BETTER LATE THAN NEVER? COMBATING CLIMATE CHANGE THROUGH CARBON CAPTURE UTILIZATION AND STORAGE

Keegan Cassady†

† J.D. Drake University Law School, May 2023, B.S. Animal Science, Dec. 2019, Oklahoma State University. The author would like to thank her family, friends, classmates, and mentors for their support and guidance. The author also dedicates her note to farmers and their complex, ever-changing relationship with the environment around them.

I. INTRODUCTION

Over the last fifty years, climate change has evolved from a distant fear to a present-day reality. Climate change is caused by an increase in greenhouse gases (GHGs) into the Earth's atmosphere.[1] This increase has raised the temperature of the Earth resulting in more extreme weather patterns along with a rise in sea level.[2] Although there are natural changes to the Earth's climate,[3] human activity is the main contributor to the rapid, unusual increase in GHGs.[4] Of these gases, one of the most damaging is carbon dioxide (CO_2) due to its persistent "forcing" of climate change.[5]

As GHGs continue to increase, developed nations have found innovative ways to reduce emissions. One of these methods is carbon geological sequestration – also known as carbon capture, utilization, and storage (CCUS).[6] This process

1. *The Causes of Climate Change*, NASA (Apr. 10, 2022, 2:31 PM), https://climate.nasa.gov/causes/ [https://perma.cc/YSH6-DD7K].

2. *What is Climate Change?*, NASA TELEVISION (Apr. 10, 2022, 2:46 PM), https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-climate-change-k4.html [https://perma.cc/42K6-8FK8].

3. *Id.*

4. *The Causes of Climate Change*, *supra* note 1.

5. *Id.*

6. *Carbon Capture, Utilization & Storage*, U.S. DEP'T OF ENERGY (Apr. 8, 2022, 3:17 PM), https://www.energy.gov/carbon-capture-utilization-storage [https://perma.cc/RF47-A9A6]; Brittany Tarufelli et al., *The Potential Impact of the U.S. Carbon Capture and Storage Tax Credit Expansion on the Economic Feasibility of Industrial Carbon Capture and Storage*, ENERGY POL'Y, Dec. 15, 2020, at 1; *see What's the Difference Between Geologic and Biologic Carbon Sequestration?*, U.S. DEP'T OF THE INTERIOR (Apr. 10, 2022, 2:51 PM), https://www.usgs.gov/faqs/what-s-difference-between-geologic-and-biologic-carbon-sequestration?qt-news_science_products=0#qt-news_science_products [https://perma.cc/F8KB-EDJA].

captures carbon before it is released into the atmosphere and stores it permanently in porous rock formations deep underground.[7] The utilization aspect of this process involves using the carbon in some way instead of storing it in the pore space.[8]

By capturing carbon before it enters the atmosphere, the impacts of climate change can be alleviated—but at what cost?[9] Many argue carbon producing practices should be prevented altogether, thus diminishing the need to sequester it. However, with imminent environmental threats and economic considerations, it is a complex problem requiring complex solutions. With the effects of climate change worsening, it's better to confront climate change late rather than not at all.

A. History

Carbon capture technology can be traced back to the 1920s when it was used to separate CO_2 from methane gas for sale.[10] The CCUS technology seen today has been utilized in North America since the 1970s.[11] Unlike Europe, CO_2 capture in the United States originated from enhanced oil recovery (EOR)—a process which involves pumping captured carbon into the ground to extract oil from developed oil fields.[12] The first large-scale carbon pipeline to an oil field was located in Texas and a major milestone for CCUS globally.[13]

B. Demand

Global demand to combat climate change has increased immensely since the implementation of the Paris Agreement. The Paris Agreement is a legally binding international treaty that became effective in November 2016.[14] President Joseph Biden reentered into the Paris Agreement in 2021 and has advocated for net-zero

7. *What's the Difference Between Geologic and Biologic Carbon Sequestration?*, *supra* note 6.

8. Paul Greening et al., *Carbon Capture, Utilization and Storage – What is the Big Deal?*, AKIN GUMP STRAUSS HAUER & FELD LLP (July 7, 2021), https://www.akingump.com/en/experience/industries/energy/speaking-energy/carbon-capture-utilization-and-storage-what-is-the-big-deal.html [https://perma.cc/XBR8-QM9U].

9. *See Carbon Capture*, CTR. FOR CLIMATE AND ENERGY SOLS. (Apr. 8, 2022, 3:16 PM), https://www.c2es.org/content/carbon-capture/ [https://perma.cc/8DU2-VXPF].

10. IEAGHG, A BRIEF HISTORY OF CCS AND CURRENT STATUS (Apr. 7, 2022, 8:35 AM), https://ieaghg.org/docs/General_Docs/Publications/Information_Sheets_for_CCS_2.pdf [https://perma.cc/9TGT-EM3R].

11. *Carbon Capture*, *supra* note 9.

12. *Id.*

13. *Id.*

14. Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104.

emissions by 2050, meaning the United States will remove at least as many GHGs as it produces.[15] Carbon accounts for 80% of emissions, making it the most abundant GHG.[16] To reach this goal, a report by Princeton University stated between 0.9 and 1.7 gigatons of CO_2 will need to be sequestered per year.[17]

CCUS has been recognized as an essential tool to meet the goals of the Paris Agreement.[18] The United Nations' Economic Commission for Europe (UNECE) published a report calling for a rapid increase in CCUS technology because it can reduce carbon emissions from fossil powered generation.[19]

II. WHAT IS CCUS?

CCUS involves capturing carbon emitted from current industrial activities and pumping it into subterranean structures deep underground.[20] There are four different methods to capture the gas: pre-combustion capture, post-combustion capture, oxy-fuel combustion, and direct air capture.[21]

Once captured, carbon is liquified and transported through a pipeline to where it will ultimately be pumped several kilometers beneath the surface into depleted oil and gas fields or saline aquifer foundations.[22] Because temperature and pressure levels increase further underground, the carbon will maintain a superficial condition.[23] This means the carbon's state is above its critical temperature and

15. Press Release, The White House, *FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies* (Apr. 21, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22 [https://perma.cc/6WYD-U3Z9].

16. *Overview of Greenhouse Gases*, U.S. ENV'T PROT. AGENCY (Apr. 12, 2022, 12:38 PM), https://www.epa.gov/ghgemissions/overview-greenhouse-gases [https://perma.cc/YJP6-RXKZ].

17. Erin Jordan, *How Far Would Iowa Pipeline Projects Go Toward U.S. Climate Change Goals?*, THE GAZETTE (Jan. 19, 2022, 6:00 AM), https://www.thegazette.com/environment-nature/how-far-would-iowa-pipeline-projects-go-toward-u-s-climate-change-goals/ [https://perma.cc/V7ED-65UV].

18. *Carbon Capture, Use and Storage (CCUS)*, U.N. ECON. COMM'N FOR EUR. (Apr. 10, 2022, 3:19 PM), https://unece.org/sustainable-energy/cleaner-electricity-systems/carbon-capture-use-and-storage-ccus [https://perma.cc/Z563-2R46].

19. *See UN Report Calls for Scaling-up Carbon Capture, Use and Storage*, U.N. (Mar. 3, 2021), https://news.un.org/en/story/2021/03/1086312 [https://perma.cc/EDW5-5VGM]; *id.*

20. *Carbon Capture, Utilization and Storage – What is the Big Deal?*, *supra* note 8.

21. *Id.*

22. *Id.*

23. *What is Carbon Capture and Storage?*, NAT'L ENERGY TECH. LAB. (Apr. 10, 2022,

pressure levels, allowing it to behave more like a liquid than a gas.[24] Because the carbon is in this condition, it can be stored at higher volumes than would be possible if it were in its gaseous state on the surface.[25]

Storage requires a specific type of sedimentary basin not found everywhere, so oftentimes the carbon is transported for miles as a liquid to the storage site.[26] There is currently over 4,500 miles of pipeline in the United States for transferring carbon.[27]

A. Utilization

Carbon capture is very expensive; however, one way to make it more feasible is to sell it to other entities for usage.[28] The "utilization" terminology of CCUS is a novel concept, but this practice has been a part of carbon capture since the beginning.[29] As previously mentioned, EOR was one of the first and most common utilizations of carbon, but this is only the beginning.[30]

Companies are able to capture the carbon and sell it as a commodity to a multitude of other industries that need it to create their products.[31] In theory, CO_2 can be used to make any petroleum-based product.[32] Carbon can be utilized to

2:43 PM), https://netl.doe.gov/coal/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/DL65-B8ZE].

24. *Id.*

25. *Id.*

26. *Underground CO2 Storage Concepts*, CLIMATE POL'Y WATCHER (Jan. 7, 2022), https://www.climate-policy-watcher.org/renewable-energy/underground-co2-storage-concepts.html [https://perma.cc/5UPV-S3D3]; *Transport of CO2*, CLIMATE POL'Y WATCHER (Jan. 7, 2022), https://www.climate-policy-watcher.org/renewable-energy/transport-of-co2.html [https://perma.cc/G625-8NC6].

27. *Carbon Capture*, *supra* note 9.

28. Diana Olick, *These Companies are Sucking Carbon Out of the Atmosphere – And Investors are Piling In*, CNBC (July 29, 2021, 3:10 PM), https://www.cnbc.com/2021/07/23/these-companies-are-sucking-carbon-from-the-atmosphere.html [https://perma.cc/H85D-8UN3].

29. David Roberts, *These Uses of CO2 Could Cut Emissions – And Make Trillions of Dollars*, VOX MEDIA (Nov. 27, 2019, 8:37 AM), https://www.vox.com/energy-and-environment/2019/11/13/20839531/climate-change-industry-co2-carbon-capture-utilization-storage-ccu [https://perma.cc/D4DS-X2S4].

30. *Id.*

31. *See* Olick, *supra* note 28.

32. Renee Cho, *Capturing Carbon's Potential: These Companies are Turning CO2 into Profits*, COLUMBIA CLIMATE SCH. (May 29, 2019), https://news.climate.columbia.edu/2019/05/29/co2-utilization-profits/ [https://perma.cc/EDT2-5299].

make fuel, plastics, metals, chemicals, and even bubbles for carbonated drinks.[33] It can also be used to make concrete through a process called "CO_2 mineralization."[34] CO_2 is mixed with mineral carbonates or substituted for water, and mineralization occurs, storing the carbon in the concrete while making it stronger and saving water.[35] For example, Blue Planet creates limestone using carbon from a power plant flue gas to create carbonate rocks.[36]

Another method of utilization is liquid fuels which "recycle" the carbon rather than storing it.[37] Traditionally, the carbon is combusted within the fuel, it is released into the atmosphere; reusing carbon is often more favorable than the alternative.[38] Ideally, carbon utilization would function on a "closed loop system," meaning all CO_2 is utilized or stored, never being emitted.[39]

B. Industries

Carbon dioxide is emitted every day through a variety of industrial processes. CCUS projects work with carbon-intensive industries, including coal-fired power generation and natural gas processing, along with agricultural industries like ethanol and fertilizer production.[40] While these industries cannot eradicate carbon emissions overnight, their emissions can be reduced.[41] Technology like CCUS can be used as one tool to reduce emissions.[42]

C. International Projects

Carbon capture and similar storage projects are found all around the world.[43] Despite concerns about the cost and environmental impact of CCUS, other nations have seen its value and opened the door for this technology.

33. *See* Olick, *supra* note 28.
34. Roberts, *supra* note 29.
35. Roberts, *supra* note 29.
36. Cho, *supra* note 32.
37. Roberts, *supra* note 29.
38. *Id.*
39. *See* Cho, *supra* note 32.
40. *Carbon Capture*, *supra* note 9.
41. Greening et al., *supra* note 8.
42. *Carbon Capture*, *supra* note 9.
43. *See* Patricia Loria & Matthew B.H. Bright, *Lessons Captured from 50 Years of CCS Projects*, 34 THE ELECTRICITY J., Jul. 16, 2021, at 1.

1. Norway

Norway has been a trailblazer for carbon capture and storage in Europe.[44] Norway's intention for utilizing this technology is combatting climate change.[45] The first project solely dedicated to geological carbon storage rather than EOR was the Sleipner Project.[46] Norway's storage site is offshore in the North Sea between the United Kingdom and Norway.[47] Since the project's inception, it has stored 19 million tons of carbon from a natural gas-processing facility.[48] The success of the Sleipner Project has paved the way for other countries to utilize carbon capture technology.[49]

2. United Kingdom

The United Kingdom has been aggressive when it comes to tackling climate change. The Climate Change Act of 2008 established the Climate Change Committee (CCC) to advise the United Kingdom on best practices to combat climate change and report progress to Parliament.[50] In order to achieve net-zero emissions recommended by the CCC, the committee asserts one of the necessary changes is CCUS for industry, bioenergy, and electricity production.[51]

Prime Minister Boris Johnson released a "Ten Point Plan for a Green Industrial Revolution" in 2020 with Point 8 as "Investing in Carbon, Capture, Usage and Storage."[52] Since then, the United Kingdom has five major proposals that will begin operating in the 2020s in Scotland, Humber, Teesside, North West, and South Wales.[53] It is estimated these projects could support 50,000 jobs by 2030.[54]

44. *Id.* at 2.

45. *Id.*

46. *Id.*

47. *Id.*

48. *Id.*

49. *Id.*

50. *About the Climate Change Committee*, CLIMATE CHANGE COMM. (Apr. 8, 2022, 3:00 PM), https://www.theccc.org.uk/about/ [https://perma.cc/M4C8-PTN2].

51. *UK Action on Climate Change*, CLIMATE CHANGE COMM. (Apr. 10, 2022, 2:41 PM), https://www.theccc.org.uk/uk-action-on-climate-change/reaching-net-zero-in-the-uk/ [https://perma.cc/DTJ4-X3XY].

52. HM GOVERNMENT, THE TEN POINT PLAN FOR A GREEN INDUSTRIAL REVOLUTION 23 (2020), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf [https://perma.cc/4QPC-5RDT].

53. *CCUS in Action*, CCUS (Apr. 8, 2022, 3:19 PM) https://www.ccsassociation.org/discover-ccus/ccus-in-action/ [https://perma.cc/35ZD-3XEF].

54. HM GOVERNMENT, *supra* note 52, at 22.

These European initiatives have paved the way for CCUS. There are now twenty-six facilities in operation worldwide capturing a total of 300 million metric tons of carbon.[55]

D. United States Projects

The United States has over 5,000 miles of carbon sequestration pipelines often used for EOR.[56] The first facility in the United States, built in 1971, was the Terrell Natural Gas Plant in Texas used for EOR and is still in use today capturing 0.4 million tons per annum (Mtpa).[57] Comparatively, the largest carbon capture operation in the world, the Shute Creek Gas Processing Plant in Wyoming, captures 7 Mtpa.[58]

1. Illinois

The first project in the United States exclusively designated to capturing carbon for geological storage occurred at Archer-Daniels-Midland (ADM), which operates an ethanol plant in Illinois.[59] This project was made possible with funding by the Department of Energy from the Recovery Act of 2009.[60] Beginning operation in 2017, ADM captures 1 Mtpa.[61] This initiative is unique because transportation is unnecessary; ADM can capture and store 95% of their emissions on site right beneath their ethanol plant.[62]

In 2021, ADM celebrated an important milestone, capturing 1 million metric

55. Loria & Bright, *supra* note 43, at 3.

56. Leah Douglas, *U.S. Carbon Pipeline Proposals Trigger Backlash Over Potential Land Seizures*, REUTERS (Feb. 7, 2022, 2:43 PM CST), https://www.reuters.com/business/environment/us-carbon-pipeline-proposals-trigger-backlash-over-potential-land-seizures-2022-02-07/#:~:text=There%20are%20currently%20about%205%2C000,increase%20pressure%20and%20boost%20production [https://perma.cc/4NBF-8JCC].

57. Loria & Bright, *supra* note 43, at 1-2.

58. *Id.* at 2.

59. *Id.*

60. *Archer Daniels Midland Company*, OFF. OF FOSSIL ENERGY AND CARBON MGMT. (Apr. 8, 2022, 3:15 PM), https://www.energy.gov/fecm/archer-daniels-midland-company [https://perma.cc/D6XQ-RDZG].

61. Loria & Bright, *supra* note 43, at 2.

62. Johnathan Hettinger, *Despite Hundreds of Millions in Tax Dollars, ADM's Carbon Capture Program Still Hasn't Met Promised Goals*, MIDWEST CTR. FOR INVESTIGATIVE REPORTING (Apr. 9, 2022, 6:49 PM), https://investigatemidwest.org/2020/11/19/despite-hundreds-of-millions-in-tax-dollars-adms-carbon-capture-program-still-hasnt-met-promised-goals/ [https://perma.cc/G4GH-8RS6].

tons of carbon.[63] This makes up a significant portion of the 5 million metric tons permanently stored in the United States.[64]Although this is not a solution for all carbon emitters due to financial and geological restrictions, this is one example of how CCUS can successfully prevent further carbon emissions.

2. Iowa

With Iowa being the largest producer of renewable fuel, there is a major demand for CCUS projects in the Midwest.[65] Navigator CO_2 and Summit Carbon Solutions are both building pipelines to capture carbon from industrial agricultural facilities and geologically sequester the gas in neighboring states.[66] The pipelines will transport carbon in opposite directions with Summit permanently sequestering carbon in North Dakota and Navigator transporting carbon to Illinois.[67] When completed, the Summit pipeline will span 2,000 miles across 5 states.[68] Navigator's project, the Heartland Greenway System, will reach 1,300 miles once completed.[69]

These projects aim to cut net GHG emissions in half by 2030.[70] Summit is working with ethanol plants to reach net-zero emissions aiming to market to states with low carbon fuel standards like California.[71] Once completed, these pipelines could remove 27 million metric tons of CO_2 annually, the equivalent of 5.8 million vehicles.[72]

In 2022, ADM expanded their CCUS to Iowa by proposing a carbon pipeline

63. *ADM Announces Successful Completion of One Million Metric Ton Carbon Capture and Storage Project*, ADM (May 19, 2021), https://investors.adm.com/news/news-releases/adm-announces-successful-completion-of-one-million-metric-ton-carbon-capture-and-storage-project [https://perma.cc/8DV7-7UHC].

64. Jordan, *supra* note 17.

65. *See* Donnelle Eller, *Iowa, Texas Companies Propose Multi-Billion-Dollar Carbon-Capture Pipelines Across Iowa, Midwest*, DES MOINES REG. (June 7, 2021, 11:32 AM), https://www.desmoinesregister.com/story/money/business/2021/06/03/companies-planning-carbon-capture-pipelines-across-iowa-midwest-navigator-co-2-ventures-summit/7511185002/ [https://perma.cc/K4PH-JDM9].

66. *Id.*

67. Eller, *supra* note 65.

68. Donnelle Eller, *What We Know About Three Carbon Capture Pipelines Proposed in Iowa*, DES MOINES REG. (Mar. 29, 2022, 11:54 AM), https://www.desmoinesregister.com/story/money/business/2021/11/28/what-is-carbon-capture-pipeline-proposals-iowa-ag-ethanol-emissions/8717904002/ [https://perma.cc/KP32-RN3Y].

69. *Id.*

70. *Id.*

71. *Id.*

72. *Id.*

to capture emissions from their ethanol plants.[73] ADM has contracted with Wolf Carbon Solutions to construct and operate a pipeline that would transport CO_2 from Cedar Rapids to their existing site in Decatur, Illinois.[74] Once completed, it is expected to store 12 million tons of CO_2 per year.[75]

Together these proposed projects could remove 33 million tons of carbon from being released into the atmosphere—a small percentage towards the United States' annual goal.[76] Although Iowa does not have a state goal for CO_2 emissions, this would significantly reduce Iowa emissions by 40%.[77]

III. GOVERNMENT SUPPORT

While CCUS is costly, government agencies have recognized the role this technology can have in addressing climate change, as evidenced by their commitment to funding research and development.[78] Additionally, Congress passed legislation and expanded the tax credit in 2018 to encourage new projects.[79]

A. American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act of 2009 (Recovery Act) allocated over $3 billion to CCUS technology.[80] The Act funded twelve projects to explore the utilization potential of carbon.[81] In 2010, President Obama created the

73. Donnelle Eller, *ADM Proposes an Iowa Carbon-Capture Pipeline, Bringing State's Total to Three*, DES MOINES REG. (Jan. 11, 2022, 5:07 PM), https://www.desmoinesregister.com/story/money/agriculture/2022/01/11/adm-stock-build-co-2-carbon-capture-pipeline-iowa-ethanol/9174490002/ [https://perma.cc/F96C-QXKE].

74. *Id.*

75. *Id.*

76. Jordan, *supra* note 17.

77. *Id.*

78. *See U.S. Department of Energy Announces $110M for Carbon Capture, Utilization, and Storage*, U.S. DEP'T OF ENERGY (Sept. 13, 2019), https://www.energy.gov/articles/us-department-energy-announces-110m-carbon-capture-utilization-and-storage [https://perma.cc/R7H8-SGV4].

79. CONG. RES. SERV., THE TAX CREDIT FOR CARBON SEQUESTRATION (SECTION 45Q) 1 (2021).

80. *American Reinvestment and Recovery Act - CCUS Elements*, IEA (Aug. 24, 2021), https://www.iea.org/policies/11691-american-reinvestment-and-recovery-act-ccus-elements [https://perma.cc/BLV4-XAD8] (citing *FE Implementation of the Recovery Act*, OFF. OF FOSSIL ENERGY & CARBON MGMT. (Apr. 9, 2022, 6:44 PM), https://www.energy.gov/fecm/fe-implementation-recovery-act [https://perma.cc/UQ36-47W5]).

81. *See generally FE Implementation of the Recovery Act*, *supra* note 80.

Interagency Task Force on Carbon Capture and Storage.[82] The goal of the Task Force was to develop a plan to make CCUS more cost-effective and bring in new demonstration projects.[83]

Since then, the Department of Energy (DOE) announced $110 million for CCUS research and development in 2019[84] and another $131 million in 2021.[85] Comparatively, the United States is behind in their adoption of CCUS; however, new legislation has been gaining bipartisan support.[86] The Senate Committee on Energy and Natural Resources passed the Storing CO_2 and Lowering Emissions (SCALE) Act in 2021 to invest in CCUS infrastructure.[87] If adopted, the SCALE Act would represent the largest United States government investment in CCUS in history.[88] This bill would provide funding pathways for CCUS across the country.[89] Supporters of this bill view CCUS as an opportunity to reduce emissions while creating jobs.[90]

B. Infrastructure Investment and Jobs Act

In 2021, Congress passed the Infrastructure Investment and Jobs Act which provided for loans for CCUS projects.[91] In this Act, Congress found "carbon capture and storage technologies are necessary for reducing hard-to-abate emissions

82. *Interagency Task Force on Carbon Capture and Storage*, OFF. OF FOSSIL ENERGY & CARBON MGMT. (Apr. 9, 2022, 6:48 PM), https://www.energy.gov/fecm/services/advisory-committees/interagency-task-force-carbon-capture-and-storage [https://perma.cc/CF9K-V959].

83. *Id.*

84. *U.S. Department of Energy Announces $110M for Carbon Capture, Utilization, and Storage*, *supra* note 78.

85. *U.S. Department of Energy Announces $131 Million for CCUS Technologies*, U.S. DEP'T OF ENERGY (Apr. 24, 2020), https://www.energy.gov/articles/us-department-energy-announces-131-million-ccus-technologies [https://perma.cc/25JH-TRGC].

86. Press Release, Chris Coons Senate Office, *Nation's First Comprehensive CO2 Infrastructure Bill Passes Committee* (July 14, 2021), https://www.coons.senate.gov/news/press-releases/nations-first-comprehensive-co2-infrastructure-bill-passes-committee [https://perma.cc/Y9Q8-JJQL].

87. *Id.*

88. *Id.*

89. *Id.*

90. *Id.*

91. Amy Mall, *CO2 Pipelines Need Safeguards, Too*, NRDC (Aug. 27, 2021), https://www.nrdc.org/experts/amy-mall/co2-pipelines-need-safeguards-too [https://perma.cc/ZB4X-XJQ5].

from the industrial sector."[92] This Act provides $2.1 billion in low-interest loans for CCUS transportation pipelines and $2.5 billion for project development.[93]

C. Department of Energy

The United States DOE has supplied extensive funding for CCUS.[94] The department has spearheaded research and development for CCUS along with regional development programs across the country.[95] Although DOE funds and supports CCUS, it is not the controlling regulatory agency.[96]

D. Carbon Tax Credit

Arguably, the most effective incentive for sequestering carbon is the Tax Credit for Carbon Sequestration Section 45Q.[97] This credit was added to the tax code in 2008 as part of the Energy Improvement and Extension Act in an effort to reduce GHG emissions.[98] The credit covers carbon oxide that would have been emitted if it was not captured by this technology.[99] Emissions are measured when captured as well as before they are injected or utilized.[100] If sequestered rather than used, it must be deposited in a "secure geological storage" site which includes "deep saline formations, oil and gas reservoirs, and unmineable coal seams."[101] If the carbon dioxide is not captured, disposed of, or used, the tax credit must be repaid.[102]

92. Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, § 40301(2), 135 Stat. 986, 986 (2021).

93. CLEAN AIR TASK FORCE, CARBON MANAGEMENT PROVISIONS IN THE INFRASTRUCTURE INVESTMENTS AND JOBS ACT 2 (April 8, 2021, 3:18 PM), https://cdn.catf.us/wp-content/uploads/2021/12/13104556/carbon-management-provisions-iija-1.pdf [https://perma.cc/Y7WM-8FF3].

94. *U.S. Department of Energy Announces $110M for Carbon Capture, Utilization, and Storage*, *supra* note 78.

95. *DOE Awards $20 Million to Help States Deploy Carbon Capture and Storage*, U.S. DEP'T OF ENERGY (Oct. 15, 2021), https://www.energy.gov/articles/doe-awards-20-million-help-states-deploy-carbon-capture-and-storage [https://perma.cc/B6XS-67HQ].

96. *See* Seth Kerschner et al., *How US Environmental Laws and Regulations Affect Carbon Capture and Storage*, CARBON CAPTURE AND STORAGE: THE LEGAL AND REG. CONTEXT (Jan. 29, 2021), https://www.whitecase.com/publications/insight/carbon-capture/how-us-environmental-laws-and-regulations-affect [https://perma.cc/EG7C-59J8].

97. *See* CONG. RES. SERV., THE TAX CREDIT FOR CARBON SEQUESTRATION (SECTION 45Q) 1 (2021).

98. *Id.*

99. *Id.*

100. *Id.*

101. *See id.*

102. *Id.*

The tax credit was expanded under the Bipartisan Budget Act of 2018, and these changes were significant.[103] The Act increased the credit amount; for equipment placed in service prior to February 9, 2018, the credit was $23.82 per metric ton of CO_2 in 2020.[104] For equipment in service on or after February 9, 2018, the credit was $31.77 per metric ton of CO_2 in 2020 and is increasing to $50 by 2026.[105] All amounts are adjusted for inflation annually.[106] Additionally, rather than requiring a 75 million metric ton cap, the Act's amendments include a 12-year claim period.[107]

The expansion also allows the credit to be used for EOR and direct air capture (DAC) along with utilization of CO_2.[108] This further demonstrates the impact of utilization being included in CCUS.[109] Lastly, the Act now allows for smaller facilities to claim the credit as well as those who own the equipment, rather than just the capturer.[110] The Department of the Treasury estimated the Section 45Q tax expenditures will amount to $2.3 billion from 2020-2029.[111]

Although it may come at a cost to taxpayers, this tax credit has been significant enough to give companies added confidence to move forward with new projects. Both Summit and Navigator stated they will rely on federal tax credits for a portion of their revenue.[112] By providing extensive funding, the United States has demonstrated their commitment to CCUS programs as a solution to climate change.

IV. CCUS REGULATION

Although these projects are highly incentivized, they are also highly regulated. CCUS technology has been in the United States since the 1970s, and federal and state government entities are working together to regulate.[113]

103. *Id.*
104. *Id.*
105. *Id.*
106. *Id.*
107. *Id.*
108. *Id.*
109. *See id.*
110. *Id.*
111. *Id.*
112. Eller, *supra* note 68.
113. Kerschner et al., *supra* note 96; *Carbon Capture*, *supra* note 9.

A. Department of Transportation (DOT)

While the DOE initiated the research and development of CCUS, the United States DOT regulates interstate pipelines transporting supercritical liquid carbon under the Pipeline and Hazardous Materials Safety Administration (PHMSA).[114] PHMSA does not regulate pipelines transporting CO_2 in a gaseous or subcritical liquid state.[115] However, most carbon is transported in a supercritical liquid state, thus being subject to PHMSA.[116]

B. Federal Energy Regulatory Commission (FERC)

The Natural Gas Act of 1938 delegated power to FERC to grant natural gas pipelines a certificate of public convenience and necessity.[117] This certificate allows pipeline companies to exercise eminent domain if they cannot gain participation for voluntary easements.[118] This has been met with controversy because many feel the benefits of these pipelines do not outweigh the infringement on the rights of landowners.[119]

C. Environmental Protection Agency (EPA)

Although there are no comprehensive environmental regulations specific to CCUS projects, the EPA oversees many of these initiatives because they often have a federal component.[120] The EPA has a rigorous characterization process to determine the risks of the storage site before issuing permission for storage.[121] Wells used for Geologic Sequestration of CO_2 are known as Class VI Wells.[122] In 2010, the EPA determined requirements for Carbon Dioxide Geological Sequestration Wells Final Rule under the Underground Injection Control Program.[123] The EPA ensures the site has sufficient sitting, construction, testing, monitoring, and

114. Kerschner et al., *supra* note 96.

115. *Id.*

116. *Id.*

117. Alexandra Klass, *Eminent Domain Law as Climate Policy*, 2020 WIS. L. REV. 49, 59-60 (2020).

118. *Id.* at 60.

119. *Id.* at 59.

120. Kerschner et al., *supra* note 96.

121. *What is Carbon Capture and Storage?*, *supra* note 23.

122. *Class VI - Wells Used for Geologic Sequestration of Carbon Dioxide*, U.S. ENV'T PROT. AGENCY (Apr. 8, 2022, 3:20 PM), https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-co2 [https://perma.cc/AG62-M4DH].

123. *Id.*

closure.[124] The purpose of these permits is to protect underground drinking water.[125]

Projects subject to federal jurisdiction must receive a permit for construction under the National Environmental Policy Act (NEPA) to consider the environmental impact.[126] This may include projects on federal land, receiving federal funds, or interstate initiatives.[127] Geologic sequestration is also subject to reporting GHG emissions under the Greenhouse Gas Reporting Program (GHGRP).[128] This program allows the EPA to track the amount of CO_2 sequestered by each site.[129] If the project crosses water or wetlands, a permit under the Clean Water Act (CWA) may be required.[130] Additionally, companies may need to consider impacts to wildlife to ensure compliance with the Migratory Bird Treaty Act and the Endangered Species Act (ESA).[131]

D. State Regulation

In most states, like Illinois and Iowa, companies must get a certificate of "public convenience and necessity" to establish a need for the pipeline.[132] This assures the public that the infringement on landowners and negative environmental impact is secondary to the economic benefits.[133] However, once they have these certificates, they can exercise eminent domain authority if landowners refuse to enter into voluntary agreements.[134]

CCUS companies must navigate this complex regulatory framework when developing these projects, along with state regulations and rights of individual property owners.[135]

V. CCUS DRAWBACKS AND CONCERNS

Although companies are offered government incentives to invest in CCUS,

124. *Id.*
125. *Id.*
126. Kerschner et al., *supra* note 96.
127. *Id.*
128. *Id.*
129. *Id.*
130. Kerschner et al., *supra* note 96.
131. *Id.*
132. Klass, *supra* note 117, at 59; 220 ILL. COMP. STAT. 5/8-406(c) (2021) (amended 2022); IOWA CODE § 479B.9 (2021).
133. Klass, *supra* note 117, at 59.
134. *Id.*
135. Kerschner et al., *supra* note 96.

carbon pipelines in the United States have not been immune from criticism. Many projects have been met with controversy from environmentalists, government officials, and landowners.[136]

A. Cost

One of the main hesitations many countries have with CCUS is cost.[137] The cost of CCUS coincides with the complexity of the project.[138] "Pure" CO_2 streams are the cheapest at $15-25 per ton of carbon, compared to $40-120 per ton of carbon for the more commonly diluted gas streams resulting from power generation.[139] The most expensive method, but arguably the most imperative, is direct air capture.[140] The complexity and early stage of development of CCUS technology contributes to the high price tag.[141] There is still potential for cost reductions as commercialization progresses.[142]

Beyond the cost of the projects themselves, government funding and tax credits come at a cost to the American taxpayer.[143] As previously mentioned, the Section 45Q tax credit will amount to $2.3 billion from 2020-2029 on top of the continuous support from Congress through spending packages.[144]

Whether the cost of CCUS is justified or not, the sequestration opportunities are a matter of priority. Challengers often argue alternatives such as solar and wind, which are trivial in cost compared to CCUS and offer more cost-effective energy solutions.[145] However, these initiatives cannot dramatically decrease CO_2 emissions in all industrial processes, such as cement, steel, and chemical production.[146] In some areas of chemical production, CCUS is currently the cheapest option.[147]

Dismissing CCUS technology due to costs would be a mistake.[148] If CCUS

136. *See* Eller, *supra* note 73.

137. Adam Baylin-Stern & Niels Berghout, *Is Carbon Capture Too Expensive?*, IEA (Feb. 17, 2021), https://www.iea.org/commentaries/is-carbon-capture-too-expensive [https://perma.cc/AUE3-2MBG].

138. *Id.*

139. *Id.*

140. *Id.*

141. *Id.*

142. *Id.*

143. *See* CONG. RES. SERV., THE TAX CREDIT FOR CARBON SEQUESTRATION (SECTION 45Q) 1 (2021).

144. *Id.*

145. *Id.*

146. *Id.*

147. *Id.*

148. *See id.*

technology was limited, the cost and complexity may increase resulting in reliance on even more costly technology.[149] Unlike wind and solar, CCUS is less dependent on seasonal changes and does not require countries to change to a completely new method of power generation; it allows existing industries to reduce emissions.[150] In many countries, CCUS offers the most cost-effective method for producing low-carbon hydrogen from fossil fuels.[151] Other sources of renewable energy are still important but diversifying our power systems is essential for dependable energy.[152]

The United States and other developed nations have recognized the possibilities CCUS offers in combatting the impacts of climate change.[153] Providing funding to agencies along with passing climate policies incentivizes these projects to continue to develop their technology, ultimately becoming a more economically competitive option.[154] For CCUS to meet its economic potential, policy support and government funding is necessary.[155]

B. Environmental Impact

Although CCUS pipelines aim to reduce GHG emissions thus combatting the effects of climate change, this technology has been divisive amongst environmentalists.[156] There are geological restrictions when it comes to storing carbon; therefore, pipelines are required for transportation to these areas that have the suitable pore space.[157] Building pipelines causes major disruption to the environment, but beyond that, there is concern about the long-term effects of geological sequestration.

One fear of storing carbon dioxide deep underground is the potential for leaks.[158] Not only is this a matter of safety but also practicality. If sequestered

149. *Id.*
150. *See id.*
151. *Id.*
152. *Id.*
153. *Id.*
154. *See id.*
155. *Id.*
156. Stephen Groves, *Carbon-Capture Pipelines Offer Climate Aid; Activists Wary*, AP NEWS (July 24, 2021), https://apnews.com/article/technology-joe-biden-business-climate-climate-change-dc976d17ccd6581f25d823b6a894f87f [https://perma.cc/EXE2-D6UT].
157. Mall, *supra* note 91.
158. Yuanrong Zhou, *Carbon Capture and Storage: A Lot of Eggs in a Potentially Leaky Basket*, The Int'l Council on Clean Transp. (Jan. 17, 2020), https://theicct.org/carbon-capture-and-storage-a-lot-of-eggs-in-a-potentially-leaky-basket/ [https://perma.cc/KJ6N-HY74].

carbon leaks back into the atmosphere, the entire process is void.[159] Fortunately, leaks of geologically sequestered CO_2 are expected to be low; less than 1% over a 1,000-year period.[160] If infrastructure is properly constructed, the vast majority of CO_2 will be trapped within the pore space and immobilized for millions of years.[161] To prevent leaks, companies must ensure proper site selection and leak detection monitoring.[162] Additionally, governmental agencies bear the responsibility of reviewing and approving CCUS initiatives with suitable plans.[163]

Environmental groups are concerned these pipelines threaten wildlife habitat, drinking water sources, and environmental justice for vulnerable groups.[164] They recognize the value of CCUS in reducing GHG emissions but fear it may cause environmental issues and increase dependency on fossil fuels and carbon-intensive industrial processes.[165] Due to these concerns, groups are advocating for Congress to require additional environmental protections rather than just funding along with opposing legislation expanding EOR.[166]

If these pipelines cross state lines, they are subject to all federal regulation under the 1938 Natural Gas Act along with each state's laws and regulations.[167] They must receive permits through NEPA and the CWA, along with complying with the ESA.[168] Opponents argue these regulations have historically fallen short of protecting the environment, so they urge for additional protections tailored to the hazards of CO_2 pipelines.[169]

The goal of CCUS is to reduce emissions, thus benefiting the environment.[170] To not create additional environmental problems while trying to solve one, Congress and state legislatures should consider the effects of these projects on the environment and enforce appropriate safeguards.[171]

159. *See id.*

160. *Id.*

161. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC SPECIAL REPORT CARBON DIOXIDE CAPTURE AND STORAGE 14 (2005), https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_summaryforpolicymakers-1.pdf [https://perma.cc/A3ZZ-TB99].

162. *Id.* at 12.

163. Michelle Michot Foss, *Energy Policy in Natural Gas Industry*, *in* 4 ENCYCLOPEDIA OF ENERGY 219, 223 (2004).

164. *See* Mall, *supra* note 91.

165. *Id.*

166. *Id.*

167. Foss, *supra* note 163, at 223.

168. *See* Clean Water Act, ch. 758 § 404 (1948) (codified as 33 U.S.C. § 1344 (2021)).

169. Mall, *supra* note 91.

170. *Carbon Capture, Use and Storage (CCUS)*, *supra* note 18.

171. Mall, *supra* note 91.

C. Landowner Rights

Pipelines and CCUS sequestration sites are vast and require large amounts of land. County officials, landowners, and farmers fear construction will cause damage to drainage tiles, fields, and reduce yields.[172] They further express eminent domain concerns.[173]

1. Damage to Land

Companies seeking to build pipelines must get right-of-way easements from landowners.[174] For example, both companies seeking to build in Iowa have made promises to restore the land to its original condition, along with repairing underground drainage tiles.[175] Companies agree to pay for easements based on market values and compensate farmers for damage to crops.[176]

Although companies have assured farmers with reimbursement plans, many doubt restorations will reach original productivity.[177] Some families have served as stewards of their land for generations, so an involuntary taking may create more than just financial hardships and create an emotional toll as well.[178] To prevent irreversible damage, farmers must work with these companies and their attorneys to ensure they are fairly compensated for the impact of the pipeline.

2. Eminent Domain

If landowners refuse to enter agreements with these pipeline companies, they may seek to take their land using eminent domain. Under the Fifth Amendment of the United States Constitution, if the government provides just compensation, they can take private property for public use.[179] The standard to grant eminent domain power varies by state, but federal eminent domain power exists where Congress recognizes a need rooted in a national interest.[180]

Under the landmark Supreme Court case, *Kelo v. New London*, the Court held furthering economic development constituted a "public use," thus exercising

172. *Id.*
173. Eller, *supra* note 73.
174. *See* Eller, *supra* note 68.
175. *Id.*
176. *Id.*
177. *Id.*
178. *Id.*
179. Klass, *supra* note 117, at 57.
180. *Id.* at 59.

eminent domain power was proper.[181] Based on this precedent, many Midwestern states have enacted laws requiring a certificate of public convenience and necessity before construction may begin.[182] States balance the environmental harm and impact on landowners with the economic benefit of the project when reviewing the permits.[183]

Once permitted, the company may exercise eminent domain use for pipelines to carry out their project.[184] The government asserting eminent domain authority for pipelines is not new.[185] In the 1940s, Congress allowed for natural gas pipelines despite state opposition.[186] Additionally, in 2019, the Iowa Supreme Court upheld the Iowa Utility Board's decision to approve the Dakota Access Pipeline's permit allowing them to exercise eminent domain in *Puntenney v. Iowa Utilities Board*.[187] They found the economic benefits to Iowa outweighed the infringement on landowner's rights and negative environmental impact.[188]

In applying the balancing test precedent applied by the court in *Puntenney*, carbon pipelines are likely to be approved under the public convenience and necessity standard.[189] Carbon pipelines for geological sequestration ultimately benefit the environment by removing GHGs from the atmosphere, thus making them more beneficial than previously approved oil pipelines.[190]

D. Broken Promises

Many fear geological sequestration will create more harm than good and see CCUS as too good to be true. Critics of CCUS argue the technology is "unproven and unsound."[191] Some experts argue CCUS has fallen short of the emission reductions promised.[192] One project promised to capture 90% or more of emissions, but only cut emissions by 55% in year one and 70% after three years.[193] Another project closed early but was estimated to only reduce emissions by 12% after 20

181. Kelo v. City of New London, 545 U.S. 469, 489-90 (2005).
182. Klass, *supra* note 117, at 59; IOWA CODE § 479B.16 (2021); ch. 220, 5/8-406(c).
183. Klass, *supra* note 117, at 59.
184. *Id.*; *See* § 479B.16.
185. *See* Klass, *supra* note 117, at 59.
186. *Id.*
187. Puntenney v. Iowa Utils. Bd., 928 N.W.2d 829, 833 (Iowa 2019).
188. *Id.*
189. *See id.*
190. *See Carbon Capture*, *supra* note 9.
191. Eller, *supra* note 73.
192. Eller, *supra* note 68.
193. *Id.*

years.[194] This begs the question whether the costs outweigh the benefit if reductions may be trivial.

VI. BENEFITS OF CCUS

CCUS does not come without its drawbacks, but there are many benefits to the environment and the economy.

A. Economic Interest

The economic impact of CCUS initiatives has been the driving force behind new projects. This technology allows new jobs to be created and maintains the profitability of current industrial practices.[195]

1. Preserves and Creates Jobs

Another benefit of CCUS is it allows current practices to continue while decarbonizing, thus preserving jobs in energy intensive industries and creating new jobs for carbon sequestration.[196] It would be unrealistic to expect countries to transition exclusively to non-carbon producing energy solutions. In 2020, about 61% of electricity came from fossil fuels in the United States.[197] Solutions, such as CCUS, offer one of the only methods reducing carbon while not changing current practices.[198] Implementing CCUS will not take away jobs from current industries; it will only create new ones.[199] Therefore, CCUS will bridge the gap until carbon-neutral technology is available.[200]

By increasing the demand for products like biodiesel and ethanol, income and job opportunities in rural communities increase.[201] The price for corn and soybeans rises, providing farmers with more money and supporting jobs in the

194. *Id.*

195. ALEX TOWNSEND ET AL., GLOBAL CCS INT., 2020 THOUGHT LEADERSHIP: THE VALUE OF CARBON CAPTURE AND STORAGE (CCS), 12-13 (2020), https://www.globalccsinstitute.com/wp-content/uploads/2020/05/Thought-Leadership-The-Value-of-CCS.pdf [https://perma.cc/JZC2-2YTZ].

196. *See Zero Starts Here*, ZERO CARBON HUMBER (Apr. 10, 2022, 2:53 PM), https://www.zerocarbonhumber.co.uk/ [https://perma.cc/Y8N9-FDQ4].

197. *What is U.S. Electricity Generation by Energy Source?*, U.S. ENERGY INFO. ADMIN. (Apr. 10, 2022, 2:48 PM) https://www.eia.gov/tools/faqs/faq.php?id=427&t=3 [https://perma.cc/Z4UM-HKXV].

198. *See Carbon Capture, Use and Storage (CCUS)*, *supra* note 18.

199. *See Zero Starts Here*, *supra* note 196.

200. *Carbon Capture, Use and Storage (CCUS)*, *supra* note 18.

201. Eller, *supra* note 68.

livestock industry utilizing ethanol byproduct for feed.[202] Additionally, CCUS projects create thousands of new jobs in operation and construction.[203]

2. Opportunities for Agriculture

Much of the demand for CCUS in the Midwest stems from agriculture. Most United States gasoline contains at least 10% ethanol.[204] As the Biden Administration continues to push for electric vehicles, the biofuels industry is challenged to reduce its carbon emissions.[205] Summit Ag Investors President, Justin Kirchhoff, states "capturing carbon makes ethanol more profitable and viable."[206] If the ethanol industry is able to reduce emissions, demand for ethanol increases and corn prices rise putting more money in farmers' pockets and creating less need for government subsidies.[207]

On the other hand, this may result in higher prices at the gas pump.[208] Critics argue efforts are better served transitioning the agriculture industry away from renewable fuels rather than attempting to salvage ethanol's viability.[209] However, current infrastructure is a long way from being able to handle all electric vehicles, and it is unrealistic to expect Americans to purchase electric vehicles overnight. Therefore, CCUS offers a relatively quick solution to a time sensitive issue.

B. Reduced Emissions

The clear benefit to CCUS is the reduced emissions of GHGs without a drastic change to American life.[210] Current industrial processes and power generation contribute large amounts of GHGs to the environment daily, and unless society is willing to completely stop this activity, CCUS is a viable option.[211]

For example, to reach net-zero emissions by 2050 required by the Paris Agreement, large sources of GHGs like vehicles would need to shift to a lower carbon power source.[212] Although there is a push for electric vehicles, even if they

202. *Id.*
203. *Id.*
204. *Id.*
205. *See id.*
206. *Id.*
207. *Id.*
208. *See id.*
209. *Id.*
210. *See Carbon Capture*, *supra* note 9.
211. *See id.*
212. Brad Plumer et al., *Electric Cars Are Coming. How Long Until They Rule the Road?*,

were to make up 60% of new car sales by 2050 as projected, the majority of vehicles would still run on gasoline.[213] It is unrealistic and uneconomical to shift to all electric vehicles prior to 2050.[214]

Ethanol is a prevalent low-carbon fuel source available now.[215] Nearly 70% of gasoline includes ethanol, offering a more environmentally friendly alternative to pure gasoline.[216] In the Midwest, demand for CCUS is dominated by ethanol and fertilizer production based on the large agricultural presence in the region.[217] With the construction of pipelines like Summit and Navigator CO_2 along with the progress already made by ADM, emissions from ethanol production will be significantly reduced while creating a low-carbon fuel.[218] Additionally, the demand for corn will increase which will have long term benefits not only for farmers but also, the environment.[219]

Extreme measures could be taken to combat climate change immediately; however, they would likely not be economically sustainable long term. CCUS can serve as a solution to reduce further emissions more quickly, while not disrupting how the world functions.

VII. WILL IT BE ENOUGH?

Even with extensive funding and international support, many opponents argue CCUS is not enough to significantly combat climate change.[220] They feel investing in CCUS is a distraction, diverting time and resources away from more

NY TIMES (Mar. 10, 2021), https://www.nytimes.com/interactive/2021/03/10/climate/electric-vehicle-fleet-turnover.html [https://perma.cc/2E79-LEBG].

213. *Id.*

214. *See id.*

215. *See Ethanol Use in Motor Vehicles*, UNIV. OF ILL. EXTENSION (Apr. 10, 2022, 3:09 PM), https://web.extension.illinois.edu/ethanol/vehicles.cfm [https://perma.cc/6MRG-HQW7].

216. *See id.*

217. *See* Eller, *supra* note 65.

218. *See id.*; *see also* Eller, *supra* note 73.

219. *See* Eller, *supra* note 73; *see also* Sarah Sellars et al., *What Questions Should Farmers Ask About Selling Carbon Credits?*, FARM DOC DAILY (Apr. 13, 2021), https://farmdocdaily.illinois.edu/2021/04/what-questions-should-farmers-ask-about-selling-carbon-credits.html [https://perma.cc/6LPF-VYQT] (Plants naturally sequester carbon during photosynthesis, so the increase in corn plants will also reduce carbon in the atmosphere).

220. Sam Meredith, *Carbon Capture is Expected to Play a Pivotal Role in the Race to Net Zero Emissions. But Not Everyone Agrees*, CNBC (July 23, 2021, 12:20 AM), https://www.cnbc.com/2021/07/20/climate-crisis-and-carbon-capture-why-some-are-worried-about-its-role.html [https://perma.cc/HSX2-Z6VZ].

viable solutions.[221] One study found CCUS will not achieve the emission reductions needed by 2030.[222] Furthermore, the study argues, "[t]he technology still faces many barriers, if these can be overcome, [it] would only start to deliver too late."[223]

Nevertheless, CCUS has international support with successful projects across the globe.[224] With time as the number one limiting factor, some feel countries must utilize every technology possible to combat climate change.[225] CCUS facilities globally have the ability to capture more than 40 metric tons of CO_2 annually.[226] As previously mentioned, the UNECE stated that development of CCUS would allow countries to "decarbonize" fossil fuel power and has called for an increase in CCUS.[227] Because of the reliance on industrial materials such as cement, oil, and steel, it will most likely be impossible to meet net-zero emissions without CCUS.[228]

VIII. CONCLUSION AND RECOMMENDATIONS

Regardless of the regulatory and legal challenges associated with CCUS technology, reducing GHG emissions remains a vital solution to combat the effects of climate change. The United States government should continue to pass policies, support funding packages, and provide tax credits supporting CCUS projects while ensuring proper regulatory enforcement to prevent negative impacts on the environment. CCUS offers a meaningful opportunity to reduce GHGs and combat the effects of climate change. While CCUS may not be a perfect solution, when it comes to mitigating the effects of climate change, it is better late than never.

221. *Id.*

222. *Briefing: Tyndall Centre, "A Review of the Role of Fossil Fuel Based Carbon Capture and Storage in the Energy Syste*m," FRIENDS OF THE EARTH SCOTLAND AND GLOBAL WITNESSES (Apr. 10, 2022, 3:18 PM), https://www.globalwitness.org/documents/20070/CCS_Research_briefing_summary_-_GW_and_FOES.pdf [https://perma.cc/9ZKF-7VY6].

223. *Id.*

224. *See UN Report Calls for Scaling-up Carbon Capture, Use and Storage*, *supra* note 19.

225. Meredith, *supra* note 220.

226. *Id.*

227. *UN Report Calls for Scaling-up Carbon Capture, Use and Storage*, *supra* note 19.

228. *See* Meredith, *supra* note 220.