

POLICIES AND PROGRAMS AVAILABLE IN THE UNITED STATES IN SUPPORT OF CARBON CAPTURE AND UTILIZATION

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Synopsis: The article seeks to compile policies and programs that provide revenue and financing support for carbon capture and utilizations projects, which are available in the United States. Often technically minded entrepreneurs and investors new to this space are unaware of available support, which could help successful development of carbon capture and utilization projects. Covered in this article are the 45Q tax credit, green bonds, loan guarantee programs, the regional greenhouse gas initiative, and low carbon fuel standards.¹ This article covers the eligibility and effect of each policy and program. The article also briefly reviews the current state of technology and summarizes how each technology pathway pairs with the policies covered in the article. The goal of the article is to serve as a primer for lawyers, corporate development professionals, and practitioners, who seek to learn about policies and programs available to support carbon capture and utilization (CCU) projects.

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1. These terms will be defined and discussed later in this article.

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I. INTRODUCTION

Meeting the two-degree Paris accords climate target² may not be possible through emissions reductions alone, which is why many believe that carbon capture will be a required part of the solution that avoids significant climate change.³ This piece of the climate solution has already been shown to be technologically feasible through research from laboratories and universities around the globe, as well as pilot and startup scale facilities already in operation worldwide.⁴ But just because we can do something, does not mean we will. It will take an investment of around \$36-\$44 trillion in climate change related projects by 2050 to reach two-degree targets, according to the International Energy Agency.⁵ An investment pool of this size is not likely to come solely from the pockets of the good-hearted looking to make a difference. Attracting investors will require climate-related projects and businesses to offer competitive and stable returns on investment. This

2. UNITED NATIONS CLIMATE CHANGE, THE PARIS AGREEMENT, <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> (last visited Mar. 16, 2020).

3. CARBON CAPTURE & STORAGE ASSOC., TACKLING CLIMATE CHANGE, <http://www.ccsassociation.org/why-ccs/tackling-climate-change/> (last visited Mar. 16, 2020).

4. Editorial Board-Earth.org, *Large-Scale Carbon Capture is Finally Underway*, IMPAKTER (July 3, 2019), <https://impakter.com/large-scale-carbon-capture-is-finally-underway/>.

5. Marc Gunther, *Can Green Bonds Bankroll A Clean Energy Revolution?*, YALE ENV'T 360 (Nov. 24, 2014), https://e360.yale.edu/features/can_green_bonds_bankroll_a_clean_energy_revolution.

article seeks to compile in one place policy initiatives that will help boost and support the returns of carbon capture and utilization (CCU) technologies in the United States. Finally, this article reviews which CCU ventures pair well with current policies, and additionally, how existing policies could be improved, through specific tailoring, tiered support and targeted subsidy increase.

CCU is a particularly attractive area of climate technology because it can offer an additional revenue stream above carbon capture and sequestration (CCS).⁶ Unless a CCS project is selling the captured carbon dioxide (CO₂) to another process, such as enhanced oil recovery or beverage bottling, a CCS project is not creating a revenue stream from its captured product.⁷ CCU, on the other hand, has the potential to transform CO₂ into a plethora of useable products including, formic acid, carbon monoxide, methane, and others.⁸ The moonshot goal of CCU should be to produce a product that not only generated a substantial profit, but also displaced the need for other carbon-intensive manufacturing operations (e.g. methane production). However, since most CCU projects currently produce very little if any profit,⁹ this article will focus on policy initiatives which support the cash-flow of CCU projects and companies through direct revenue support, tax credits, and access to low-cost capital.

This article is intended for an audience of entrepreneurs with startups focused on carbon capture, as well as lawyers, corporate development professionals, and practitioners interested in taking on carbon capture projects at their existing companies. For business development professionals running financial models around carbon capture projects and companies, the assumptions made need to include support from the policy initiatives discussed in this article, because these policies can make the marginal difference needed to attract venture capital investment for entrepreneurs or beat a required hurdle rate for development projects.

For quick reference, the table in the appendix of this article summarizes the policies covered within this article, which is a comprehensive list of policies affecting CCU within the United States of America. For each policy, an overview, eligibility requirement, and effect of the policy on the financial bottom line is covered. Not every CCU project will qualify for the benefits under all of these policies. Some policies will depend on the source of CO₂ captured, for example the Regional Greenhouse Gas Initiative (RGGI) that applies to CCU projects attached to power generating stations.¹⁰ Other policies will depend on the product made, for example the Low Carbon Fuel Standard that applies to production of chemicals

6. CARBON CAPTURE COALITION, CARBON CAPTURE FACTS: OCTOBER 2018 (Oct. 31, 2018), <https://carboncapturecoalition.org/carbon-capture-facts-october-2018/>.

7. WORLD COAL ASSOC., CARBON CAPTURE, USE & STORAGE, <https://www.worldcoal.org/reducing-co2-emissions/carbon-capture-use-storage>.

8. David Miller et al., *Toward Transformational Carbon Capture Systems*, 62 ALCHE JOURNAL no. 1, 2015.

9. GLOBAL CCS INSTIT., CAN WE MAKE CO₂ CAPTURE PROFITABLE? (June 10, 2019), <https://www.globalccsinstitute.com/news-media/insights/can-we-make-co2-capture-profitable>.

10. THE REG'L GREENHOUSE GAS INITIATIVE, ELEMENTS OF RGGI, <https://www.rggi.org/program-overview-and-design/elements> (last visited Mar. 16, 2020).

to be used as fuels.¹¹ The table provides a brief overview of each policy for the reader to understand which policies are most relevant to them.

II. FEASIBILITY

Policy alone will not commercialize CCU. It will take a combination of well-structured policy, advantaged economics, and technology innovation. So, what is the current state of technology and how does it pair with the available policies for revenue support?

Below, the feasibility of CCU is reviewed in three key areas: Capture, Process, and Product. Though some technologies are currently more advanced than others, predicting which technologies will be the first to successfully commercialize is beyond the scope of this article.

Other key features that will not be covered are compression and transportation, because these areas are well-proven commercially. This part of the process is already deployed commercially, both in CO₂ lines used for Enhanced Oil Recovery (EOR) and other processes, and in the natural gas industry.

A. Capture

Point source capture is furthest along in its technical viability. Purer CO₂ streams makes carbon capture easier and less expensive.¹² Reviewing the point source opportunities in approximate order of the quality of their CO₂ stream, biorefineries produce a nearly pure stream of CO₂ that requires very little separation.¹³ Carbon capture is currently occurring at a commercial scale biorefinery facility located in Decatur, Illinois, resulting from a partnership between Arthur Daniels Midland and the U.S. Department of Energy (DOE).¹⁴ That facility is currently capturing and sequestering 1 million tons of CO₂/y,¹⁵ which is double the maximum allowed by the 45Q.¹⁶ Another facility operated by Red Tail Energy is set to sequester 180,000 tCO₂/y in Richardton, North Dakota in 2020.¹⁷

11. CALIFORNIA AIR RES. BD., LOW CARBON FUEL STANDARD, <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard> (last visited Mar. 16, 2020).

12. Adele Peters, *We have the tech to suck CO₂ from the air – but can it suck enough to make a difference?*, FAST CO., <https://www.fastcompany.com/90356326/we-have-the-tech-to-suck-co2-from-the-air-but-can-it-suck-enough-to-make-a-difference> (last visited Mar. 16, 2019).

13. Daniel L. Sanchez et al., *Near-term deployment of carbon capture and sequestration from biorefineries in the United States*, 115 PNAS no. 42, 2018.

14. Scott McDonald, *Eliminating CO₂ Emissions from the Production of Vio Fuels – A ‘Green’ Carbon Process*, ILL. INDUS. CARBON CAPTURE & STORAGE PROJECT (July 11, 2017), https://www.energy.gov/sites/prod/files/2017/10/f38/mcdonald_bioeconomy_2017.pdf.

15. Sanchez et al., *supra* note 13.

16. 26 U.S.C. § 45Q(a) (2012) (offering a tax credit to taxpayers who own and operate qualifying carbon capture equipment).

17. Sanchez et al., *supra* note 13.

Natural gas processing facilities also produce a nearly pure stream of CO₂.¹⁸ When processing raw natural gas, CO₂ is separated to bring the natural gas within specification for transportation and end-use.¹⁹ Carbon capture from natural gas processing plants has already proven successful at industrial scale.²⁰ There is a processing plant in Louisiana that separates CO₂ and pipes it to West Texas for EOR.²¹ Exxon currently captures 4 million tons of CO₂/y from a processing plant in La Barge, Wyoming for use in EOR projects.²² In North Dakota, Encana is capturing gas from a gasification plant to send to Saskatchewan, Canada for EOR.²³ Though this project is not eligible for the 45Q because the CO₂ is not stored within the borders of the United States.²⁴ For Occidental's ambitious EOR projects, CO₂ will be sourced from a Sandridge Energy gas processing plant where they plan to capture 13.5 million ton of CO₂/y for EOR.²⁵ The scale of these projects shows that there is plenty of CO₂ available from natural gas processing for use in CCU projects.

Carbon capture from electric generating facilities is also commonly discussed, but the contaminants in the flue gas present technical and economic barriers that make this process more difficult.²⁶ Though it is not currently done in the United States, capturing the flue gas from natural gas fired generating stations is less technically challenging than capturing CO₂ from coal or oil fired generating stations.²⁷ Currently, carbon capture from natural gas fired generating stations has proven successful at industrial scale in Norway, at Sargas & Technology Centre Mongstad.²⁸ In the United States, carbon capture from so called "clean coal" has been covered in the media, but there are only two plants running this process.²⁹

18. James Conca, *Net Zero Natural Gas Plant—The Game Changer*, FORBES (July 31, 2019), <https://www.forbes.com/sites/jamesconca/2019/07/31/net-zero-natural-gas-plant-the-game-changer/#3610c59d1de2>.

19. U.S. ENERGY INFO. ADMIN., NATURAL GAS EXPLAINED - DELIVERY AND STORAGE OF NATURAL GAS, <https://www.eia.gov/energyexplained/natural-gas/delivery-and-storage.php> (last visited Mar. 16, 2019).

20. DEP'T OF ENERGY, CARBON CAPTURE OPPORTUNITIES FOR NATURAL GAS FIRED POWER SYSTEMS, https://www.energy.gov/sites/prod/files/2017/01/f34/Carbon%20Capture%20Opportunities%20for%20Natural%20Gas%20Fired%20Power%20Systems_0.pdf (last visited Mar. 17, 2020).

21. NAT'L ENERGY TECH. LAB., CARBON DIOXIDE ENHANCED OIL RECOVERY, www.netl.doe.gov/sites/default/files/netl-file/CO2_EOR_Primer.pdf (last visited Mar. 17, 2020).

22. *Id.*

23. NAT'L ENERGY TECH. LAB., 7.5.2. WEYBURN PROJECT, <https://www.netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/weyburn>.

24. 26 U.S.C. § 45 Q.

25. NAT'L ENERGY TECH. LAB., CARBON DIOXIDE ENHANCED OIL RECOVERY, www.netl.doe.gov/sites/default/files/netl-file/CO2_EOR_Primer.pdf.

26. Maura Vaccarelli et al., *Energy and Economic Analysis of the CO₂ Capture from Flue Gas of Combined Cycle Power Plants*, SCI. DIRECT (2014), <https://www.sciencedirect.com/science/article/pii/S1876610214001234>.

27. *Id.*

28. CLEANAIR TASK FORCE, NATURAL GAS WITH CARBON CAPTURE, http://www.fossiltransition.org/pages/_copy_of_natural_gas_w_ccs/182.php.

29. Chris Mooney, *America's First 'clean coal' plant is now operational – and another is on the way*, WASH. POST (Jan. 10, 2017), <https://www.washingtonpost.com/news/energy-environment/wp/2017/01/10/america-first-clean-coal-plant-is-now-operational-and-another-is-on-the-way/>.

NRG's Petra Nova facility in Thompsons, Texas is supported by the DOE. Another commercial facility is on the Boundary Dam 3 generating station in Canada.³⁰ Additionally, a company called Net Power has created a pilot scale natural gas fired power plant that integrated carbon capture directly into the plant's design.³¹ In doing so, Net Power's generating station produces a nearly pure stream of CO₂ making carbon capture from this facility much easier and cheaper.³² The carbon captured from Net Power's pilot scale facility will be used for EOR.³³

Direct Air Capture maybe the capture method most think of when considering carbon capture, but it is likely the furthest from commercial viability. This technology is still in the pilot stage and because the operating cost of capture is inversely proportional to the concentration of CO₂ in the source stream, the economics are strained by the fact that the concentration of CO₂ is very low in the atmosphere.³⁴ With that said, Carbon Engineering has developed a pilot scale plant in Squamish, Canada that is capturing 1 million tons of CO₂/y,³⁵ which doubles the maximum allowable capture credit for the 45Q.³⁶ The fact that a scale pilot plant can double this amount evidences why the high-end cap on the 45Q credit must be increased to help commercialize these processes.

B. Process & Product

There is a myriad of products that can be created from CO₂.³⁷ Some products can be produced through multiple pathways, and are in a wide range of stages of commercial readiness.³⁸ This article will not cover all of these pathways, but it will look at a few that are closest to commercial viability.

The first pathway is reductive processes for creating products from CO₂.³⁹ A reductive process is a chemical reaction where one atom gains electrons, requiring electrons and energy.⁴⁰ Note that for these processes to be carbon negative, they will require renewable energy for the electron and energy source.⁴¹ The National

30. Catherine Morehouse, *Can carbon capture save the San Juan coal plant?*, UTILITY DIVE (Nov. 21, 2019), www.utilitydive.com/news/can-carbon-capture-save-the-san-juan-coal-plant/567678/.

31. NET POWER, WE CAN ACHIEVE NET ZERO CO₂, <https://netpower.com>.

32. Conca, *supra* note 18.

33. *Id.*

34. Rory Jacobson, *The Case for Investigating in Direct Air Capture Just Got Clearer*, GREENBIZ 2 (May 28, 2019), <https://www.greenbiz.com/article/case-investing-direct-air-capture-just-got-clearer>.

35. David Keith, et. al., *A Process for Capturing CO₂ from the Atmosphere.*, 2 JOULE, no. 8, 2018.

36. *Id.* at 3.

37. Conca, *supra* note 18.

38. *Id.*

39. Ricardo A. Wolosiuk, et al., *The Reductive Pentose Phosphate Cycle For Photosynthetic CO₂ Assimilation: Enzyme Modulation*, 7 FASEB J. 622 (1993) ("The reductive pentose phosphate cycle is the main biochemical pathway for the conversion of atmospheric CO₂ to organic compounds.").

40. *Id.*

41. Richard Eisenberg et al., *Addressing the Challenge of Carbon Free Energy*, PROCEEDINGS OF THE NAT'L ACADEMY OF SCI. OF THE U.S., 2, 5 (Aug. 19, 2019), <https://www.pnas.org/content/pnas/early/2019/10/01/1821674116.full.pdf>.

Renewable Energy Lab (NREL) has published a comprehensive article on reductive processes in great technical detail.⁴²

NREL shows Indirect Thermochemical Utilization (ITU) is the most technologically advanced method due to years of research in the area by the fossil fuel industry.⁴³ The chemical reaction in an indirect process requires breaking the carbon-oxygen double bond in CO₂ before the final product is formed.⁴⁴ Thermochemical reactions require heat. ITU is feasibly two to four years away from commercialization.⁴⁵ Essentially, these processes are already commercialized utilizing non-anthropogenic CO₂.⁴⁶ ITU is also advantaged in that many high value products can be created from this process, such as MeOH, olefins, and fuels.⁴⁷ Demand for these products is substantial, giving this process a substantial upside once commercialized. Additionally, the production of fuels would qualify these processes under the Low Carbon Fuel Standard (LCFS), meaning more revenue support as commercialization gets underway. Much of the literature around ITU indicates that CO₂, Formic Acid, Fischer-Tropcz, and MeOH are the closest to commercialization from a product price and production cost standpoint.

Indirect Bioelectrical Reduction (IBR) also shows near-term promise.⁴⁸ Bioelectrical reactions involve electrons produced by organisms.⁴⁹ Currently, these processes are commercial and pre-commercial.⁵⁰ A company called microBenergy has been upgrading CO₂ back to methane in Germany since 2015, and Electrochaea has done so in Denmark since 2014.⁵¹ Feasibly in four to six years we could see IBR at full commercial scale with Anthropogenic CO₂. IBR is also advantaged in that it pairs well with renewable energy because it can be easily cycled with minimal start-up and shut-down costs.⁵² This trait also makes it possible to use IBR processes as a chemical battery, which could add another revenue stream to the process.

42. See generally Dutta Talmadge et al., *Process Design and Economics for Conversion of Lignocellulosic Biomass to Ethanol*, NAT'L RENEWABLE ENERGY LAB. (May 2011), <https://www.nrel.gov/docs/fy11osti/51400.pdf>.

43. See generally S. Phillips et al., *Thermochemical Ethanol Via Indirect Gasification and Mixed Alcohol Synthesis of Lignocellulosic Biomass*, NAT'L RENEWABLE ENERGY LAB (April 2007) <https://www.nrel.gov/docs/fy07osti/41168.pdf>.

44. Gary Grim et al., *Feasibility Study for the Utilization of CO₂ and Electrons: Pathways, Technical Challenges, and Products*, NAT'L RENEWABLE ENERGY LAB (May 4, 2018).

45. *Id.*

46. See generally Lee Beck, *Carbon Capture and storage in the USA: the role of US innovation leadership in climate-technology commercialization*, OXFORD ACAD. (Dec. 24, 2019), <https://academic.oup.com/ce/advance-article/doi/10.1093/ce/zkz031/5686277>.

47. Robert Grim et al., *Transforming the carbon economy: challenges and opportunities in the convergence of low-cost electricity and reductive CO₂ utilization*, 13 ENERGY & ENVTL. SCI. 472 (2020).

48. *Id.*

49. *Id.*

50. *Id.*

51. Grim et al., *supra* note 44. See also MICROBENERGY, VISION DER GANZHEITLICHEN ENERGIEWENDE, <https://www.microbenergy.de/unternehmen>; ELECTROCHAEA, ABOUT ELECTROCHAEA, <http://www.electrochaea.com/about/>.

52. Grim et al., *supra* note 47.

In addition to reductive processes, there are non-reductive processes that utilize CO₂. Cement production using CO₂ as an additive is one such process, which has already been shown to be technically feasible.⁵³

The exciting thing about CCU is that it is likely closer to commercialization than many realize. It is likely many CCU processes will become commercial over time and the green products that are created will continue to improve the economy and the environment.

III. 45Q

A. Overview

As noted earlier, 45Q refers to section 45Q of the 2008 U.S. tax code, which offers a tax credit to taxpayers who own and operate qualifying carbon capture equipment.⁵⁴ The program was adjusted and expanded under the Budget Bill, approved by the U.S. Congress in February 2018.⁵⁵ The program covers carbon capture and sequestration through dedicated geological storage, storage via EOR, and storage via utilization processes.⁵⁶ For the purposes of this article, we will focus on how the current program applies to carbon capture and utilization processes.

B. Eligibility

CCU processes are eligible to receive a tax credit based on the amount of CO₂ captured and disposed of that would have otherwise been released.⁵⁷ For example, CO₂ sourced from a bioethanol plant is of biogenic origin and therefore is considered CO₂ that would have otherwise been released.⁵⁸ CO₂ from natural sources, such as naturally occurring underground reservoirs, is not eligible for credit under this program.⁵⁹ By this definition, emitting facilities cannot scale back on other means of reducing CO₂ emissions in order to capture the credit.⁶⁰ The credit value will be adjusted for the portion of utilized CO₂ shown to reduce overall emissions, using the same criteria as the life cycle analysis, per section 211 (o)(1)(H) of the Clean Air Act.⁶¹

53. CO₂CONCRETE, LLC, CARBON CAPTURE PROCESS, <https://www.co2concrete.com/carbon-capture-process/>.

54. INTERNAL REVENUE SERV., CREDIT FOR CARBON DIOXIDE SEQUESTRATION UNDER SECTION 45Q, <https://www.irs.gov/pub/irs-drop/n-09-83.pdf>.

55. *Id.*

56. *Id.*

57. 26 U.S.C. § 45Q; Simon Bennett & Tristan Stanley, *US Budget Bill May Help Carbon Capture Get Back on Track*, INT'L ENERGY AGENCY (Mar. 12, 2018), www.iea.org/newsroom/news/2018/march/commentary-us-budget-bill-may-help-carbon-capture-get-back-on-track.html; Keith Martin, *Tax Equity and Carbon Sequestration Credits*, NORTON ROSE FULBRIGHT (Apr. 10, 2018), www.nortonrosefulbright.com/knowledge/publications/165331/tax-equity-and-carbon-sequestration-credits.

58. Bennett & Stanley, *supra* note 57.

59. *Id.*

60. Martin, *supra* note 57.

61. *Id.*

Tax credit is provided to the tax payer who owns the capture equipment and disposes of, or contracts for the disposal of, the CO₂.⁶² CO₂ must be captured and disposed of in the United States or a possession (territory) of the United States.⁶³ Criteria of satisfactory disposal will fall on the Environmental Protection Agency (EPA), Secretary of Energy, and Secretary of the Interior.⁶⁴ The IRS has the final say about permitted commercial utilization.⁶⁵

For carbon capture and utilization equipment to be eligible, the process must capture greater than 25,000 tCO₂/yr,⁶⁶ the volume cap on the credit was removed as part of the Bipartisan Budget Act of 2018.⁶⁷ CO₂ must be metered at the source and again at the point of disposal, to be eligible for the credit.⁶⁸

To be eligible for the tax credit adjusted under the 2018 Budget Bill, equipment must be installed on or after February 9, 2018, and before January 1, 2024.⁶⁹ In February 2020, the IRS released guidance clarifying that for projects to be considered as under construction before the start of 2024, the operator must begin physical work or prove 5% of the project's costs had been paid by that date.⁷⁰

62. 26 U.S.C. § 45Q.

63. *Id.*

64. *Id.*

65. Martin, *supra* note 57.

66. Bennett & Stanley, *supra* note 57.

67. Scott Pollock et al., *Treasury Issues Long-Awaited Carbon Sequestration Tax Guidance*, SIDLEY (Feb. 25, 2020), <https://www.sidley.com/en/insights/newsupdates/2020/02/treasury-issues-long-awaited-carbon-sequestration-tax-guidance>.

68. 26 U.S.C. § 45 Q.

69. Bennett & Stanley, *supra* note 57; Martin, *supra* note 57.

70. Pollock et al., *supra* note 67.

C. Effect on Bottom Line

The adjusted tax credit under the 2018 Budget Bill, provides a credit in the amount of \$12.66/tCO₂ in 2017, linearly interpolated to \$35/tCO₂ in 2026, and afterwards adjusted for inflation.⁷¹ Credits can be claimed for up to twelve years.⁷²

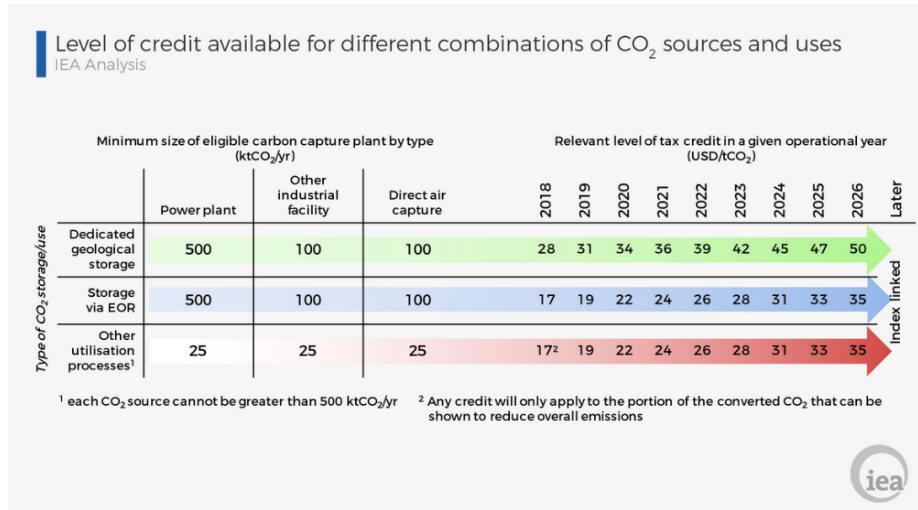


Figure 1. Level of Credit Available for Different Combinations of CO₂ Sources and Uses.⁷³

Credit amount will be adjusted for the portion of utilized CO₂ shown to reduce overall emissions, using the same criteria as the life cycle analysis, per section 211 (o)(1)(H) of the Clean Air Act.⁷⁴ It is estimated that for CO₂ used to create hydrocarbon fuels, only around half of the credit will be granted.⁷⁵ However, the 45Q will likely increase the uptake of low carbon fuel standards, because the revenue support from the 45Q can be stacked with the revenue support from the low carbon fuel standards.⁷⁶ Processes utilizing CO₂ to create durable products will be eligible for a larger portion of the credit.⁷⁷

71. Edward Hirsch, *Policies and Programs Available in the United States in Support of Carbon Capture and Utilization*, KENAN FLAGLER BUS. SCH. MBA CLASS OF 2019 (Mar. 2019), <https://energyatkenanflagler.unc.edu/wp-content/uploads/2019/06/Policies-and-Programs-Available-in-the-United-States-in-Support-of-Carbon-Capture-and-Utilization.pdf>; Martin, *supra* note 57.

72. Martin, *supra* note 67.

73. Hirsch, *supra* note 71, at 4; *see also* Bennett & Stanley, *supra* note 57.

74. Martin, *supra* note 57.

75. Bennett & Stanley, *supra* note 57.

76. *Id.*

77. *Id.*

Entrepreneurs should keep in mind that relatively small policy incentives can tip the scales towards investment.⁷⁸ Experts estimate the adjusted 45Q tax credit could lead to \$1 billion in capital investment in the United States over the next six years.⁷⁹ Because the credit increases faster than inflation through 2026, the majority of investment will likely come in the mid-2020's as the credit becomes more valuable.⁸⁰

The 45Q credit reduces the levelized cost of CO₂ from carbon capture to cost parity with carbon dioxide from natural sources.⁸¹ Choosing a low-cost feedstock of carbon dioxide is important for reducing operating expense and increasing the margins of the project. Possible feedstock options for facilities in the United States are provided in the chart below. The purer the CO₂ stream, the less expensive it is to capture.⁸²

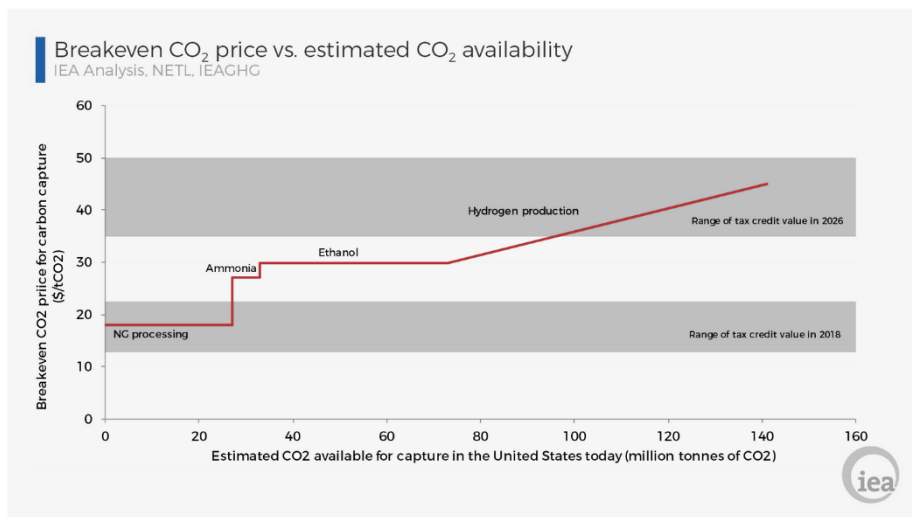


Figure 2. Breakeven CO₂ Price vs. Estimated CO₂ Availability.⁸³

Any carbon capture and utilization process will have to create a value proposition greater than the difference between the dedicated geological storage credit and the life cycle analysis adjusted credit, minus the cost of transportation and storage for dedicated geological storage.⁸⁴ Otherwise, CCU will not be a good

78. *Id.*

79. *Id.*

80. Bennett & Stanley, *supra* note 57.

81. *Id.*

82. *Id.*

83. Hirsch, *supra* note 71; *see also* Bennett & Stanley, *supra* note 57.

84. Martin, *supra* note 57.

value proposition for qualified facilities, where dedicated geological storage is an alternative.

It will be possible to sell the tax credit on the tax equity markets, which was confirmed in the IRS guidance for the 45Q, from February 2020.⁸⁵ Those companies without track records of good financial metrics will have a hard time in the tax equity markets,⁸⁶ so a good joint venture partner may be important for companies looking to play in the tax equity market. The financial stability provided by loan guarantees may help higher risk companies find tax-equity partners. Startup companies that are looking for a partner should therefore consider the potential partner's experience in the tax equity market.⁸⁷ As the IRS's guidance on tax equity partnerships is similar to other credit-driven industries, specifically renewable wind energy and building rehabilitation,⁸⁸ potential partners with experience in those other industries should be well positioned to efficiently take advantage of the 45Q tax equity market.

This strategy is not without risk. The credits are subject to recapture by the IRS, if the product is later found to release carbon into the atmosphere that had been considered already disposed.⁸⁹ For example, this is a theoretical risk for CCU projects producing ethylene – tax credits associated with ethylene used in plastic that is later incinerated at the end of its useful life could be subject to recapture.

IV. GREEN BONDS

A. Overview

Green bonds are a category of bonds that are expressly issued to finance environmentally friendly projects.⁹⁰ These bonds can be self-labeled by the issuer or verified by third parties.⁹¹ Theming bonds in this way can attract investors who are investing for more than solely financial reasons⁹² (e.g. World War II bonds issued by the U.S. Government to attract investors in support of the war effort). Attracting investors to a common purpose can allow the issuer access to more investors, thus driving demand and reducing the issuer's cost of capital.⁹³ This section will discuss both self-labeled and verified green bonds.

85. Pollock et al., *supra* note 67.

86. Martin, *supra* note 57.

87. *Id.*

88. Pollock et al., *supra* note 67.

89. Martin, *supra* note 57.

90. Gunther, *supra* note 5.

91. GLOB. GREEN BOND P'SHIP, GREEN BOND FRAMEWORK, LABELING, VERIFICATION, CERTIFICATION, AND NATIONAL/REGIONAL STANDARDS, <https://www.globalgreenbondpartnership.org/verification> (last visited Mar. 8, 2020).

92. MAINSTREET PARTNERS, UNDERSTANDING THE GROWING THEMATIC BOND MARKET (Mar. 15, 2018), <https://www.mspartners.org/understanding-the-growing-thematic-bond-market/>.

93. Gunther, *supra* note 5.

B. Eligibility

Currently, any bond issuer can label their bonds as “green bonds” without verification.⁹⁴ Though this self-labeling can provide benefits for the issuer, it is a problem for the green bond market as a whole because skepticism exists around the validity of green bonds, thus dampening their demand.⁹⁵ Increasing demand for green bonds from environmentally conscious investors is crucial to lowering the cost of capital for the issuer, as explained below.

The Climate Bond Initiative (CBI) certifies a number of financial instruments, classified as bonds, any of which could be used for CCU projects and described by the institute as follows:⁹⁶

Use of Proceeds Bond: a standard recourse-to-the-issuer debt obligation for which the proceeds shall be credited to a sub-account, moved to a sub-portfolio or otherwise tracked by the issuer and attested to by a formal internal process that will be linked to the issuer’s lending and investment operations for Eligible Projects & Assets.

Use of Proceeds Revenue Bond: a non-recourse debt obligation in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes etc., and the use of proceeds of the bond goes to related or unrelated Eligible Projects & Assets. The proceeds shall be credited to a sub-account, moved to a sub-portfolio or otherwise tracked by the issuer and attested to by a formal internal process that will be linked to the issuer’s lending and investment operations for Eligible Projects and Assets.

Project Bond: a project bond for a single or multiple Eligible Projects & Assets for which the investor has direct exposure to the risk of the project(s) with or without potential recourse to the issuer.

Securitized Bond: a bond collateralized by one or more specific Eligible Projects & Assets, including but not limited to covered bonds, Asset Backed Securities (ABS), Mortgage Backed Securities (MBS), and other structures. The first source of repayment is generally the cash flows of the assets.⁹⁷

The goal of the program is to ensure that the green bond label is assigned to bonds used for financing projects that avoid climate change by reducing greenhouse gases (GHG) or develop low-carbon industries.⁹⁸ CCU projects adhere to these goals, and bonds issued to finance CCU projects are therefore eligible for green bond verification under the Climate Bond Standard.⁹⁹

In an effort to combat skepticism regarding the validity of green bonds, investment bankers introduced the so-called Green Bond Principles to “encourage transparency, disclosure, and integrity.”¹⁰⁰ In addition, the CBI was promulgated

94. GLOB. GREEN BOND P’SHIP, *supra* note 91.

95. Gunther, *supra* note 5.

96. CLIMATE BONDS INITIATIVE, ASSURANCE/INTEGRITY/TRANSPARENCY, https://www.climatebonds.net/files/files/standards/Standards_24Nov11.pdf; CLIMATE BONDS INITIATIVE, CLIMATE BONDS STANDARD V2.1 (2017), https://www.climatebonds.net/files/files/Climate%20Bonds%20Standard%20v2_1%20-%20January_2017%281%29.pdf; Caroline Flammer, *Green Bonds Benefit Companies, Investors, and the Planet*, HARVARD BUS. REV. (Nov. 22, 2018), <https://hbr.org/2018/11/green-bonds-benefit-companies-investors-and-the-planet>.

97. CLIMATE BONDS STANDARD, *supra* note 96, at 5.

98. *Id.*

99. *Id.*

100. Gunther, *supra* note 5.

establishing the Climate Bond Standard used by approved third-party certification firms, such as First Environment & Sustainability in the United States, to verify that green bonds are truly green.¹⁰¹

The Green Bond Principles are used by approved certification firms to verify green bonds are as follows:

Use of proceeds: the issuer should declare the eligible green project categories it intends to support. It should also provide a clear definition of the environmental benefits connected to the project(s) financed by the proceeds.

Process for project evaluation and selection: the issuer should outline the investment decision-making process it follows to determine the eligibility of individual investments using the green bond's proceeds.

Management of proceeds: the proceeds should be moved to a sub-portfolio or otherwise attested to by a formal internal process that should be disclosed.

Reporting: the issuer should report at least annually on the investments made from the proceeds, detailing wherever possible the environmental benefits accrued with quantitative/qualitative indicators.¹⁰²

The Climate Bond certification process operates alongside the normal bond issuance process and is separated into pre-issuance and post-issuance processes, both officiated by the CBI.¹⁰³ The pre-issuance process verifies that the green bond will meet the requirements of the Green Bond Principles before the bond is priced and issued.¹⁰⁴ The pre-issuance certification allows the issuer to market the bond as a verified green bond on their investor roadshow, in marketing materials used to attract investors.¹⁰⁵ The post-issuance process verifies that the green bond has been properly allocated beginning twelve months after issuance and continues with annual self-reporting by the issuer until the bond matures.¹⁰⁶

Meeting the CBI's requirements under the Green Bond Principles means going through a two-step process for verification.¹⁰⁷ First, the verifying firm determines if the project meets the basic requirements of the Green Bond Principles and the application goes through the Climate Bond Taxonomy, which categorizes the project for which the bond will be issued.¹⁰⁸ The application is then verified against sector-specific criteria for final approval based on that categorization.¹⁰⁹ As of March 2020, a handful of sector-specific criteria was available, but the CBI is working on more, as shown in the figure below.¹¹⁰

101. CLIMATE BONDS INITIATIVE, APPROVED VERIFIERS UNDER THE CLIMATE BONDS STANDARD, <https://www.climatebonds.net/certification/approved-verifiers>.

102. UNITED NATIONS DEV. PROGRAMME, GREEN BONDS (Feb. 26, 2016.), <https://www.undp.org/content/dam/sdfinance/doc/green-bonds>.

103. See CLIMATE BONDS STANDARD, *supra* note 96.

104. *Id.* at 11.

105. *Id.*

106. *Id.*

107. *Id.* at 9.

108. See CLIMATE BONDS STANDARD, *supra* note 96, at 9.

109. *Id.*

110. *Id.* at Annex A.

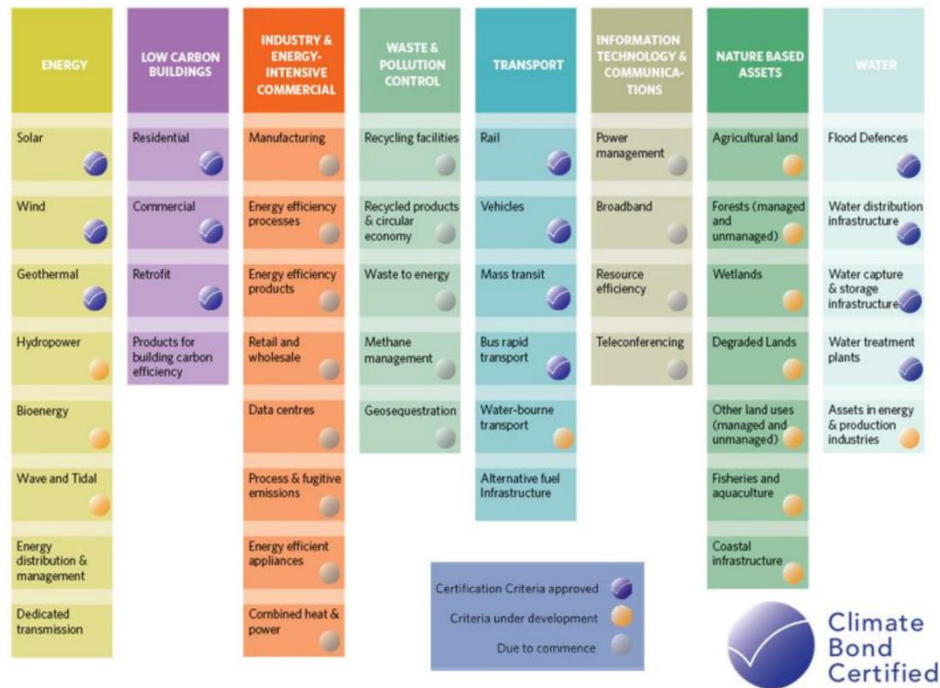


Figure 3. Climate Bonds Taxonomy and Technical Criteria.¹¹¹

Unfortunately, CCU falls under the pollution control sector and does not yet have a sector-specific requirement through CBI.¹¹² However, green bonds have been issued for pollution control projects.¹¹³ The small percentage for this category is likely due to the relatively small size of the pollution control sector and limited exposure to the benefits of green bond issuance from companies in the sector, which is a problem this article strives to fix.

111. CLIMATE BONDS INITIATIVE, *LOW CARBON TRANSPORT BONDS* (Sept. 2016), <https://www.climatebonds.net/files/files/CBI%20Webinar%20Slides-%20Green%20Transport%20Bonds%208-9-16.pdf>.

112. ASSURANCE/INTEGRITY/TRANSPARENCY, *supra* note 96.

113. Finn Schuele & David Wessel, *Municipalities Could Benefit from Issuing More Green Bonds*, THE BROOKINGS INSTIT. (July 16, 2018), www.brookings.edu/blog/up-front/2018/07/16/municipalities-could-benefit-from-issuing-more-green-bonds/.

Volume of issuance of green and ordinary bonds by use of proceeds, 2010-2016		
Use of proceeds	Green (\$ M)	Ordinary (\$ M)
Mass/Rapid Transit	1,480	27,100
Pollution Control	19	10,200
Land Preservation	0	505
Water and Sewer	5,210	170,000
Other	5,928	1,618,355
Total	12,637	1,826,160

Figure 4. Volume of Issuance of Green and Ordinary Bonds by Use of Proceeds, 2010-2016.¹¹⁴

From the bond investor's perspective, the ongoing disclosure requirement has been an issue that presents a risk to the green bond market. Some investors are concerned that they may buy a green bond that—during the ongoing disclosure process—is found not to comply with green bond standards and principles, thus losing its green bond label and reducing the value of the bond.¹¹⁵ This fear does not seem to have stifled the market, but it should be considered before issuing a green bond. Given the GHG mitigating benefits of CCU, it is unlikely bonds associated with these projects would be found out of compliance as long as ongoing disclosure procedures are properly followed.

Bond markets rely heavily on standards and easy comparability.¹¹⁶ The strict standards of the CBI seem to be giving investor more confidence, as evidenced by the rising popularity of green bonds, which we discuss in more detail below.¹¹⁷

C. *Effect on Bottom Line*

The direct benefit of issuing green bonds is two-fold: access to capital that may not have otherwise been available and reduction in project cost because the overall cost of capital drops due to the lower yields of these high-demand bonds.¹¹⁸

114. *Id.*

115. ENV'T FIN., HUGE POTENTIAL FOR US GREEN MUNI BONDS AS MARKET EVOLVES (Jan. 9, 2018), www.environmental-finance.com/content/the-green-bond-hub/huge-potential-for-us-green-muni-bonds-as-market-evolves.html.

116. ASSURANCE/INTEGRITY/TRANSPARENCY, *supra* note 96.

117. See UNITED NATIONS DEV. PROGRAMME, *supra* note 102.

118. GOGREENBONDS, WHY GREEN BONDS, <http://www.gogreenbonds.org/why-green-bonds/> (last visited Mar. 17, 2020).

1. Access to Capital

The bond market is the largest capital market at \$102.8 trillion USD¹¹⁹ and the green bond market portion has been steadily growing since 2013.¹²⁰ In 2017, the total green bond issuance reached \$155.5 billion USD.¹²¹ The United States has led the way in green bond investment, but China has been increasing its investment recently as evidenced by the chart below.¹²²

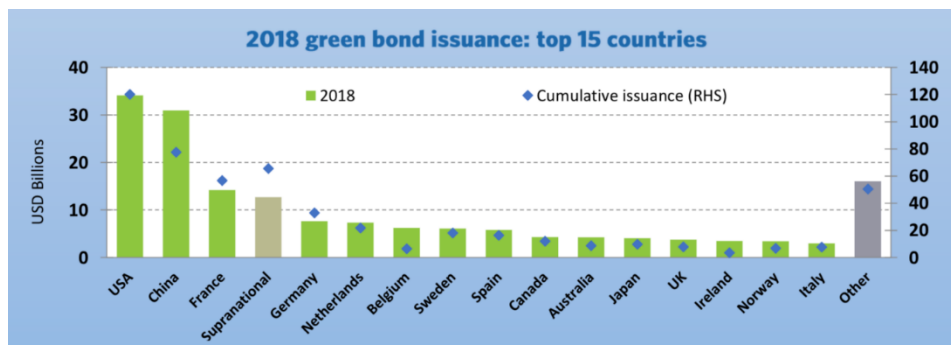


Figure 5. 2018 Green Bond Issuance: Top 15 Countries.¹²³

Investors with \$60 trillion USD in assets under management have committed to making responsible investments and the growing popularity of green bonds is evidence that green bonds are seeing opportunities beyond just the most environmentally-responsible investors.¹²⁴

In the United States, green bonds offer tax exemptions and tax credits for investors, making them attractive even to investors who are not in the market for the environmental benefit of the bond.¹²⁵ Much of the U.S.-based bond investment does come from pension funds and endowments, which are tax-exempt entities. Therefore, the tax-exempt benefit is most attractive to individual investors.¹²⁶

119. ASSURANCE/INTEGRITY/TRANSPARENCY, *supra* note 96.

120. CLIMATE BONDS INITIATIVE, 2018 GREEN BOND MARKET HIGHLIGHTS (Jan. 18, 2019), <https://www.climatebonds.net/files/files/2018%20green%20bond%20market%20highlights.pdf>.

121. CLIMATE BONDS INITIATIVE, GREEN BOND MARKET HIGHLIGHTS 2017 (Jan. 2018), <https://www.climatebonds.net/files/reports/cbi-green-bonds-highlights-2017.pdf>.

122. See CLIMATE BONDS INITIATIVE, *supra* note 120.

123. *Id.*

124. UNITED NATIONS DEV. PROGRAMME, *supra* note 102.

125. CLIMATE BONDS INITIATIVE, *supra* note 120.

126. Malcolm Baker et al., *Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds*, THE BROOKINGS INSTIT. (Apr. 27, 2018), <https://www.brookings.edu/wp-content/uploads/2018/07/Wurgler-J.-et-al..pdf>.

Capital formation around green bonds has reached a tipping point in the last couple of years, with some investor pools raised exclusively for green investment.¹²⁷ All this has led to the pricing benefits of green bonds being realized, as had been promised for years previous.¹²⁸

2. Cost of Capital

The high demand for green bonds has recently been shown to reduce the yield of these bonds¹²⁹—a promise that the market has been waiting to realize since its inception. The reduction in yield will make green projects—like CCU—cheaper to build and may allow projects which otherwise would have been uneconomic to beat their hurdle rate.¹³⁰ Issuance of green bonds also affords the issuer more flexibility in the use of capital as compared to capital obtained from traditional debt.¹³¹

Realizing this reduction in yield is also key in offsetting the costs and fees associated with verifying the green bond. Registering with the CBI costs one-tenth of a basis point value of the bond.¹³² A recent paper out of the Brookings Institution's Municipal Finance Conference shows that controlling for other factors, green bonds issue six basis points below yields of comparable conventional bonds and this factor “doubles or triples” for third-party verified green bonds.¹³³ Over a ten-year bond life, a six basis point difference in yield equates to 0.6% difference in value for the bond,¹³⁴ which more than covers the cost of verifying the green bond.

It is thought that this difference reflects willingness of investors to give up some returns in order to hold green bonds.¹³⁵ This trend will likely continue with the amount of commitment to responsible investment, further reducing the relative yields of green bonds.

3. Tangential Benefit – Equity Value

Analysis shows public companies issuing green bonds received a cumulative adjusted return of +0.67% in their stock price within two days of the issuance.¹³⁶ This increase is doubled if the green bonds are verified by an independent third party.¹³⁷ The increase is also larger for companies whose operations are directly impacted by the natural environment, such as utilities and agriculture.¹³⁸ It is

127. Gerald Hayes, *Build It Green and They Will Come*, GLOBALCAPITAL (Sept. 30, 2013), <https://www.globalcapital.com/article/jbxq41knz2t1/build-it-green-and-they-will-come>.

128. ENVTL. FIN., *supra* note 115, at 1.

129. Baker et al., *supra* note 126, at 16.

130. Gunther, *supra* note 5, at 3.

131. UNITED NATIONS DEV. PROGRAMME, *supra* note 98, at 3.

132. ASSURANCE/INTEGRITY/TRANSPARENCY, *supra* note 96.

133. Baker et al., *supra* note 126, at 2-3; Schuele & Wessel, *supra* note 113, at 1.

134. Baker et al., *supra* note 126, at 3.

135. *Id.*

136. Flammer, *supra* note 96, at 2.

137. *Id.*

138. *Id.* at 3.

thought that the positive bump is the market reacting to the companies' perceived commitment towards positive environmental impacts.¹³⁹ Altogether, this finding is another incentive for CCU projects developed by utilities, biorefineries, agricultural process, and other heavy industries to be funded with green bonds.

V. LOAN GUARANTEES

A. Overview

The DOE created the Innovative Technology Loan Guarantee Program under Title 17 of the Energy Policy Act of 2005.¹⁴⁰ The purpose of the program is to provide innovative projects access to funding they would not otherwise have in the private sector by backing loans made to these projects.¹⁴¹ The focus of this section is on the CCU part of this loan program with a brief discussion of other relevant programs.

B. Eligibility

CCU projects and companies that source CO₂ from fossil-burning electric generating stations or industrial facilities are eligible for the Innovative Technology Loan Guarantee Program.¹⁴² It is a common misconception that the Title 17 program is only open to renewable technologies, when in actuality, the program has set aside over \$30 billion in loan guarantee funds, \$8.5 billion of which can be accessed for advanced fossil energy projects.¹⁴³ A loan guarantee from the advanced fossil energy projects pool was granted to the only carbon capture project in the program thus far, which is further discussed below.¹⁴⁴ An additional \$4.5 billion has been set aside for renewable energy and energy efficiency programs.¹⁴⁵ This is relevant because CCU projects can also qualify for funds from the renewable energy and energy efficiency pool if renewable energy provides the energy inputs to the system, or if the process produces a fuel that is shown to tangibly increase energy efficiency through a life cycle analysis.¹⁴⁶ Life cycle analyses are explained in more detail in the Low Carbon Fuel Standard section of the article.¹⁴⁷

The DOE Loan Program Office (LPO) has already granted \$30 billion in loan guarantees into over thirty projects and has an additional \$40 billion committed to

139. *Id.*

140. Nikki Springer, *Loan-Guarantee Program Fuels Innovative Energy Technology*, CLEAN ENERGY FIN. FORUM (June 12, 2018), <https://cleanenergyfinanceforum.com/2018/06/12/loan-guarantee-program-fuels-innovative-energy-technology>.

141. *Id.*

142. *Id.*

143. *Id.*; *Risky Business: The Doe Loan Guarantee Program: Joint Hearing Before the S. Comm. on Energy & S. Comm. On Oversight*, 115th Cong. 1 (2017) (statement of Rep. LaHood).

144. Springer, *supra* note 140.

145. *Id.*

146. Martin, *supra* note 57.

147. *See discussion infra* Section VII.

the program.¹⁴⁸ John Sneed, Executive Director of the LPO has said, “I think the program will be financing high-impact energy-infrastructure projects that will create a truly all-of-the-above energy portfolio. And we want to let stakeholders know that this office is an energy-infrastructure-lending group.”¹⁴⁹ His statement indicates that innovative projects like CCU should apply for the program, consistent with the language of the Energy Policy Act of 2005 authorizing “the Secretary of Energy (Secretary) to make loan guarantees for projects that avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases.”¹⁵⁰ Interestingly, this direction leaves the door open for agriculturally sourced or direct air capture CCU to apply.

To qualify, a project must show substantial improvement of technologies versus commercial technology.¹⁵¹ The project must be located in the United States at a single location, unless the project is “comprised of installations or facilities employing a single New or Significantly Improved Technology that is deployed pursuant to an integrated and comprehensive business plan.”¹⁵² Thus, startup companies deploying a new technology exclusively within the United States are eligible for the program.

To be eligible for the program a project must adhere to the Cargo Preference Act, which requires the use of U.S. flagged ships for moving cargo in international waters, and the Davis-Bacon Act, which requires that laborers be paid at rates equal or above rates paid for labor on similar projects, as determined by the Secretary of Labor.¹⁵³

As of March 2020, only one carbon capture project has been approved under the program, and the funds were sourced from the advanced fossil energy pool. It is a methanol production facility in Louisiana, with CCS equipment attached. The CO₂ produced by the plant is captured and piped to Texas for use in EOR.¹⁵⁴

C. Effect on Bottom Line

A loan guarantee transfers the credit risk from the borrower to the entity assuming the debt obligation, which is the federal government under the Energy Policy Act of 2005.¹⁵⁵ Innovative projects, like CCU, are inherently high risk and

148. Loan Programs Office, *Advanced Fossil Energy Loan Guarantees*, DEP’T OF ENERGY (2019), <https://www.energy.gov/sites/prod/files/2019/01/f58/LPO-advanced-fossil-energy.pdf>.

149. Springer, *supra* note 140.

150. Final Rulemaking, *Loan Guarantees for Projects That Employ Innovative Technologies*, 81 Fed. Reg. 90,699, at 90,700 (2016) (to be codified at 10 C.F.R. pt. 609).

151. *Id.*

152. *Id.* (explaining that new technologies are “expected to help sustain and promote economic growth, produce a more stable and secure energy supply and economy for the United States, and improve the environment,” “as compared to commercial technologies in service in the United States at the time the guarantee is issued” in order to qualify as significantly improved).

153. *Id.*

154. Matthew Daly, *Energy Dept. Offers \$2B Loan to Carbon-Storage Project*, PUB. BROADCASTING CO. (Dec. 21, 2016), <https://www.pbs.org/newshour/nation/energy-dept-loan-carbon-storage>; Springer, *supra* note 139.

155. Springer, *supra* note 140.

seen as unproven technologies by lending institutions. Often, innovative projects and startup companies can only secure loans with very high interest rates and unfavorable terms, if they are able to access the debt market at all.

With a loan guarantee, the entity assuming the debt (e.g. the federal government) agrees to repay the loan in the event of a default.¹⁵⁶ Therefore, the lending institution will apply the credit rating of the entity assuming the debt obligation to the portion of the loan covered under the loan guarantee, which is 80% of the loan for this program.¹⁵⁷

The Title 17 program will guarantee up to 80% of the project's cost that is the subject of the loan.¹⁵⁸ The interest rate for the loan must be approved by the office of U.S. Secretary of Energy and the term will be the "lesser of 30 years or 90% of the projected useful life of the physical asset financed by the [loan]."¹⁵⁹

The eligible costs of the project include costs to engineer, build, and insure the project, as well as the cost of legal, financial, and other professional services related to the project.¹⁶⁰ The costs of operation, research and development, proof of concept or branding are not covered under the program.¹⁶¹

A loan guarantee may allow the project access to debt financing from traditional banks. However, because 20% of the loan money is not guaranteed,¹⁶² the project or company sponsoring the project will need to show proven cashflows to be able to take advantage of the programs, because a traditional bank will avoid companies at the earliest stages of maturity.¹⁶³ This is likely the reason that most projects guaranteed so far under the advanced fossil energy program have been plant expansion or innovative projects from well-established firms.¹⁶⁴

With that said, the purpose of the program is to ensure that innovative technologies secure adequate funding.¹⁶⁵ So, startup companies that have found a venture capital sponsor and have made it through series funding or have gained access to specialty finance companies should look to this program for further capital needs.

It should be noted that once the technology is proven at commercial scale and the perceived risks are thought to be low, the department will stop providing financing, as has been the case with utility scale photo-voltaic solar industry.³⁰

156. *Id.*

157. 10 C.F.R. § 609.7(b)(7).

158. 42 U.S.C. § 16512(c) (2017).

159. *Id.* § 16512(f).

160. 24 C.F.R. § 93.201(d) (2016).

161. 42 U.S.C. § 16512(c).

162. *Id.* § 16512(f).

163. For example, seed stage or angle stage companies with negative cash flow. Katie Jensen, *Valuing a Company with No Cash Flow*, CHRON, <https://smallbusiness.chron.com/valuing-company-cash-flow-38538.html>.

164. Loan Programs Office, *supra* note 148.

165. 13 C.F.R. § 311.11 (2016).

D. Other Loan Guarantee Programs

A loan guarantee program that included eligibility for carbon capture technologies using agriculturally sourced CO₂, called the Carbon Utilization Act, was proposed in the U.S. Senate in 2018.¹⁶⁶ Sponsored by Sen. Michael Bennett (D-CO) and Sen. Sheldon Whitehouse (D-RI), the proposal would allow carbon capture projects access to USDA loan guarantees, among other benefits.¹⁶⁷

VI. REGIONAL GREENHOUSE GAS INITIATIVE

A. Overview

The RGGI is the first mandatory GHG cap and trade program implemented in the United States.¹⁶⁸ The program regulates GHG emissions from the power sector in the nine participating states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, Rhode Island, and Vermont.¹⁶⁹ New Jersey and Virginia are currently in the process of joining the program.¹⁷⁰

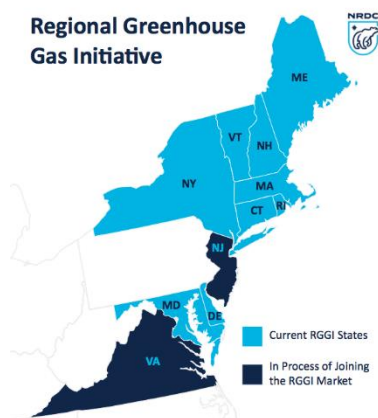


Figure 6. Regional Greenhouse Gas Initiative Participating States.¹⁷¹

166. Peter Folger, *Carbon Capture and Sequestration (CCS) in the United States*, CONG. RES. SERV., <https://fas.org/sgp/crs/misc/R44902.pdf>.

167. Tim Albrecht, *Carbon utilization bill could create value for CO₂ emissions*, BIOMASS MAGAZINE (June 8, 2018), biomassmagazine.com/articles/15356/carbon-utilization-bill-could-create-value-for-co2-emissions.

168. THE REG'L GREENHOUSE GAS INITIATIVE, WELCOME, <https://www.rggi.org/>.

169. *Id.*

170. Bruce Ho, *The Regional Greenhouse Gas Initiative Is a Model for the Nation*, NAT. RES. DEF. COUNCIL (July 3, 2018), <https://www.nrdc.org/resources/regional-greenhouse-gas-initiative-model-nation>.

171. *Id.*

The program requires fossil-fuel burning generating stations, with a capacity of 25 MW or above, to purchase allowances to emit CO₂.¹⁷² A set number of allowances are available for the operators of the generating stations to purchase and that allowance cap then declines by 2.5% annually from 2015-2020¹⁷³ and then by 3% annually from 2021-2030.¹⁷⁴ The allowances are sold at quarterly auctions and traded in a secondary market.¹⁷⁵ The states invest the proceeds from the allowance auctions into energy efficiency, renewable energy, and other consumer benefit programs.¹⁷⁶

The cost of the allowances acts like a carbon tax on the companies operating generating stations in these states.¹⁷⁷ CCU projects built on the generating stations within the RGGI participating states will reduce their emissions and thus avoid this additional cost of carbon. Only CCU projects with CO₂ sourced from the power sector within the RGGI participating states will see a benefit from the program and will therefore be the focus of this section.

B. Eligibility

The RGGI applies to all generating stations with a capacity of 25 MW or above within participating states.¹⁷⁸ Therefore only CCU projects sourcing CO₂ from generating stations larger than 25 MW capacity and regulated under the RGGI will see a benefit from the emissions reduction, but each ton of CO₂ captured is one allowance the station operator will have to purchase.¹⁷⁹

1. Offsets

In addition to reducing the amount of CO₂ emitted, CCU projects may qualify as an offset under the program.¹⁸⁰ Some of the states participating in the RGGI have a provision that allows companies to offset up to 3.3% of their required emissions allowances from projects outside the electricity sector.¹⁸¹ However, offset projects are currently limited to five project categories: landfill methane capture, sulfur hexafluoride, forestry & afforestation, end-use efficiency, and avoided agricultural methane.¹⁸²

172. MARYLAND DEPT. OF THE ENV'T., TECHNICAL SUPPORT DOCUMENT FOR AMENDMENTS TO COMAR 26.09 MD CO₂ BUDGET TRADING PROGRAM 4 (July 26, 2013), https://mde.maryland.gov/programs/regulations/air/Documents/TSD_Amendments_for_072613_to_COMAR_2609.pdf.

173. Ho, *supra* note 169.

174. *Id.*

175. THE REG'L GREENHOUSE GAS INITIATIVE, *supra* note 168.

176. THE REG'L GREENHOUSE GAS INITIATIVE, INVESTMENTS OF PROCEEDS, <https://www.rggi.org/investments/proceeds-investments>.

177. David Stevenson, *A Review of the Regional Greenhouse Gas Initiative*, CATO INST. (Feb. 7, 2018), www.cato.org/cato-journal/winter-2018/review-regional-greenhouse-gas-initiative.

178. MARYLAND DEPT. OF THE ENV'T., *supra* note 172.

179. THE REG'L GREENHOUSE GAS INITIATIVE, ELEMENTS OF RGGI, <https://www.rggi.org/program-overview-and-design/elements>.

180. THE REG'L GREENHOUSE GAS INITIATIVE, OFFSETS, <https://www.rggi.org/allowance-tracking/offsets>.

181. *Id.*

182. *Id.*

Carbon capture does not currently apply to these categories, though it does fit the stated requirement for “CO₂ emissions reductions or carbon sequestration that is real, additional, verifiable, enforceable, and permanent.”¹⁸³ It is possible, therefore, that CCU projects could qualify as offsets in the future. If CCU projects are granted offset status under the provisions, they would have to be built within the same participating state as the generating station, to qualify as an offset.¹⁸⁴

2. Investment

Participating states can invest the proceeds from allowance auctions at the state’s discretion, though the majority of investment falls under four categories: energy efficiency, renewable energy, greenhouse gas abatement, and direct bill assistance.¹⁸⁵ Though it appears CCU qualifies as GHG abatement, no carbon capture projects have received investment to date. Typically, clean transportation and electric vehicle programs have fallen under this category.¹⁸⁶ With that said, there is also no restriction against carbon capture projects qualifying for investment under the program, though projects receiving RGGI funded investment cannot also qualify as offset projects.¹⁸⁷

C. Effect on Bottom Line

For companies operating generating stations above 25MW in RGGI participating states, adding CCU projects to new or existing fossil-burning generating stations offers a savings on the value of emissions allowances required to operate those facilities.

Allowances are priced on a dollar per short ton of CO₂ basis.¹⁸⁸ The price for allowances purchased at the quarterly state-run auctions is a single clearing price. The price on the secondary markets is market based.¹⁸⁹

The auction implements two mechanisms to control the allowance prices.¹⁹⁰ The first is the Cost Containment Reserve (CCR), which serves as an artificial price cap.¹⁹¹ The CCR holds in reserve 10% of the allowances, which are only

183. *Id.*

184. *Id.*

185. THE REG’L GREENHOUSE GAS INITIATIVE, INVESTMENTS OF PROCEEDS, <https://www.rggi.org/investments/proceeds-investments>.

186. THE REG’L GREENHOUSE GAS, THE INVESTMENT OF RGGI PROCEEDS IN 2017 (Oct. 2019), https://www.rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2017.pdf.

187. THE REG’L GREENHOUSE GAS INITIATIVE, *supra* note 180.

188. ELEMENTS OF RGGI, *supra* note 179.

189. *Id.*

190. *Id.*

191. *Id.*

made available in the event that the allowance bidding price exceeds a preset trigger price.¹⁹² Trigger prices for the CCR are provided in the table below.¹⁹³ Once the trigger is hit the CCR increases the supply of credits and drives down prices.¹⁹⁴

The second mechanism is the Emissions Containment Reserve (ECR), which serves as an artificial price floor and will be implemented starting in 2021.¹⁹⁵ In the event that allowance prices fall below the trigger point for the ECR, allowances will be withheld from the auction, thus reducing the allowance supply.¹⁹⁶ This reduces the supply and drives up prices. Seven of the participating states plan to implement the ECR: Connecticut, Delaware, Maryland, Massachusetts, New York, Rhode Island, and Vermont.¹⁹⁷

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CCR (Price Cap)	\$10.25	\$10.51	\$10.77	\$13.00	\$13.91	\$14.88	\$15.92	\$17.03	\$18.22	\$19.50	\$20.87	\$22.33	\$23.89
ECR (Price Floor)	-	-	-	\$6.00	\$6.42	\$6.87	\$7.35	\$7.86	\$8.41	\$9.00	\$9.63	\$10.30	\$11.02

Figure 7. Trigger Prices for CO₂ Allowance Cost-Bounding Mechanisms.¹⁹⁸

With these two mechanisms in place it is likely that the allowance prices will be within the bounds of the CCR and ECR trigger prices within a given year. However, this is not guaranteed. This range can be used for sensitivity analysis for allowance savings in CCU financial modeling and forecasting.

Prices in the secondary market did run below the ECR trigger in 2018.¹⁹⁹ The table below provides prices from the secondary market for 2018, which is the most recently published annual data.²⁰⁰

192. *Id.*; CTR. FOR CLIMATE AND ENERGY SOLUTIONS, REG'L GREENHOUSE GAS INITIATIVE (RGGI) (Aug. 23, 2018), www.c2es.org/content/regional-greenhouse-gas-initiative-rggi.

193. *See infra* Figure 7.

194. ELEMENTS OF RGGI, *supra* note 179.

195. *Id.*

196. *Id.*; THE REG'L GREENHOUSE GAS INITIATIVE, *supra* note 168.

197. *Id.*

198. *Id.*

199. *See supra* Figure 7.

200. *See infra* Figure 8.

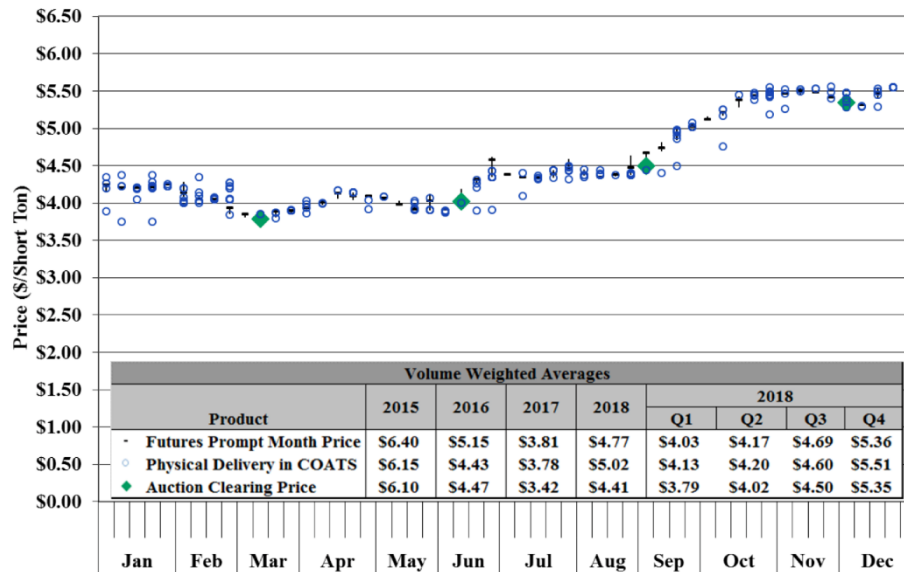


Figure 8. Observations Regarding Prices in Auctions and the Secondary Market.²⁰¹

Prices are affected by supply-and-demand forces as well as speculation around regulations and changes to the program. Since the RGGI released the Model Rule in 2014, the price has increased significantly due to increased demand.²⁰² In 2015, after the Clean Power Plan (CPP) was announced, prices hit a peak of \$7.50 per ton and the CCR fully sold out.²⁰³ Since the CPP has been put on the shelf, prices steadily decreased, to a low of \$2.53 per ton in 2017.²⁰⁴

For CCU projects with CO₂ sourced from power stations, the revenue support from the 45Q and the cost saving against RGGI allowances offer significant positive economic support.

201. See ISO NEW ENGLAND, INC., 2018 ANNUAL MARKETS REPORT (May 23, 2019), <https://www.iso-ne.com/static-assets/documents/2019/05/2018-annual-markets-report.pdf>.

202. CTR. FOR CLIMATE AND ENERGY SOLUTIONS, *supra* note 192.

203. *Id.*

204. *Id.*

VII. LOW CARBON FUEL STANDARD

A. Overview

The LCFS, a state policy initiative passed in California in 2007, is a market-based cap and trade program for transportation fuels.²⁰⁵ The policy is designed to curb GHG emissions by 10% in 2020, as compared to the 2007 baseline.²⁰⁶ The program, which is administered by the California Air Resources Board (CARB), sets a target Carbon Intensity (CI) score, which is reduced year-over-year for California's transportation fuel pool.²⁰⁷ All regulated transportation fuels, be they petroleum-based fuels, biofuels, or alternative fuels, are assigned a CI score based on a complete Life Cycle Assessment (LCA) of the fuel, similar to the LCA from the national Renewable Fuel Standard (RFS) program.²⁰⁸ The LCA for the LCFS includes direct emission from using the fuel, as well as emissions from producing and transporting the fuel.²⁰⁹

Fuels with a CI score below the benchmark are granted LCFS credits, while fuels with a CI score higher than the benchmark produce a LCFS deficit.²¹⁰ In order to comply with the program, producers who run a deficit must acquire enough LCFS credits each year to offset their deficit. The credits are traded between fuel producers on an open market at market-based prices.²¹¹

Similar programs to the one in place in California have been adopted in Oregon and British Columbia, together called the Pacific Coast Collaborative, showing the expanding popularity of the program.²¹² Because California is the trend-setting legacy program of this type, it will be the focus of this section.

B. Eligibility

As of yet, no CCU pathway is approved under the program, but they are eligible.²¹³ Only CCU processes that produce a fuel are eligible to participate in the program.²¹⁴ The LCFS applies to any number of transportation fuels, including gasoline, diesel, natural gas, ethanol, propane, and electricity.²¹⁵ Therefore, CCU processes producing methane, ethane, propane, or ethanol are good candidates to participate.

Fuels that receive a CI score lower than the benchmark are not required to participate in the program, but they must opt-in to the program in order to sell

205. CALIFORNIA AIR RES. BD., LOW CARBON FUEL STANDARD – ABOUT, <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about>.

206. *Id.*

207. *Id.*

208. *Id.*

209. *Id.*

210. CALIFORNIA AIR RES. BD., *supra* note 205.

211. CAL. CODE REGS. tit. 17 § 95490 (2019); CALIFORNIA AIR RES. BD., *supra* note 205.

212. CALIFORNIA AIR RES. BD., *supra* note 205.

213. *Id.*

214. CAL. CODE REGS. tit. 17 § 95482 (2019).

215. *Id.*

LCFS credits in the market.²¹⁶ Alternative fuel suppliers who supply less than 3.6 million gallons of gasoline equivalent per year are exempt from the program and would participate only if they opt-in.²¹⁷ Typically, reformulated gasoline and diesel run a deficit while alternative fuels produce credits.²¹⁸

Any regulated fuel producer, called a Regulated Party (RP), must register their fuel production pathway with CARB, in order to receive a CI score.²¹⁹ Production pathways fall under two categories called Tiers. Tier 1 covers conventional pathways and Tier 2 covers so-called next-generation pathways.²²⁰

Renewable fuels, such as those that fall under the RFS, are classified as Tier 1 pathways.²²¹ Given that CCU fuel production is in its infancy, CCU fuels would be classified as Tier 2 pathways.²²² Tier 1 pathways are well known to CARB and a Tier 1 fuel producer will receive a CI score based on a predetermined analysis for that fuel pathway.²²³ Tier 2 pathways will undergo a CI score analysis as part of the application, and the application will therefore go through a few extra steps before approval and may be at risk of denial.²²⁴ For full approval, the RP must produce two years of steady state commercial data, though a provisional certification may be granted with a minimum of one quarter of steady state commercial data.²²⁵ To qualify, the RP must also be able to prove active fuel production in and/or transport to the California market.²²⁶

The program has a carbon capture provision that allows a RP to claim up to 20% reduction in their CI score from carbon capture at the fuel refinery, called project-based CCS.²²⁷ This would apply to CCU projects with CO₂ sourced from both petroleum refineries and biorefineries if the product produced was not a fuel and was found to prevent emission of CO₂ based on the product's LCA. If the CCU process produced a fuel, it would not be eligible for the project-based CCS credit, but it would be eligible to apply under the Tier 2 pathway certification.²²⁸

Because the RFS has been discussed here, it should be noted CCU-produced fuel does not qualify under the RFS, even if the CO₂ is sourced from a biorefinery. The RFS program is specifically for fuels refined from biomass.²²⁹

216. CAL. CODE REGS. tit. 17 § 95484.

217. CAL. CODE REGS. tit. 17 § 95482.

218. CAL. CODE REGS. tit. 17 § 95486.

219. CAL. CODE REGS. tit. 17 § 95488.1.

220. *Id.*

221. *Id.*

222. *Id.*

223. *Id.*

224. CAL. CODE REGS. tit. 17 § 95488.7.

225. CAL. CODE REGS. tit. 17 §§ 95488.6, 95488.7.

226. CAL. CODE REGS. tit. 17 § 95482.

227. CAL. CODE REGS. tit. 17 § 95490.

228. *Id.*

229. CAL. CODE REGS. tit. 17 § 95482.

C. Effect on Bottom Line

As stated above, typically reformulated gasoline and diesel run a deficit while alternative fuels produce credits. This means traditional petroleum refiners and gasoline blenders produce a deficit and must purchase credits on the LCFS exchanges in order to maintain compliance and sell fuel in the California and Pacific Coast Collaborative markets. Historical average prices can be found in the chart below and ranged from \$100-\$190 in 2018.

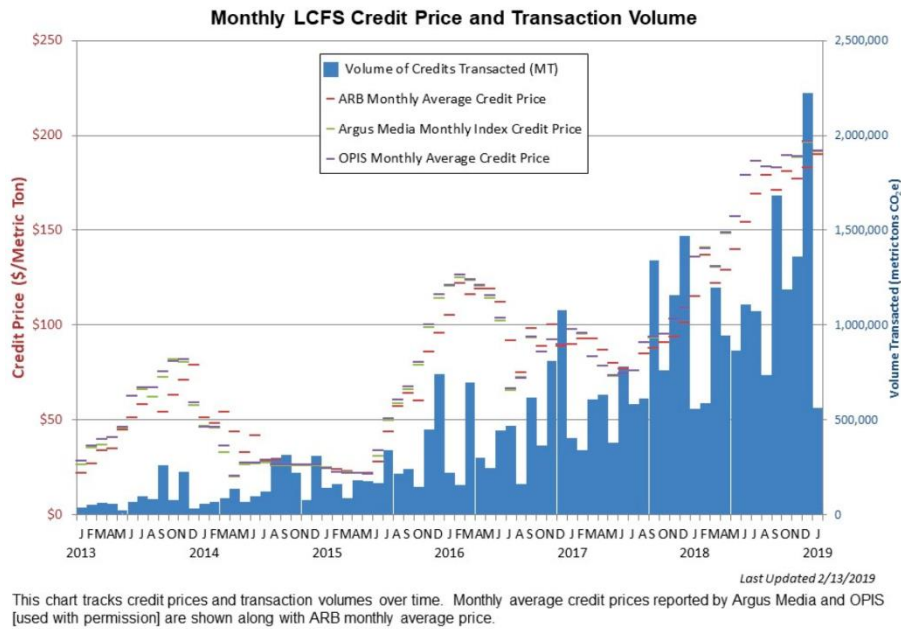


Figure 9. Monthly LCFS Credit Price and Transaction Volume.²³⁰

The value of LCFS credits created by a fuel pathway is directly proportional to the CI score of that process, as shown in the chart below for gasoline.²³¹ A pathway with a CI score of zero will receive the full value of the LCFS credit price.²³² While a pathway, with a CI score half of the compliance benchmark score will receive double the value of the LCFS credit price.²³³

230. CALIFORNIA AIR RES. BD., DATA DASHBOARD (last updated Mar. 11, 2020), <https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>.

231. See *infra* Figure 10.

232. *Id.*

233. *Id.*

Credit Value Calculator: Estimated LCFS Premium at Sample LCFS Credit Prices

Alternative Fuel Premiums at Sample LCFS Credit Prices (\$/gal gasoline-equivalent for fuels used as gasoline substitutes)						
CI Score (gCO ₂ e/MJ)	Credit Price					
	\$190	\$80	\$100	\$120	\$160	\$200
-273	\$8.06	\$3.39	\$4.24	\$5.09	\$6.79	\$8.48
10	\$1.83	\$0.77	\$0.96	\$1.16	\$1.54	\$1.93
20	\$1.61	\$0.68	\$0.85	\$1.02	\$1.36	\$1.70
30	\$1.39	\$0.59	\$0.73	\$0.88	\$1.17	\$1.46
40	\$1.17	\$0.49	\$0.62	\$0.74	\$0.99	\$1.23
50	\$0.95	\$0.40	\$0.50	\$0.60	\$0.80	\$1.00
60	\$0.73	\$0.31	\$0.38	\$0.46	\$0.62	\$0.77
70	\$0.51	\$0.22	\$0.27	\$0.32	\$0.43	\$0.54
80	\$0.29	\$0.12	\$0.15	\$0.18	\$0.25	\$0.31
90	\$0.07	\$0.03	\$0.04	\$0.04	\$0.06	\$0.07
100	-\$0.15	-\$0.06	-\$0.08	-\$0.09	-\$0.13	-\$0.16
110	-\$0.37	-\$0.16	-\$0.19	-\$0.23	-\$0.31	-\$0.39
120	-\$0.59	-\$0.25	-\$0.31	-\$0.37	-\$0.50	-\$0.62
130	-\$0.81	-\$0.34	-\$0.43	-\$0.51	-\$0.68	-\$0.85
140	-\$1.03	-\$0.43	-\$0.54	-\$0.65	-\$0.87	-\$1.08
150	-\$1.25	-\$0.53	-\$0.66	-\$0.79	-\$1.05	-\$1.32
CaRFG* (\$/gallon)	100.82	-\$0.135	-\$0.057	-\$0.071	-\$0.085	-\$0.113

* Maximum pass-through cost for gasoline. Assumes a blend of CARBOB with 10 volume percent ethanol at a CI of 79.9 g/MJ. Ethanol at 79.9 g/MJ is assumed to receive no LCFS premium.

The value of a bundled credit is shown per gallon-equivalent as revenue for alternative fuel producers at a range of sample CI values and credit prices. Using the calculator, the credit value of any fuel can be determined; for example, at Q1 2016 credit prices of approximately \$120/MT, a renewable diesel fuel with a CI score of 30 gCO₂e/MJ generates LCFS credits worth \$1.13 per diesel-gallon equivalent (DGE). Each kilowatt-hour of grid electricity used in an electric vehicle will earn an additional \$0.10 (\$3.10 per gasoline-gallon equivalent GGE) through the LCFS credits generated.

Figure 10. Credit Value Calculator: Estimated LCFS Premium at Sample LCFS Credit Prices.²³⁴

Below is a chart of the benchmark compliance score for gasoline and diesel.²³⁵ The benchmark level is reduced each year as part of the program to achieve the desired reduction in GHG emissions.²³⁶

234. CALIFORNIA AIR RES. BD., *supra* note 230.

235. See *infra* Figure 11.

236. *Id.*

**Compliance Schedule for Gasoline
and Diesel Fuel and their Substitutes**

Year	Gasoline Average CI (gCO ₂ e/MJ)	Diesel Average CI (gCO ₂ e/MJ)
2016	96.50	99.97
2017	95.02	98.44
2018	93.55	96.91
2019	91.08	94.36
2020 onwards	88.62	91.81

Figure 11. Compliance Schedule for Gasoline and Diesel Fuel and their Substitutes.²³⁷

CARB uses Argonne National Lab's GREET model (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) to calculate the CI score.²³⁸ The CI score will be different based on the LCA of the CCU process, depending on factors such as the energy input source, the CO₂ source, or the efficiency of the process. However, there are many useful benchmarks available.

Grid electricity for electric vehicle charging has a CI score of 105.61. Hydrogen produced via electrolysis using solar electricity had a CI score of 0.00, while hydrogen produced via electrolysis using grid electricity had a CI score of 164.46.²³⁹ The clear takeaway here is that CCU with electrical input from the grid would receive far fewer LCFS credits than CCU using renewable sourced electricity, if grid sourced CCU produced any LCFS credits at all.

LCFS credits never expire and a pool of excess credits has been accumulating since inception of the program.²⁴⁰ Despite this bank of excess credits, the trading price of the credits has trended upwards. In 2017, LCFS deficits produced for the year were higher than LCFS credits, leading to a drawdown in the credit bank which pushed prices even higher.²⁴¹ This trend was designed by the program's creators, who hoped the accumulation of credit early in the program would give the market time to innovate for cleaner fuels.²⁴² Therefore it is likely the credit bank will be further reduced in coming years, driving prices for LCFS credits higher through market forces.

237. Marshall Frank, *California Leads the Way in Reducing Carbon Emissions*, INT'L HUMAN RES. DEV. CORP. (Oct. 12, 2016), <https://blog.ihrdc.com/marshall-frank/california-leads-way-reducing-carbon-emissions/>.

238. CAL. CODE REGS. tit. 17 § 95490.

239. Cal. Code Regs. tit. 17 § 95488.5.

240. CAL. CODE REGS. tit. 17 § 95490.

241. CALIFORNIA AIR RES. BD., *supra* note 230.

242. CAL. CODE REGS. tit. 17 § 95490.

For those sellers in the California's transportation fuel pool who fail to meet the requirements of the LCFS face fines. Now that the program is more than a decade old, CARB has been cracking down on and fining violators for violations such as: failing to meet the CI target, misreporting fuel transactions, and misreporting the type of low carbon fuel sold.²⁴³

VIII. RECOMMENDATION

Having compiled this list of policies and programs available to CCU projects, two recommendations can be drawn from the research. First, how these policies can be improved to encourage more investment in this space. Second, what CCU projects would receive the most support from existing programs.

A. Program Improvements

To improve these programs, CCU should be considered and mentioned explicitly and separately from CCS. Of the policies and programs for which CCU projects are eligible, only the 45Q mentions CCU directly.²⁴⁴ Programs, such as the RGGI and Green Bond certifications initiatives, should state explicitly that CCU and other carbon capture projects qualify. The RGGI specifically, should also clarify that CCU projects can qualify as offset projects under the program. Ambiguity about whether or not CCU projects qualify for a given program leaves the applicants at risk of not taking advantage of all available policy support, which is a problem this article seeks to remedy.

The 45Q could be improved in a number of ways to encourage the initial CCU commercial builds. First, the amount of credit given should be raised. As stated above, the 45Q seeks to give emitted CO₂ cost parity with naturally sourced CO₂.²⁴⁵ However, this may not account for the perceived risk associated with receiving a tax credit that could be eliminated by an unsupportive Congress. The program also does not consider that the first carbon capture projects will cost significantly more than projects undertaken after the industry matures. The policy could be adjusted so that credits are bucketed, giving the first projects to come online a higher value credit than later projects, which would encourage companies and entrepreneurs to move forward with projects sooner.

B. Support Maximizing Ventures

Utilities are likely to receive the most benefit from carbon capture projects or joint ventures with startups in the space. Many utilities have a tax appetite large enough to take advantage of the credits without needing to enter the tax equity markets. Or, if the utility does need to sell into the tax equity market, they likely have employees able to handle this complex task. Utilities are also familiar with the bond market and some may already be issuing green bonds. Many utilities

243. Dave Clegern, *CARB Cracks Down on Low Carbon Fuel Standard Violators*, CALIFORNIA AIR RES. BD. (Apr. 25, 2018), <https://ww2.arb.ca.gov/news/carb-cracks-down-low-carbon-fuel-standard-violators>.

244. 26 U.S.C. § 45Q.

245. *Id.*

will also have the size and creditworthiness needed to back the 20% of loans not covered under the Loan Guarantee Program.²⁴⁶ Additionally, northeastern utilities in RGGI states will benefit from avoided costs for carbon allowances.

Finally, where we see interest from the oil and gas industry in CCS used for EOR, it is unlikely CCU will receive the same support. CCU does not complement oil production, and some of the products produced by CCU are in competition with petroleum products.²⁴⁷ In contrast, CCU would not compete with a utility's core business. However, midstream is one sector of the oil and gas business that could benefit from CCU. The pure CO₂ stream from natural gas processing facilities has the lowest breakeven cost for carbon capture. Converting this CO₂ into methane and injecting it into the processed natural gas stream would help these companies offset product losses.

IX. CONCLUSION

As this article demonstrates, the policies and initiatives that are available to support CCU are varied. It is of critical importance for entrepreneurs and project developers to know what support is available and how to gain access throughout all phases of development.

Knowing where the support lies can help in the planning phase for CCU projects by guiding time and effort to ventures that source CO₂ and create products eligible for support. In the development and growth phase, access to lower-cost capital from loan guarantees and green bonds can expedite growth and attract other investors who need a lower investment risk, which is particularly critical for unproven technologies. Tax credits from the 45Q can be used as a negotiating tool for strategic partnerships between CCU projects or companies and investors with large tax appetites such as banks or utilities. Approval for a LCFS certification can be set as an achievable milestone for CCU entrepreneurs and startup companies to improve their negotiating position with venture capitalists investing in those companies.

Having great technology may not be enough to get CCU projects or companies past the many hurdles in the way of their goal. Entrepreneurs and investors evaluating these projects should understand how policy and regulation can be a benefit instead of hurdle for a project's development. As we've seen, policies can provide direct financial benefits, management flexibility, and market access. Applied to the right project, this support could be enough to tip the scales toward securing financing, successful development, and competitive returns for CCU projects.

Finally, this article has only focused on those policies that are available today in the United States. As we see the effects of climate change worsen, the result will only be more policy implementation in support of climate technology like

246. Loan Programs Office, *supra* note 148.

247. Renee Cho, *Capturing Carbon's Potential: These Companies are Turning CO₂ into Profits*, STATE OF THE PLANET, EARTH INST., COLUMBIA U. (May 29, 2019), <https://blogs.ei.columbia.edu/2019/05/29/co2-utilization-profits/>.

CCU. The reader should be on the lookout for new polices and expansion of the policies, especially the loan guarantee program, relating to their companies and projects. Resources such as North Carolina State University's Database for State Incentives for Renewables & Efficiency (DSIRE)²⁴⁸ is a great place to start.

Achieving the two-degree climate target will not come from one solution alone. CCU offers an important piece to the solution, with the potential for excellent returns from the products created from CO₂ emissions. Policy support will help bring this technology to economic maturity.

X. APPENDIX

Reference table for CCU Polices and Programs

Policy	Incentive Type	Eligibility	Effect on Bottom Line
45Q	Tax Credit	<ul style="list-style-type: none"> • Processes capturing and disposing >25,000 tCO₂/yr that otherwise would be released. • CO₂ must be metered at the source and disposal location. • CO₂ must be captured and disposed within the US or US territories. • Equipment must be installed before 2024. 	<ul style="list-style-type: none"> • Tax credit for \$12.66/t in 2017 interpolated to \$35/t in 2026, afterwards, inflation adjusted. • Up to 500,000 tCO₂/yr • Credit amount will be adjusted for the portion of utilized CO₂ shown to reduce overall emissions, using the same criteria as the life cycle analysis.

248. NC CLEAN ENERGY TECH. CTR., DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, <https://www.dsireusa.org/>.

Green Bond	Themed Bond Program	<ul style="list-style-type: none"> • Currently green bonds have the option of self-identified as having positive environmental benefit • Green bonds can be verified against the Green Bond Principles by third-party firms, accredited by the Climate Bond Initiative. 	<ul style="list-style-type: none"> • Access to the bond market, the world's largest capital market • 12-18 basis point reduction for verified green bond yield versus comparable conventional bonds • 6 basis point reduction in green bond yield for self-identified green bonds
Title 17 of the Energy Policy Act (EPA 2005)	Loan Guarantee Program	<ul style="list-style-type: none"> • Applicants are selected through the D.O.E.'s Loan Program Office • CO₂ must be sourced from fossil-burning energy generating facilities qualify under the Advanced Fossil Energy Projects solicitation • Recipients must be in the U.S. and adhere to the Cargo Preference Act & the Davis-Bacon Act 	<ul style="list-style-type: none"> • Access to debt financing, for high-risk unproven projects and companies • Lower cost of debt, though transfer of credit risk to the entity assuming the debt obligation of the borrower • Guarantees 80% of project cost to be repaid within 30 year or 90% of the project's life

Regional Greenhouse Gas Initiative	Cap and Trade	<ul style="list-style-type: none"> • CCU projects with CO₂ sourced from +25MW power plants • The power plant must be located in a state participating in RGGI 	<ul style="list-style-type: none"> • Cost savings through reductions in the number of allowances required for CO₂ emissions
Low Carbon Fuel Standard	Cap & Trade Policy	<ul style="list-style-type: none"> • Transportation fuel producing entities in California, Oregon and British Columbia • CCU projects must prove produced fuel is being used in participating states 	<ul style="list-style-type: none"> • Fuel producers who produce fuels with low carbon intensity, based on a life cycle analysis for the production process, can generate credits to sell to fuel producers with high carbon intensity.