2022-IP01: OGCI (Oil & Gas Climate Initiative) Gulf Countries CCUS (Carbon, Capture, Utilisation and Storage) White Paper External Stakeholder Workshop, 25th January 2022

The OGCI convened a GCC (Gulf Co-operation Council) workshop to outline and discuss the potential for CCUS in the Gulf region. The virtual event had strong representation from Saudi Arabia, Bahrain, Qatar, UAE, Oman and Kuwait. The IEA, CEM, International Energy Forum, GCSSI, ADNOC plus IEAGHG and several other organisations also participated.

The impact of climate change to the GCC was stressed in the opening remarks by Gasem Fallatah, Ministry of Energy for Saudi Arabia. The Minister highlighted the importance of the Circular Carbon Economy (CCE) to Saudi Arabia, which has an ambition to reach net zero by 2060. Carbon capture is projected to contribute 30-33% of all measures required to meet this target. A first step, and the focus of the workshop, is to establish a regional CCUS centre.

The framework for the workshop comprised of a series of presentations on the prospects for CCUS for the GCC. The research was conducted by AFREY and GaffneyCline and commissioned by the OGCI. The technical background began with an overview of global CCUS before concentrating on the key CCUS components for the GCC, specifically: carbon sources and sinks; business models for the development of a low carbon regional economy; a macroeconomic analysis and a roadmap for the future.

The OGCI is proactively exploring how the oil and gas industry can transition to a low carbon economy. The organisation's Refresh Strategy is under pinned by three key components:

- Net zero operations + leverage influence in non-operated assets.
- Leading the entire oil and gas industry
- Accelerating actions to help decarbonize society (with a focus on CCUS and hydrogen production)

The dependency of the global economy on hydrocarbons and carbon based raw materials, often in concentrated industrial conglomerations, highlights the necessity for CCUS hub development. Initial steps to identified where these centres might be located has led the OGCI to identify 24 CCUS industrial hubs worldwide mostly in Europe, China and North America. Broader investigation has identified over 200 potential hubs across 52 countries. OGCI has also embarked on CCUS commercialisation studies in Saudi Arabia and China as well as policy mechanisms to support the large scale deployment of carbon capture and storage. Other initiatives include:

- Article 6 / Carbon Storage Unit (CSU) mechanism Study – an initiative to incentivise geological storage of CO_2 in context of Article 6. The initiative also sets out ways to explore how value and recognition can be accrued to CO_2 storage.
- A regional CCUS White Paper looking at prospects for Brazil and India specifically policy and regulatory gaps
- Standardised storage resource assessment for different countries using the SRM system.

The OGCI's report for the GCC has four study components:

- Carbon sources and sinks in the region
- Business models, cost reduction, hydrogen production, hub analysis and carbon removal

- Macroeconomic analysis – multiple scenarios impacts on the oil and gas sector, investment impacts and socio-economic value generation.

- Road map to match GCC net zero ambition based on 5 main phases: initiation; scale-up; mass deployment; consolidation; and net zero.

To place the GCC region into context, in terms of current industrial activity and related CO_2 emissions, the following factors are worth noting:

- Saudi Arabi and the UAE account for >60% of GCC CO_2 emissions driven by oil refineries, petrochemical plants and power generation.
- The majority of industrial emissions from all sources are concentrated along the Arabian Gulf coast with subordinate contributions from locations along the Red Sea coast.
- Bahrain has the lowest CO_2 emissions in GCC region due to its population size and smaller economy with aluminum smelting being the prime source of CO_2 emissions.
- Qatar's CO_2 emissions are expected to increase as it expands its LNG, petrochemicals and aluminum production.
- Electricity generation contributes the highest CO_2 emissions (50%) in GCC because of the dependence on natural gas and oil feedstocks.
- The main industrial emitters are petrochemicals, oil refining and aluminum smelting.
- An increase in CO_2 emissions is anticipated because of the growth in the power and industrial sectors.
- The purity and concentration of CO_2 from emission streams govern the sectors with the most economic CO_2 capture: petrochemicals; fertilisers; and to a lesser extent aluminum, steel and oil refining.
- CO_2 capture is likely to be limited to new build power plants rather than retrofitting due to technical and contractual difficulties.

Carbon Sinks

In parallel with a number of previous studies, this most recent investigation has identified significant CO_2 geological storage potential across 11 sedimentary sequences in both depleted oil and gas fields and saline aquifers. The best prospects are in the Rub'al Khali Basin and Kuwait. Well sealed sandstones and shallow carbonates with proven reservoir properties are prime candidates. Deep, low permeable carbonates are less attractive because of injectivity conditions and uncertain reservoir distribution. The Oman Ophiolite could offer storage potential. This formation has a high concentration of reactive Mg-rich minerals that could potentially lock CO_2 in a mineralized form however, there is uncertain on the efficiency of the process. (See IEAGHG Technical Review 2017-TR2 for a concise overview of CO_2 storage in this type of formation[1]).

The study has concluded that the storage volume could reach ~170 Gt of CO_2 equivalent to 230 years of current annual emissions from the GCC countries. The region is technically competitive with other regions with respect to storage prospects, quality and volumes. A series of storage play fairways with optimum risk has also been generated. Specific opportunities will require more detailed investigation.

Hubs

The current investigation has identified a number of point source CO_2 emission clusters that could be coupled with storage. Jubail, Saudi Arabia, on the Arabian Gulf Coast, Northern Qatar and Abu Dhabi are the most favourable CCUS hubs in the GCC due to the concentration of high purity CO_2 emission sources and proximity to Rub'al-Khali Basin. Oman has a variety of CO_2 emission sources including some high purity streams and proximity to the Oman Ophiolite. Bahrain and Kuwait have lower

[1] 2017-TR2 Review of CO2 Storage Basalts

emissions by comparison with other GCC countries but could be clustered to improve their prospects within a future GCC CCUS market. The first hub could be online by 2025, with second and third hubs by 2030.

Business Models

There is clear evidence of sources and sinks within the GCC region, but there is an absence of an effective domestic driver to stimulate investment in CCUS. The current study highlights the requirement for a strong business model and incentive scheme. It advocates models that decouple risk with separate value chains. One proposed component is a model where national oil companies are responsible for CO_2 transport and storage, based on their geological expertise, whilst de-coupling cross-chain risk from capture projects. For capture IPP (Independent Power Producer) contracts in the GCC power sector is favoured as a preferable basis for CCUS in any industry where there is a single buyer (for example, power or hydrogen production). Auctions could determine who provides a service. For industries that produce products to a market rather than a single buyer a subsidy scheme is a more suitable option.

Given the absence of any regional business model early engagement and negotiations across the GCC are needed to develop a business model that handles imports and cross border transport. The current primary incentive elsewhere is CO_2-EOR (enhanced oil recovery). A policy initiative tailored to the GCC is required to stimulate its development. New commercial drivers might include carbon border adjustments on exports, capture and storage obligations on industry.

Cost reduction potential is a key consideration for CCUS in the GCC countries. There are some regional advantages as costs are expected to decrease by ~43% in the GCC with a lower cost base compare to other regions. Advances is capture technologies are likely benefit for global research, development, demonstration and deployment. Transport and storage storage benefit from local factors in the GCC countries. High volume hubs with access to well characterised onshore storage sites expected in GCC mean transport and storage costs in $US5 – 10/ton CO2 range are possible.

This OGCI funded study has concluded that capture costs for fertilizer, chemicals and natural gas processing for GCC are similar to the US benchmark cost of ~<US$20/t CO_2. The cost advantage for GCC located industry with more dilute CO_2 emissions are more favourable for the GCC compared with US. The overall cost advantage is 15-25% lower than US benchmarks. The GCC region benefits from economies of scale, lower operational costs and finance. Overall costs are expected to be ~40% of 2025 levels by 2050.

In terms of emergent carbon removal opportunities DACCs deployment is a possible long term option. BECCS is better suited in the short term. This study concluded that DACCs could prove cost effective in GCC if the requirements for water are met. It stressed the benefit DACCs can offer as a means to manufacture zero carbon syn-fuels especially for replacing conventionally produced aviation fuel.

Hydrogen potential is a significant opportunity for the GCC and the study recommends a number of potential factors that influence its development:

- A twin track approach producing hydrogen via electrolysis using renewable energy alongside derivation from hydrocarbons.
- Pyrolysis of oil to produce hydrogen could launch new industries, but is subject to further R&D.
- Hydrogen production could vary across the GCC region but would benefit from a collaborative approach rather than a competitive one.

- Ammonia is the best solution for large scale transport based on cost and versatility.
- Salt caverns in GCC are the most attractive options for long term storage for balancing demand and export.
- Establishment of a pipeline network.
- Current regional demand and projected global demand supports establishment of a hydrogen supply industry. There is a large market for hydrogen and low carbon derivatives such as ammonia and steel.
- Competition from other regions means there is some risk to establish global market share. Exports will not compensate for lost oil revenues.
- Potential hydrogen export growth could reach a global market share of 19% (worth US$114bn).

The workshop concluded with a general consensus that there should open dialogue to co-ordinate national plans for CCUS. Defining specific projects for CCS or hydrogen projects was also advocated. Policy engagement within the GCC will be aided by IEA participation and discussed at the next Ministerial meeting in May. The experience of hub development elsewhere should be shared with the GCC especially as it has all the ingredients for successful CCUS regional development. The macroeconomic benefits could amount to an addition of $US15-44bn in gross value added (GVA) to the GCC in 2050 supporting between 87k-245k in jobs.

The OGCI announced that a paper on carbon storage units is to be published soon which is of relevance to GCC.

James Craig

30th January 2022