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Energy

Carbon Capture: A Hidden Opportunity?

Competitive advantages position US Energy to scale and lead carbon capture & storage. In our base case, Energy, together with Chemicals & Power, addresses a $225 billion market globally for CCS in 2050, helping improve the Energy sector's resilience through the move to a lower carbon world.

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Executive Summary

Relative to European peers, US Energy companies have lagged on the advancement of sustainability strategies. Most notably, the US sector has pivoted less aggressively toward low carbon technologies that reduce reliance on long-term oil & gas demand. **However, a shift, led by the US majors, is underway —** one that includes commitments to emission reductions, including Paris-aligned "net-zero" targets, along with more investment in scaling solutions to reduce emissions. Notably, US majors are focusing on "New Energies" technologies, including carbon capture and storage (CCS), where they have a competitive advantage and underinvestment is prevalent.

Among these low carbon alternatives — carbon capture and storage has received a wave of investment from US Energy — uniquely an area of leadership from the industry, not only among the global sector, but also the broader market. Unlike some low carbon technologies, such as solar and wind, US Energy has a foothold in CCS development:

- **Leading market share.** Among global CCS capacity, ~50% is located in the United States. Much of this is synergistic with existing businesses — captured through natural gas processing and sequestered in enhanced oil recovery.
- **Geologic expertise with unique access to storage for CO_2.** Among identified storage, ⅔ resides in North America. Oil & gas reservoirs represent much of this capacity, requiring the sector's subsurface knowledge.
- **Key role in the carbon infrastructure.** North America already has a substantial footprint of CO_2 pipelines, and US Energy (most notably the midstream sector), will be responsible for building out this backbone. CO_2 hubs, with shared infrastructure and storage across multiple projects, will be integral to improving economics and scaling CCS technology. We see potential for such a system in the Gulf Coast, characterized by both a high concentration of CO_2 sources and ample storage capacity.
- **Increasingly supportive policy backdrop.** Currently, the 45Q tax credit and California Low Carbon Fuel Standard (LCFS) provide monetization for CO_2. This applies not only to EOR sequestration, but also dedicated storage and potential production of low-carbon synthetic fuels. In may instances, the value of avoided CO_2 in the US can exceed carbon prices elsewhere in the world. Moreover, the Biden administration has signaled support for CCS in the form of a "reformed and expanded" 45Q tax credit.

What is the addressable market for CCS? For this report, we focus on the Energy, along with the Chemicals and Utilities / Clean Tech (primarily power generation) sectors, which we also view as well positioned to incorporate CCS technology. Our analysis of the IEA's Sustainable Development Scenario (a Paris-aligned vision for the energy system), suggests that together, these sectors must achieve CCS capacity of ~0.5 Gtpa in 2030 and ~4.0 Gtpa in 2050. To size the market, we apply a social price of CO_2 (in the context of a hypothetical policy framework) to assumed carbon capture volumes, based on varying degrees of alignment with the SDS. Below are our bull/base/bear cases in 2050:

- **Bull case (Paris-aligned): ~$500 billion 2050 TAM; $2.2 trillion capex.** Volumes align with the SDS (~4 Gtpa); $124/t price of CO_2, which according to a recent academic study co-authored by economist Noah Kaufman (see *here*), is the high-end of the price range required to achieve net-zero in 2050.
- **Base case: ~$225 billion 2050 TAM; $1.6 trillion capex.** Volumes reach 75% of those in the SDS (~3 Gtpa); $75/t price of CO_2, our estimate for the breakeven of CCS technology (note the breakeven can vary meaningfully by application).
- **Bear case: ~$100 billion 2050 TAM; $1.1 trillion capex.** Volumes reach 50% of those in the SDS (~2 Gtpa); $50/t price of CO_2, in-line with the current 45Q tax credit in the US for permanently stored CO_2.

Beyond these primary markets, we see a role for US Energy to help decarbonize other sectors. . . US Energy companies have broadly committed to reducing Scope 1 and 2 emissions, and next, we expect this will expand to Scope 3. To accomplish this, we see a role for CCS partnerships with other sectors, especially those considered hard-to-decarbonize. Some companies have established carbon management as new business opportunities, such as ExxonMobil Low Carbon Solutions, Chevron Technology Ventures, and OXY Low Carbon Ventures.

. . . while helping make the US Energy sector more resilient through the transition. Increasingly, investors are becoming concerned with "stranded asset risk" — assets in oil & gas portfolios that are at risk of impairments due to structural demand destruction from the energy transition. CCS offers a way to offset the emissions footprint of the core oil & gas business, extending the useful life of these assets. In such a scenario, buyers could pay a premium for "sustainable" oil & gas volumes. Longer term, the role of oil & gas companies — some of which have in operation for over a century — are questionable in a "net-zero" world. CCS technology, along with other low carbon technologies including hydrogen and renewable fuels, provide investment opportunities that align with core competencies — helping to further these companies into the next century.

Pandemic Recovery Progresses Climate Agendas

Post-pandemic backdrop reckons with climate risks. . . Unprecedented disruption caused by COVID-19 has spurred a reevaluation of policy paths and business models around the world. Post-pandemic recovery plans, both from governments and corporates, have emphasized "green" agendas — more aggressive emission reduction targets, accelerated clean energy investment, and more transparent climate disclosure. Internationally, the European Union has allocated at least 30% of the European recovery package, or €225 B, toward addressing climate change. In the US, a Democratic sweep in the 2020 election, and a broad executive review of regulatory policies, appears set to usher in a step-change in US climate policy. More broadly, over 110 countries and ~20% of the 2,000 largest public companies around the globe have committed to net-zero targets — important first steps toward realigning the planet's emission pathway with the goals set out in the Paris Agreement.

Exhibit 3:

Countries committing to net-zero targets have grown to over 110, representing >65% of Global CO2 emissions and >70% of the world economy

Source: Earthbound, UN

. . . and advances key technologies to halt global warming. In late 2019, our ESG team outlined $50 T of investment across 5 key technologies – renewables, electric vehicles, carbon capture & storage (CCS), hydrogen and biofuels – required to reduce net emissions to at or around net zero by 2050 and achieve the goals inscribed in the Paris Agreement (see *Decarbonisation: The Race to Net Zero*). Since then, policy support has trended ahead of their expectations, and the team raised their capacity forecasts across all five technologies (see *Investing in The Race To Net Zero: One Year On*).

Notably, US Energy has begun to reposition for the Energy transition — in part through carbon capture & storage. Along with targeted emission reductions, some companies, led by the majors, have begun to transition portfolios toward low carbon businesses in efforts to reduce reliance on long-term oil & gas demand. As part of this, the sector has recently announced a wave of investment in CCS — an underinvested area of the energy transition where larger Energy companies can leverage their scale and project development expertise. Primarily, the sector has made these investments through "carbon management" subsidiaries, platforms carry these companies into a lower carbon world.

Sizing the CCS Market

Demand forming for negative emission technologies. Growing stakeholder pressure to decarbonize, coupled with a potentially more stringent regulatory backdrop, have driven sectors across the US market to re-assess carbon footprints. Now, corporates are more broadly embracing carbon reduction targets alongside more transparent emission reporting. However, few alternatives exist to decarbonize some industries, including steel, cement, and chemicals – positioning CCS as a potential solution. For others, direct efforts to reduce emissions, such as sourcing renewable electricity or more energy efficient operations, are insufficient relative to more ambitious targets. In these instances, the growing carbon offset market, including credits generated from CCS, could fill emission voids.

Exhibit 4:

Mentions in company transcripts of carbon capture, along with net zero and carbon offsets, have risen sharply over the past quarter and year.

	YoY Change	QoQ Change
Biodiversity	29%	33%
Biofuel	22%	-1%
Carbon Capture	194%	67%
Carbon Offset	134%	72%
Circular Economy	60%	4%
Decarbonization	81%	49%
Digital Tax	56%	39%
Electric Vehicles	99%	51%
Employee Satisfaction	33%	31%
ESG	34%	25%
EU Taxonomy	525%	39%
Furlough	327%	-29%
Green Deal	46%	19%
Hydrogen	258%	34%
Net Zero	352%	107%
Renewables	16%	7%

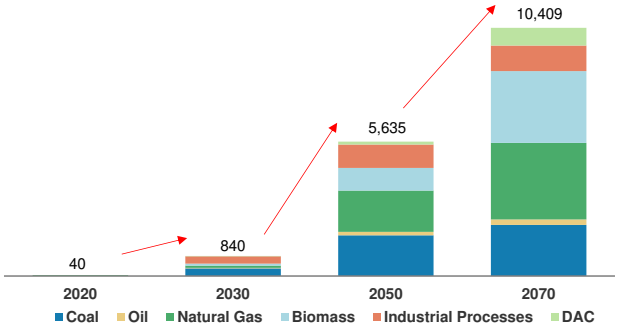
Source: AlphaSense; Morgan Stanley Sustainability Research

CCS requires a step-change in investment to meet climate goals. According to the IEA's Paris-aligned Sustainable Development Scenario (SDS), CCS capacity must grow from 40 Mtpa in 2020 to 840 Mtpa and 5,635 Mtpa by 2030 and 2050, respectively. For this report, we focus on the subset of required CCS capacity directly associated with energy, chemicals, and utility applications: ~0.5 Gtpa in 2030 and ~4.0 Gtpa in 2050. Similarly, a recent academic paper estimates a CO_2 price of $77-124 would be required to incentivize net-zero emissions midway through this century (see *here*).

Exhibit 5:

According to the IEA's Sustainable Development Scenario SDS), captured CO2 volumes must grow to ~800 Mtpa in 2030 and ~5,600 Mtpa in 2050.

Total Carbon Capture (Mtpa)



Source: IEA, Morgan Stanley Research

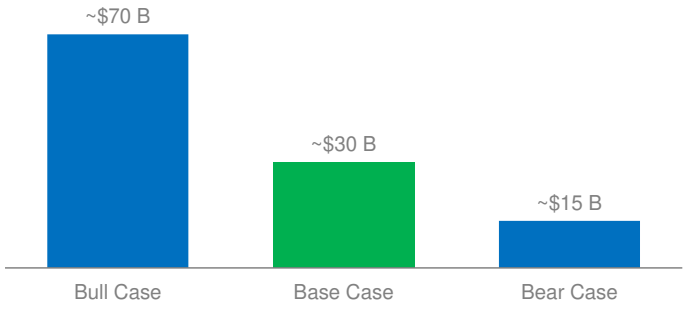
To size the market across Energy/Chems/Power, we apply a social price of CO_2 (in the context of a hypothetical policy framework) to assumed carbon capture volumes, based on varying degrees of alignment with the SDS (bull case is Paris-aligned; base and bear cases do not achieve the goals outlined in the Paris Agreement). According to a recent academic study co-authored by economist Noah Kaufman (see *here*), achieving net-zero in 2050, a Paris-aligned scenario, would require $77-124/t of CO_2. To quantify the required spend to achieve each scenario, we assume our ESG team's estimates for CCS capital costs and deflation (see *Investing in The Race To Net Zero: One Year On*): $668 per Mtpa of capacity with 15% deflation by 2040 and 30% deflation by 2050.

Addressable Market in 2030:

- **Bull case (Paris-aligned): ~$70 B 2030 TAM; ~$330 B capex.** Volumes align with the SDS (~4 Gtpa); $124/t price of CO_2, which according to a recent academic report co-authored by economist Noah Kaufman (see *here*), is the high end of the price range required to achieve net-zero in 2050.
- **Base case: ~$30 B 2030 TAM; ~$240 B capex.** Volumes reach 75% of those in the SDS (~3 Gtpa); $75/t of CO_2, an estimate for the breakeven of CCS technology (note the breakeven can vary meaningfully by application).
- **Bear case: ~$15 B 2030 TAM; ~$150 B capex.** Volumes reach 50% of those in the SDS (~2 Gtpa); $50/t of CO_2, in-line with the current 45Q tax credit in the US for permanently stored CO_2.

Exhibit 6:
In our base case in 2030, we forecast an addressable market for CCS of ~$30 B, assuming 75% of CCS volumes under the IEA's Sustainable Development Scenario and a CO_2 price of $75/t.

Carbon Capture & Storage: Addressable Market (2030)



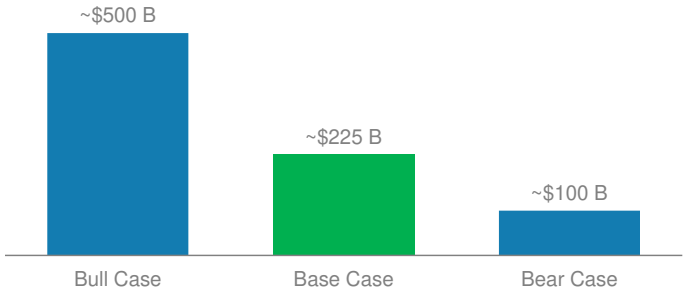
Source: International Energy Agency (IEA); Kaufman, N., Barron., Krawczyk, W. Et al. A near-term to net zero alternative to the social cost of carbon for setting carbon prices; Morgan Stanley Research; Note: Addressable market represents a social cost of carbon derived from applying an assumed price of CO_2 (hypothetical policy mechanism) to CCS volumes.

Addressable Market in 2050:

- **Bull case (Paris-aligned): ~$500 B 2050 TAM; ~$2.2 T capex.** Volumes align with the SDS (~4 Gtpa); $124/t price of CO_2, which according to a recent academic study co-authored by economist Noah Kaufman (see *here*), is the high end of the price range required to achieve net-zero in 2050.
- **Base case: ~$225 B 2050 TAM; ~$1.6 T capex.** Volumes reach 75% of those in the SDS (~3 Gtpa); $75/t of CO_2, an estimate for the breakeven of CCS technology (note the breakeven can vary meaningfully by application.
- **Bear case: ~$100 B 2050 TAM; ~$1.1 T capex.** Volumes reach 50% of those in the SDS (~2 Gtpa); $50/t of CO_2, in-line with the current 45Q tax credit in the US for permanently stored CO_2.

Exhibit 7:
In our base case in 2050, we forecast an addressable market for CCS of ~$225 B, assuming 75% of CCS volumes under the IEA's Sustainable Development Scenario and a CO_2 price of $75/t.

Carbon Capture & Storage: Addressable Market (2050)



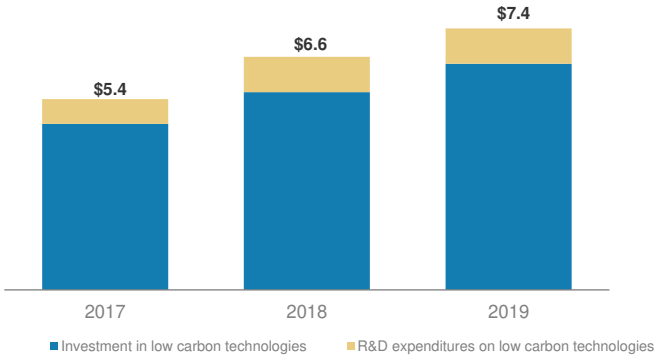
Source: International Energy Agency (IEA); Kaufman, N., Barron., Krawczyk, W. Et al. A near-term to net zero alternative to the social cost of carbon for setting carbon prices; Morgan Stanley Research; Note: Addressable market represents a social cost of carbon derived from applying an assumed price of CO_2 (hypothetical policy mechanism) to CCS volumes.

US Energy: CCS is a Scalable Solution for the Energy Transition

US Energy companies uniquely positioned to advance CCS technology. Along with the rest of the market, US energy companies have begun to offer "net-zero" emission targets and more explicitly incorporate emission intensity into long-term capital allocation. Relative to European peers, however, the domestic sector has lagged on the advancement of sustainability strategies. Now, we are seeing the beginnings of a shift — one that includes more investment in scaling solutions to reduce emissions. Importantly, these strategies go beyond traditional wind and solar projects, where competition is high and returns can often be low. Instead, they focus on technologies that are necessary to achieve global climate goals, but where underinvestment could support higher returns. Among these technologies, CCS has garnered increasing investment from the Energy sector. CCS is both synergistic with traditional energy businesses (EOR, pipelines, and storage) and benefits from large-scale, project development expertise.

Exhibit 8:
Energy spend on low carbon technologies has increased in recent years.

Spending on Investment and R&D in Low Carbon Technologies ($B)



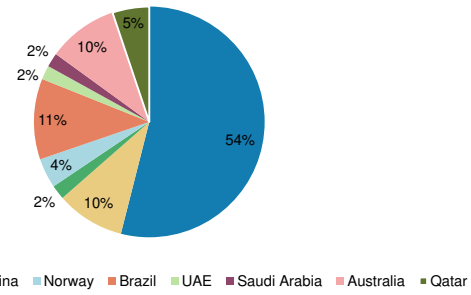
Source: ; OGCI, Morgan Stanley Research; Note: sample is 10 companies reporting for investing and 9 companies reporting for R&D

While the US has lagged on climate progress, the domestic energy sector has foothold in the CCS market. . . US Energy companies have captured CO_2 for decades, primarily sourced from natural gas processing. Much of this CO_2 has been transported by pipeline to oil fields for enhanced oil recovery (EOR), a method of injection to recover oil from hydrocarbon reservoirs. Relative to the 40 Mtpa carbon capture market, ~70% is associated with natural gas processing, and ~60% of capacity primarily sequesters CO_2 through EOR captured through natural gas processing (according to data from the Global CCS Institute). Moreover, 54% of existing CCS capacity resides in the United States.

Exhibit 9:

. . . and is concentrated in the United States, where over 50% of CO2 is captured globally.

Global Distribution of Carbon Capture Capacity



Source: Global CCS Institute, Morgan Stanley Research

. . . and US policy has become increasingly accommodative for further CCS development. Initially introduced in 2008, the 45Q tax credit provides a monetary value for carbon captured and sequestered, including through enhanced oil recovery (EOR). In 2018, Congress expanded the scope and value of the 45Q tax credit, including direct air capture applications. Most recently, as part of the omnibus spending bill at the end of 2020, Congress extended the tax credit by two years to qualify projects that begin construction by YE'25. Moreover, the legislation also include multi-billion dollar funding support for the CCS industry. Now, a recently introduced bipartisan bill, the SCALE Act, seeks to provide funding to further CO_2 transportation and storage infrastructure in the US.

Across the CCS value chain, we see multiple, complementary applications for the energy sector — *both in CO_2 capture. . .*

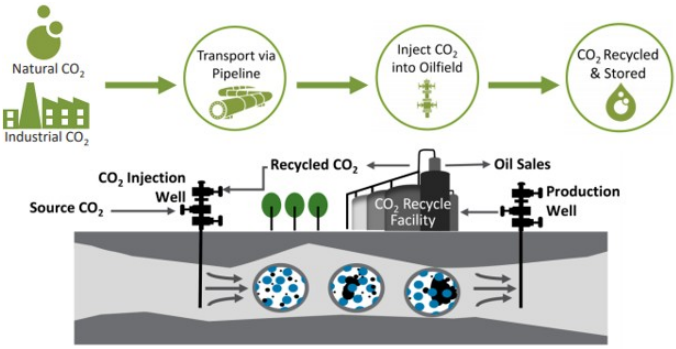
- **Natural gas processing & liquefaction.** Separating CO_2 from methane is a key component of natural gas processing and can be captured at a relatively low cost. We are also beginning to see CCS applied in the natural gas liquefaction process.
- **Industrial facilities.** CCS from industrial sources includes refining, chemicals, steel and cement – generally hard to decarbonize industries. We expect transportation and storage hubs will be integral to making these projects cost-competitive.
- **Blue hydrogen.** As an alternative to "green hydrogen" production through electrolysis, CCS technology can capture CO_2 in hydrogen production from natural gas.

. . . and utilization

- **Enhanced oil recovery (EOR).** Sequestration through EOR sources CO_2 from a mix of naturally occurring CO_2 deposits and anthropogenic capture. As oil & gas companies decarbonize, we anticipate volumes of anthropogenic CO_2 will grow.
- **CO_2 in fuels.** Through chemical conversion processes, captured CO_2 and hydrogen can be converted to synthetic liquid fuels. Potential applications primarily include the transportation industry, most notably aviation.
- **CO_2 in aggregates.** This technology is still in pre-commercialization phase. Among the more notable developers, Blue Planet (CVX is an investor) converts CO_2 into carbonate rock, an alternative to natural limestone.
- **Chemicals.** Celanese recently announced that its Clear Lake facility will begin using recycled/previously vented process CO2 as an alternative feedstock in the production of methanol, a key raw material in the manufacturing of a number of acetyls products. Additionally, we believe that CF, Nutrien, Air Products, and Linde already utilize recycled CO2 in variety of applications across their respective operations (i.e., upgraded urea, purchased process gasses, dry reforming technology). Lastly, OXY is collaborating with Cemvita Factory in an effort to produce ethylene from CO_2, among other applications.

Exhibit 10:

Currently, enhanced oil recovery (EOR) offers the most synergistic application for US Energy and CCS.



Source: Denbury company presentation

We also see a role for energy companies in emerging negative emission technologies. Two carbon capture technologies can result in a net reduction in emissions — direct air capture (DAC) with storage and bioenergy with carbon capture and storage (BECCS). DAC captures CO_2 from the ambient air in the atmosphere, rather than at an industrial source. Siting DAC facilities near CO_2 storage capacity can obviate transportation costs. Among those developing DAC technology, 1PointFive (partially owned by OXY) has advanced the most – undergoing a FEED study for the world's first commercial DAC facility (in-service expected in 2024). In BECCS, biomass is used to generate power and heat or produce biofuels. Associated CO_2 emissions are then captured, which in some instances results in net negative emissions. BECCS is primarily applied in ethanol production, though more nascent forms are entering service in the coming years.

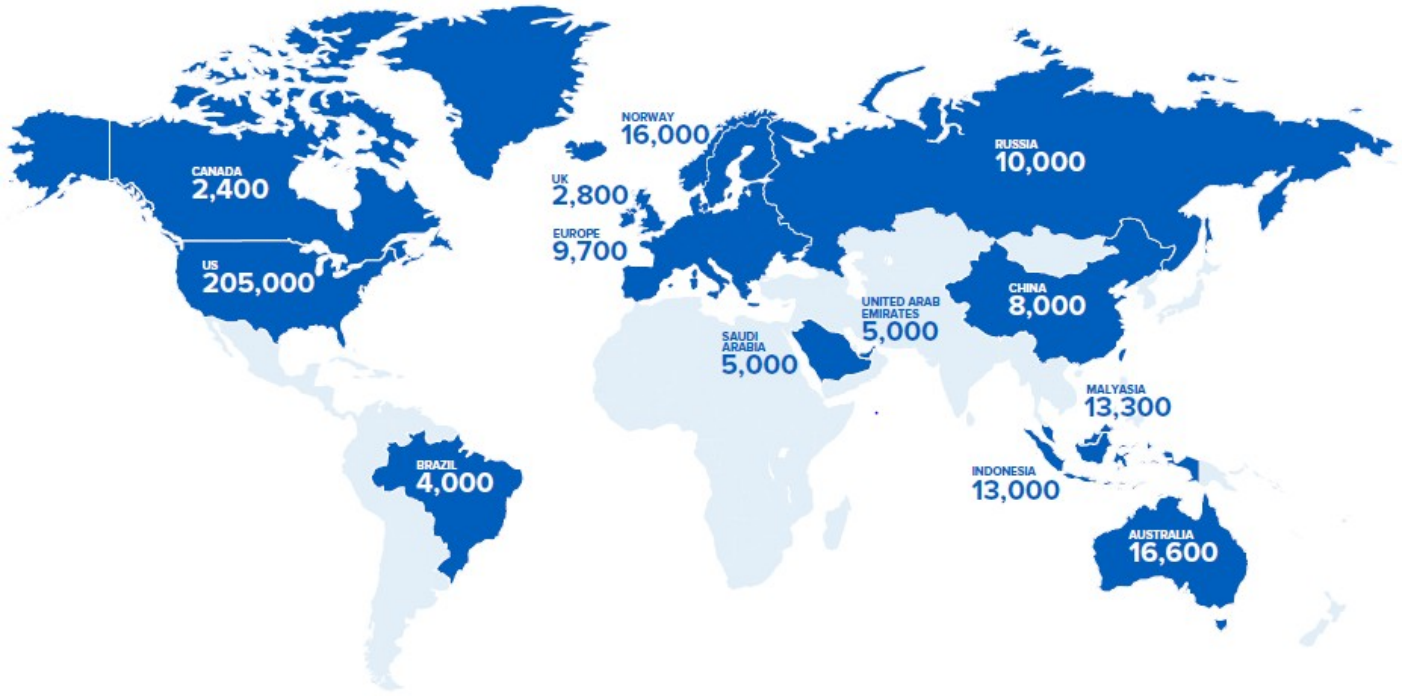
For example, CVX, along with SLB and MSFT (covered by Keith Weiss) plans to develop a BECCS plant that converts agricultural waste biomass into renewable syngas for electricity generation.

Beyond these applications, US benefits from large CO_2 infrastructure and storage backbone. We view shared transportation and storage infrastructure through a "CCS hub" concept as integral to scaling CCS deployment. Currently, the US has both the largest CO_2 transportation network (85% of CO_2 pipelines globally) and storage (~2/3 of global capacity in oil & gas fields, according to data from the Global CCS Institute). Potential outlets for CO_2 storage include depleted shale reservoirs, an opportunity for US E&Ps.

Improving economics for CCS technology. According to data from the National Petroleum Council, the costs per tonne of CO_2 over a plant's 20-year life (opex and capex) are $20-35/t for higher concentration sources (ammonia, natural gas processing, and ethanol) and $60-150/t for lower concentration sources (cement, iron & steel, power generation, etc.). However, this data in part includes an assessment of historical studies, and we believe first-of-a-kind projects and/or retrofits likely overstate go-forward economics. For example, Shell's Quest facility, which captures CO_2 from hydrogen production, entered service in 2015. Last year, Shell had disclosed that operating costs were 35% lower than originally forecast in 2015, and if constructed today, the project would cost ~30% less due to capital efficiency improvements. Separately, LNG developer NEXT, which plans to develop CCS technology alongside the company's Rio Grande LNG project (FID outstanding, provided all-in costs of $63-74/Mt$CO_2$ ($13-24/Mt$CO_2$ net of 45Q tax credits). Management noted that CCS installation on a greenfield project (such as Rio Grande) can be 60-80% less capital intensive than retrofitting an operating facility.

Exhibit 11:

~2/3 of global storage for CO_2 in major oil & gas fields resides in the United States. Note, graphic depicts storage for CO_2 in oil & gas fields by country (millions of tonnes).



Source: Global CCS Institute; According to the Global CCS INstitute, storage in saline formations is hundreds of times larger than capacity shown in the depiction.

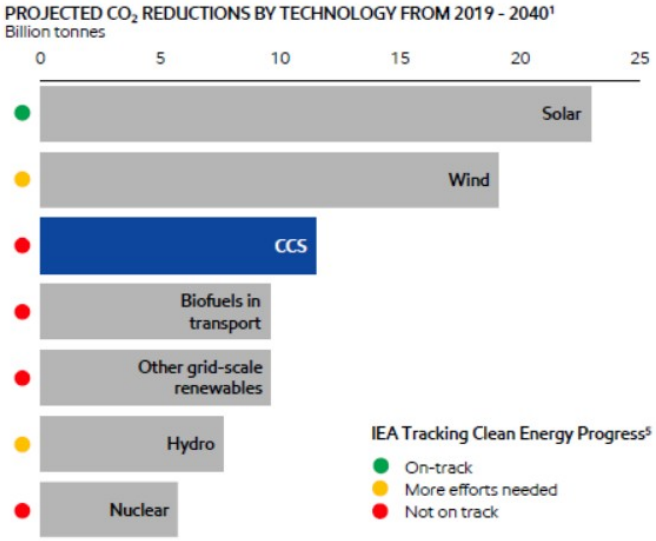
Subsector & Equity Implications

Integrated Oil

Advantages of scale support portfolio repositioning. Messaging from US majors has recently become more proactive around adapting portfolios for the energy transition. For both **CVX** & **XOM,** some low carbon businesses are arguably outside of their "core competencies" (such as wind and solar), though global scale across the energy value chain (including global fuels distribution networks) offers a key competitive advantage in others – most notably carbon capture, hydrogen, and renewable fuels. Both companies view CCS as an underinvested area of the energy transition, and so far have led the wave of investment into this technology. Targeted growth in each company's low carbon subsidiaries (Chevron Technology Ventures and ExxonMobil Low Carbon Solutions), including CCS deployment, could further confront climate risks and support our constructive thesis on both stocks.

- **CVX (OW).** To date, **CVX** has invested >$1 B in CCS R&D and deployment. Earlier this year, CVX launched the company's second Future Energy Fund with $300 MM, targeting technologies that include CCS. Notable CCS projects and investments include: Gorgon Carbon Sequestration Project (one of the largest sequestration projects globally), Mendota BECCS (bioenergy with CCS) Project, Blue Planet (start-up manufacturer of carbonate aggregates using captured CO), Carbon Engineering (direct air capture) and Kern River Carbon Capture (partnership with Svante to pilot CCS).
- **XOM (OW).** Through the company's recently formed ExxonMobil Low Carbon Solutions subsidiary, XOM plans to invest $3 B on emission energy solutions through 2025 — initially focusing on CCS and hydrogen. Currently, XOM, is evaluating >20 new CCS projects around the world, and notably, has already captured more CO_2 than any other company. Key CCS projects include: Le Barge CCS facilities (natural gas treating; ~7 Mtpa with potential expansion), Qatar (natural gas liquefaction; captures 2.1 Mtpa with potential expansion), PORTHOS and H-Vision (CCS hub in the north Sea, along with blue hydrogen production), Port of Antwerp (CCS hub in Belgium), Southeast Texas CCS hub, Singapore CCS hub, and the Acorn Project in Scotland. Lastly, XOM recently entered into an agreement with Porsche to test efuels, which are synthetic fuels derived form hydrogen and captured CO_2.

Exhibit 12:
Oil Majors have competitive advantages in scaling required decarbonization technologies that currently lack adequate investment and/or cost competitiveness, including Carbon Capture, Biofuels, and Hydrogen



Source: ExxonMobil

US E&Ps

For large, global E&Ps, sustainable strategies have included investment in low carbon technologies. Similar to majors, and unlike smaller shale peers, larger E&Ps have the scale to more aggressively reposition portfolios. Among these low carbon alternatives, CCS can be highly complementary for US E&Ps. Upstream energy, including both E&Ps and majors, have leading CCS market share, substantial existing carbon infrastructure, and geologic expertise. Moreover, since the early 1970s, CO_2 has been captured from natural gas processing and transported by pipeline to oil fields for enhanced oil recovery (EOR), which involves the injection of CO_2 in the process of producing oil. Now, investments have expanded to more nascent applications, such as OXY's involvement in direct air capture (DAC), as well as CCS infrastructure hubs.

OXY (EW) offers the most direct exposure to CCS across our broader US Energy coverage. Through OXY's business unit, OXY Low Carbon Ventures (OLCV), the company is developing multiple, potentially transformative, solutions to de-carbonize complementary oil & gas and chemicals businesses. Most notably, through participation in development company 1PointFive, OXY recently signed a licensing agreement to develop the world's largest direct air capture facility — up to 1 million metric tons of CO_2 captured annually, with construction expected to begin in 2022 and in-service in 2024.

Moreover, United Airlines (covered by Ravi Shanker) has committed a "multimillion-dollar" investment in 1PointFive, supporting United's efforts toward a 100% reduction in GHG emissions by 2050. Separately, Shopify (covered by Keith Weiss) agreed to purchase 10 ktpa from 1PointFive's plant, representing the largest publicly announced corporate purchase to-date (see *here*).

Beyond OXY, other E&Ps have expressed an interest in investing in CCS. COP (OW), which has an ambition to achieve net-zero for operated emissions by 2050, has indicated the company is assessing CCS. Separately, **FANG** (OW) established a "Net Zero Now" initiative, producing every hydrocarbon with zero net Scope 1 emissions. Initially, this will include purchased carbon offsets, but over time, FANG plans to invest in income-generating projects to more directly offset Scope 1 emissions. As part of this, FANG has discussed potentially co-investing in CCS with a "subject matter expert." Lastly, Denbury (not covered) sees an opportunity to participate in CCS through its expansive US EOR footprint, producing potentially carbon negative "blue oil."

Chemicals

We view CCS — both at the manufacturing plant level and now potentially on the farm — as one of the four "big ideas" emerging in Chemicals ESG with the potential to drive valuation higher.

While we believe further proliferation and developments in green initiatives related to ammonia/hydrogen production, mechanical/molecular recycling and bioplastics, et al. are afoot, global demand is likely to grow faster than incremental dedicated green supply. Net, there is likely no easy near-term alternatives to using fossil fuels in Chemical production. As such, CCS will offer a much needed solution for reducing the carbon intensity of the industry. To that point, we note that a number of chemical/agriculture companies have made meaningful steps to furthering CCS capabilities at the manufacturing plant level: **ADM** (EW — Illinois Industrial CCS project), **APD** (OW — VSA technology, Valero/Port Arthur CCS retrofit, Project Porthos), **CE** (EW – CO_2 to methanol), **CF** (EW — blue ammonia), **LIN** (OW — dry reformation, PCC, oxyfuel technologies), **NTR** (EW — blue ammonia). Now, too, some potentially are doing so on the farm through early stage carbon capture/credit programs: **BAYGn** (OW) and **NTR.**

Midstream & Diversified Natural Gas

Infrastructure investment to support low carbon technologies could improve utilization, contracting and useful life expectations for existing assets, and create new opportunities. Scaling CCS would require a meaningful infrastructure build-out. In our view, much of this would be longer-dated, with the near-to-medium term spend likely limited to connecting CO_2 hubs to nearby injection sites, while longer-haul trunklines would be required over time to connect major CO_2 sources to storage sites. While limited to only a handful of companies at this point (e.g., **ENB, KMI, TRP, WMB, OKE**), there does appear to be increased proactiveness by some midstream management teams to evaluate asset repurposing and new potential investments, including CCS transportation and storage.

KMI (EW) currently operates one of the largest CO_2 pipeline networks in the US, with >1,300 miles of pipeline and >3 Bcf/d of total system capacity. The company, which recently announced the formation of a New Energy Transition Ventures Group to pursue opportunities in the low-carbon energy transition, notes that while EOR is "widely viewed to be the best disposition for captured CO_2," the best EOR sites are distant from most major sources of CO2, requiring new pipelines to transport the CO_2 from supply source to site. The company also notes that converting other types of pipelines to long-haul CO_2 is rarely feasible.

NEXT (EW) announced one of the most recent CCS projects. NEXT formed a low carbon subsidiary to develop CCS technology alongside the company's Rio Grande LNG project (FID outstanding). NEXT provided all-in CCS costs of $63-74/mt ($13-24/MtCO2 net of 45Q tax credits). We expect the CCS project to be a key differentiator for customers seeking low and no-carbon LNG cargoes — potentially increasing NEXT's prospects of signing incremental offtake contracts and progressing toward project sanctioning (see *NEXT Carbon Solutions: A Shift Towards "Green LNG"; Upgrading to EW*).

Utilities & Clean Tech

CCS has yet to find its place in discussions of decarbonization in the Utilities and Clean Energy space. Driven by the surprisingly low cost of renewables, our latest US power supply mix forecasts show carbon-emitting generation representing only 20% of the energy mix by 2035. In order to make this happen, carbon-heavy utilities that have not historically led the pack in clean energy deployment, are accelerating their earnings growth by pursuing a "virtuous cycle": shutting down expensive coal plants and investing in cheap renewables (more on this dynamic here and here). Beyond 2035, we believe it will be tough to reach a 100% carbon-free Power sector absent technological breakthroughs, given the baseload reliability that gas-fired power plants provide (vs. intermittent renewables).

BE (EW), a fuel-cell company, is working on its own CCS technology that could help enable a net-zero Power sector. Bloom has a working prototype of a carbon separation module that can be attached to its own solid oxide fuel cell. This module would separate the CO2 emissions for its fuel cell to be sequestered, or used. This would result in a firm, reliable, zero-carbon resource. Offering this product commercially would improve the company's ESG profile, and could open up a host of opportunities with the increasing number of corporations that are seeking to decarbonize their electricity sources. Bloom is working on identifying a commercial commitment from a partner and we believe this could be announced in 4Q21. Management sees a path to get carbon capture at a cost below $30/tonne, and identifies a $335 B TAM for its pending Carbon Capture solution.

Oil Services

Our top picks in Oil Services with exposure to CCS include **BKR, GTLS,** and **SLB.**

- **BKR (OW).** BKR's expanding portfolio of products and services supporting the CCS value-chain positions it well to capitalize on longer-term growth opportunities, in our view. BKR has endorsed its strategic commitment to expanding its presence in this market with several recent announcements, including the acquisition of Compact Carbon Capture (3C) — a company specializing in carbon capture solutions, forming a partnership with Horisont Energi on a carbon capture, transport and storage (CCTS) project, and an agreement with SRI International to utilize its Mixed-Salt Process (MSP) for carbon capture solutions.
- **GTLS (OW).** GTLS is emerging as a uniquely positioned key supplier of high-tech equipment with opportunities from trends among various emerging decarbonization solutions, including biogas, carbon capture, and hydrogen, among others. GTLS's recent corporate actions aimed at expanding its addressable market and product capacity for CCS and direct air capture include the ~$20MM acquisition of SES and a ~$15MM investment and commercial MOU with Svante.
- **SLB (OW).** We view SLB's capital-light approach to positioning for the energy transition favorably, where the company has relayed plans to leverage its expertise in the subsurface arena to pursue opportunities in the geothermal and CCS markets, which it believes it can accomplish at a relatively low level of capital investment. In support of these plans, SLB has recently announced the roll-out of its Schlumberger New Energy segment where several new ventures are currently underway. Notably, SLB recently announced a collaboration with Chevron, Microsoft, and Clean Energy Systems to develop a carbon negative bioenergy project.