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# Transitioning to Net-Zero: CCUS and the Role of Oil and Gas Producing Countries

## Introduction

A key distinguishing feature of climate change is the unevenness of its impacts on countries and regions[1]. The physical impacts of climate change and the ability to adapt to its consequences is not the same across countries. Also, the adjustments needed to reduce emissions are not uniform. Some countries, for instance those that rely heavily on the hydrocarbon sector as the main source of their income and export revenues, will have to undergo much deeper adjustments and transformations to reduce their emissions when compared to more diversified economies[2]. This unevenness also applies to capabilities and capacities, where even within the group of oil and gas exporters, some are in a better position to cope with the challenges of reducing greenhouse gas (GHG) emissions and investing in low carbon technologies. Climate policies can also induce substantial distributional effects and cause a significant reallocation of wealth. Oil and gas exporting countries are expected to experience a decline in their incomes and their wealth as the demand for their key export products is projected to fall[3].

Diversifying away from oil and gas production is often presented as an effective strategy to confront these adverse effects. However, diversifying from this core sector is fraught with challenges and most oil and gas exporters have not implemented the reforms required to undergo such a deep transformation. Also, during the transition, countries need to draw on their sources of competitive advantage and main source of income to mitigate the potential socio-economic impacts associated with the energy transition[4].

In addition to diversification, oil and gas exporters could pursue policies to increase the resilience of their core energy sector in a world transitioning to net-zero emissions by competing on reducing emissions[5]. This Energy Insight argues that technologies related to geological storage of CO2 should

[1] See Stiglitz, J. 2015. 'Overcoming the Copenhagen Failure with Flexible Commitments', Economics of Energy & Environmental Policy, International Association for Energy Economics, vol. 4 (Number 2).
[2] Stiglitz, J. 2015. 'Overcoming the Copenhagen Failure with Flexible Commitments', Economics of Energy & Environmental Policy, International Association for Energy Economics, vol. 4 (Number 2).
[3] Oil and gas exporting countries do not constitute a uniform group and these countries differ substantially in many aspects including the level of their economic development and diversification, the sophistication and the level of integration of their energy sectors, the pace of reforms among other factors and thus their capacities to deal with the challenges and the impacts of the energy transition are not uniform.
[4] See Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies; see also Peszko et al, 2020. 'Diversification and Cooperation in a Decarbonizing World', World Bank Publications, The World Bank, number 34011.
[5] See Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies.

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be at the core of these countries' near- and longer-term, low-emissions development strategies. These technologies are referred to as carbon capture, use, and storage (CCUS) when the CO2 stored is derived from industrial point sources, and to direct air capture with Carbon Storage (DACCS) when the CO2 is captured from the ambient air. DACCS actually achieves removal of CO2 from the atmosphere and the same holds when biogenic CO2 from biofuels is captured and stored (widely referred to as "BECCS").

CCUS is a climate mitigation action through which some oil and gas exporters could establish a competitive advantage given their natural (e.g. geological storage capacities, depleted hydrocarbon reservoirs, existing infrastructure) and technical resources (e.g. the expertise in subsurface technology). Also, the deployment of CCUS could provide oil and gas exporters with an opportunity to continue to monetise their reserves more sustainably and retain the competitiveness of their energy intensive industries in a net-zero emissions world. Although some believe that the combination of clean electrification and green hydrogen can deliver net-zero emissions by 2050[6], the uncertainty surrounding the speed of the transition coupled to the variations in transition strategies likely to be adopted by different countries means many scenarios still project that oil and gas will remain part of the energy mix in many countries for the foreseeable future (see below). Also, from the perspective of achieving net-zero emissions, CCUS is a key mitigation technology needed to achieve governments' ambitious net-zero targets. For some energy intensive hard-to abate sectors such as steel and cement, technical options to reduce emissions without CCUS are currently limited. Also, CCUS fits within the existing energy system without significant requirements for its fundamental transformation[7].

Given that CCUS is a technology that could be utilised to reduce emissions and achieve net-zero targets, and given that CCUS could prove to be of strategic importance for oil and gas exporters to increase their resilience, multilateral agreements such as the Paris Agreement and global policies to incentivise emissions reductions should take these trends into account. It is in the interest of large oil and gas reserve holders either individually or as a group to implement projects to prove CCUS technology at scale, reduce its costs, and develop sustainable business models. This requires exporters to take a more active role in developing and scaling up CCUS through investments in the sector. Higher capital and operating costs reduce the return on projects compared to exporting unabated gas and oil, and this strategy comes at a cost. But these costs could be lower than those associated with diversifying into new non-energy sectors; CCUS can support countries' industrialisation strategy into energy intensive industries; these costs are expected to reduce over time; and above all these costs could increase the competitiveness of a key sector in a world transitioning to net-zero emissions. Furthermore, the adaptation cost arising from a failure to mitigate climate change could prove to be higher.

However, it should be recognised that producers' economies would have to undergo some of the deepest transformations and adjustments and shifting the costs to producers alone is not viable.  Also, if costs are too high or domestic competition from other sectors for the use of hydrocarbon revenues intensifies during the transition, then scaling CCUS to levels that are needed for it to be an effective mitigation strategy will not materialise in these countries. Shifting the cost to these countries alone may not incentivise the use of CCUS at a large scale. Thus, policies could be developed to encourage and incentivise the development of CCUS in oil and gas exporting countries.  Most of the investment in CUCS so far has been concentrated in developed economies[8].

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[6] See for instance, Energy Transition Commission. 2021 'Clean electrification and hydrogen can deliver net-zero by 2050, says global private-sector coalition', April 26, https://www.prnewswire.com/news-releases/clean-electrification-and-hydrogen-can-deliver-net-zero-by-2050-says-global-private-sector-coalition-301277104.html

[7] See Bui, M., Adjiman, C., Bardow, A., Boston, A., Brown, S., Fennell, P., Fuss, S., et al. 2018. 'Carbon capture and storage: the way forward'. *Energy & Environmental Science, 11* (5), 1062-1176. https://doi.org/10.1039/c7ee02342a

[8] IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.

Existing policies that just focus on emissions reduction, such as carbon pricing, are not sufficient to induce investment in CCUS projects at the scale required for it to be an effective mitigation strategy[9]. Also, policies that aim at restricting the supply of hydrocarbons[10] as a way to reduce emissions run the risk of disincentivising oil and gas exporters from playing a more constructive role in climate change negotiations and solutions.

To incentivise investment in CCUS by oil and gas exporters, policies should aim to distribute their costs across the supply chain, but also between importers and exporters so the burden is shared more equitably. From the perspective of achieving net-zero emissions, this could enable a key mitigation strategy to help countries achieve their ambitious targets. From a producers' perspective, it allows producers to play a more active role in climate change negotiations and encourages them to be part of the solution through utilising their own expertise and financial and geological resources. It could also help these countries diversify into new sectors which could ease the burden of the transition. This requires developing frameworks and mechanisms that complement existing instruments with policies that assign value to CO2 storage[11]. This poses various challenges, but the benefits could be substantial. In addition to enabling a key mitigation technology, it reinforces certain key principles such as the emphasis on national circumstances, common but differentiated responsibility[12] and just and inclusive energy transition.

## Managing the transition to a low emissions economy

In the face of a shock that could disrupt a strategic sector such as oil and gas, an effective strategy could be to diversify away from that sector[13]. However, most oil and gas producing countries face real challenges in realising meaningful diversification, particularly fiscal diversification that reduces the reliance of their government budgets on hydrocarbon revenues. Diversification could be successful if the country could generate new pools of uncorrelated income streams through creating new sectors and alternative sources of income through direct and indirect taxation. Also, diversification into substantively different areas away from their core competitive advantage runs the risk of failure of establishing viable non-resource export sectors. Achieving diversification also requires building human capital and improving the education system as well as extensive structural reforms to improve the economic and business environment, enhance transparency and economic governance, and remove barriers to private sector participation. There is significant uncertainty regarding how fast or even whether such extensive economic and institutional reforms can be implemented by most oil and gas exporters[14]. Despite decades of trying to diversify their economies and income sources, the track record has generally been poor[15], and most oil and gas exporters find themselves confronting the challenge of the transition from a weak position.

Furthermore, the oil and gas sectors remain very profitable and still enjoy higher margins than any new industries or sectors that governments in oil and gas exporting countries aim to establish. Reduced investment flows into the oil and gas sector and some International Oil Companies (IOCs) pulling out of oil activities under pressure from shareholders, financiers and governments, can cause supply to fall faster than demand resulting in high margins at least for short periods of time. Governments can also

[9] See for instance Element Energy & Vivid Economics, 2018. CCS market mechanisms: Policy mechanisms to support the large-scale deployment of Carbon Capture and Storage (CCS).

[10] Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.

[11] See Mitchell-Larsen, E., P. Zakkour, and W. Heidug, 2020. 'Achieving Net-Zero in the G20: A Novel Supply-Side Climate Policy to Value Carbon Sinks', T20 Task Force 2, Climate Change and Environment.

[12] UNFCCC, 'Introduction to Climate Finance', https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance/introduction-to-climate-finance

[13] See Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies.

[14] Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies.

[15] See for instance, IMF 2016. 'Economic Diversification in Oil-Exporting Arab Countries', Policy Paper, April 29. https://www.imf.org/en/Publications/Policy-Papers/Issues/2016/12/31/Economic-Diversification-in-Oil-Exporting-Arab-Countries-PP5038

leverage oil and gas revenues to ease the pain of structural reforms by developing compensation mechanisms to offset the adverse impacts on households and firms. Also, the oil and gas sector can contribute to diversification efforts by creating forward and backward linkages in the economy[16]. Given the speed of the transition is highly uncertain and its impacts are uneven across the globe, exiting too early from such an established strategic sector deprives the country of an important source of income[17]. After all, countries are likely to pursue different transition strategies and even importing countries don't constitute a homogeneous group. Several importing countries could continue using oil and gas if prices are lowered because of forced compression of demand in 'committed' countries.

If diversifying fully from the oil and gas sector is sub-optimal and in many hydrocarbon-rich countries it can't be achieved at a rapid pace, the issue then becomes how to enhance the competitiveness and increase the resilience of the hydrocarbon sector in a world that is transitioning towards net-zero emissions.

One key aspect of competitive advantage is cost. Given the size and the nature of their hydrocarbon reserves, some oil and gas exporters, particularly those in the Gulf, can compete effectively on the cost of development and extraction. They have the option to invest in technology development that further improves the efficiency and lowers the cost of production. Also, in the face of uncertainty about demand, and in response to importing countries' oil substitution policies, some exporters can adopt faster extraction and monetization strategies. However, lack of fiscal diversification and the high 'social cost of production' act as a constraint on this strategy[18]. Increasing supply in the face of slowing or declining demand could result in lower revenues at least in the short-term (in the medium- to long-term, such a policy could result in high-cost and less stable producers exiting the market with some producers increasing their market share partially compensating for the lower revenues due to the lower oil price).

This is not the only constraint. In response, oil importers may decide to implement carbon taxes based on carbon content, creating a wedge between the revenues generated by oil exporters and revenues generated by importing countries with the latter capturing a substantial part of the rent[19]. This is nothing new as importing countries, especially in Europe, and Japan, have always taxed fossil fuels heavily. Although this was not motivated necessarily by environmental but by budgetary reasons, the underlying motivation makes no difference in terms of importing countries capturing part of the rent. Franks, Edenhofer, and Lessmann[20] recognise that this could cause resistance from the resource owners and incentivize them to accelerate the extraction of resources with adverse environmental impacts (known as the green paradox, a term coined by Sinn[21]). However, in contrast to Sinn[22], Franks, Edenhofer, and Lessmann[23] find that under a realistic set of assumptions, the carbon tax will not give rise to a green

[16] Hvidt M. 2021. 'Economic Diversification and Job Creation in the Arab Gulf Countries: Applying a Value Chain Perspective'. In When Can Oil Economies Be Deemed Sustainable? The Political Economy of the Middle East, edited by G. Luciani and T. Moerenhout. Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-5728-6_11.

[17] Fattouh, B., R. Poudineh, and R. West, 2019. 'The rise of renewables and energy transition: What adaptation strategy exists for oil companies and oil-exporting countries?'. Energy Transit. 3: pp. 45– 58. https://doi.org/10.1007/s41825-019-00013-x.

[18] Dale, S. and Fattouh, B. 2018. 'Peak Oil Demand and Long Run Oil Prices', OIES Energy Insight 25, Oxford Institute for Energy Studies. https://www.oxfordenergy.org/publications/peak-oil-demand-long-run-oil-prices/.

[19] See Franks, M. and O. Edenhofer, and K. Lessmann, 2015. 'Why Finance Ministers Favor Carbon Taxes, Even If They Do Not Take Climate Change into Account'. Available at SSRN: https://ssrn.com/abstract=2599482 or http://dx.doi.org/10.2139/ssrn.2599482

[20] See Franks, M. and O. Edenhofer, and K. Lessmann, 2015. 'Why Finance Ministers Favor Carbon Taxes, Even If They Do Not Take Climate Change into Account'. Available at SSRN: https://ssrn.com/abstract=2599482 or http://dx.doi.org/10.2139/ssrn.2599482

[21] Sinn, H. 2015. 'The Green Paradox: A Supply-Side View of the Climate Problem'. CESifo Working Paper Series No. 5385, Available at SSRN: https://ssrn.com/abstract=2621998

[22] Sinn, H. 2015. 'The Green Paradox: A Supply-Side View of the Climate Problem'. CESifo Working Paper Series No. 5385, Available at SSRN: https://ssrn.com/abstract=2621998

[23] See Franks, M. and O. Edenhofer, and K. Lessmann, 2015. 'Why Finance Ministers Favor Carbon Taxes, Even If They Do Not Take Climate Change into Account'. Available at SSRN: https://ssrn.com/abstract=2599482 or http://dx.doi.org/10.2139/ssrn.2599482

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paradox and instead the resource owners will react by reducing the rate of extraction and therefore carbon taxes have beneficial environmental implications.

Another option for managing the transition is to diversify into products and sectors closely related to hydrocarbons where energy is an important component of competitiveness such as petrochemicals, steel, cement, fertilizers and other energy intensive industries. This could create a range of higher-value-added products providing a hedge against oil and gas price volatility and if implemented properly could lead to the development of services and tradable sectors with technological spillovers[24]. But this strategy is not without risks. Industrialization into energy intensive industries increases domestic emissions of GHG and some importers such as the European Union (EU) are already developing policies to measure and verify the carbon content of final goods and have plans to implement carbon border adjustment (CBA) measures[25] to address the problem of carbon leakage.

Thus, in addition to the cost dimension, hydrocarbon rich countries could compete on reducing their CO2 emissions. This is key to increasing the resilience of their strategic energy sectors in a world where policies to reduce emissions are being implemented at an increasing rate, key actors including governments and consumers are changing their behaviours, and when the speed and perceptions about the role of hydrocarbons in the energy mix is shifting fast[26].

## CCUS an integral part of Producers' Energy Strategies

Increasing the resilience and competitiveness of the energy sector can take different forms. The most obvious strategy is to invest in renewables, such as solar and wind and green hydrogen, which in addition to energy efficiency programmes and energy pricing reforms, can optimise the energy mix and reduce CO2 emissions and create new sectors[27]. Also, such technologies could be integrated with existing hydrocarbon infrastructure to reduce emissions in oil and gas production. Most oil and gas exporters have great potential for renewable energies due to high levels of irradiation, and wind potential in some. Also, many countries, particularly in the Gulf, have fewer limitations on the use of land for construction of wind and solar farms.

But the margins in renewables are small and can't fully substitute for the rents generated by the hydrocarbon sector and thus exporters could work towards ensuring that their production processes and core hydrocarbon products can also compete on the emissions front[28]. This involves reducing emissions from both the production process (Scope 1 and Scope 2 emissions, from the producers perspective) and in the consumption of gas and products derived from crude (Scope 3 emissions, from the producers perspective). Regarding the production process, some oil and gas exporters such as Saudi Arabia are already in a relatively better position compared to other producers due to the low carbon content of their crude and their heavy investment in infrastructure to reduce gas flaring and methane emissions[29].

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[24] Peszko et al, 2020. 'Diversification and Cooperation in a Decarbonizing World', World Bank Publications, The World Bank, number 34011.

[25] Peszko et al, 2020. 'Diversification and Cooperation in a Decarbonizing World', World Bank Publications, The World Bank, number 34011.

[26] See Fattouh B., and A. Sen. 2021. 'Economic Diversification in Arab Oil-Exporting Countries in the Context of Peak Oil and the Energy Transition'. In When Can Oil Economies Be Deemed Sustainable? The Political Economy of the Middle East, edited by G. Luciani and T. Moerenhout. Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-5728-6_5.

[27] See for instance, in the context of Saudi Arabia, Fattouh, B. 2021. 'Saudi Oil Policy: Continuity and Change in the Era of the Energy Transition', OIES Paper WPM 81. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/01/Saudi-Oil-Policy-Continuity-and-Change-in-the-Era-of-the-Energy-Transtion-WPM-81.pdf

[28] See Fattouh B., and A. Sen. 2021. 'Economic Diversification in Arab Oil-Exporting Countries in the Context of Peak Oil and the Energy Transition'. In When Can Oil Economies Be Deemed Sustainable? The Political Economy of the Middle East, edited by G. Luciani and T. Moerenhout. Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-5728-6_5.

[29] See Fattouh, B. 2021. 'Saudi Oil Policy: Continuity and Change in the Era of the Energy Transition', OIES Paper WPM 81. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/01/Saudi-Oil-Policy-Continuity-and-Change-in-the-Era-of-the-Energy-Transtion-WPM-81.pdf

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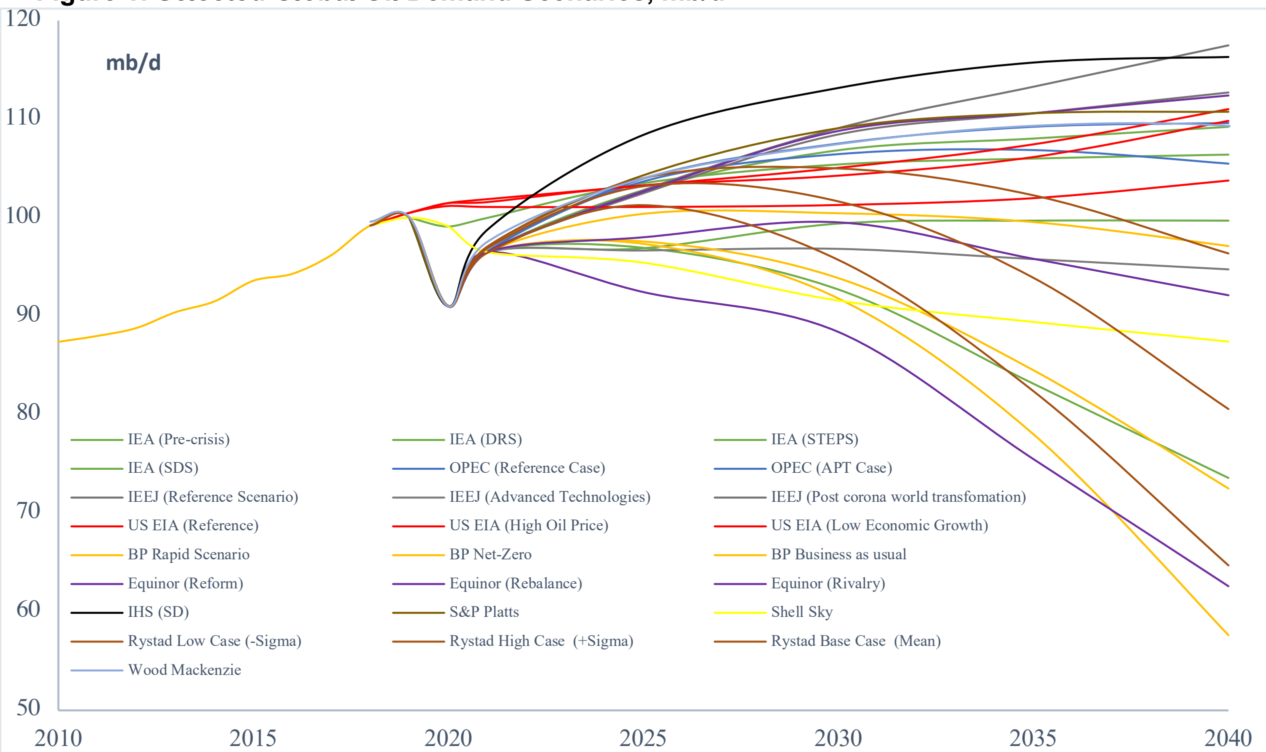
However, the real challenge lies in reducing emissions from the consumption of the gas/petroleum products. This is where CCUS can play an important role in oil and gas exporters' policies and strategies for a number of reasons.

First, global deployment of CCUS is needed to help achieve the goal of net zero emissions given that oil and gas are projected to remain an important part of the energy mix at least for the foreseeable future. Models projecting long-term oil demand are highly sensitive to the underlying assumptions (GDP growth, population growth, carbon prices, transformations in the transport sector) and the purpose of the underlying exercise (point forecasting or backcasting[30]) and therefore the uncertainty surrounding oil demand projections is very wide. But even in the most aggressive scenarios, oil demand will remain part of the energy mix, though in the most aggressive scenarios the decline is quite substantial (see Figure 1). A similar picture emerges for projections of natural gas demand (see Figure 2). There are a number of forecasts that would imply a significantly lower demand for hydrocarbons, some even forecasting no role for hydrocarbons in the energy mix with the combination of clean electrification and green hydrogen delivering the net-zero emissions by 2050[31]. But even assuming new oil and gas developments cease in 2021, the IEA Net Zero Roadmap still suggests 7.6 Gt (gigatons) CO2 being stored in 2050.

**Figure 1: Selected Global Oil Demand Scenarios, mb/d**

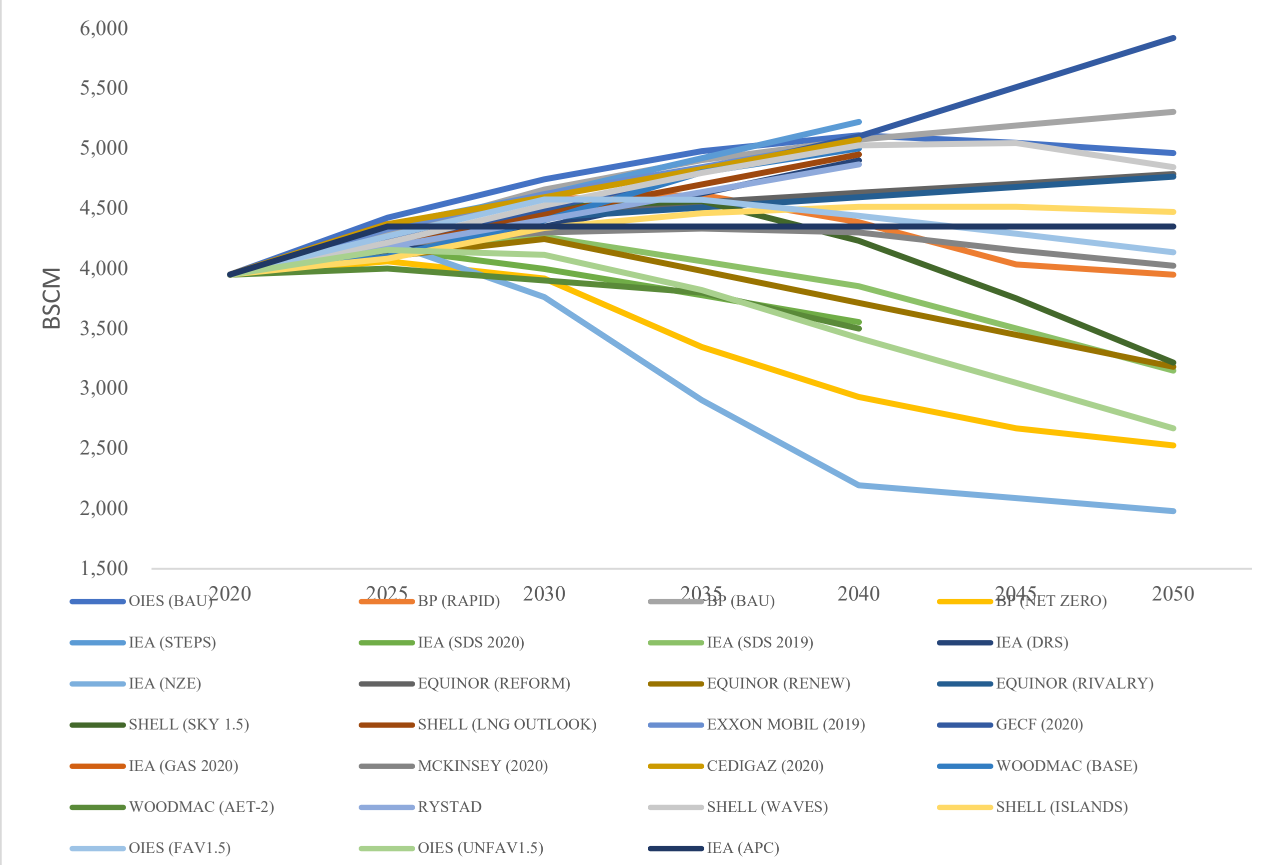



Source: Various Reports

[30] In backcasting exercises, the modeler assumes that the world will achieve net zero emissions at a certain point in the future (say by 2050) and then work backward some transition paths that would achieve that outcome. Such an exercise allows to identify the steps needed to occur to achieve a desired objective.

[31] See for instance, Energy Transition Commission 2021. 'Clean electrification and hydrogen can deliver net-zero by 2050, says global private-sector coalition', April 26, https://www.prnewswire.com/news-releases/clean-electrification-and-hydrogen-can-deliver-net-zero-by-2050-says-global-private-sector-coalition-301277104.html

**Figure 2: Selected Global Gas Demand Scenarios, BSCM**




Source: Various Reports

Second, CCUS could reduce the cost of meeting climate targets as other sectors have to pursue more expensive mitigation options and CCUS enables continuing access to lower cost fossil fuels[32]. Also, in many models, CCUS plays an important role in achieving the 2°C scenario. For instance, Koelbl et al. find that CCS plays a key role in all of the models' mitigation portfolios that they investigate and while the range of CO2 captured varied widely between models (up to 3050 GtCO2 cumulatively until 2100 in some instances), none of them captured less than 600 GtCO2. Interestingly, the authors do not find a decreasing role for CCUS over time[33]. However, not everyone accepts this conclusion, and some models predict the role of CCUS to fall over time and it not constituting a core decarbonization technology[34].

Third, the Intergovernmental Panel on Climate Change (IPCC) scenarios rely on the availability of carbon sinks (either biological or geological) to achieve negative emissions and the 1.5 degree goal[35].

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[32] See Element Energy & Vivid Economics. 2018. CCS market mechanisms: Policy mechanisms to support the large-scale deployment of Carbon Capture and Storage (CCS).

[33] B. S. Koelbl , M. A. van den Broek , A. P. C. Faaij and D. P. van Vuuren 2014. Uncertainty in carbon capture and storage (CCS) deployment projections: a cross-model comparison exercise, *Clim. Change*, **123** , 461 —476.

[34] See Element Energy & Vivid Economics. 2018. CCS market mechanisms: Policy mechanisms to support the large-scale deployment of Carbon Capture and Storage (CCS).

[35] Rogelj, J., D. Shindell, K. Jiang, S. Fifita, P. Forster, V. Ginzburg, C. Handa, H. Kheshgi, S. Kobayashi, E. Kriegler, L. Mundaca, R. Séférian, and M.V.Vilariño, 2018. 'Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development'. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O.

Recently, Germany has been focusing on negative emissions with the country's energy agency (Dena) urging the government to develop a strategy to rapidly upscale and deploy negative GHG emissions technologies to meet its climate targets, recognising that investors will need financial incentives such as integrating CO2 removal credits in the EU emissions Trading System[36]. CCS offers long lived storage solutions that can complement nature-based solutions which offer shorter lived storage options[37]. Oil and gas producing countries are well endowed with geological sinks. These could be used as part of CCUS to decarbonise hard-to-abate sectors and provide an option via DACCS to achieve negative emissions.

Fourth, for some energy intensive hard-to abate sectors such as steel and cement, technical options to reduce emissions without CCUS are currently limited[38]. Given that energy intensive industries are at the heart of industrialisation and development strategy of many hydrocarbon-rich countries, CCUS is an essential technology to decarbonise and maintain the competitiveness of these sectors in a world with carbon taxes.

Fifth, this is a sector where some exporters could establish a clear comparative advantage and contribute to emissions reduction given their geological storage capacities and access to depleted fields, existing infrastructure, and the expertise built over the years. Developing a CCUS sector would also complement their efforts of diversifying into new sectors and finding new opportunities to utilise carbon.

Finally, as noted by Allen et al[39] policies aimed at controlling emissions, for instance by limiting consumption or extraction of hydrocarbons reserves, are economically intrusive and do not constitute a solution on their own. The authors also argue that 'policies focused on emission rates make tension between growth and climate protection seem inevitable' especially in oil and gas exporting and developing countries that rely on hydrocarbons to fuel their economies. Instead, Allen[40] proposes that the climate change problem is reframed as a stock rather than a flow problem, one similar to an industrial waste disposal problem where fossil fuel producers can continue to extract their reserves but are required to dispose a certain fraction (known as the sequestered adequate fraction of extracted or SAFE) of the carbon dioxide from the products sold through deploying technologies such as CCUS and DACCS. As long as cumulative emissions don't exceed some allowable total, which requires adjusting SAFE over time, fossil fuels reserves can continue to be extracted and consumed. Allen et al[41] acknowledge that fossil fuels will be more costly under a SAFE carbon regime (which will depend on the cost of sequestration).

Thus, the deployment of technologies such as CCUS provide oil and gas exporters with the opportunity to continue to monetise their reserves sustainably in a net-zero emissions world while contributing to mitigation. This contrasts with demand side policies such as carbon tax which focus on emissions reduction, but also other supply side policies which aim to reduce emissions by limiting the consumption and the extraction of hydrocarbon reserves[42]. Lazarus and Von Asselt[43] note that many of the current

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Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]

[36] Argus Media, German energy agency urges negative emissions plan, June 16, 2021. https://www.argusmedia.com/en/news/2225360-german-energy-agency-urges-negative-emissions-plan

[37] The Oxford Principles for Net Zero Aligned Carbon Offsetting, 2020. https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf

[38] See Krahé, M., W. Heidug, J. Ward, and R. Smale. 2013. 'From demonstration to deployment: An economic analysis of support policies for carbon capture and storage', *Energy Policy* 60: 753-763. See also Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.

[39] Allen, MR., DJ. Frame, and CF. Mason. 2009. 'The case for mandatory sequestration?' *Nature Geoscience* 2: 813-814.

[40] Allen, M., 2014. Stocks, flows and myopia: the challenge of limiting cumulative carbon emissions

[41] Allen, MR., DJ. Frame, and CF. Mason. 2009. 'The case for mandatory sequestration?' *Nature Geoscience* 2: 813-814.

[42] Zakkour, P.D., W. Heidug , A. Howard , R.S. Haszeldine , M.R. Allen & D. Hone (2021) Progressive supply-side policy under the Paris Agreement to enhance geological carbon storage, Climate Policy, 21:1, 63-77, DOI: 10.1080/14693062.2020.1803039

[43] Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.

supply side policies are underpinned by the belief that 'continued investment in fossil fuel exploration, extraction, and delivery infrastructure makes global climate protection objectives much harder to achieve' and thus policies that discourage the extraction of fossil fuel can complement demand side policies.

The movement of divesting away from fossil fuels and/or measures to increase the cost of finance and reduce the flow of funds to hydrocarbon projects fall within such supply side policies. Many private and development banks have announced that they will no longer finance certain fossil fuel projects with the Asian Development Bank being the latest institution to announce that it plans to end financing of coal fired power projects and oil, gas, and coal mining[44]. Others have warned against the risks of financial institutions being exposed to fossil fuels which could lose value overtime posing a systemic risk for the global financial system[45]. As such there have been increasing calls for mandatory climate risk disclosure, with the Group of Seven (G7) rich countries recently supporting measures to force banks and companies to disclose their exposure to climate-related risks[46]. Governments can also rely on regulatory frameworks, for instance by restricting leases for the development of hydrocarbon reserves or infrastructure[47]. Recent examples include the U.S. Interior Department's plans to cancel oil and gas lease sales from public lands and the decision by the Biden Administration to cancel the Keystone pipeline. Another example is Spain's recent decision to end its limited fossil fuel production by 2042 under its new climate law[48]. Other instruments include paying resource owners to keep their fossil fuels underground, but such schemes have failed to gain traction[49].

Surprisingly, technologies such as CCUS do not feature heavily in such supply side policies[50]. Many remain sceptical about the role of CCUS as a climate mitigation technology, citing factors such as its high cost and fears around the safety and permanence of storage. Sceptics argue that CCUS can also perpetuate the use of fossil fuels and discourage change in societal behaviour and reinforce existing dependencies and power structures[51]. It is also argued that CCUS could discourage countries from pursuing clean technologies. As such, the support for CCUS is weak, especially from some NGOs and the wider public[52]. For instance, Climate Action Network Europe calls for natural carbon sinks to 'continue to be prioritised in any consideration of the need for net negative emissions'; that 'CCS must not be used in the EU power sector'; that 'BECCS should not at the present moment be part of a pathway towards net-zero or net-negative emissions as the current EU's long-term target can and should be reached by other means'[53].

However, as noted by Allen et al[54], 'worthwhile policies should be pursued in their own right. Solving climate change is too important to be held hostage to any other issue'. Also, supply-side policies that focus on restricting the use of oil and gas amplify the distributional impacts of climate change policies making hydrocarbon exporters worse off, even if one considers the benefits from reduced threats from

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44 See Argus Media, 'Asian Development Bank to end coal oil financing', 13 May 2021.
45 Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.
46 Reuters, 'G7 backs making climate risk disclosure mandatory' June 5, 2021.
47 Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.
48 S&P Global Platts, 'Spain passes climate bill banning new oil, gas exploration', May 14, 2021.
49 Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.
50 Zakkour, P.D., W. Heidug , A. Howard , R.S. Haszeldine , M.R. Allen & D. Hone (2021) Progressive supply-side policy under the Paris Agreement to enhance geological carbon storage, Climate Policy, 21:1, 63-77, DOI: 10.1080/14693062.2020.1803039
51 Lazarus, M., and H.van Asselt. 2018. 'Fossil fuel supply and climate policy: exploring the road less taken' *Climatic Change* 150: 1-13.
52 See Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.
53 See Climate Action Network Europe, 'Can Europe's Position on Carbon Capture and Storage and/or Use (CCSU)', Jun 2020. https://caneurope.org/content/uploads/2021/03/Position-paper_CCS-and-CCU_June-2020_CAN-Europe.pdf
54 Allen, M.R., D.J. Frame, and C. F. Mason. 2009. 'The case for mandatory sequestration?' *Nature Geoscience* 2: 813-814.

climate change.[55] They ignore the political economy of oil and gas producers and the central role the hydrocarbon sector plays in their economies.[56] Such proposals are also short, or even absent, in identifying concrete mechanisms that could help producers in their adaptation process. Also, to expect oil and gas exporters to keep their resources underground, and/or fully diversify away from the oil and gas sectors which constitute their core competitive advantage, and, for this strategic sector to play a lesser role in the transition process, is not only unrealistic it is also sub-optimal, as these economies will limit their scope for risk reduction and adaptation strategies in the face of a potentially disruptive shock[57].

Policies focused only at restricting the supply of hydrocarbons can risk disincentivising oil and gas exporters from playing a more constructive role in climate change negotiations and reducing their incentive to be part of the solution to climate change, especially in the absence of a global framework that channels funds (for instance through the establishment of Green Funds) to help these countries adapt to the disruptions of the energy transition[58].

Many oil and gas exporters recognise the climate change threat and are adopting a fundamentally different approach from the past and have shown a willingness to employ technical and financial resources and lead on initiatives to fight climate change. For instance, Saudi Arabia has been advocating the Circular Carbon Economy (CCE) approach and its 4Rs (Reduce, Reuse, Recycle, and Remove) to confront the challenge of climate change[59]. Of these 4Rs, 'Remove' is key as it enables oil exporters to exploit their resources while reducing net emissions through the deployment of technologies such as CCUS and DACCS. From oil and gas producers' perspective, carbon sink-based mitigation strategy can reinforce certain principles which are key for a smooth energy transition. These include:

- The recognition of national circumstances in climate change negotiations.
- The recognition that there will be various transition paths depending on starting points, core competencies and existing assets of each of the countries. Insisting on a single path and selecting winning technologies while excluding other technologies leading to an inefficient transition.
- The concept of a 'just transition' and the recognition that adjustments cost is not uniform across the globe and therefore the importance to offset some of the adverse impacts through the establishment of mechanisms that allow for cost sharing and reducing the adjustment cost for the most affected countries.

## Why Investment in CCUS remains limited in Oil and Gas Exporting Countries?

If CCUS is essential to reduce emissions, and if it needs to be an integral part of the low emissions strategies for exporters, a key question is why investment in CCUS remains limited, particularly in oil and gas exporting countries? Despite the fact that CCUS technology has been demonstrated and projects can be successfully delivered, the number of projects and the scale of the sector are nowhere

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[55] See Stiglitz, J. 2015. 'Overcoming the Copenhagen Failure with Flexible Commitments', Economics of Energy & Environmental Policy, International Association for Energy Economics, vol. 4 (Number 2).
[56] See for instance, Shehabi, M. 2021.' 'Quantifying Long-Term Impacts of COVID-19 and Oil Price Shocks in a Gulf Oil Economy', OIES Research Paper: MEP 25, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/06/Quantifying-Long-Term-Impacts-of-COVID-19-and-Oil-price-Shocks-in-a-Gulf-Oil-Economy-MEP25.pdf ; Luciani G. 2021. 'Framing the Economic Sustainability of Oil Economies'. In: Luciani G., Moerenhout T. (eds) When Can Oil Economies Be Deemed Sustainable? The Political Economy of the Middle East. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-15-5728-6_2; Fattouh, B., & El-Katiri, L. 2013. Energy subsidies in the Middle East and North Africa. Energy Strategy Reviews, 2(1), 108-115.
[57] Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies.
[58] See Stiglitz, J. 2015. 'Overcoming the Copenhagen Failure with Flexible Commitments', Economics of Energy & Environmental Policy, International Association for Energy Economics, vol. 4 (Number 2).
[59] Al-Khuwaiter, A., and Y. Al-Mufti. 2020. 'An Alternative Energy Transition Pathway Enables by the Oil and Gas Industry'. Oxford Energy Forum 121 (March): p.14-19.

near the levels needed for CCUS to play an effective role in reducing CO2 emissions. According to the International Energy Agency (IEA), the world has 22 large commercial CCUS facilities with capacity to capture only 40 to 50 MtCO2 each year, with most of these projects located in developed economies. Also, most of these projects are concentrated in OECD countries which have about five times more operational CO2 capture than the rest of the world, with Europe and North America expected to capture almost three-fourths of the future capacity development[60]. In contrast, in the IEA's Sustainable Development Scenario (SDS), non-OECD economies, particularly China, India, and the Middle East region, are expected to see a significant increase in CCUS deployment, especially after 2030, but with the United States, which currently leads the world in terms of the deployment of CCUS, continuing to play a key role with capture reaching around 1,200 MtCO2 by 2070.[61]

But the outlook for CCUS projects is improving[62]. The IEA notes that there are also at least 40 commercial projects that have been announced recently and between 2020 and May 2021 at least $12 billion has been committed by governments and the private sector to CCUS projects with almost $30 billion worth of projects nearing a Final Investment Decision[63]. However, the scale of CCUS deployment remains small. Kearney estimates that with the ongoing projects, storage would increase to about 220Mt CO2 per year, which is well below the target of 800Mt CO2 per year in the IEA's Sustainable Development Scenario (SDS)[64].

Pricing GHG emissions through mechanisms such as carbon taxes and emissions trading systems (ETS) is considered the economically most efficient way to correct for the externalities associated with climate change[65]. However, there is a wide recognition that carbon taxes and ETS are not sufficient to induce investment in geological storage given the low and volatile carbon prices which do not compensate for the upfront costs nor provide long-term certainty for investors. As noted by Mitchel-Larson et al[66], there is currently no well-defined policy framework in place which recognises that storage of carbon has value, which is separate from emissions reductions, and this disincentivises investment in carbon sinks. Challenges in financing CCUS projects include the high upfront capital cost, imperfect information and information asymmetry and the complementary markets problem where the different parts of the supply chain are dependent on each other (if these are not vertically integrated) which increases risks and disincentivises investment in CCUS projects[67].

Therefore, it is recognised that additional layers of financial resources are needed to support investment in CCUS projects[68]. Examples of recent CCUS projects that have received direct government support include the Northern Lights CCUS project in Norway and the Quest CCUS project in Canada. In the Netherlands, the SDE++ scheme includes support for a broad range of technologies including CCUS. Under this scheme, the Dutch government has granted around €2 billion in subsidies for a CCUS project (Porthos) in the Dutch sector of the North Sea[69]. In the US, fiscal incentives for CCUS are provided by a tax credit (known as 45Q) for CO2 permanently stored via usage, tertiary oil injection or in geological formations[70].

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[60] See Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.
[61] IEA 2020. Energy Technology Perspectives 2020: Special Report on Carbon Capture Utilisation and Storage. Paris: IEA
[62] IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.
[63] IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.
[64] See Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.
[65] See for instance, Edenhofer, O., and A. Ockenfels. 2015. 'Climate Policy at an Impasse'. In Global Carbon Pricing: The Path to Climate Cooperation, 2017, edited by P. Cramton, D. J. MacKay, A. Ockenfels, and S. Stoft. Cambridge, MA: MIT Press.
[66] Mitchell L., P. Zakkour, and W. Heidug, 2020. 'Achieving Net-Zero in the G20: A Novel Supply-Side Climate Policy to Value Carbon Sinks', T20 Task Force 2, Climate Change and Environment.
[67] See Krahé, M., W. Heidug, J. Ward, and R. Smale. 2013. 'From demonstration to deployment: An economic analysis of support policies for carbon capture and storage', *Energy Policy* 60: 753-763.
[68] IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.
[69] See 'Dutch government grants $2.4bn in subsidies for giant North Sea CCS project' Upstream Online, 10 May 2021, https://www.upstreamonline.com/energy-transition/dutch-government-grants-2-4bn-in-subsidies-for-giant-north-sea-ccs-project/2-1-1008239
[70] Beck, L. 2020. 'The US Section 45Q Tax Credit for Carbon Oxide Sequestration: An Update', Global CCUS Institute, April 2020.

These support scheme have enabled the financing of CCUS in OECD countries. In contrast, there are very few projects in oil and gas producing countries, including the GCC, where the potential for storage is large but with few CCUS projects are in operation. Presently only about 2.1 MtCO2[71] are stored per annum in the region.

Failure to lead on the CCUS front could risk undermining the position of oil and gas exporters. It is of strategic importance for large oil and gas reserve holders, either individually or as a group, to implement more projects to prove CCUS technology at scale, reduce its cost, and develop sustainable business models. This would help to decouple growth of demand for oil from the growth of emissions. While such capital outlays reduce the return on existing projects compared to the current default strategy of exporting unabated oil and gas, such investments can de-risk the current source of revenue and trigger the development of new skills and capabilities. Alongside diversification, this could constitute an additional strategy to manage the low-carbon transition[72]. In fact, given the poor record of diversification in most oil and gas exporting countries, such investments may prove to be more effective.

Investment in CCUS can also increase the potential for integration between sectors. ADNOC's Al Ryadah facility is a good example of how energy intensive industries could be linked to the oil sector providing co-benefits. The project consists of capturing 800,000 tones of CO2 from Emirates Steel manufacturing complex, which is then transported to Al Ryadah facility for compression & dehydration and then metered and exported for Enhanced Oil Recovery (EOR) in oilfields.[73]

## Burden Sharing Mechanisms

If the cost of CCUS projects is too high and if it is shifted to producers alone, the returns of such a strategy can be low reducing the incentive to undertake CCUS projects. Thus, if CCUS is to emerge as a key mitigation strategy, costs need to be spread for oil and gas exporting countries to play a role in contributing to its development. So far, many of the CCUS projects in oil and gas exporting countries have been implemented through National Oil Companies (NOCs) and State-Owned Enterprises (SOEs)[74]. But this model may not be sustainable given the competing needs for funding from other sectors and the need for scaling up CCUS. Also, not all oil and gas exporters have the technical capacity and expertise to build CCUS projects. Thus, the challenge is how to put in place frameworks and business models that allow for the large-scale deployment of geological CO2 storage to become profitable.

A key aspect here relates to the sharing of the cost of CCUS projects between oil exporting and oil consuming countries. It could be argued that international financing mechanisms including multilateral climate funds are essential for the advancement of CCUS. So far, no CCUS project has been financed through such multilateral schemes, although the World Bank has allocated funding for CCUS related capacity building in developing countries.

This highlights another dimension of carbon taxes and emissions trading systems (ETS) which have important distributional effects. Franks, Edenhofer, and Lessmann[75] show that since the ownership of fossil resources gives rise to scarcity rents, from an importing country perspective, a carbon tax is more advantageous than a capital tax since it allows importing governments to capture part of that rent. But this 'rent leakage' to importing countries reduces the potential resources available to oil and gas exporters for low carbon investment, including investment in CCUS projects. Policy measures have been proposed to help oil exporters keep more of the rents so these could be specifically targeted for

[71] See Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.
[72] Poudineh, R., and B. Fattouh. 2020. 'Diversification Strategy Under Deep Uncertainty for MENA Oil Exporting Countries'. OIES Energy Insight 69, May. Oxford: Oxford Institute for Energy Studies.
[73] See Kearney, 2021. 'Carbon Capture Utilization and Storage: Towards Net-Zero'.
[74] IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.
[75] Franks, M. and O.Edenhofer and K. Lessmann, 2015, 'Why Finance Ministers Favor Carbon Taxes, Even If They Do Not Take Climate Change into Account'. Available at SSRN: https://ssrn.com/abstract=2599482 or http://dx.doi.org/10.2139/ssrn.2599482

investment in technologies to reduce emissions. For instance, some have suggested the introduction of wellhead carbon taxes collected by the producers at the extraction point, which are a variant of the international carbon pricing scheme[76]. Through a wellhead carbon tax, producers can reduce the revenues leaking to importing countries and utilise these revenues to support CCUS projects. This could be implemented under the umbrella of the type of novel cooperative mechanism envisaged by the Paris Agreement. By harmonising tax rates and agreeing to share the revenue from taxation between oil exporters and importers, this could provide a way to resolve the distribution issue. In effect importers would agree not to tax carbon on imported oil and gas and the tax share collected by exporters could then be used to support emission reduction efforts (CCUS, renewables, etc) and diversification in oil and gas producing countries.

The following points emerge from the above discussion:

- Carbon pricing on its own can't induce investment in CCUS projects at the scale required to be an effective mitigation strategy.
- Like other technologies, CCUS requires government support at least until the technology matures. This requires clear political commitment from governments. Governments have not provided consistent support for CCUS.[77]
- Oil and gas exporters have an intrinsic strategic interest to play a more active role in advancing the technology through Research& Development (R&D) and demonstration projects.
- Policies should aim to distribute these costs across the supply chain, but also between importers and exporters so the burden is shared more equitably. Shifting the cost to exporters alone will not incentivise the use of CCUS at a large scale in exporting countries. These policies could be enacted under the Paris Agreement where Article 6.2 allows countries to strike bilateral voluntary agreements to trade units known as the Internationally Transferred Mitigation Outcomes and accounts for both emissions reductions and emissions removal which implies there is a scope of complementarity between policies aimed at reducing emissions and those that assign value to CO2 storage.

Several proposals have been suggested to address the burden sharing problem. Some elements of these proposals are worth highlighting.

First, not all countries have a strong incentive to support CCUS and therefore there have been suggestions to create clubs from like-minded countries that have a strong interest in developing the technology (for instance, those countries that are highly dependent on hydrocarbons) and have the financial and technical expertise to enable CCUS as a mitigating technology[78]. These countries can rely on the expertise of the national and private oil companies that have the capability to deliver and scale up projects. Article 6.2 under the Paris Agreement allows for such agreements.

Second, only a few countries have made explicit reference to CCUS as part of their nationally determined contributions (NDCs). To promote CCUS, the Clean Energy Ministerial recommends, as one of its key financing principles, that Governments consider 'CCUS as part of their Nationally Determined Contributions (NDC) under the Paris Agreement' and include CCUS under Article 6 as this 'will encourage novel CCUS financial and cost-sharing mechanisms that benefit both developed and developing countries, helping to meet their NDCs'[79].

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[76] Peszko et al, 2020. 'Diversification and Cooperation in a Decarbonizing World', World Bank Publications, The World Bank, number 34011.

[77] For instance, in the UK, the government cancelled a £1 billion competition for CCS in 2015 just few months before it was due to be awarded. See Damian Carrington, 'UK cancels pioneering £1bn carbon capture and storage competition, The Guardian, November 25 2015, https://www.theguardian.com/environment/2015/nov/25/uk-cancels-pioneering-1bn-carbon-capture-and-storage-competition

[78] Zakkour, P., and W. Heidug. 2019. "A Mechanism for CCUS in the Post-Paris Era: Piloting Results-Based Finance and Supply Side Policy Under Article 6" KAPSARC Discussion Paper, April.

[79] See Clean Energy Ministerial's (CEM) 2020. 'Key Financing Principles for Carbon Capture, Utilization and Storage',

So far, most of the focus of the climate change policy discussion has been on demand side policies which assign value to emission reduction. For instance, under the EU-ETS system, emitting “installations” are allocated emissions allowances (EUAs). Installations are required to cover their emissions by surrendering an equivalent number of EUAs otherwise they face penalties. Since installations with a surplus of EUAs can trade they have an incentive to invest in emissions reduction technologies. The Clean Development Mechanism of the Kyoto Protocol was aimed at supporting emission-reduction projects in developing countries. It was meant to provide incentives for countries with reductions commitment under the Kyoto Protocol to implement emissions reduction projects in developing countries against which the country could earn tradable certified emission reduction (CER) credits which could be counted towards meeting their Kyoto targets.

To incentive investment in CCUS projects, such instruments should be complemented by policies that assign value to CO2 storage, which is separate from emissions reductions. Carbon Storage Units (CSUs) can play such a role[80]. Here the focus would not be on reduced emissions but rather on the CO2 securely stored in geological sinks. For every ton of CO2 committed to storage the companies/countries could obtain a storage certificate which could be used towards meeting climate change obligations or traded. The generation of CSUs, and their trade, could be integrated into a multilateral system taking advantage of the mechanisms under Article 6. Such a system would incentivize producers to invest in CCUS by creating an additional layer of revenue streams provided that international mechanisms are in place to reward storage. An appealing option is that through generating CSUs oil producers could offset the emission of the oil they produce at the consumers end (Scope 3 emissions). Currently, many companies under the pressures from shareholders, governments and investors, have announced voluntary targets to reduce emissions and these are meant to be achieved through carbon offset mechanisms (e.g. nature-based carbon sink solutions). Storage certificates can offer additional instruments to meet such voluntary targets.

The challenges in creating value for CO2 storage and integrating the concept into multilateral and regional mechanisms are various (and beyond the scope of this Insight). But this should not preclude oil and gas exporting countries from proactively supporting and shaping an international mechanism to make large-scale storage in geological sinks financially viable. Oil and gas exporters will have to share part of the involved costs, but the hope is that these costs will decline over time as the technology scales up. The establishment of such a mechanism creates new revenue streams for oil producing countries enabling them to play a decisive role in the global low-carbon transition.

Outside multilateral financing, the financial sectors all over the world could also play a role and ensure that CCUS ‘is part of their climate change strategies and is eligible for sustainable finance’. [81] Given that Environmental, Social and Governance (ESG) factors have emerged as key to financing decisions, the impact of ESG on CCS and vice-versa will only increase in importance. However, so far, the limited evidence is not encouraging. Havercroft[82] finds that investment in CCS does not impact ESG as it is undervalued as a mitigation strategy and only a small number of institutions incorporate CCS in their ratings and disclosure models.

## Conclusions

The energy transition and the road to net-zero emissions will create serious challenges for all oil and gas exporters, though this group is far from homogenous, and some are in a better position to adapt to these challenges. Diversifying away from the oil and gas sector is often presented as an effective transition strategy to confront these challenges. However, diversifying from this core sector is fraught

[80] Zakkour, P. and W. Heidug. 2019. ‘A Mechanism for CCUS in the Post-Paris Era: Piloting Results-Based Finance and Supply Side Policy Under Article 6’, KAPSARC Discussion Paper, April.
[81] See Clean Energy Ministerial’s (CEM) 2020. ‘Key Financing Principles for Carbon Capture, Utilization and Storage’,
[82] Havercroft, I. 2020. ‘Environmental, Social and Governance (ESG) Assessments and CCS’, Global CCS Institute.

with risks and most oil and gas exporters have not implemented the reforms essential for the success of such a transformation. A complementary transition strategy would be to increase the competitiveness and the resilience of the oil and gas sector. This would allow oil and gas exporting countries to draw on their sources of competitive advantage to mitigate the potential impacts associated with the energy transition.

Rather than just compete on cost alone, exporters could also compete on reducing emissions both from their oil and gas activities and in the consumption of final petroleum products. Technologies such as CCUS that store carbon in terrestrial sinks could allow these countries to continue to monetise their hydrocarbon reserves while simultaneously harmonising the transition to a net-zero emissions world and enabling CCUS as a key mitigation sector and one in which some oil and gas exporters could establish a competitive advantage. This requires exporters to take a more active role in developing and scaling up CCUS and geological storage through investments in the sector. Higher capital and operations costs reduce the return on projects compared to exporting unabated gas and oil, and this strategy comes at a cost. But these costs could be lower than those associated with diversifying into new non-energy sectors; CCUS can support current industrialisation strategy into energy intensive industries;  these costs are expected to reduce over time; and above all these costs could increase the competitiveness of a key sector in a carbon constrained world. Furthermore, the cost of doing nothing could prove to be much higher.

However, it should also be recognised that producers’ economies would have to undergo some of the deepest transformations and shifting the costs to producers alone is not viable. If the costs are too high or domestic competition from other sectors for the use of hydrocarbon revenues intensifies during the transition, then scaling CCUS to levels that are needed for it to be an effective mitigation strategy will not materialise in these countries. Here lies the importance of developing burden sharing frameworks and mechanisms that allow for the costs to be shared more equally both across the supply chain and between exporting and importing countries. From the perspective of achieving net-zero emissions, this could enable a key mitigation strategy to help countries achieve their ambitious targets. From a producers’ perspective, it allows producers to play a more active role in climate change negotiations and encourages them to be part of the solution through utilising their own expertise and financial and geological resources. It could also help these countries diversify into new sectors which could ease the burden of the transition. These objectives can be achieved through frameworks and mechanisms that assign value to CO2 storage and linking it to multilateral frameworks for financing. While various challenges are posed, the benefits could be high. In addition to enabling a key mitigation technology, it reinforces certain key principles such as the emphasis on national circumstances, common but differentiated responsibility and a just and inclusive energy transition.