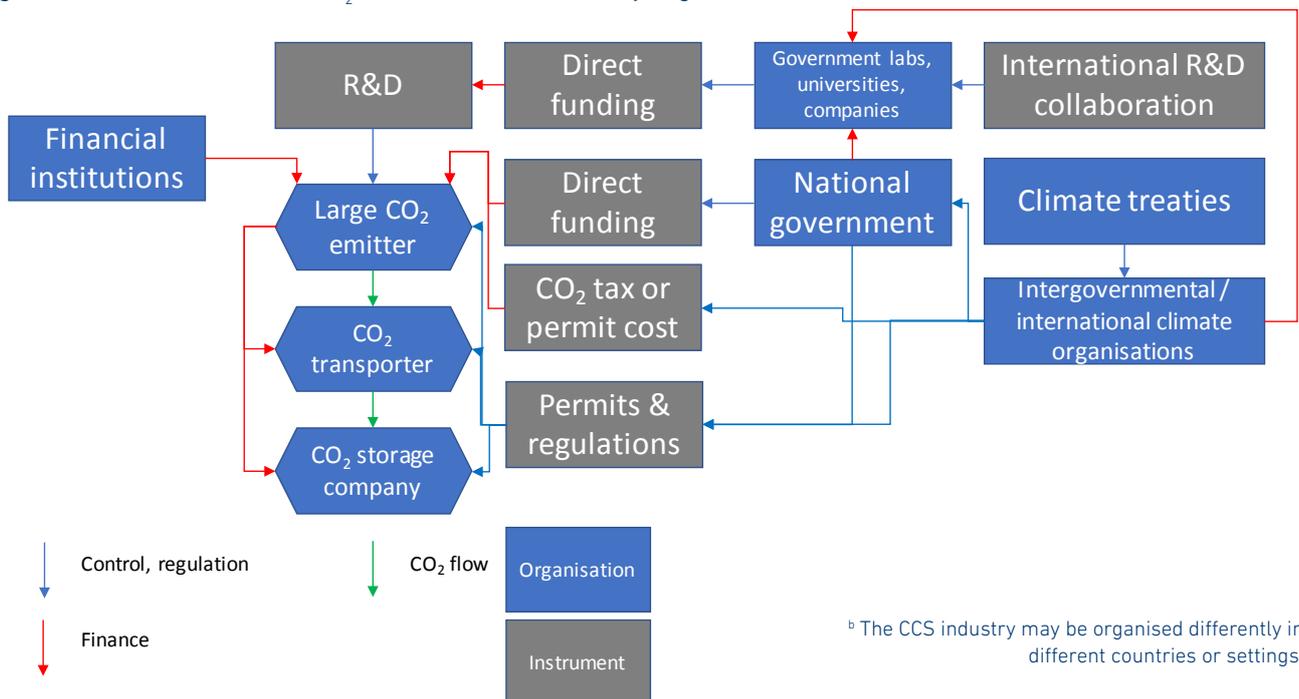
Large CO₂ emitters propose and structure CCS projects, receiving some funding from financial institutions

(a mix of commercial lenders, international financial institutions, and government-backed environmental finance institutions).

These project sponsors then pay other companies to transport and store their CO₂ (or include them in vertically-integrated projects, e.g. by an oil company which captures its CO₂ emissions and uses them for EOR).

A wide range of organisations are involved globally in different parts of what may be loosely termed 'CCS governance'. A few are dedicated to CCS; many do so as part of a wider climate, energy or environmental responsibility. They may be national (or even sub-national), multi-national (involving a defined group of countries) or international/global. A non-exhaustive selection is given in Table 1 (see following pages).

Figure 1 Schematic of Global CO₂ Governance and Industry Organisations^b



^b The CCS industry may be organised differently in different countries or settings.

Table 1 Selected Institutions Currently or Potentially Involved in CCS^c

Multinational		
Organisation	CCS Role	GCC Involvement
International Energy Agency (IEA)	Coordinates member nations and associates to promote cost-effective CCS policies and technologies	OPEC coordinates with IEA via the IEF
IEA GHG	International collaborative research programme under the IEA focusing on greenhouse gas reductions, including CCS	OPEC and Masdar are members ⁷
Organisation of Petroleum Exporting Countries (OPEC)	(Potentially) studies and advocates for CCS from the viewpoint of oil exporters	UAE, Saudi Arabia, Kuwait and Qatar are members
Organisation of Arab Petroleum Exporting Countries	Largely ineffective on CCS	All GCC countries except Oman are members
International Energy Forum (IEF)	(Potentially) coordinates the interests of oil and gas importers and exporters on CCS	Forum for OPEC-IEA cooperation
Gas Exporting Countries Forum	No known policy, but a potential venue for gas exporters' role in CCS	Includes Qatar and the UAE, and (as observer) Oman
Gulf Cooperation Council	No known policy on CCS	GCC members
EU-GCC Clean Energy Network ⁸	Catalyses partnerships between clean energy stakeholders	Open to members from all GCC states and holds regular events across the GCC
Carbon Pricing Leadership Coalition	Group of governments, companies and civil society organisations, led by the World Bank, advocating for carbon pricing; research includes carbon pricing's impact on CCS ⁹	None
US-China Clean Energy Research Centre ¹⁰	Coordinating body for two consortia of Chinese and American coal companies and research institutes, including on CCS	None
Mission Innovation	Global initiative including as its members EU, US, China and others; one of its seven 'Innovation Challenges' is carbon capture, led by Saudi Arabia and the US ¹¹	Includes the UAE and Saudi Arabia
Clean Energy Ministerial	High-level forum grouping 23 countries on clean energy; its CCUS programme closed out in 2014 ¹² and was transferred to the Carbon Sequestration Leadership Forum	Includes the UAE and Saudi Arabia
Global Green Growth Institute	Promotes sustainable economic growth in developing and emerging economies, including use of CCS	Country programme in UAE
Energy Charter	Legally-binding multilateral instrument; considers the protections provided by the Treaty ¹³ as pertaining to investment in CCS, CO ₂ transport and trade (to which Treaty provisions do not apply), and technology transfer, but not CO ₂ transport and trade (to which Treaty provisions do not apply since CO ₂ is not an energy commodity)	None
Oil & Gas Climate Initiative ¹⁴	Coalition of 10 oil companies; is investing US\$1 billion in climate technologies, including CCUS	Includes Saudi Aramco
Zero Emission Platform	Coalition of European government and corporate stakeholders supporting CCS research and demonstration	None
Clean Energy Business Council MENA	Private-sector non-profit organisation representing the clean energy sector across the MENA region ¹⁵	Based in Masdar City, UAE; includes many GCC corporate members
Carbon Capture and Storage Association	UK-based organisation representing members' interests in the development of CCS	None, but open to members from any country
Four Kingdoms Initiative	Promotes large-scale deployment of CCS	Groups Saudi Arabia with the UK, Norway and the Netherlands

^c Many of these institutions have roles spanning much more than CCS; only their CCS role is covered here. Some of these organisations have no CCS role currently but it could be appropriate for them to take it on (e.g. the GCC).

Table 1 Selected Institutions Currently or Potentially Involved in CCS (continued)

International		
Organisation	CCS Role	GCC Involvement
Carbon Sequestration Leadership Forum ¹⁶	Ministerial level including EU, China, Russia and others; develops and coordinates CCS policies in communications, research, deployment and financing	Includes UAE and Saudi Arabia
Global CCS Institute	International, Australia-based membership organisation, with members including US, China, European countries, NGOs and companies; aims to accelerate the deployment of CCS globally by advice, advocacy and knowledge sharing	GCC states are not (yet) members though some GCC entities are (Emirate of Abu Dhabi, Masdar)
International Renewable Energy Agency	CCS is not within IRENA's remit, but is included as part of the agency's research into energy futures	All GCC countries are members; headquarters in Abu Dhabi
World Trade Organisation	Might possibly be involved in international trade of CO ₂ , but this does not seem to relate to CO ₂ considered as a waste product	All GCC countries are members
London Protocol	Global treaty with 43 parties regulating waste disposal at sea; amended to cover sub-seafloor storage and international transport of CO ₂ – however these amendments have not yet been ratified (needs ratification by 2/3 of parties; only two ratified so far with five in progress) ¹⁷	Saudi Arabia is party to the Protocol but has not ratified the CO ₂ amendments; Oman, UAE are party to the earlier London Convention which does not cover CO ₂ ; Bahrain, Kuwait, Qatar are party to neither
UN Framework Convention on Climate Change (UNFCCC)	International treaty governing cooperation on reduction of greenhouse gas emissions and for follow-up agreements such as the Paris Agreement; covers technology transfer such as for CCS; Kyoto Protocol's CDM covers CCS but the future of this under the Paris Agreement is unclear	All GCC have ratified
Green Climate Fund	Fund established under the UNFCCC to fund climate projects in developing countries, with a US\$100 billion goal from developed countries to be funnelled through the GCF; CCS projects are eligible but none financed as of December 2015 ¹⁸	GCC countries have not contributed funds and do not have accredited entities to the GCF
Intergovernmental Panel on Climate Change	Catalyses partnerships between clean energy stakeholders	GCC eligible to contribute financially and through scientists via membership of the World Meteorological Organisation; GCC participates in working group meetings
Global Carbon Project	Consortium of China, Japan, South Korea, France and other countries, which conducts research on the global carbon cycle, including CCS	None

Three significant trends can be noted. Firstly, for most of the bodies with a wider remit than just CCS, it is relatively a secondary activity (with perhaps the IEA as an exception). Secondly, some key energy bodies that could help to group oil producers' CCS activity have done very little (OPEC, OAPEC, IEF and the GCC). Thirdly, Saudi Arabia and the UAE appear in most of the key global bodies related to CCS while the other GCC countries are mostly absent.

Beyond these specific organisations, a wide range of other actors are involved in CCS as regulators, researchers, advocates, investors and opponents. These include: environmental NGOs, with positions on CCS that vary from hostile to supportive; local community groups; regulators and policy-setters such as ministries of environment and energy (and often foreign affairs in the case of climate change negotiations); companies (oil and gas, power, industry, equipment suppliers and many others); and investment companies and banks.

Weaknesses in Global CCS Governance

There is no over-arching global framework for CCS governance. Nuclear has the International Atomic Energy Agency IAEA and renewable energy has the International Renewable Energy Agency (IRENA), two intergovernmental organisations at the heart of their respective areas. The IEA is the closest equivalent but only includes OECD members with a few non-OECD associates, and has had historically a somewhat adversarial relationship with OPEC (albeit now improved by communication through the International Energy Forum, IEF). The IEA also has both a narrower and wider remit – narrower in that it originally focussed on oil, and particularly the energy security aspect; wider in that it now in principle covers all energy sources.

The core group of countries showing strong interest in CCS is also quite well-defined – mainly, the UAE and Saudi Arabia, China, Canada, US, UK, Australia and Norway, with some involvement of the Netherlands, Brazil, Japan, South Korea, India, Russia and South Africa. This includes most of the major economies and users of fossil fuels, and several large producers. The US, as a player, is problematic for now given the lack of attention from the current administration to climate policy, even if CCS has been given some support by the current US energy secretary, primarily as part of backing the coal industry.¹⁹

However, for most of these countries, CCS, while important, is not a top climate priority, where renewables have taken top billing (with its own international agency). The success of CCS as an existential issue is salient for the GCC (and other major oil producers), Norway, and some states/provinces of the US, Canada and Australia – namely those entities for which fossil fuels are a critical part of the economy. They therefore have to take the lead as far as possible.

There is a plethora of fora and organisations either dedicated to CCS or which have CCS as part of their mandate. Research funding has been available across a wide number of projects, but it is scattered, to some extent duplicative, and not sufficiently concentrated on cracking the key immediate challenges. Numerous funds for deployment are available, but these are usually sub-national or national, and while the scale of some is quite large, it is not of the scale sufficient to sustain a pipeline of new projects.

GCC engagement with these organisations has largely been limited to the UAE and Saudi Arabia. Qatar has dealt with CCS primarily through major oil companies and made little headway. The most

promising institutions for further progress are those which group a relatively small number of countries with technical and financial capability and a strong commitment to CCS.

There is potentially a certain tension between gas and coal producers, who are in fierce competition. Gas has presented itself as a relatively climate-friendly alternative to coal. In the long-term, gas will require widespread CCS too, but for now quick and cheap CO₂ savings can be made by switching to gas. There is thus a divergence of interest between those countries which wish to preserve the viability of their domestic coal resources (China, India, some US states), those which want to encourage switching to gas while ensuring a long-term market for their reserves (Qatar, other US states), and those which potentially want to do both (Canada, Australia).

Many major oil, gas and coal producers have historically taken little action on climate, and have been laggards or even obstructionists in international negotiations. This has caused them to lose goodwill, credibility and public opinion. Fossil fuel companies face the same problem, to a greater extent. This leads to scepticism over their sincerity in promoting CCS now.

In domestic policy, it has proved very hard for most countries to impose stringent carbon costs on their economy, given a lack of coordinated international action. Carbon trading and taxes have been blocked entirely, as in the US as a whole, reversed as in Australia, or are rife with exemptions and over-allocation which has led to a very weak price signal (the EU Emissions Trading Scheme and the CDM). Special sectoral interests are able to block a cost on carbon, or manipulate it to their advantage.

Politically, it has proved much easier, though with larger hidden costs, to proceed by mandates and subsidies for renewable energy, efficiency, electric vehicles, biofuels and other such approaches. With a few exceptions, CCS projects have not attracted the large government funds required to make them viable in the absence of a strong carbon price.

Potential Areas for Improvement for Global CCS Governance

To make CCS viable on the required scale, it needs at least three elements: many more repeatable projects to bring down costs and build confidence; a viable business model with a supportive economic rationale; and the support of politicians and public opinion. These cannot be dealt with separately. Even large countries

such as the US have not been able to achieve these consistently on their own, pointing to the requirement for international coordination.

A universal framework for CCS is not necessary. What is required is a critical mass of countries with the finance, technology and CCS opportunities to move ahead. Progress has been made over the last two decades or so in advancing the safety and legal basis of CCS, and this is probably sufficient for now. Regulation has been achieved in the major players at a national (or EU) level, usually by adapting existing oil and gas regulation. Other legal instruments have been used to govern the cross-boundary transport of CO₂.

The question of establishing a wider climate framework that would make CCS, along with other low-carbon technologies, viable without special subsidies or project-by-project support is a topic with ramifications beyond this paper.

However, as David Victor²⁰ proposes, instead of the unwieldy global framework of the COP process, smaller 'clubs' of countries may be able to make progress. Sharing of technology, finance and project opportunities for CCS can be one 'carrot' to encourage countries into a club. In return, the members could commit to specific policies, targeted as in Victor's approach to inputs and not outputs. This could include a robust and rising carbon price, and possibly standards on CO₂ emissions – though it would be important to ensure these two policies do not conflict or that standards do not weaken the price signal.

A global or at least multinational consensus by a club of large emitters could help overcome this hurdle by creating a commitment to apply a consistent and sufficient cost of carbon, and/or clean energy standards effectively requiring the use of CCS. An international sectoral approach, for instance on cement, would help overcome the problem of diminished industrial competitiveness that application by a single country would incur. This could be included in trade agreements.

The poor public image of CCS is partly due to its association with oil, gas and coal companies. That is unavoidable, except in that widespread use of CCS would help those industries clean up their image. High-profile cost overruns and cancellations, inevitable in a new industry, are another negative. More visible, large-scale, successful projects in a range of industries and countries will help dampen scepticism.

In order to mobilise public support, CCS needs a more positive image, like that the solar industry has created for itself. This can include the branding of certain industries that commit to CCS, for instance cement, as 'green'. A way to attract skilled people and investors into the sector is to stress the technological advances and excitement. Successfully testing^d bio-CCS and direct air capture is a third angle, as a long-term solution to 'over-shooting' and the slow progress to date on slowing emissions. This is a contentious in some quarters, due to fears of 'moral hazard', but it is an essential component of nearly all serious plans to keep long-term temperature increase below 2°C or 1.5°C, and it would help assure the GCC countries' long-term economic viability.

The Path to Improvement – A Role for the GCC?

CCS needs to be backed by countries with a strong interest in its success. Amongst major oil and gas exporters, the UAE, Saudi Arabia and Norway have been notable. Algeria has fallen away after making an initial contribution.^e

The rest of the GCC, and other major oil producing states such as Iran, Iraq, Libya and Nigeria, have played little role. Political divisions and internal security problems contribute to this, and mean several of these countries have more urgent priorities. They may also offer little in terms of finance or technology. Russia, another leading petroleum player, has not been a climate leader. However, the diplomatic support of these countries, in a coalition behind a small leading group, may be useful in international negotiations on CCS policy.

The GCC states could also benefit from working with other leading oil and gas producers with an interest in CCS, such as Mexico and Brazil. There are possible trade-offs for diplomatic support, for instance backing Brazil's efforts on reducing deforestation. Such coordination with Brazil was a contributor to the UAE and Saudi Arabia's success in December 2011 in having CCS accepted as a valid technology within the Clean Development Mechanism of the Kyoto Protocol.²¹ A few projects relating to CO₂ utilisation have been approved under the CDM.²²

The GCC countries have limited institutional, diplomatic and scientific bandwidth. They therefore have to be selective with regard to which initiatives and organisations they join or engage with, choosing

^d If large-scale active removal of CO₂ from the atmosphere is not feasible, it is also important to find this out soon given how many climate plans already incorporate it.

^e The In Salah project has ceased injecting CO₂ and there have been no further projects.

those with maximum impact and likelihood of advancing CCS.

The GCC itself has had limited success at promoting economic integration between its members, and has largely stayed out of the energy sector. Current political problems suggest that the GCC as a body is not the right entity to lead a drive for CCS. Of the GCC countries, the UAE and Saudi Arabia have been most active within CCS and seem likely to continue leading, but would benefit from support from other major oil exporters.

OPEC is one possible organisation for coordinating CCS policy between oil states. Recent cooperation between OPEC and non-OPEC (primarily Russia, with Oman, Kazakhstan, Mexico and others) members offers some encouragement. Despite political disagreements between some of its members, OPEC has continued to function effectively and indeed to depoliticise oil market issues internally.

However, working on CCS would be a major change for the organisation, which has focussed on market management and coordination. And externally OPEC's image remains negative, associated in the US and Europe with the 1970s oil shocks and market manipulation. The IEF, formed to improve communication between OPEC and the IEA, may assist in aligning OPEC countries' interest in CCS with the IEA's long-running efforts on research and promotion. The Gas Exporting Countries Forum could help in bringing in those of its members who are not OPEC members.

The Carbon Sequestration Leadership Forum (CSLF) and Global CCS Institute are probably the two most prominent international organisations focussed entirely on CCS. The UAE and Saudi Arabia are involved in the CSLF. These could prove the best vehicle for advancing a consistent policy to encourage CCS within the 'club', and to provide it with an economic rationale not dependent on one-off projects.

The oil-producing states need to internalise this policy, though, whether by incorporating a carbon charge in their own economies, or by setting a standard on utilities and industries that requires a progressive implementation of CCS. Given the continuing persistence of energy subsidies, though, this is a major challenge.

Recommendations

The GCC countries should make advancing CCS a core goal of their climate policy. This will contribute to their economic development, enhance the environmental and economic future of their oil and gas resources, and advance their international diplomatic standing. Realistically, given current political tensions, and the lack of interest from other GCC states, the UAE and Saudi Arabia will have to lead this effort until the other GCC members choose to be more involved.

Further research, though important, should not be the only activity for now. The keys are:

- to implement a suite of CCS demonstration projects to bring down costs and develop confidence in the required technologies;
- to encourage adoption of a consistent mechanism to make large-scale adoption of CCS viable, most promisingly a carbon tax; and
- support a positive image for CCS, and avoid further disseminating the image that CCS is merely about rescuing the 'dirty' fossil fuel industry.

To achieve this, the UAE and Saudi Arabia can consider pursuing the following path:

1. Work with a club of like-minded countries that prioritise CCS and have a critical mass of emissions, projects and diplomatic weight. The most promising ones in this regard are Australia and Norway, and possibly Canada. Other countries for which CCS is important but not an absolute priority are the US, UK, China, the Netherlands, South Africa, Japan and South Korea. India, Brazil and Russia have had some involvement.
2. Coordinate with a venue to bring in support from major oil producers and the IEA members. OPEC and the IEF are possible candidates. OPEC is a member of IEA-GHG, whose role is noted in Table 1.

For international organisations already dedicated to CCS, the Global CCS Institute and the Carbon Sequestration Leadership Forum appear to have the most momentum currently. The GCC states are not currently members of the GCCSI though a few individual entities from the GCC are, so they could step up their involvement.

From the private sector, oil companies (mostly European) are already involved, and GCC states have deep, long-standing relationships with them, including on CCS through the Oil & Gas Climate Initiative (see Table 1). International oil companies are ideal partners in technology, implementation and finance, and can work with Saudi Aramco, ADNOC and other national oil companies. Although they are not politically popular in Europe and North America, they can assist in lobbying their national governments to gain the requisite support for CCS.

3. Consider which concessions and trade-offs could be made to mobilise support for CCS, for instance stepping up efforts on renewables, supporting avoided deforestation in other countries, or targeting CO₂-emitting industries for binding standards.
4. To the extent that international (rather than national) direct funding of CCS projects is required, it may be necessary for major hydrocarbon exporters to contribute.

These four steps would be intended to lead to the formation of a CCS club, of countries with consistent and somewhat harmonised policies supportive of development of the CCS industry on a self-sustaining basis.

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