# Public Engagement and Carbon Dioxide Removal

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*As atmospheric carbon dioxide concentrations continue to rise, policy makers increasingly are turning to carbon dioxide removal (CDR) to help respond to climate change. CDR techniques, such as afforestation and soil carbon sequestration, remove carbon dioxide from the air and store it underground or in an inert form. One technique, direct air capture and storage (DACS), has attracted particular interest because of its potential to permanently store large quantities of carbon. Although DACS's energy requirements and high costs have limited its deployment to date, planning and construction efforts rapidly expanded in recent years, thanks to generous government support. However, DACS facilities are not always welcomed by local communities or environmental advocates because of safety and environmental concerns.*

*This Article evaluates the adequacy of public engagement with respect to overall CDR policies as well as the siting and operation of individual DACS facilities. Public engagement efforts so far have focused on individual DACS projects and have largely been absent from broader CDR policy making. However, insufficient engagement on CDR policies not only undermines individual projects but also threatens long-term decarbonization efforts. Policy-level public engagement is needed to facilitate a just energy transition, determine suitable CDR pathways, and identify CDR locations and activities with public support. Furthermore, project-level community engagement can provide a social license for specific DACS projects and address environmental and safety concerns.*

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## INTRODUCTION

As atmospheric carbon dioxide ($CO_2$) concentrations continue to rise, policy makers increasingly view carbon dioxide removal (CDR) as essential to combating climate change. CDR refers to strategies for removing $CO_2$ directly from the atmosphere.[1] One prominent CDR technique, direct air capture and storage (DACS), uses physical and chemical processes to capture $CO_2$ from the

1. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACRP RESEARCH REPORT 270: CARBON REMOVAL AT AIRPORTS 16 (2024); NAT'L ACADS. OF SCIS., ENG'G, & MED., NAT'L RSCH. COUNCIL, CLIMATE INTERVENTION: CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION 33 (2015) [hereinafter NAT'L ACADS. OF SCIS., ENG'G, & MED., CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION].

ambient air, concentrate the captured $CO_2$, and store the $CO_2$ underground.[2] Carbon capture and sequestration (CCS), in contrast to CDR, refers to the removal of $CO_2$ from industrial exhaust before it is released into the atmosphere.[3] Although certain CDR techniques use some of the same processes as CCS, only CDR could be deployed to address legacy emissions and even generate net negative emissions.[4]

California's plan for achieving carbon neutrality assumes the removal of 100 million metric tons of $CO_2$ annually by 2045 to counter residual greenhouse gas (GHG) emissions.[5] The European Union includes carbon removal involving forestry and land use in its 2030 emissions reduction strategy,[6] and it is proposing to meet its 2040 emissions reduction goal in part by removing 280 million metric tons of $CO_2$ annually via DACS and other techniques.[7] Canada is currently considering the establishment of national carbon removal goals.[8] The U.S. federal government devoted billions of dollars to investment in DACS projects and development until the Trump administration froze much of the funding for DACS in late 2025.[9] Recent legislation nonetheless left in place significant federal tax subsidies for DACS while boosting support for CCS, to the apparent benefit of fossil fuel companies that are investing in both DACS and the use of captured carbon for enhanced oil recovery.[10]

DACS in particular has attracted policy makers' attention because of its potential to remove and permanently store large quantities of carbon. Until recently, DACS's high costs and substantial energy requirements had prevented its deployment.[11] But thanks to generous government support, DACS planning

2. *See infra* Part I.A.

3. NAT'L ACADS. OF SCIS., ENG'G, & MED., CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION, *supra* note 1, at 33-34.

4. *The Difference Between Carbon Removal and Carbon Capture*, CARBON180 (July 29, 2024), https://carbon180.org/blog/the-difference-between-carbon-removal-and-carbon-capture.

5. CAL. AIR RES. BD., 2022 SCOPING PLAN FOR ACHIEVING CARBON NEUTRALITY 94 (2022).

6. Council of the European Union Press Release 231/23, Fit for 55 Package: Council Adopts Regulations on Effort Sharing and Land Use and Forestry Sector (Mar. 28, 2023).

7. European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Towards an Ambitious Industrial Carbon Management for the EU*, at 2, COM (2024) 62 final (Feb. 6, 2024); *EU Sets Ambitious 2040 Climate Target and Highlights Need for Carbon Removals*, CLIMEWORKS, https://climeworks.com/news/eu-sets-ambitious-2040-climate-target-including-carbon-removals (last visited Feb. 6, 2024).

8. Corbin Hiar, *Lawmakers Push Canada to Adopt Carbon Removal Goals*, CLIMATEWIRE, (Feb. 11, 2026).

9. Corbin Hiar, *Direct Air Capture Takes "Huge Hit" in DOE Funding Cuts*, ENERGYWIRE, Oct. 3, 2025; Courtni Holness, *The Fate and Future of DACS Hubs*, Carbon180, Oct. 7, 2025, https://carbon180.org/blog/doe-rescinds-dac-hubs-funding/.

10. Corbin Hiar, *Trump Reshaped a Climate Program to Extract More Oil. This Company Stands to Profit.*, CLIMATEWIRE (Aug. 4, 2025) [hereinafter Hiar, *Trump Reshaped*], https://www.eenews.net/articles/trump-reshaped-a-climate-program-to-extract-more-oil-this-company-stands-to-profit.

11. *See infra* Part I.A.

and construction efforts expanded.[12] The 2021 Bipartisan Infrastructure Law established a $3.5 billion program to launch four regional DACS hubs, each designed to capture and sequester one million metric tons of $CO_2$ a year.[13] Further government support has included funding for engineering, design, and feasibility studies, as well as tax credits for geologic storage of $CO_2$ via DACS.[14]

However, DACS offers only an imperfect and partial solution to climate change. DACS requires significant amounts of energy and water, poses risks of $CO_2$ leakage and groundwater contamination, and can be used to increase fossil fuel production through enhanced oil recovery.[15] More generally, DACS and other CDR techniques could undermine direct efforts to reduce GHG emissions.[16] Public engagement is needed to address these concerns and build public support for CDR as a long-term strategy to counter climate change.

This Article evaluates the adequacy of public engagement with respect to overall CDR policies as well as the siting and operation of DACS facilities. Part I offers background on CDR (with a focus on DACS), explores the concerns surrounding DACS, and discusses relevant laws and policies. Part II describes elements of public engagement, underlying rationales for engagement, and engagement efforts in ongoing CDR initiatives. Part III offers recommendations on public engagement for CDR. Ideally, such engagement would occur at both a policy level—national or regional—and a community-based project level. National or regional policy discussions might consider CDR's role within overall climate strategy, pros and cons of different types of CDR, appropriate regulations, research priorities, planning for a network of CDR facilities and infrastructure, and other overarching policy questions. Community-based project level discussions would center site-specific proposals and focus on the needs, concerns, and values of those directly impacted by an individual project.

## I. BACKGROUND: CDR AND THE RISE OF DIRECT AIR CAPTURE

Ideally, society would reduce or eliminate GHG emissions before they escape into the atmosphere.[17] CDR techniques, in contrast, remove $CO_2$ already found in the atmosphere.[18] CDR is viewed as inferior to direct emissions

12. *See infra* Part I.A.
13. *See infra* Part I.A.
14. *See infra* Part I.A.
15. *See infra* Part I.B.
16. *See infra* Part I.B.
17. *See* STEPHEN M. SMITH ET AL., THE STATE OF CARBON DIOXIDE REMOVAL 9 (2d ed. 2024).
18. Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, ENVT'L RSCH. LETTERS, June 2018, at 4, 13. The term "negative emission technologies" refers to technologies that remove GHGs from the atmosphere, including CDR technologies. *See* Albert C. Lin, *Making Net Zero Matter*, 79 WASH. & LEE L. REV. 679, 687-88 (2022). As almost all negative emission technologies under consideration aim to remove $CO_2$, this Article uses the terms carbon dioxide removal or carbon removal instead of "negative emission technologies."

mitigation because it is generally less effective, riskier, and more expensive.[19] CDR also has the potential to undermine society's willingness to reduce emissions.[20] However, limited progress in mitigating emissions,[21] along with the potentially high cost of completely eliminating them, has led to a growing consensus that CDR is essential to achieve the temperature targets established by the 2015 Paris Agreement.[22] According to experts, CDR must take place on an immense scale—several gigatons of $CO_2$ per year by 2050—to avoid some of climate change's most catastrophic effects.[23]

Land-based CDR techniques fall into two basic categories: nature-based carbon removal and engineered carbon removal.[24] Nature-based carbon removal techniques include forest carbon management and soil carbon sequestration.[25] Engineered carbon removal techniques include DACS, bioenergy with carbon capture and storage, and enhanced weathering.[26] Nature-based techniques generally are more ready to deploy but offer relatively limited and transitory

19. *See* NAT'L ACADS. OF SCIS., ENG'G, & MED., CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION, *supra* note 1, at 5.

20. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES AND RELIABLE SEQUESTRATION: A RESEARCH AGENDA 4 (2019) [hereinafter NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES].

21. *See* Zhu Liu et al., *Global Carbon Emissions in 2023*, 5 NATURE REVS. EARTH & ENV'T 253, 253 (2024) (noting that global $CO_2$ emissions rebounded to pre-pandemic levels by 2021 and continued to grow—albeit more slowly—in subsequent years).

22. SMITH ET AL., *supra* note 17, at 9-10; NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 2-3.

23. SMITH ET AL., *supra* note 17, at 9 (estimating central range of CDR deployment of seven to nine gigatons per year in 2050 under "more sustainable" scenarios); SARA NAWAZ ET AL., AM. UNIV. INST. FOR RESPONSIBLE CARBON REMOVAL, AGENDA FOR A PROGRESSIVE POLITICAL ECONOMY OF CARBON REMOVAL 6 (2024) [hereinafter NAWAZ ET AL., AGENDA]; JAMES BOYD ET AL., RES. FOR THE FUTURE, POLICY INCENTIVES TO SCALE CARBON DIOXIDE REMOVAL: ANALYSIS AND RECOMMENDATIONS 3 (2024) (discussing estimates of carbon removal volume needed); Robinson Meyer, *The Dawn of A New Climate Industry*, HEATMAP (Aug. 15, 2023), https://heatmap.news/economy/carbon-dioxide-removal-industry-biden (summarizing the Intergovernmental Panel on Climate Change conclusion that keeping global warming below 1.5 °C would be impossible without significant CDR). One expert report estimates that the United States can remove at least one gigaton of $CO_2$ per year by 2050. JENNIFER PETT-RIDGE ET AL., LAWRENCE LIVERMORE NAT'L LAB'Y, ROADS TO REMOVAL: OPTIONS FOR CARBON DIOXIDE REMOVAL IN THE UNITED STATES ES-2 (2023).

24. Lin, *supra* note 18, at 689; *see also* SMITH ET AL., *supra* note 17, at 28 (distinguishing between "conventional CDR," which encompasses well-established methods that are almost exclusively nature-based, and "novel CDR," which encompasses all other types of CDR). CDR techniques can also be classified according to whether they rely on photosynthesis to capture $CO_2$ from the air or on chemical reactions to bind $CO_2$ to a substrate material, or according to whether a technique is land-based or ocean-based. Maria Erans et al., *Direct Air Capture: Process Technology, Techno-Economic and Socio-Political Challenges*, 15 ENERGY & ENVT'L SCI. 1360, 1363-64 (2022).

25. PETT-RIDGE ET AL., *supra* note 23, at ES-6; Lin, *supra* note 18, at 689.

26. Bioenergy with carbon capture and storage involves combustion of biomass to produce energy, combined with the capture and storage of $CO_2$ generated during combustion. Enhanced weathering involves absorption of $CO_2$ from the atmosphere using ground-up rocks. Lin, *supra* note 18, at 690-91.

carbon storage capacity.[27] Engineered techniques generally involve more substantial and permanent storage capacity, though at higher costs per ton of carbon removed, and require additional technological development to be feasible.[28] Furthermore, the leading engineered carbon removal techniques, DACS and bioenergy with carbon capture and storage, generate volumes of concentrated $CO_2$ that may be used to propagate fossil fuel extraction through enhanced oil recovery.[29]

The public tends to perceive nature-based CDR as simpler, more natural, and more open to personal involvement, such as through individual tree planting efforts.[30] Nonetheless, in recent years policy makers have devoted greater attention to engineered CDR because of its potential to reduce atmospheric GHG concentrations on the immense scales needed.[31] Technical estimates suggest that DACS might eventually enable the storage of tens of gigatons of carbon per year.[32] While much of the analysis here is relevant to engineered CDR in general, this Article focuses on DACS because it has received the strongest policy support among engineered CDR techniques.

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27. *See* PETT-RIDGE ET AL., *supra* note 23, at ES-6; Lin, *supra* note 18, at 689. Most of the estimated two gigatons of $CO_2$ removal already taking place each year involves afforestation, reforestation, and other forest-related activities that have been carried out for decades. SMITH ET AL., *supra* note 17, at 10.

28. Lin, *supra* note 18, at 690-92; *see* BOYD ET AL., *supra* note 23, at 5-7, 9-10; *see also* PETT-RIDGE ET AL., *supra* note 23, at 1-6 to -7. Not all engineered carbon removal techniques require cutting-edge technologies: An Arkansas carbon removal facility forms bricks from sawdust and buries the bricks underground. Corbin Hiar, *Exclusive: World's Largest Carbon Removal Plant Is About to Open*, CLIMATEWIRE (Feb. 6, 2024), https://www.eenews.net/articles/exclusive-worlds-largest-carbon-removal-plant-is-about-to-open; *see also* MICHAEL TOMAN ET AL., RES. FOR THE FUTURE, ISSUE BRIEF 24-01, POLICIES FOR SCALING UP CARBON DIOXIDE REMOVAL IN THE UNITED STATES 2 (2024) (discussing biomass carbon removal and storage).

29. Andy Stone & Peter Psarras, *Exploring Direct Air Capture's Role in Enhanced Oil Recovery*, KLEINMAN CTR. FOR ENERGY POL'Y (Sept. 14, 2022), https://kleinmanenergy.upenn.edu/commentary/blog/exploring-direct-air-captures-role-in-enhanced-oil-recovery.

30. SMITH ET AL., *supra* note 17, at 110; Sean Low et al., *Public Perceptions on Carbon Removal from Focus Groups in 22 Countries*, 15 NATURE COMMC'NS, 2024, at 2-3, 6-7.

31. *See* NAWAZ ET AL., AGENDA, *supra* note 23, at 6-7; *see also* BOYD ET AL., *supra* note 23, at 13-18. One estimate suggests that 1.5 gigatons of $CO_2$ could be removed globally each year through forest management and three gigatons through soil carbon sequestration. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 6 tbl.S.1. DACS's carbon storage capacity is difficult to gauge because of uncertainty surrounding its development, but some estimates range up to forty gigatons per year in 2100, if cost, energy, and other concerns are set aside. *See* Kasra Motlaghzadeh et al., *Key Uncertainties Behind Global Projections of Direct Air Capture Deployment*, 348 APPLIED ENERGY, 2023, at 5.

32. Mohammed Al-Juaied & Adam Whitmore, *Prospects for Direct Air Carbon Capture and Storage: Costs, Scale, and Funding*, HARV. KENNEDY SCH., BELFER CTR. FOR SCI. & INT'L AFFS., (Nov. 30, 2023), https://www.belfercenter.org/publication/prospects-direct-air-carbon-capture-and-storage-costs-scale-and-funding; Steffen Fahr et al., *Assessing the Physical Potential Capacity of Direct Air Capture with Integrated Supply of Low-Carbon Energy Sources*, 12 GREENHOUSE GASES SCI. & TECH. 170, 170 (2022). The United States alone "has a technical potential of over 9 billion tonnes of $CO_2$ per year for DACS powered by local purpose-built renewable electricity." PETT-RIDGE ET AL., *supra* note 23, at ES-9. Note, however, that energy requirements, costs, and other factors may limit removals to a small fraction of current GHG emissions. *See id.* at ES-17.

### *A. Technical Details on DACS*

Direct air capture (DAC) is a chemical process in which a capture agent—a basic liquid or solid—is exposed to ambient air and reacts with the $CO_2$ in it.[33] Subjecting the resulting material to heat or a vacuum regenerates the capture agent and releases a concentrated stream of $CO_2$.[34] The concentrated $CO_2$ can be used in manufacturing low-carbon cement or, as more typically envisioned, stored underground.[35] For underground storage, $CO_2$ is compressed into a supercritical fluid and injected into a geologic formation.[36] Suitable formations for long-term $CO_2$ storage are composed of porous and permeable rock overlain by relatively impermeable rock that serves as a reservoir seal.[37] Carbon storage can occur in depleted hydrocarbon reservoirs, deep saline aquifers, and coal seams.[38] Most $CO_2$ storage so far has occurred as a by-product of enhanced oil recovery operations.[39] Operators inject $CO_2$ in underground oil fields, forcing oil trapped in pore spaces towards production wells and leaving $CO_2$ behind.[40] Although the use of captured $CO_2$ for enhanced oil recovery undermines the climate benefits of capturing $CO_2$ in the first place, it also boosts the financial viability of DAC operations and could drive further development of the underlying technology.[41]

Compared with other CDR techniques, DAC offers advantages of locational flexibility and a relatively small physical footprint.[42] On the flip side, DAC presently faces much higher costs than other types of CDR.[43] DAC requires

33. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 189-90.

34. *Id.* at 190, 196, 213 (discussing desorption process).

35. Erans et al., *supra* note 24, at 1366 (noting that geological storage of $CO_2$ should be the primary aim for climate change mitigation strategies but also discussing possible uses of $CO_2$).

36. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 319. When heated above its critical temperature and compressed above its critical pressure, $CO_2$ "behaves as a supercritical fluid, . . . expanding to fill its container like a gas but with a density like that of a liquid." Luisa F. Cabeza et al., *Supercritical $CO_2$ as Heat Transfer Fluid: A Review*, 125 APPLIED THERMAL ENG'G 799, 799 (2017).

37. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 319.

38. Tara K. Righetti, *Siting Carbon Dioxide Pipelines*, 3 OIL & GAS NAT. RES. & ENERGY J. 907, 922 (2017). Offshore $CO_2$ storage under the seabed is generally more expensive than underground storage. *See* Aishan Hatta et al., Global CCS Institute, Cost of $CO_2$ Storage 3, 8 (2025); *see also* JAMES R. COLLINS ET AL., OCEAN CARBON DIOXIDE REMOVAL METHODS 14 (2022), https://www.edf.org/sites/default/files/documents/Ocean%20Carbon%20Dioxide%20Removal%20Methods.pdf.

39. Emma Martin-Roberts et al., *Carbon Capture and Storage at the End of a Lost Decade*, 4 ONE EARTH 1569, 1573 (2021).

40. *See* Righetti, *supra* note 38, at 921-22.

41. Stone & Psarras, *supra* note 29.

42. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 189, 224.

43. *Id.* at 189, 365 ("The primary impediment to direct air capture is high cost."); *see* Yang Qiu et al., *Environmental Trade-Offs of Direct Air Capture Technologies in Climate Change Mitigation Toward 2100*, 13 NATURE COMMC'NS, 2022, at 2 (noting that large scale deployment could "require large amounts of additional energy").

large amounts of energy to extract $CO_2$, which is present in the ambient air in relatively dilute concentrations.[44] Cost estimates range from several hundred to one thousand dollars per ton of $CO_2$ removed, well above the per-ton costs of other CDR techniques.[45] Indeed, removing carbon via DAC is generally far more expensive than mitigating carbon emissions directly.[46]

DACS—DAC plus storage—typically involves relatively permanent geological storage of $CO_2$ underground, although even properly selected storage sites can leak, causing local pollution and re-releasing the removed carbon.[47] Facilities can be sited in a wide range of locations, but DACS's high energy demands and storage needs point toward siting near cheap energy generation sites and suitable geological storage reservoirs.[48]

DACS builds on CCS technologies developed to capture $CO_2$ emissions from power plants, cement plants, and other significant emission sources.[49] Both DACS and CCS rely on chemical processes to capture $CO_2$, and they use the same processes to transport and store $CO_2$ once it is isolated in a concentrated form.[50] As noted at the outset, CDR (including DACS) differs from CCS in that it can result in net negative emissions by removing $CO_2$ from the atmosphere. The main technical difference between DACS and CCS is that CCS extracts $CO_2$ from exhaust air containing $CO_2$ at much higher concentrations than DACS and thus should be easier to implement.[51] The fact that costs, technical difficulties, and public opposition have hampered CCS deployment nonetheless raises concern that DACS might encounter similar difficulties.[52]

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44. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 189, 365; Qiu et al., *supra* note 43, at 2.

45. Mihrimah Ozkan et al., *Current Status and Pillars of Direct Air Capture Technologies*, 25 ISCIENCE, Apr. 2022, at 9; Nicola Jones, *As Carbon Air Capture Ramps Up, Major Hurdles Remain*, YALE ENV'T 360 (Mar. 20, 2024), https://e360.yale.edu/features/direct-air-capture; *see* Robert F. Service, *U.S. Unveils Plans for Large Facilities to Capture Carbon Directly from Air*, SCIENCE (Aug. 11, 2023), https://www.science.org/content/article/us-unveils-plans-for-large-facilities-to-capture-carbon-directly-from-air. Technological advances and economies of scale could eventually lower DACS's per ton cost to between $100 and $200 or less. Ozkan et al., *supra*, at 9-10.

46. *See Global Carbon Market Outlook 2024*, BLOOMBERGNEF (Feb. 21, 2024), https://about.bnef.com/blog/global-carbon-market-outlook-2024 (reporting market prices of carbon credits under $100 per ton).

47. *See* NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 367.

48. *See* Qiu et al., *supra* note 43, at 2.

49. Erans et al., *supra* note 24, at 1363.

50. *See id.* at 1365-66 (describing CCS and DACS and characterizing the latter as a "variation[]of CCS"); Holly Jean Buck, *Social Science for the Next Decade of Carbon Capture and Storage*, 34 ELEC. J., Aug-Sept. 2021, at 2 [hereinafter Buck, *Social Science*].

51. *Direct Air Capture*, INT'L ENERGY AGENCY (last updated Apr. 25, 2024), https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/direct-air-capture (noting that capturing $CO_2$ from the air "is the most expensive application of carbon capture," as $CO_2$ concentrations in the air are more dilute than in exhaust from industrial facilities).

52. Erans et al., *supra* note 24, at 1391; *see* Buck, *Social Science*, *supra* note 50, at 1. The number of CCS projects planned or operating worldwide also has grown substantially. Carlos Anchondo, *Planned CCS Projects Jump 102%—Report*, ENERGYWIRE (Nov. 9, 2023) [hereinafter

Only a handful of relatively small DAC projects are currently in operation, but deployment of the technology has been rapidly expanding.[53] Over one hundred DAC plants are in development worldwide.[54] The first commercial DAC plant in the United States, operated by Heirloom Carbon Technologies, opened in November 2023 and has an estimated removal capacity of one thousand tons of $CO_2$ per year.[55] A DAC facility in Texas launched operations in late 2025 and promises to remove five hundred thousand metric tons of $CO_2$ per year.[56] And as described below, government-funded DAC facilities are expected to remove one million metric tons of $CO_2$ per year.[57] Yet even facilities of such scale would remove only a small fraction of the International Energy Agency's target of removing one billion metric tons of $CO_2$ per year by 2050.[58]

Generous government support under the Biden administration fueled the rapid expansion of DACS projects. The 2021 Bipartisan Infrastructure Law established a $3.5 billion program to launch four regional DACS "hubs."[59] These hubs would serve as "a network of direct air capture projects, potential carbon dioxide utilization off-takers, connective carbon dioxide transport infrastructure, subsurface resources, and sequestration infrastructure located within a region."[60] The legislation required each hub to capture and sequester at least one million metric tons of $CO_2$ a year and at least two hubs to be "located in economically distressed communities in the regions of the United States with high levels of coal, oil, or natural gas resources."[61]

In 2023, the Department of Energy (DOE) selected two DACS hubs for potential grants totaling $1.2 billion: a south Texas hub to be operated by

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Anchondo, *Planned CCS*], https://subscriber.politicopro.com/article/eenews/2023/11/09/planned-ccs-projects-jump-102-report-00126069.

53. Jones, *supra* note 45. Most existing plants use captured $CO_2$ to make a product rather than sequestering it underground. *Id.*

54. *Id.*

55. Corbin Hiar, *First U.S. Direct Air Capture Plant Opens in California*, CLIMATEWIRE (Nov. 10, 2023), https://www.eenews.net/articles/first-u-s-direct-air-capture-plant-opens-in-california.

56. Sasha Ranevska, *Occidental and 1PointFive Secure EPA Class VI Permits for Stratos DAC in Texas*, CARBON HERALD, Apr. 8, 2025, https://carbonherald.com/occidental-and-1pointfive-secure-epa-class-vi-permits-for-stratos-dac-in-texas/; 1PointFive (press release), 1PointFive and Bain & Company Announce Agreement for Direct Air Capture Carbon Removal Credits, Jan. 13, 2026, https://www.1pointfive.com/news/1pointfive-and-bain-company-announce-agreement-for-direct-air-capture-carbon-removal-credits (noting that STRATOS DAC facility "is progressing through start-up activities"); Jones, *supra* note 45.

57. *See infra* text accompanying notes 59-61.

58. *See id.*

59. 42 U.S.C. § 16298d(j); Corbin Hiar, *DOE Awards $1B for 2 Carbon Removal Projects on Gulf Coast*, CLIMATEWIRE (Aug. 11, 2023), https://www.eenews.net/articles/doe-awards-1b-for-2-carbon-removal-projects-on-gulf-coast.

60. 42 U.S.C. § 16298d(j)(1)(B).

61. *Id.* § 16298d(j)(2)(B)(ii), (j)(3)(C)(iv). The Biden administration specifically sought this provision requiring location of hubs in economically distressed communities. Jean Chemnick, *'Down Your Throat': Biden Pushes CCS on Polluted Places*, CLIMATEWIRE (Aug. 22, 2023) [hereinafter Chemnick, *'Down Your Throat'*], https://www.eenews.net/articles/down-your-throat-biden-pushes-ccs-on-polluted-places.

Occidental Petroleum, and a southwest Louisiana hub (Project Cypress) to be operated by Batelle Memorial Institute.[62] Grant awards to these two hubs will occur in phases and are contingent on negotiations between the project developers and DOE.[63] DOE also awarded $99 million in matching funds to nineteen other DACS hub proposals that are not as far along in the development pipeline.[64] This funding will support front-end engineering and design studies, as well as "early-stage efforts to explore the feasibility of a potential direct air capture hub location, ownership structure, and business model."[65] Some of these efforts presumably may lead to full-scale DACS hub projects down the road.[66]

Tax credits and government-sponsored prizes are also aimed at boosting DACS. A federal tax credit of $180 per ton is available for U.S. facilities capturing and storing at least one thousand tons of $CO_2$ per year via DAC and

62. Hiar, *DOE Awards $1B*, *supra* note 58. Under the Trump administration, the status of funding for these two hubs is somewhat uncertain. Corbin Hiar, *Direct Air Capture Takes "Huge Hit" in DOE Funding Cuts*, ENERGYWIRE, Oct. 3, 2025, https://www.eenews.net/articles/direct-air-capture-takes-huge-hit-in-doe-funding-cuts/ (reporting that ten DAC projects collectively lost $47.4 million in funding but that "two DOE_backed hubs that are under development on the Gulf Coast" were "spared from the cuts"); Corbin Hiar, *Trump Targets Carbon Removal Project in Speaker's District*, CLIMATEWIRE (May 8, 2025), https://subscriber.politicopro.com/article/eenews/2025/05/08/trump-targets-carbon-removal-project-in-speakers-district-00332957 (reporting that Trump's budget proposal would cancel funding for projects "removing carbon dioxide from the air"); Maeve Allsup, *The Mad Dash to Save Direct Air Capture Hubs from DOGE*, LATITUDE MEDIA (Apr. 8, 2025), https://www.latitudemedia.com/news/the-mad-dash-to-save-direct-air-capture-hubs-from-doge (reporting that DOE's hit list of clean energy projects initially included the Cypress and south Texas hubs, but a subsequent list designated funding for the Cypress hub for further evaluation after lobbying by Louisiana officials); *see* Korey Silverman-Roati et al., *100 Days of Trump 2.0: Carbon Management and Negative Emissions*, CLIMATE L.: A SABIN CTR. BLOG (May 1, 2025), https://blogs.law.columbia.edu/climatechange/2025/05/01/100-days-of-trump-2-0-carbon-management-and-negative-emissions.

63. *See* Coral Davenport, *U.S. to Fund a $1.2 Billion Effort to Vacuum Greenhouse Gases from the Sky*, N.Y. TIMES (Aug. 11, 2023), https://www.nytimes.com/2023/08/11/climate/carbon-dioxide-direct-capture.html (reporting DOE official's comments that the projects are subject to a "go, no-go" procedure); *Regional Direct Air Capture Hubs Selected and Awarded Projects*, U.S. DEP'T OF ENERGY, https://www.energy.gov/oced/regional-direct-air-capture-hubs-selected-and-awarded-projects (last visited Dec. 29, 2024); *Award Negotiations*, U.S. DEP'T OF ENERGY, https://www.energy.gov/oced/award-negotiations (last visited Jan. 6, 2026). DOE planned to select the other two hubs after soliciting a subsequent round of applications, but Congress has since reallocated the funding for those hubs to other programs. Christa Marshall, *What the Spending "Minibus" Means for DOE, Energy Star*, ENERGYWIRE (Jan. 29, 2026) (noting that legislation reallocated $1 billion in unobligated funds that had been slated for regional direct air capture hubs); Hiar, *DOE Awards $1B*, *supra* note 59; Corbin Hiar, *DOE Plans to Spend $1.8B on Direct Air Capture Hubs*, CLIMATEWIRE (Sept. 23, 2024), https://www.eenews.net/articles/doe-plans-to-spend-1-8b-on-direct-air-capture-hubs/.

64. DEP'T OF ENERGY, OFF. OF FOSSIL ENERGY & CARBON MGMT., REGIONAL DIRECT AIR CAPTURE HUBS (2023), https://www.energy.gov/sites/default/files/2023-08/Project%20Selections%20for%20FOA%202735%20Regional%20Direct%20Air%20Capture%20Hubs%20TA1%20and%20TA2_1.pdf.

65. *Id.*; *see also* Corbin Hiar, *What's Next for Direct Air Capture?*, CLIMATEWIRE (Oct. 11, 2023), https://www.eenews.net/articles/whats-next-for-direct-air-capture.

66. Meyer, *supra* note 23.

permanent geologic storage.[67] Furthermore, California's Low Carbon Fuel Standards (LCFS) allow DACS projects located in the United States to generate carbon credits that fuel distributors in the state can use to satisfy LCFS requirements.[68] Under the Biden administration, DOE also offered a suite of monetary prizes aimed at spurring innovation in DACS.[69] Extensive government support for DACS—whether in the form of subsidies, tax credits, or prizes—has been essential for developing and deploying this expensive technology.

More limited government support extends to other types of CDR. DOE's Carbon Negative Shot program "call[s] for innovation in carbon dioxide removal pathways that will capture carbon dioxide from the atmosphere and store it at gigaton scales for less than $100/net metric ton of carbon dioxide-equivalent."[70] Pilot projects sponsored by the program might remove carbon through biomass cultivation, mineralization, marine techniques, or a combination of pathways.[71] Thus, while federal CDR policy has concentrated on improving and scaling up DACS technology, it is also fostering the development of other CDR techniques.[72]

Private funding complements government support for CDR innovation and deployment. Private support includes funding from private investors and venture capital firms, as well as $100 million in prizes offered by the nonprofit XPrize.[73] Private sector support also has taken the form of commitments by major

67. 26 U.S.C. § 45Q(a), (b)(1)(A)-(B), (d)(2), (h); BIPARTISAN POL'Y CTR., INFLATION REDUCTION ACT SUMMARY 9 (2022) (explaining that the 2022 Inflation Reduction Act lowered the threshold for facility size eligibility and more than tripled the applicable tax credit).

68. CAL. CODE REGS. tit. 17 § 95490(a), (b)(3), (c)(2)(A), (f).

69. *See, e.g.*, *Direct Air Capture Prizes*, DEP'T OF ENERGY AM.-MADE CHALLENGES, https://americanmadechallenges.org/challenges/direct-air-capture (last visited Dec. 30, 2024); *Direct Air Capture Commercial Prize*, DEP'T OF ENERGY AM.-MADE CHALLENGES, https://americanmadechallenges.org/challenges/direct-air-capture/commercial (last visited Dec. 30, 2024).

70. U.S. DEP'T OF ENERGY, STRATEGY FOR THE CARBON NEGATIVE SHOT™ 3 (2025), https://www.energy.gov/sites/default/files/2025-01/Strategy%20for%20the%20Carbon%20Negative%20Shot.pdf.

71. Chelsea Harvey, *DOE Offers $100M for Carbon Removal Pilot Projects*, CLIMATEWIRE (Feb. 13, 2024), https://subscriber.politicopro.com/article/eenews/2024/02/13/doe-invests-up-to-100-million-in-carbon-removal-pilot-projects-00141069. The program also aims to pilot a competitive program for purchasing CDR credits. U.S. DEP'T OF ENERGY, AM.-MADE PROGRAM, COMMERCIAL DIRECT AIR CAPTURE PRIZE: CARBON DIOXIDE REMOVAL PURCHASE PILOT PRIZE MODIFICATION 4, 6-9 (2024), https://americanmadechallenges.org/challenges/direct-air-capture/docs/DAC-Commercial-CDR-Purchase-Pilot-Prize-Official-Rules.pdf.

72. Meyer, *supra* note 23.

73. *See* SMITH ET AL., *supra* note 17, at 60 ("DACCS has become a primary focus for corporate and other large investors in CDR."); BIPARTISAN POL'Y CTR., NAVIGATING THE STAGES OF COMMERCIALIZATION TO DEPLOY DIRECT AIR CAPTURE AT SCALE 14, 16-18 (2023); Corbin Hiar, *XPrize Names 20 Finalists in $100M Carbon Removal Contest*, CLIMATEWIRE (May 8, 2024), https://subscriber.politicopro.com/article/eenews/2024/05/08/xprize-names-20-finalists-in-100m-carbon-removal-contest-00156552. XPrize offers monetary prizes to incentivize technological breakthroughs in selected areas. *See Our Mission*, XPRIZE, https://www.xprize.org/about/mission (last visited Oct. 6, 2025).

companies to pay above-market prices for voluntary carbon offsets that DACS projects will generate.[74]

### *B. Concerns Surrounding DACS*

The rise of DACS has not gone unopposed. Public perceptions of CDR depend on various factors: the components used to capture, transport, and store carbon; the energy source powering the system; impacts on ecosystems; a technique's perceived naturalness; and its feasibility.[75] In addition, perceptions vary according to the audience in question, as communities may focus on local impacts, and broader publics may focus on DACS's systemic effects.

Despite promises of economic investment and employment opportunities,[76] DACS projects have triggered economic, environmental, and other concerns, particularly at the local level. In contrast to some climate-driven infrastructure projects—such as renewable energy facilities that replace coal-fired power plants—DACS projects may offer little immediate co-benefits for local communities other than employment opportunities.[77] In some instances, local residents have turned a wary eye toward promises from fossil fuel companies that their DACS projects will avoid health and environmental impacts.[78] Such concerns have blocked the construction of $CO_2$ pipelines and other components of carbon removal systems.[79]

DAC facilities have a smaller footprint than other CDR techniques but still demand significant amounts of energy, land, and other resources.[80] First, the facilities themselves require steel, concrete, and raw chemical sorbents.[81] Additionally, the projects have land requirements that depend on a facility's technical design as well as its energy source.[82] Water requirements can be substantial, as some DAC techniques use up to thirteen tons of water to capture

74. BIPARTISAN POL'Y CTR., *supra* note 73, at 14.

75. Terre Satterfield et al., *Exploring Public Acceptability of Direct Air Carbon Capture with Storage: Climate Urgency, Moral Hazards and Perceptions of the 'Whole Versus the Parts'*, 176 CLIMATIC CHANGE, 2023, at 15; SMITH ET AL., *supra* note 17, at 111-12.

76. CELINA SCOTT-BUECHLER & SIMONE H. STEWART, DATA FOR PROGRESS, CHARTING A PATH TO JUST DIRECT AIR CAPTURE HUBS 3 (2022).

77. *See* Celina Scott-Buechler et al., *Communities Conditionally Support Deployment of Direct Air Capture for Carbon Dioxide Removal in the United States*, 5 COMMC'NS EARTH & ENV'T, 2024, at 2 [hereinafter Scott-Buechler et al., *Communities*]; *see* PETT-RIDGE ET AL., *supra* note 23, at 7-23 to -24.

78. Evan Halper, *Biden and Oil Companies Like This Climate Tech. Many Americans Do Not*, WASH. POST (May 11, 2024), https://www.washingtonpost.com/business/2024/05/11/carbon-capture-climate-change-exxonmobil-montana/.

79. Jeffrey Tomich et al., *Scuttled CO2 Pipeline Renews Debate About State Hurdles*, ENERGYWIRE (Oct. 23, 2023), https://www.eenews.net/articles/scuttled-co2-pipeline-renews-debate-about-state-hurdles (reporting cancellation of 1,300-mile $CO_2$ pipeline after South Dakota regulators rejected permit application).

80. NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 224.

81. Ozkan et al., *supra* note 45, at 15.

82. *Id.* at 8.

one ton of $CO_2$.[83] Energy requirements are especially daunting: operating DACS on a scale sufficient to meaningfully counter elevated global GHG concentrations could consume half of the electricity generated globally today.[84] Burning fossil fuels to generate this energy would undermine DACS's benefits and expose nearby communities to harmful pollution.[85] Even facilities that rely on renewable energy could generate noise and air emissions.[86]

The transport and storage of captured $CO_2$ can also raise environmental and safety concerns.[87] $CO_2$ is often transported through pipelines in a high-density, high-pressure supercritical state that poses heightened risks of pipeline damage, corrosion, and leaks.[88] If leaked into the air, $CO_2$ becomes a dense gas that displaces oxygen and can cause headaches, drowsiness, rapid breathing, and—at extreme concentrations—asphyxiation.[89] A $CO_2$ leak from pipelines or storage facilities can endanger nearby residents, as demonstrated by a $CO_2$ pipeline rupture in Satartia, Mississippi in 2020.[90] That accident left dozens of people shaking, unconscious, and unable to breathe.[91] A number of victims continued to suffer respiratory and neurological impairment long after $CO_2$ concentrations returned to normal levels.[92] Some vehicles lacking sufficient oxygen to carry out combustion processes stopped running as oxygen was displaced by $CO_2$,

83. *Id.* at 2.

84. Giulia Realmonte et al., *An Inter-Model Assessment of the Role of Direct Air Capture in Deep Mitigation Pathways*, 10 NATURE COMMC'NS, 2019, at 7; Andreas Malm & Wim Carton, *Seize the Means of Carbon Removal: The Political Economy of Direct Air Capture*, 29 HIST. MATERIALISM 3, 28 (2021).

85. *See* SCOTT-BUECHLER & STEWART, *supra* note 76, at 4.

86. *See* PETT-RIDGE ET AL., *supra* note 23, at 7-23 to -24 tbl.7-3 (noting "uncertain" emissions of hydroxide aerosols, calcium carbonate solids, ammonia, and volatile organic compounds).

87. Scott-Buechler et al., *Communities*, *supra* note 77, at 2.

88. MARTIN LOCKMAN, SABIN CTR. FOR CLIMATE CHANGE L., PERMITTING CO2 PIPELINES: ASSESSING THE LANDSCAPE OF FEDERAL AND STATE REGULATIONS 46 (2023). Transport in a supercritical state is more cost-effective for pipeline operators than transport in non-supercritical gas and liquid forms. NAT'L ASS'N OF REGUL. UTIL. COMM'RS (NARUC), ONSHORE U.S. CARBON PIPELINE DEPLOYMENT: SITING, SAFETY, AND REGULATION 11 (2023) [hereinafter NARUC]. The $CO_2$ may contain toxic impurities such as hydrogen sulfide and sulfur dioxide. *Id.* at 30.

89. OFF. OF PIPELINE SAFETY, PIPELINE & HAZARDOUS MATERIALS SAFETY ADMIN., U.S. DEP'T OF TRANSP., FAILURE INVESTIGATION REPORT—DENBURY GULF COAST PIPELINES, LLC—PIPELINE RUPTURE/ NATURAL FORCE DAMAGE, 2-3 (2022) [hereinafter FAILURE INVESTIGATION REPORT], https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2022-05/Failure%20Investigation%20Report%20-%20Denbury%20Gulf%20Coast%20Pipeline.pdf. The lack of a robust model for how $CO_2$ disperses has added to public concern. NARUC, *supra* note 88, at 20, 30.

90. Julia Simon, *The U.S. Is Expanding CO2 Pipelines. One Poisoned Town Wants You to Know Its Story*, NPR (Sept. 25, 2023), https://www.npr.org/2023/05/21/1172679786/carbon-capture-carbon-dioxide-pipeline; FAILURE INVESTIGATION REPORT, *supra* note 89, at 2.

91. *See* Simon, *supra* note 90.

92. *Id.* A government report investigating the incident found that "[l]ocal emergency responders were not informed by [the pipeline operator] of the rupture and the nature of the unique safety risks" and called for "[i]mproved public engagement efforts to ensure public and emergency responder awareness of nearby $CO_2$ pipeline and pipeline facilities and what to do if a $CO_2$ release occurs." FAILURE INVESTIGATION REPORT, *supra* note 89, at 2.

hampering emergency responses.[93] The pipeline operator also failed to notify emergency responders of the leak and associated safety risks, exacerbating the impacts of the leak.[94] Indeed, prior to the accident, the operator had not conducted safety drills with local emergency responders or informed locals of potential hazards because it mistakenly assumed Satartia would not be impacted by a pipeline rupture.[95] Although $CO_2$ poses less severe hazards than some other materials transported in pipelines,[96] environmental justice advocates worry that the safety risks of $CO_2$ pipelines will disproportionately burden disadvantaged communities located near carbon removal and storage infrastructure.[97]

Further environmental concerns arise from the underground storage of $CO_2$ in geologic formations, which can contaminate groundwater.[98] Injected $CO_2$ can mobilize contaminants previously trapped in underground rock and facilitate their movement into drinking water aquifers.[99] When injected $CO_2$ comes in contact with water, it forms a weak acid that can cause naturally occurring metals and other contaminants to leach into drinking water aquifers.[100] Aquifer contamination can also result from hydrogen sulfide and other impurities in the injected $CO_2$ itself and from the intrusion of naturally occurring salty water under pressure from injected $CO_2$.[101]

Local residents further worry that $CO_2$ pipelines or storage facilities will have other adverse impacts. These facilities can damage farmland and trigger seismic activity.[102] Although developers promise tangible economic benefits,

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93. Simon, *supra* note 90.

94. *Id.*; FAILURE INVESTIGATION REPORT, *supra* note 89, at 2.

95. *See* FAILURE INVESTIGATION REPORT, *supra* note 89, at 5; Mike Soraghan & Carlos Anchondo, *Biden Releases Plan to Avoid "Dangerous" CO2 Pipeline Failures*, ENERGYWIRE (May 27, 2022), https://www.eenews.net/articles/biden-releases-plan-to-avoid-dangerous-co2-pipeline-failures.

96. *See Are There Risks to Transporting Carbon Dioxide in Pipelines?*, MIT CLIMATE PORTAL: ASK MIT CLIMATE (July 10, 2024), https://climate.mit.edu/ask-mit/are-there-risks-transporting-carbon-dioxide-pipelines.

97. NARUC, *supra* note 88, at 9. One option for addressing such environmental justice concerns would be to recognize a community consent requirement for DACS projects in marginalized communities that have already borne disproportionate harms from polluting industries. *See infra* Part III.B.1.b.

98. *See Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide ($CO_2$) Geologic Sequestration (GS) Wells Final Rule*, EPA (last updated July 30, 2025), https://www.epa.gov/uic/federal-requirements-under-underground-injection-control-uic-program-carbon-dioxide-co2 (discussing regulation of underground CO2 storage to protect underground sources of drinking water); Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide ($CO_2$) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 43492, 43495, 43497 (July 25, 2008) (to be codified at 40 C.F.R. pts. 144, 146); NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 20, at 346.

99. *See* Federal Requirements Under the UIC Program for $CO_2$ Geologic Sequestration Wells, 73 Fed. Reg. at 43497.

100. *Id.*

101. *Id.*

102. Peter Kelemen et al., *An Overview of the Status and Challenges of $CO_2$ Storage in Minerals and Geological Formations*, FRONTIERS IN CLIMATE, Nov. 2019, at 10-11; Mike Soraghan, *Can a CO2*

pipelines in particular offer few jobs or other local economic benefits.[103] Affected communities fear that powerful companies will strain local infrastructure and profit at locals' expense.[104] DACS facilities might reduce property values or saddle nearby communities with the costs of building and maintaining them.[105] Communities also express concern that they could lose traditional ways of life.[106] Opposition from landowners has hampered developers' efforts to obtain pipeline rights-of-way voluntarily.[107] Absent voluntary agreement, developers can turn to eminent domain authority, but its use or threatened use may trigger further opposition.[108]

At a broader policy level, opponents contend that CDR "will extend reliance on fossil fuels and delay the transition to cleaner energy sources."[109] The concern, often phrased in terms of mitigation deterrence or moral hazard,[110] is that CDR will divert resources and policies away from mitigating GHG emissions—a more direct, proven, and effective means of addressing climate change.[111] Even in the absence of significant CDR activity, CDR's mere potential "to bail us out" might blunt mitigation efforts, though any such effect is difficult to measure.[112] Growing investment in CDR by major fossil fuel companies, including Occidental and Exxon Mobil, as well as support for CDR by leading petrostates, lends weight to greenwashing concerns that CDR will

*Pipeline Developer Change How Farmers Are Treated?*, ENERGYWIRE (Aug. 14, 2023), https://www.eenews.net/articles/can-a-co2-pipeline-developer-change-how-farmers-are-treated.

103. Holly Jean Buck, *Mining the Air: Political Ecologies of the Circular Carbon Economy*, 5 ENV'T & PLAN. E: NATURE & SPACE 1086, 1098-99 (2022) [hereinafter Buck, *Mining the Air*].

104. Scott-Buechler et al., *Communities*, *supra* note 77, at 3, 6.

105. NARUC, *supra* note 88, at 8; *see* WORLD RES. INST., CCS AND COMMUNITY ENGAGEMENT: GUIDELINES FOR COMMUNITY ENGAGEMENT IN CARBON DIOXIDE CAPTURE, TRANSPORT, AND STORAGE PROJECTS 59, 70 (2010) (noting community interest in impact on property values and liability if operator leaves town); Scott-Buechler et al., *Communities*, *supra* note 77, at 3.

106. WORLD RES. INST., *supra* note 105, at 70.

107. PAUL W. PARFOMAK, CONG. RSCH. SERV., IN11944, CARBON DIOXIDE PIPELINES: SAFETY ISSUES 2 (2022) [hereinafter PARFOMAK, CARBON DIOXIDE PIPELINES].

108. *See* NARUC, *supra* note 88, at 8; PARFOMAK, CARBON DIOXIDE PIPELINES, *supra* note 107 (noting that eminent domain authority typically accompanies state siting permits).

109. NARUC, *supra* note 88, at 8; Chemnick, *'Down Your Throat'*, *supra* note 61 (noting environmental justice advocates' concerns that CCS and CDR efforts "work[] against their objective of putting polluting industries out of business").

110. Nils Markusson et al., *Carbon Removal and the Empirics of Climate Delay*, 161 ENV'T SCI. & POL'Y, Nov. 2024, at 1; Malm & Carton, *supra* note 84, at 13; *see* Albert C. Lin, *Does Geoengineering Present a Moral Hazard?*, 40 ECOLOGY L.Q. 673, 674-75 (2013).

111. *See* Chelsea Harvey & Corbin Hiar, *Carbon Removal Isn't Weird Anymore. That Worries Scientists.*, CLIMATEWIRE (Dec. 18, 2023), https://www.eenews.net/articles/carbon-removal-isnt-weird-anymore-that-worries-scientists; Markusson et al., *supra* note 110, at 2 (identifying three main processes by which CDR contributes to mitigation deterrence).

112. Malm & Carton, *supra* note 84, at 13; *cf.* Duncan McLaren, *Quantifying the Potential Scale of Mitigation Deterrence from Greenhouse Gas Removal Techniques*, 162 CLIMATIC CHANGE 2411, 2418-24 (2020) (noting "it is difficult to predict or quantify the possible scale and effects of mitigation deterrence" but nonetheless offering preliminary estimates of the possible extent of mitigation deterrence effect resulting from CDR).

facilitate the continued burning of fossil fuels.[113] This concern helps to explain the frequent opposition to carbon capture infrastructure in communities that have suffered disproportionately from fossil fuel pollution.[114] Not surprisingly, some such communities express heated opposition to DACS projects led by fossil fuel companies.[115] Residents may worry about the direct environmental consequences of DACS projects as well as the extended lifespans of fossil fuel facilities that DACS projects may enable.[116]

### *C. Regulation Potentially Applicable to DACS*

Notwithstanding the relatively limited deployment of DACS, various laws may govern such projects or their components. Careful oversight of DACS under these laws, including the development of regulatory requirements specific to DACS, can address some of the concerns just discussed.

DACS projects are potentially subject to the National Environmental Policy Act (NEPA), which requires the federal government to prepare an environmental impact statement (EIS) for "major Federal actions significantly affecting the quality of the human environment."[117] Major federal actions include projects directly undertaken by the federal government as well as federally funded and federally permitted projects.[118] In preparing an EIS, the federal government invites likely affected persons to participate in scoping, a process that engages stakeholders and the public to determine the issues to be analyzed.[119] The government must also take public comments once a draft EIS is completed and respond to any comments before issuing a final EIS.[120]

A handful of states have NEPA analogues that apply to decisions by state and local governments.[121] In addition, specific components of DACS projects, particularly pipelines and $CO_2$ storage facilities, may require both federal and

113. *See* Harvey & Hiar, *supra* note 111; *see* Malm & Carton, *supra* note 84, at 14-15; NAWAZ ET AL., AGENDA, *supra* note 23, at 7 (quoting comment that DAC could offer industry "a license to continue to operate"); *see also* Ellen Palm et al., *Imagining Circular Carbon: A Mitigation (Deterrence) Strategy for the Petrochemical Industry*, 151 ENVT'L SCI. & POL'Y, Jan. 2024, at 6-8 (explaining how petrochemical industry frames CDR as part of circular carbon imaginary that assumes increased plastic and chemical production).

114. *See* Chemnick, *'Down Your Throat'*, *supra* note 61.

115. Scott-Buechler et al., *Communities*, *supra* note 77, at 4, 6-7.

116. *See* TOMAN ET AL., *supra* note 28, at 5.

117. 42 U.S.C. § 4332(C).

118. 40 C.F.R. § 1508.1. Pursuant to Executive Order 14,154, the Council on Environmental Quality revoked its NEPA regulations in February 2025, leaving federal agencies to rely on their own NEPA regulations or on the rescinded Council on Environmental Quality regulations as guidance. Removal of National Environmental Policy Act Implementing Regulations, 90 Fed. Reg. 10610, 10614 (Feb. 25, 2025). Federal agencies have begun to issue their own revised NEPA rules or guidance aimed at paring down NEPA reviews. Kevin Bogardus, *Agencies Roll Out Plans to Pare Down NEPA Reviews*, E&E NEWS PM (June 30, 2025), https://subscriber.politicopro.com/article/eenews/2025/06/30/agencies-roll-out-plans-to-pare-down-nepa-reviews-00433842.

119. 40 C.F.R. § 1502.4(c) (rescinded by Removal of NEPA, 90 Fed. Reg. at 10616).

120. 40 C.F.R. §§ 1503.1, 1503.4 (rescinded by Removal of NEPA, 90 Fed. Reg. at 10616).

121. *See, e.g.*, California Environmental Quality Act, CAL. PUB. RES. CODE §§ 21000-21189.

state approvals. These approvals may include permits to survey, access, and use surface property and pore space, as well as permits for exploratory, monitoring, and injection wells.[122]

*1. Pipelines*

Regulation of $CO_2$ pipelines consists of a patchwork of approvals and reviews by multiple agencies focused on various sets of impacts.[123] The federal government lacks general siting authority over $CO_2$ pipelines and exercises no regulatory authority over their operation.[124] States may impose siting and operating requirements on $CO_2$ pipelines but in many cases have not done so.[125] Moreover, although existing laws may apply in specific circumstances, such laws often were not adopted with $CO_2$ pipelines in mind.[126] The resulting regulatory hodgepodge has slowed development of $CO_2$ transportation and storage networks.[127]

Pipeline construction affecting waters of the United States is subject to federal environmental permitting under the Clean Water Act (CWA) and the Rivers and Harbors Act (RHA).[128] The CWA requires a permit for the discharge of dredged or fill material into waters of the United States.[129] Nationwide Permit 58, which allows for construction of pipelines that cause the loss of a half-acre or less of waters of the United States, may cover the construction of some $CO_2$ pipelines.[130] Projects not covered by this general permit must obtain an individual permit, which involves public interest review based on environmental criteria.[131] Separately, the RHA requires a permit for building a structure in, over, or affecting any water of the United States.[132] Review of permit applications under the RHA involves balancing costs and benefits to determine if the project is in the public interest.[133] Such permitting requirements, combined with local

122. NAT'L ENERGY TECH. LAB'Y, U.S. DEP'T OF ENERGY, BEST PRACTICES: PUBLIC OUTREACH AND EDUCATION FOR GEOLOGIC STORAGE PROJECTS 22 (rev. ed., 2017).

123. LOCKMAN, *supra* note 88, at 56; *see also* Righetti, *supra* note 38, at 924 (explaining that most aspects of $CO_2$ pipelines, other than safety, are not subject to comprehensive federal regulation).

124. LOCKMAN, *supra* note 88, at 9-10 (noting contrast with pipelines carrying oil, natural gas, and other materials). One commentator suggested in 2017 that federal regulation of $CO_2$ pipeline siting may not yet be needed because "[s]tates are better equipped to establish public participation and consider significant local concerns about safety, land use, and impacts to property and the environment." *See* Righetti, *supra* note 38, at 962; *but cf.* Lockman at 58-62 (recommending that Congress "consider federalizing the siting of interstate $CO_2$ pipelines" or, in the alternative, that states centralize governance regimes and mitigate environmental justice concerns).

125. *See* Righetti, *supra* note 38, at 927, 937, 940; LOCKMAN, *supra* note 88, at 10-15 (discussing a variety of approaches to regulating $CO_2$ pipelines among selected states).

126. LOCKMAN, *supra* note 88, at 50-53.

127. *Id.*

128. *Id.* at 28-30.

129. 33 U.S.C. §§ 1311, 1344(a); LOCKMAN, *supra* note 88, at 28-29.

130. LOCKMAN, *supra* note 88, at 29.

131. Righetti, *supra* note 38, at 933-34.

132. 33 U.S.C. § 403.

133. LOCKMAN, *supra* note 88, at 30.

concerns regarding DACS facilities, could influence the design and siting of DACS hubs.[134]

Pipeline projects requiring a federal permit or right-of-way are subject to NEPA's analysis and disclosure requirements.[135] However, $CO_2$ pipelines are eligible for streamlined federal permitting and coordinated NEPA review.[136] Further, pipelines that cross only private land and that lack significant federal involvement may avoid federal environmental review altogether.[137] State environmental permitting requirements for pipelines vary, with some states requiring review of all actions taken, funded, or approved by state or local agencies that may have a significant impact on the environment, and other states reviewing only pipelines' effects on wetlands and water crossings.[138]

With respect to pipeline safety, the Pipeline and Hazardous Materials Safety Administration (PHMSA) oversees interstate and intrastate pipelines transporting $CO_2$ in a supercritical state.[139] $CO_2$ pipelines are governed by design, operation, and other safety requirements that apply generally to hazardous liquid pipelines.[140] States are generally preempted from regulating the safety of pipelines under the PHMSA's jurisdiction but may impose additional safety requirements on intrastate pipelines under specified conditions.[141]

In response to the Satartia accident, the federal government announced that it would issue new safety rules specific to $CO_2$ pipelines.[142] The Biden administration proposed a comprehensive set of safety rules, but the Trump administration withdrew them for further review.[143] Worries about pipeline

134. *See* PAUL W. PARFOMAK, CONG. RSCH. SERV., IN12269, SITING CHALLENGES FOR CARBON DIOXIDE ($CO_2$) PIPELINES 1-2 (2023).

135. LOCKMAN, *supra* note 88, at 31-34.

136. *See* PARFOMAK, CARBON DIOXIDE PIPELINES, *supra* note 107, at 2 (referring to USE IT Act (Section 102 of Division S of P.L. 116-260)); 42 U.S.C. § 4370m(6) (defining "covered project" under Fixing America's Surface Transportation (FAST) Act to include $CO_2$ pipelines and other carbon capture infrastructure); *see generally* Thomas C. Jensen et al., *Infrastructure Permit Streamlining Under the FAST Act*, 46 ENV'T L. REP. 10369 (2016) (discussing streamlining of federal permitting under the FAST Act).

137. Righetti, *supra* note 38, at 932.

138. LOCKMAN, *supra* note 88, at 36-41.

139. 49 C.F.R. § 195.2 (defining $CO_2$ as "a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state"); NARUC, *supra* note 88, at 17, 30 (explaining that PHMSA's regulatory definition of $CO_2$ leaves "regulatory gaps over the safety of pipelines that transport $CO_2$ as a liquid or a gas" and has not been updated since 1991 "despite recognition by PHMSA's predecessor that it has the authority to regulate all forms of $CO_2$ transport by pipeline").

140. Righetti, *supra* note 38, at 925.

141. *Id.* at 925-27; LOCKMAN, *supra* note 88, at 48-49.

142. Soraghan & Anchondo, *supra* note 95; *PHMSA Advances CO2 Pipeline Safety Regulations*, SABIN CTR. FOR CLIMATE CHANGE L., https://climate.law.columbia.edu/content/phmsa-advances-co2-pipeline-safety-regulations (last visited Jan. 11, 2026) (reporting submission of proposed Notice of Proposed Rulemaking by PHMSA on February 1, 2024).

143. *USDOT Proposes New Rule to Strengthen Safety Requirements for Carbon Dioxide Pipelines*, U.S. DEP'T OF TRANSP. (Jan. 15, 2025); *Notice of Proposed Rulemaking, Pipeline Safety: Safety of Carbon Dioxide and Hazardous Liquid Pipelines*, PIPELINE & HAZARDOUS MATERIALS SAFETY ADMIN., DEP'T OF TRANSP. (Jan. 10, 2025), https://www.phmsa.dot.gov/sites/

safety prompted a petition urging a moratorium on federal permitting of $CO_2$ pipelines until the PHMSA revises its safety regulations.[144] California initially banned $CO_2$ pipelines until the PHMSA finished its rulemaking but will allow intrastate CO2 pipelines once the state adopts regulations that are at least as stringent as the PHMSA's proposed standards for interstate CO2 pipelines.[145]

*2. Storage*

EPA regulates underground carbon storage through its Class VI underground injection well permitting program, established under the Safe Drinking Water Act.[146] Class VI permits may be issued by EPA or by states that have been delegated permitting authority.[147] Permit applicants must demonstrate that $CO_2$ will not leak or contaminate underground sources of drinking water.[148] In considering applications, EPA must provide public notice, hold public hearings if there is "a significant degree of public interest," and solicit and respond to public comment.[149] Agency guidance issued in 2023 further counseled EPA to identify and reach out to communities with environmental justice concerns, assess disproportionate impacts on them, and minimize such

phmsa.dot.gov/files/2025-01/PHMSA%20Notice%20of%20Proposed%20Rulemaking%20for%20CO2%20Pipelines%20-%202137-AF60.pdf; *DOT Withdraws Proposed Carbon Dioxide Pipeline Safety Rules*, SABIN CTR. FOR CLIMATE CHANGE L., https://climate.law.columbia.edu/content/dot-withdraws-proposed-carbon-dioxide-pipeline-safety-rules (last visited Jan. 11, 2026). While it is unclear whether the Trump administration will proceed with $CO_2$ pipeline safety regulation, at least some industry members have expressed support for regulatory oversight in the view that it will enable $CO_2$ pipeline projects to proceed. *See, e.g.*, Mike Soraghan, *Trump Order Puts 2 Pending Pipeline Rules in Limbo*, ENERGYWIRE (Jan. 30, 2025), https://subscriber.politicopro.com/article/eenews/2025/01/30/trump-order-puts-2-pending-pipeline-rules-in-limbo-00201190; David Elam, *Pipeline Safety*, CARBON CAPTURE MAG. (Apr. 30, 2025), https://carboncapturemagazine.com/articles/pipeline-safety.

144. Letter and Petition to Joseph Biden, U.S. President, $CO_2$ Pipeline Moratorium Now! (May 30, 2023), https://www.foodandwaterwatch.org/wp-content/uploads/2023/05/CCS-Pipeline-Moratorium-Org-Letter-to-Biden-.pdf.

145. SB 614 Sec. 4 (Govt. Code 51011.5(a)); SB 614 Sec. 12 (amending Pub. Res. Code 71465); LOCKMAN, *supra* note 88, at 49.

146. *Class VI - Wells Used for Geologic Sequestration of Carbon Dioxide*, EPA (last updated Dec. 16, 2025), https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide [hereinafter *Class VI Wells*, EPA]; 40 C.F.R. §§ 146.81-146.95 (Subpart H).

147. ANGELA C. JONES, CONG. RSCH. SERV., R48033, CLASS VI CARBON SEQUESTRATION WELLS: PERMITTING AND STATE PROGRAM PRIMACY 8-9 (2024) (noting that several states have been granted or are applying for authority to issue permits); Carlos Anchondo, *CO2 Storage Approval Forecast Slashed 65%*, ENERGYWIRE (May 29, 2025), https://subscriber.politicopro.com/article/eenews/2025/05/29/co2-storage-approval-forecast-slashed-65-00373500 (noting that four states have authority to issue permits and that delegating such authority to states "has emerged as a priority for the Trump administration").

148. *Class VI Wells*, EPA, *supra* note 146.

149. 40 C.F.R. §§ 124.10-124.12; *see id.*; *see also* EPA, GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE – UIC QUICK REFERENCE GUIDE 1, 5 (2011) [hereinafter EPA, UIC QUICK REFERENCE], https://www.epa.gov/sites/default/files/2015-07/documents/uic-quick-reference-guide_public-participation_final-508.pdf (explaining that general EPA permitting procedures at 40 C.F.R. Part 124 apply to Class VI injection well permit applications); JONES, *supra* note 147, at 6 (noting that "EPA has not issued specific regulatory requirements for public participation for the Class VI permit application process").

impacts.[150] Applicants themselves were not required to conduct public engagement but were advised to identify stakeholders, develop messages, and consider environmental justice issues.[151] The apparent withdrawal of that guidance in February 2025, however, suggests that agency engagement on environmental justice concerns may no longer occur.[152]

## II. PUBLIC ENGAGEMENT

DACS proposals sometimes encounter opposition and community resistance because of their hazards and potential to extend reliance on fossil fuels. Nonetheless, the broad scope and extent of CDR needed to counter climate change have led to a growing recognition that DACS and other CDR efforts must garner public support to succeed. Public engagement in the planning and implementation of DACS is essential to establishing the support necessary to sustain DACS over the long term. Such engagement can foster a better understanding of the technology and its risks, build public trust in DACS operations, and lead to better project designs that respond to community concerns.[153] Practical considerations and procedural justice demand public engagement, though it may not fully address the concerns surrounding DACS. Through such engagement, DACS can become acceptable to affected communities and the broader public even if it is not ideal.

### *A. Rationales for Public Engagement*

Public engagement is supported by normative, instrumental, and substantive rationales.[154] Normatively, engagement is "the right thing to do"; instrumentally, engagement can help project proponents achieve desired

150. Memorandum from Radhika Fox, EPA Assistant Adm'r, to Reg'l Water Div. Dirs., Regions I-X, Environmental Justice Guidance for UIC Class VI Permitting and Primacy (Aug. 17, 2023).

151. *See* EPA, UIC QUICK REFERENCE, *supra* note 149, at 2-3. EPA's advice focuses on communicating information to stakeholders and the public. *Id.* at 5-8 (discussing developing messages, selecting communication methods, and testing effectiveness of communications). EPA currently faces a sizeable backlog of well permit applications. Corbin Hiar, *Climate Startup to Put Carbon in Concrete to Avoid Permitting Chokepoint*, CLIMATEWIRE (Nov. 11, 2023), https://subscriber.politicopro.com/article/eenews/2023/11/01/climate-startup-to-put-carbon-in-concrete-to-avoid-permitting-chokepoint-00124551. As of April 2024, EPA had issued eight Class VI permits and was in the process of reviewing 130 pending applications for forty-four projects. JONES, *supra* note 147, at 7-8.

152. This guidance no longer appears on EPA's website. *See Final Class VI Guidance Documents*, EPA, https://www.epa.gov/uic/final-class-vi-guidance-documents (last updated Feb. 13, 2025); *see also* Matthew Dobbins et al., *Outlook on the New Administration: What's Next for CCS Permitting?*, VINSON & ELKINS (Feb. 26, 2025), https://www.velaw.com/insights/outlook-on-the-new-administration-whats-next-for-ccs-permitting (discussing Trump administration efforts to limit or remove environmental justice considerations in federal environmental reviews, including with respect to carbon storage).

153. *See infra* Part II.A.

154. Andy Stirling, *Opening Up or Closing Down? Analysis, Participation and Power in the Social Appraisal of Technology*, *in* SCIENCE AND CITIZENS: GLOBALIZATION AND THE CHALLENGE OF ENGAGEMENT 218, 220 (Melissa Leach et al. eds., 2005).

outcomes; and substantively, engagement can lead to objectively better results.[155]

First, as a normative matter, public engagement and participation can advance democratic values and social justice.[156] Environmental justice requires fair treatment for all and meaningful involvement of those who may be affected by a decision.[157] Fair engagement procedures strive to include relevant stakeholders and affected communities in dialogues and decision making.[158] Offering individuals opportunities to express their views throughout decision-making processes fosters fairer outcomes, political equality, and an informed and active citizenry.[159]

Second, public engagement can legitimize and secure support for decisions.[160] Public engagement, in other words, can serve instrumental purposes and generate a social license.[161] Engagement with affected communities, particularly at an early stage, "often leads to smoother implementation, as it builds trust and a sense of ownership among local stakeholders, . . . reducing the likelihood of opposition or conflict."[162] Through engagement, communities may gain a sense of control and a better understanding of health and environmental risks.[163] Just as robust public engagement can build trust, inadequate or

155. *Id.*

156. ALBERT C. LIN, PROMETHEUS REIMAGINED: TECHNOLOGY, ENVIRONMENT, AND LAW IN THE TWENTY-FIRST CENTURY 20 (2013); Daniel J. Fiorino, *Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms*, 15 SCI. TECH. & HUM. VALUES 226, 227-28 (1990).

157. Jonathan Skinner-Thompson, *Procedural Environmental Justice*, 97 WASH. L. REV. 399, 406 (2022).

158. UGBAAD KOSAR & VANESSA SUAREZ, CARBON180, REMOVING FORWARD: CENTERING EQUITY AND JUSTICE IN A CARBON-REMOVING FUTURE 29 (2021); Duncan P. McLaren, *Procedural Justice in Carbon Capture and Storage*, 23 ENERGY & ENV'T 345, 345-46 (2012) (stating that common themes of procedural justice include consistency of treatment, impartiality, voice, and transparency).

159. *See* PANEL ON PUB. PARTICIPATION IN ENV'T ASSESSMENT & DECISION MAKING, NAT'L RSCH. COUNCIL, PUBLIC PARTICIPATION IN ENVIRONMENTAL ASSESSMENT AND DECISION MAKING 46-47 (Thomas Dietz & Paul C. Stern, eds., 2008) [hereinafter PANEL ON PUB. PARTICIPATION].

160. *See* LIN, *supra* note 156, at 20; Fiorino, *supra* note 156, at 228.

161. PETER PSARRAS et al., KLEINMAN CTR. FOR ENERGY POL'Y, ADVANCING THE SOCIAL LICENSE FOR CARBON MANAGEMENT IN ACHIEVING NET-ZERO GHG EMISSIONS 7 (2024), https://kleinmanenergy.upenn.edu/wp-content/uploads/2024/02/KCEP-Digest-60-Advancing-Social-License-for-Carbon-Management-1.pdf (discussing need to generate social license for CCS and CDR through attention to interested parties' concerns); Off. of Fossil Energy & Carbon Mgmt, U.S. Dep't of Energy, Comments of Clean Air Task Force in Response to Notice of Intent and Request for Information Regarding Launching a Responsible Carbon Management Initiative (Sept. 30, 2023), at 2 (suggesting that lack of social license can be a barrier to CDR projects).

162. Jennifer Hirsch et al., The Crucial Role of Just Process for Equitable Industrial Decarbonization: An Action Research Agenda for Carbon Management and Other Emerging Technologies 5 (Feb. 14, 2024) (unpublished paper) (available at https://www.nationalacademies.org/event/41881_02-2024_developing-and-assessing-ideas-for-social-and-behavioral-research-to-speed-efficient-and-equitable-industrial-decarbonization-a-workshop).

163. *See* Dave Huitema, *Hazardous Decisions. The Siting of Hazardous Waste Disposal Facilities in Canada and the United States*, *in* PARTICIPATION AND THE QUALITY OF ENVIRONMENTAL DECISION MAKING 223, 237 (Frans H. J. M. Coenen et al. eds., 1998) [hereinafter Huitema, *Hazardous Decisions*].

unsuccessful community engagement can foster distrust.[164] Trust serves as a foundation for ongoing relationships that facilitate future decision making and project implementation.[165]

Inadequate public engagement and trust have exacerbated opposition to CCS projects—and could likewise affect views on DACS.[166] Worries about safety, property damage, and reduced property values, as well as a sense of exclusion from decision-making processes, have contributed to the cancellation of CCS projects.[167] DACS projects could face similar opposition—and failure—in the absence of sufficient community engagement.[168]

Public trust in decarbonization efforts is essential. Decarbonization will be a protracted and transformational process requiring sustained political, social, and financial support.[169] The process will involve new or unfamiliar technologies—such as DAC and carbon sequestration—that can trigger fear, uncertainty, and opposition.[170] Left unaddressed, opposition may slow or block the extensive infrastructure and policies needed to deploy CDR and other decarbonization technologies at scale.[171] Public engagement is necessary to build and maintain support for phasing out fossil fuels, establishing carbon removal systems, and making other systemic changes.[172] It can also reduce resistance to or even generate support for individual projects.

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164. *See* Hirsch et al., *supra* note 162, at 9; Anchondo, *supra* note 52; *see also* Huitema, *Hazardous Decisions*, *supra* note 163, at 234 (noting in the hazardous waste siting context that "in almost every study[,] an approach of decision-making that lacks participation fails to arrive at approval of proposals").

165. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 51.

166. Anchondo, *Planned CCS*, *supra* note 52.

167. PHILIPPA PARMITER & REBECCA BELL, PUBLIC PERCEPTION OF CCS: A REVIEW OF PUBLIC ENGAGEMENT FOR CCS PROJECTS 7-8 (2020), https://ccuszen.eu/sites/default/files/TG1_Briefing-Report-Public-Perception-of-CCS.pdf (discussing cancellation of Barendrecht project in the Netherlands); Jacob A. E. Nielsen et al., *Community Acceptance and Social Impacts of Carbon Capture, Utilization and Storage Projects: A Systematic Meta-Narrative Literature Review*, 17 PLOS ONE, 2022, at 22 (discussing lack of transparency as contributing factor in cancellation of Vattenfall project in Brandenburg, Germany as well as Barendrecht project).

168. Matthias Honegger et al., *The ABC of Governance Principles for Carbon Dioxide Removal Policy*, 4 FRONTIERS IN CLIMATE, 2022, at 5 (explaining that "[t]ransparent and public deliberation processes can help address and alleviate concerns" that could prompt local or national opposition to CDR).

169. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION IN THE UNITED STATES: TECHNOLOGY, POLICY, AND SOCIETAL DIMENSIONS 244 (2024) [hereinafter NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION]; Jason Chilvers et al., *A Systemic Approach to Mapping Participation with Low-Carbon Energy Transitions*, 6 NATURE ENERGY 250, 256 (2021); Buck, *Social Science*, *supra* note 50, at 5.

170. Sara Nawaz et al., *An Independent Public Engagement Body Is Needed to Responsibly Scale Carbon Removal in the US* [hereinafter Nawaz et al., *Independent*], 19 ENVT'L RSCH. LETTERS, Jan. 2024, at 2; WORLD RES. INST., *supra* note 105, at 20, 75 (noting the "common perception . . . that new technologies are always more risky than established practices").

171. Buck, *Mining the Air*, *supra* note 103, at 1100; NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 247.

172. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 244-45.

Third, public engagement may contribute to better substantive outcomes.[173] Public engagement can yield useful insights, improve project design, identify risks, and establish mechanisms for resolving community concerns.[174] Information and opinions generated in the engagement process can help adapt technologies and projects to local needs and conditions.[175] Furthermore, members of the public may express opinions about risk that reflect social and political values overlooked in expert judgments.[176] Ultimately, public engagement can "deliver tangible and meaningful benefits . . . and acknowledge, mitigate, and compensate for the disruptions, risks, losses, and added burdens many will experience."[177]

Public engagement efforts at the Deep Sky Alpha DAC testing facility in Alberta, Canada illustrate some of the benefits of engagement. Fully operational as of August 2025, the facility is testing the feasibility of multiple DAC technologies that may eventually be deployed at larger scales.[178] Local residents greeted the initial announcement of the facility with hostility over safety and environmental concerns.[179] In response, the company developed a social engagement plan and held numerous stakeholder meetings and well-attended open house sessions with townspeople.[180] Measures adopted to address safety and environmental concerns include sound barriers and operational protocols to reduce noise, as well as remediation plans to ensure the facility is appropriately decommissioned.[181] As part of ongoing engagement, the company also hosts tours of the facility for local science teachers and other events for different audiences.[182]

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173. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 50; LIN, *supra* note 156, at 20.

174. WORLD RES. INST., *supra* note 105, at 20.

175. Katarina Buhr & Victoria Wibeck, *Communication Approaches for Carbon Capture and Storage: Underlying Assumptions of Limited Versus Extensive Public Engagement*, 3 ENERGY RSCH. & SOC. SCI. 5, 9 (2014).

176. Fiorino, *supra* note 156, at 227.

177. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 244.

178. Corbin Hiar, *Canadian Carbon Removal Plant Begins Storing CO2 Underground*, CLIMATEWIRE (Aug. 20, 2025), https://www.eenews.net/articles/canadian-carbon-removal-plant-begins-storing-co2-underground.

179. Sasha Ranevska, *Community Engagement: A Key Factor for Carbon Management Success*, CARBON HERALD (Mar. 24, 2025), https://carbonherald.com/community-engagement-a-key-factor-for-carbon-management-success.

180. *Id.*; Johnnie Bachusky, *Deep Sky Overjoyed with 'Phenomenal' Carbon Removal Open House in Innisfail*, THE ALBERTAN (Sept. 24, 2024), https://www.thealbertan.com/innisfail-news/deep-sky-overjoyed-with-phenomenal-carbon-removal-open-house-in-innnisfail-9547264; *Deep Sky Community Engagement Report*, DEEP SKY, https://www.deepskyclimate.com/blog/deep-sky-alpha-innisfail-alberta (last visited Dec. 27, 2025).

181. DEEP SKY, *supra* note 180.

182. Bachusky, *Deep Sky's Carbon Removal Facility in Innisfail Open for Tours, Operations*, THE ALBERTAN (Sept. 1, 2025), https://www.thealbertan.com/innisfail-news/deep-skys-carbon-removal-facility-in-innisfail-open-for-tours-operations-11105974.

While public engagement in decarbonization efforts is generally desirable, it is neither a simple task nor an unalloyed good. Public engagement takes time and resources.[183] Additional outreach and resources may be necessary to ensure participation by marginalized and disadvantaged groups.[184] Individuals who participate in engagement processes may not represent community views and cannot be held politically accountable.[185] Also, project developers worry that "too early" engagement can reveal confidential information.[186]

Furthermore, public engagement will not necessarily foster mutually or socially beneficial outcomes. In some instances, engagement processes can lead to groupthink and less rational decisions.[187] Engagement processes also may yield confusion, delay, or further conflict.[188] For example, participants may be confused if project sites have not yet been chosen or are subject to change.[189] Or worse, participatory processes can be manipulated by parties who frame the questions or have power over the processes.[190] Engagement exercises carried out merely for show can leave participants feeling frustrated and powerless.[191]

Notwithstanding these costs and risks, public engagement on DACS policy and projects is essential. Well-executed engagement can promote democratic values, legitimize decisions, and lead to better outcomes.

### *B. Elements of Public Engagement*

What exactly is public engagement, anyway?

One conception of public engagement, the "ladder of participation," distinguishes between engagement processes according to participants'

183. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 54; Tina Nabatchi & Lisa Blomgren Amsler, *Direct Public Engagement in Local Government*, 44 AM. REV. PUB. ADMIN. 63S, 75S (2014).

184. Julie L. MacArthur, *Challenging Public Engagement: Participation, Deliberation and Power in Renewable Energy Policy*, 6 J. ENVT'L STUD. & SCI. 631, 638 (2016).

185. *See* Nicholas A. Fromhertz, *From Consultation to Consent: Community Approval as a Prerequisite to Environmentally Significant Projects*, 116 W. VA. L. REV. 109, 146 (2013) (noting concerns that nongovernmental organizations are vulnerable to capture and may not be accountable or representative).

186. Comment Letter from Carbon Capture Coal. to Off. of Fossil Energy and Carbon Mgmt. 5 (Sept. 29, 2023) [hereinafter Carbon Capture Coalition Comment Letter] (available at https://www.regulations.gov/comment/DOE-HQ-2023-0054-0023).

187. Nabatchi & Amsler, *supra* note 183, at 75S; PANEL ON PUB. PARTICIPATION, *supra* note 159, at 54-55; *see also id.* at 76 (concluding that public participation generally leads to better results in terms of quality, legitimacy, and capacity, but can sometimes yield undesired results).

188. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 10, 53-54; Buhr & Wibeck, *supra* note 175, at 9.

189. Carbon Capture Coalition Comment Letter, *supra* note 186, at 6.

190. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 10, 52; Nielsen et al., *supra* note 167, at 13.

191. *See* Nabatchi & Amsler, *supra* note 183, at 75S; *see also* PANEL ON PUB. PARTICIPATION, *supra* note 159, at 10, 52 (noting that some officials may view public input "as having little value, even as they orchestrate the public participation process to gain the desired legitimacy").

influence over ultimate decisions.[192] Notification and information-sharing processes simply inform the public but allow for little or no public voice.[193] Consultative processes offer members of the public an opportunity to express their views and be heard but usually involve limited public influence.[194] Processes allowing for more public influence may delegate decision-making authority to the public; for example, a community may have the right to refuse a proposed project.[195] In other arrangements, such as collaboration, cooperation, and partnership, the public and "traditional powerholders" share power and negotiate decisions.[196]

The ladder of participation suggests several distinct components of public engagement: communication, public discussion and deliberation, and involvement in decision making.[197] In addition, engagement efforts vary in scope, scale, and openness. Public engagement may occur at a single site or at multiple sites, on local, regional, or national scales, and over discrete periods or on an ongoing basis.[198] Participation opportunities may be open only to directly affected individuals, include selected representatives of community interests, or allow anyone to participate.[199]

Communication is a necessary element of public engagement. Communication may occur unilaterally, as when a project developer provides information to the public. Information also may flow unilaterally in the opposite direction. For example, the public may convey information and viewpoints to developers or policy makers in a meeting, public hearing, or survey.[200] In multilateral communications, citizens, developers, and regulators exchange information and viewpoints with each other.[201] Typically, the public receives little or no support in processing the information it receives or in navigating the

192. Sherry R. Arnstein, *A Ladder of Citizen Participation*, 35 J. AM. INST. PLANNERS 216, 217 (1969).

193. *Id.* at 217, 219.

194. *Id.*

195. *Id.* at 217; Hirsch et al., *supra* note 162, at 5.

196. Arnstein, *supra* note 192, at 217; *see* Livia Fritz et al., *Public Engagement for Inclusive and Sustainable Governance of Climate Interventions*, 15 NATURE COMMC'NS, 2022, at 3-4.

197. *See* Dave Huitema, *Hazardous Waste Anyone? A Comparison of Participatory and Non-Participatory Approaches to Hazardous Waste Siting*, *in* PUBLIC PARTICIPATION AND BETTER ENVIRONMENTAL DECISIONS 111, 115 (Frans H.J.M. Coenen ed. 2009); *see also* PANEL ON PUB. PARTICIPATION, *supra* note 159, at 14 (listing five "dimensions" of public participation—who is involved, when they are involved, intensity of involvement, extent of participants' influence, and goals of the process); NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 253; McLaren, *supra* note 158, at 346 (suggesting that fair procedures at a minimum should "include information (notification), voice (participation or representation), and consistent and impartial decision making").

198. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 254.

199. Huitema, *supra* note 197, at 115.

200. Gene Rowe & Lynn J. Frewer, *A Typology of Public Engagement Mechanisms*, 30 SCI. TECH. & HUM. VALUES 251, 255 (2005); Arnstein, *supra* note 192, at 217, 219.

201. *See* Huitema, *supra* note 197, at 115.

engagement process.[202] More inclusive and expansive communication efforts may provide financial or technical support to participants and offer outreach in multiple languages and diverse formats.[203]

Participatory mechanisms in public engagement processes involve varying amounts of public discussion and deliberation.[204] Traditional communication mechanisms, such as television or newspaper announcements, simply convey information without active public deliberation.[205] Public hearings, frequently used by local governments, allow members of the public to express their views.[206] However, public hearings "rely on the public to come to the information" and tend to attract proactive individuals already interested in the matter under consideration.[207] In addition, public hearings and meetings do not necessarily impact actual decisions and may leave participants frustrated.[208] Participatory processes that involve greater deliberation but fewer participants include focus groups and study circles, which convene a relatively small number of people on multiple occasions for in-depth discussions.[209] Action planning workshops and citizens' juries incorporate experts into discussions to answer questions from public participants.[210] Online forums and other virtual processes can engage citizens who might be unwilling or unable to participate in person but may be less effective in promoting accountability, deliberation, and mutual understanding.[211]

Members of the public rarely have the authority to decide the details of a proposal or the criteria for evaluating it.[212] However, public participation must be "more than therapeutic, oppositional, or pleading" if it is to be meaningful.[213] One measure of the efficacy of public engagement is the use of information provided by the public.[214] Members of the public serving on an advisory committee may provide input that decision makers consider along with other factors.[215] Or citizens may directly shape the proposals, decisions, or processes

202. *See id.*

203. *See* NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 273.

204. *See* Fiorino, *supra* note 156, at 229-30; Rowe & Frewer, *supra* note 200, at 256-57, 276-82 tbl.3 (listing methods of engagement including public hearings, town hall meetings, open houses, informal "chats," focus groups, one-on-one meetings, mediated discussions, and virtual workshops); WORLD RES. INST., *supra* note 105, at 61.

205. Rowe & Frewer, *supra* note 200, at 278 tbl.3.

206. *Id.*

207. *Id.*

208. Nabatchi & Amsler, *supra* note 183, at 76S.

209. Rowe & Frewer, *supra* note 200, at 280-81 tbl.3.

210. *Id.*

211. Nabatchi & Amsler, *supra* note 183, at 79S.

212. *See* Fiorino, *supra* note 156, at 236.

213. *See id.* at 229.

214. *See* Peter W.B. Phillips, *Democracy, Governance, and Public Engagement*, *in* PUBLIC ENGAGEMENT AND EMERGING TECHNOLOGIES 46, 56-58 (Kieran O'Doherty & Edna F. Einsiedel eds., 2013).

215. Rowe & Frewer, *supra* note 200, at 254.

for reaching an outcome.[216] The public might even help to set goals and design and implement policy decisions.[217]

Public engagement on specific projects can include negotiations on a community benefit agreement to address collective benefits and compensation.[218] Community benefit agreements are legally enforceable agreements in which project developers commit to mitigation measures, employment opportunities, and equity benefits for host communities.[219] In return, community groups—including neighborhood associations, faith-based organizations, environmental groups, and labor unions—agree to support or not oppose the project.[220] Specific benefits in an agreement may include access to employment and business opportunities, job training, employment-related childcare or transportation subsidies, and education programs.[221] Other benefits may involve revenue distribution, electricity discounts, and environmental and energy benefits.[222] In communities overburdened by pollution, DACS project benefits might redress past harms caused by industry.[223] Because DACS projects may otherwise offer limited direct benefits to host communities, benefits negotiated in a community benefit agreement can be especially critical in securing community support.[224] Ultimately, community benefit agreements provide developers a social license to operate while enabling communities to hold developers accountable for promised benefits.[225]

### *C. Public Engagement in Current CDR Efforts*

Recent planning and construction efforts for DACS projects generally acknowledge the importance of public engagement. However, as the following discussion illustrates, engagement efforts for each project vary widely.

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216. Huitema, *supra* note 197, at 115; NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 273.

217. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 246 (suggesting public input on how the energy system transition should occur).

218. *Id.* at 264-65.

219. KOSAR & SUAREZ, *supra* note 158, at 30, 44; Chemnick, *'Down Your Throat'*, *supra* note 61.

220. U.S. DEP'T OF ENERGY, FAQ: COMMUNITY BENEFITS AGREEMENTS, at 2 (no date).

221. U.S. DEP'T OF ENERGY, COMMUNITY BENEFITS PLAN TEMPLATE FOR DEMONSTRATION AND DEPLOYMENT 7-8 (2024), https://infrastructure-exchange.energy.gov/FileContent.aspx?FileID=e0e71b86-71f5-4bd3-b689-30bd21c8577b; *see* KOSAR & SUAREZ, *supra* note 158, at 44.

222. COMMUNITY BENEFITS PLAN TEMPLATE FOR DEMONSTRATION AND DEPLOYMENT, *supra* note 221, at 7-8.

223. KOSAR & SUAREZ, *supra* note 158, at 30 (discussing example of reparative justice in which a fossil fuel company seeking to conduct geologic carbon storage addresses industry harms to nearby communities, including through reparations).

224. *See* Scott-Buechler et al., *Communities*, *supra* note 77, at 2.

225. KOSAR & SUAREZ, *supra* note 158, at 44.

*1. Mandated Public Engagement*

In some circumstances, public engagement is legally mandated. Most notably, DOE required applicants for regional DACS hub grants to incorporate a community benefit plan demonstrating that a proposed hub would provide societal benefits and mitigate negative impacts.[226] In addition, a key factor considered in evaluating applications has been "[t]he extent to which the project demonstrates a clear and appropriately robust plan to meaningfully engage local stakeholders."[227] Pursuant to these requirements, the two regional hubs selected for award negotiations have commenced community engagement, which is slated to continue as the projects move through subsequent phases.[228] DOE recognizes that the bulk of engagement will occur after it awards grant funding but expects that public input will feed into decisions about whether to proceed with further phases of each project.[229]

Project Cypress, the first regional DACS hub awarded funding, illustrates how mandated public engagement might proceed.[230] In the initial project phase, the project developers plan, design, and engage with the community and labor.[231] Initial outreach efforts have included open houses in communities where the

226. U.S. DEP'T OF ENERGY OFF. OF FOSSIL ENERGY AND CARBON MGMT., FINANCIAL ASSISTANCE FUNDING OPPORTUNITY ANNOUNCEMENT 36-37, 95 (2022) [hereinafter U.S. DEP'T OF ENERGY, FUNDING OPPORTUNITY] (noting that community benefit plan component constitutes 20 percent of overall merit evaluation). A recent DAC grant solicitation from the California Energy Commission likewise mandates community engagement as well as the expenditure of at least 7 percent of grant funds for community engagement, education, and risk-benefit analysis. CAL. ENERGY COMM'N, GRANT FUNDING OPPORTUNITY: DIRECT AIR CAPTURE RESEARCH, DEMONSTRATION, AND COMMUNITY ENGAGEMENT, GFO-24-303, 10, 33 (2024).

227. U.S. DEP'T OF ENERGY, FUNDING OPPORTUNITY, *supra* note 226, at 95.

228. *DAC Hubs Local Engagement Opportunities*, U.S. DEP'T OF ENERGY OFF. OF CLEAN ENERGY DEMONSTRATIONS, https://www.energy.gov/oced/dac-hubs-local-engagement-opportunities (last visited Dec. 30, 2024).

229. *Id.*

230. Public engagement by developers of the South Texas DAC hub offers a further example. The developers reported that they conducted multiple meetings with key stakeholders, including community-based organizations and environmental advocacy organizations. U.S. DEP'T OF ENERGY OFF. OF CLEAN ENERGY DEMONSTRATIONS, SOUTH TEXAS DAC HUB COMMUNITY BRIEFING 26 (2023), https://www.energy.gov/sites/default/files/2023-10/2023.09%20Texas%20-%20OCED%20DAC%20Hubs%20Briefing%20Presentation.pdf. Notably, the local chamber of commerce appears to have played a substantial role in developers' outreach efforts. *See* Jean Chemnick, *'False Promise': DOE's Carbon Removal Plans Rankle Community Advocates*, CLIMATEWIRE (Sept. 25, 2023) [hereinafter Chemnick, *False Promise*], https://www.eenews.net/articles/false-promise-does-carbon-removal-plans-rankle-community-advocates. Although details on further community engagement are yet to be announced, the South Texas developers have made broad commitments similar to those made with respect to Project Cypress: "community and labor engagement," "diversity, equity, inclusion, and accessibility," "investing in the American workforce," and compliance with the Justice40 Initiative. SOUTH TEXAS DAC HUB COMMUNITY BRIEFING, *supra*, at 42.

231. *OCED Issues $50M to Direct Air Capture Hub Project Cypress*, U.S. DEP'T OF ENERGY OFF. OF CLEAN ENERGY DEMONSTRATIONS (Mar. 27, 2024), https://www.energy.gov/oced/articles/oced-issues-50m-direct-air-capture-hub-project-cypress; *see also Regional Direct Air Capture Hubs Selected and Awarded Projects*, *supra* note 63 (noting commitments to establish a community engagement council "to solicit ongoing community input at every stage of the project").

project's DAC plants will be located, though local resident attendance was modest.[232] The developers are in the process of establishing community engagement councils of stakeholders at its two site locations.[233] The councils will include members of disadvantaged and limited English proficiency communities, local workforce development and training entities, labor organizations, and community groups concerned about DAC and $CO_2$ transportation and storage.[234] The councils will assist project developers in identifying community priorities and addressing community concerns, serving as a communication channel between the broader community and the developers.[235] Project developers have also paid heed to just transition concerns associated with fossil fuel-centered local economies. Specifically, the developers have committed to providing construction and operations employment opportunities for local residents and to hiring 10 percent of workers formerly employed in the fossil fuel or plastics industries.[236]

The influence of the community engagement councils and the distribution of project benefits and burdens are yet to be determined, however.[237] The Alliance for Affordable Energy, a local organization that promotes "equitable, affordable, and environmentally responsible energy," warns that Project Cypress features "a dangerous, expensive, and unproven technology" that is "not a climate solution."[238] In addition, environmental justice groups criticize DOE's limited outreach prior to selecting Project Cypress for award negotiations.[239] The groups allege that the community engagement promised by DOE and project developers is taking place only after site selection, too late in the process to be meaningful.[240] These groups also assail DOE's refusal to disclose projects'

232. Corbin Hiar, *Trump Win Forces Carbon Removal Developers to Reconsider Oil*, CLIMATEWIRE (Nov. 25, 2024), https://www.eenews.net/articles/trump-win-forces-carbon-removal-developers-to-reconsider-oil (discussing October 2024 open houses in Shreveport and Lake Charles, Louisiana).

233. U.S. DEP'T OF ENERGY OFF. OF CLEAN ENERGY DEMONSTRATIONS, PROJECT CYPRESS: COMMUNITY BENEFITS COMMITMENTS SUMMARY 3 (2024), https://www.energy.gov/sites/default/files/2024-06/Project%20Cypress%20Community%20Benefits%205.30.24.pdf; *see also Community Engagement Council*, PROJECT CYPRESS, https://www.projectcypress.com/community-engagement-council (last visited Dec. 30, 2025) (describing purpose of council and timeline for establishing council).

234. PROJECT CYPRESS: COMMUNITY BENEFITS COMMITMENTS SUMMARY, *supra* note 233, at 3.

235. *Id.*

236. *Id.* at 5.

237. *See* Nasya Dodson & Ugbaad Kosar, *With Project Cypress, Community Benefit Plans Begin to Take Shape*, CARBON180 (May 2, 2024), https://carbon180.org/blog/with-project-cypress-community-benefits-plans-begin-to-take-shape (noting that the councils were scheduled to be seated in September 2024); *Project Cypress, Community Engagement Council*, *supra* note 233 (identifying members of Project Cypress Southwest Community Engagement Council).

238. *About Us*, ALL. FOR AFFORDABLE ENERGY, https://www.all4energy.org/about-us (last visited Dec. 31, 2025); *An Opportunity to Provide Your Input on Project Cypress*, ALL. FOR AFFORDABLE ENERGY (Oct. 2, 2023), https://www.all4energy.org/watchdog/project-cypress-community-briefing.

239. Chemnick, *False Promise*, *supra* note 230.

240. *Id.*

community benefit plans until after the agency concludes negotiations with project developers.[241] At that point, they worry, plan details will already be final, and any community engagement could be moot.[242] In sum, the engagement efforts surrounding Project Cypress appear to fall short of the timely and robust sort of public engagement that builds trust and responds to community concerns.[243]

*2. Voluntary Public Engagement*

Where no applicable law mandates public engagement, project organizers may nonetheless choose to undertake public engagement. Voluntary public engagement does not guarantee any particular process and can take multiple forms such as conventional project-based outreach, community-centered engagement prior to identification of a developer, and even engagement in the absence of a project proposal.

a. Conventional Project-Based Outreach

Public engagement efforts conducted for STRATOS, a Texas facility built by a subsidiary of Occidental Petroleum (Oxy), illustrate conventional project-based outreach.[244] Once fully operational, STRATOS promises to be the "world's largest direct air capture plant."[245] The facility is privately financed through investments by Oxy and BlackRock and commitments by Amazon, AT&T, and other corporations to purchase carbon credits from the facility.[246] These companies anticipate that the carbon credits will balance out the

241. *Id.*

242. *Id.*

243. *See supra* Part II.A.

244. OXY LOW CARBON VENTURES, COMMUNITY ENGAGEMENT AND ENVIRONMENTAL JUSTICE ASSESSMENT, BROWN PELICAN CO2 SEQUESTRATION PROJECT 1-2 (2024).

245. *1PointFive Holds Groundbreaking for World's Largest Direct Air Capture (DAC) Plant*, 1POINTFIVE (Apr. 28, 2023), https://www.1pointfive.com/news/1pointfive-holds-groundbreaking; *see* Amanda Drane, *Permian Basin Pivot*, LONE STAR THERMAL ENG'G (Apr. 29, 2023), https://lsheattransfer.com/carbon-capture/permian-basin-pivot; OXY, 1POINTFIVE FAST FACTS 2 (2023), https://www.oxy.com/siteassets/documents/publications/fast-facts/oxy_fast_facts_1pointfive.pdf. Oxy, which plans to boost oil and gas production in coming years, anticipates achieving net zero emissions by 2050 through the deployment of DACS. Natasha White et al., *Oxy Quietly Ditched a West Texas Carbon Capture Plant*, MIDLAND REP.-TELEGRAM (Oct. 30, 2023), https://www.mrt.com/business/article/oxy-quietly-ditched-west-texas-carbon-capture-18442622.php.

246. Amanda Drane, *BlackRock to Invest $550M in Oxy's 'Ambitious' Direct Air Capture Hub in West Texas*, HOUS. CHRON. (Nov. 8, 2023), https://www.houstonchronicle.com/business/energy/article/oxy-blackrock-carbon-capture-hub-west-texas-18468112.php (reporting $550 million investment by BlackRock); Susanna Twidale & Peter Henderson, *Amazon Makes First Investment in Direct Air Capture Climate Technology*, REUTERS (Sept. 12, 2023), https://www.reuters.com/business/environment/amazon-makes-first-investment-direct-air-capture-climate-technology-2023-09-12; *AT&T Agrees to Purchase Carbon Credits from Occidental's 1PointFive*, REUTERS (Mar. 13, 2024), https://www.reuters.com/sustainability/sustainable-finance-reporting/att-agrees-purchase-carbon-credits-occidentals-1pointfive-2024-03-13.

companies' carbon emissions and help them satisfy their voluntary carbon neutrality pledges.[247]

STRATOS is located in a somewhat remote area in the Permian Basin, approximately twenty miles southwest of the city of Odessa.[248] The site is surrounded by existing fossil fuel extraction infrastructure,[249] and the nearest home is over six miles away.[250] Engagement efforts included two public meetings with the community, conversations with community leaders, and informational presentations and booths at community events.[251] Oxy reported that only a few businesses and local landowners attended community meetings even though they were widely publicized.[252] The primary participants in engagement were businesses, business professionals, and local organizations such as the Odessa Chamber of Commerce.[253] In general, engagement efforts appeared to be focused on providing information about the project, although the developer also solicited public comment.[254] Oxy claimed that it has "not encountered or been made aware of any organized opposition to the Project," which it attributed to its "comprehensive approach to meaningful public engagement" and efforts to "mitigate community impacts and provid[e] local benefits."[255]

Over a year after Oxy broke ground on the air capture portion of the project, EPA held hearings on whether to issue Class VI injection well permits to store carbon captured by STRATOS.[256] At these hearings, residents aired concerns about potential seismic activity and groundwater contamination.[257] EPA nonetheless issued the permits in April 2025.[258] These permits authorize Oxy to

247. Twidale & Henderson, *supra* note 246; *AT&T Agrees to Purchase Carbon Credits from Occidental's 1PointFive*, *supra* note 246; Amanda Drane, *A Houston Oil Giant is Pioneering a New Climate Technology. It's a Costly Gamble*, HOUS. CHRON. (Oct. 29, 2024), https://www.houstonchronicle.com/business/energy/article/oxy-carbon-capture-climate-solution-ector-county-19855224.php.

248. OXY LOW CARBON VENTURES, *supra* note 244, at 2.

249. *Id.* at 5.

250. *Id.* at 1.

251. *Id.* at 1, 8.

252. *Id.* at 8.

253. *Id.*

254. *Id.* at 9.

255. *Id.*

256. Carlos Nogueras Ramos, *The Largest Carbon Capture Project in the U.S. Could Be in West Texas. Do Residents Want It?*, TEX. TRIB. (Oct. 2, 2024), https://www.texastribune.org/2024/10/02/west-texas-carbon-capture-project-oxy; *see* Carlos Anchondo, *EPA Proposes First-of-a-Kind CO2 Storage Permits in Texas*, ENERGYWIRE (Sept. 5, 2024), https://subscriber.politicopro.com/article/eenews/2024/09/05/epa-proposes-first-of-a-kind-co2-storage-permits-in-texas-00177391.

257. Carlos Nogueras Ramos, *West Texans Split on Proposed Direct Air Capture Project that Would Be Largest in U.S.*, TEX. TRIB. (Oct. 4, 2024), https://www.texastribune.org/2024/10/04/west-texas-carbon-capture-project-occidental.

258. *Id.* (reporting on October 2024 public meetings); *see* Carlos Anchondo, *EPA Issues First Permits in Texas for Dedicated Carbon Storage*, E&E NEWS PM (Apr. 7, 2025) [hereinafter Anchondo, *EPA Issues*], https://subscriber.politicopro.com/article/eenews/2025/04/07/epa-issues-first-permits-in-texas-for-dedicated-carbon-storage-00276501.

inject $CO_2$ underground for the purpose of long-term storage, though Oxy now appears poised instead to use that $CO_2$ elsewhere for enhanced oil recovery.[259]

Outreach efforts at Heirloom Carbon Technologies' facility in Tracy, California, offer a more harmonious example of voluntary community engagement, albeit at a facility involving no underground $CO_2$ storage.[260] Touted as the first commercial DAC plant in the United States, the facility captures a relatively modest quantity of $CO_2$ and mixes it into concrete.[261] Heirloom pledges to avoid the use of $CO_2$ for enhanced oil recovery and to thereby "demonstrate a carbon removal approach that is completely decoupled from any oil and gas interests or any claim of expanded fossil fuel production."[262] Heirloom envisions the Tracy facility as a blueprint for the larger DAC facilities it plans to build.[263] The company has made a general commitment to community engagement, including co-creating community benefit agreements that will be "routinely refreshed by local feedback through an evergreen commitment to community engagement."[264] Such agreements "could include investments in environmental remediation or reparative justice to redress past harms; support for regional housing and transit programs; or even food insecurity and STEM programs."[265]

Shortly after opening the Tracy facility, Heirloom launched a "community governance model" to convene community groups in quarterly meetings.[266] According to Heirloom, these groups will "gather routine community feedback

259. Hiar, *Trump Reshaped*, *supra* note 10. Recent legislation left in place the $180 per ton tax credit for the permanent geological storage of $CO_2$ captured from the air but also made the tax credit available if such $CO_2$ is used for enhanced oil recovery. *Id.* As a result, Oxy will be able to claim the tax credit for $CO_2$ captured by STRATOS whether it uses the $CO_2$ for enhanced oil recovery or simply stores the $CO_2$ underground. *Id.*

260. Brad Plumer, *In a U.S. First, a Commercial Plant Starts Pulling Carbon from the Air*, N.Y. TIMES (Nov. 9, 2023), https://www.nytimes.com/2023/11/09/climate/direct-air-capture-carbon.html.

261. *Id.* (reporting plant's capacity to remove one thousand tons of carbon annually); *Heirloom Unveils America's First Commercial Direct Air Capture Facility*, HEIRLOOM (Nov. 9, 2023), https://www.heirloomcarbon.com/news/heirloom-unveils-americas-first-commercial-direct-air-capture-facility.

262. Petya Trendafilova, *"Heirloom Demonstrating You Can Operationalize DAC Without a Use Case for Fossil Fuels, Shows Others Can Follow Suit," Vikrum Aiyer, Head of Climate Policy*, CARBON HERALD (Feb. 12, 2024), https://carbonherald.com/heirloom-demonstrating-you-can-operationalize-dac-without-a-use-case-for-fossil-fuels-shows-others-can-follow-suit-vikrum-aiyer-head-of-climate-policy-heirloom; Shashank Samala et al., *The New Climate Economy Needs Rule of the Road. Here's a Start*, HEIRLOOM (Oct. 2, 2023), https://www.heirloomcarbon.com/news/the-new-climate-economy-needs-rules-of-the-road.

263. Clare Fonstein, *A Surprising Green Technology Rises in the San Joaquin Valley*, S.F. CHRON. (Nov. 10, 2023), https://www.sfchronicle.com/climate/article/carbon-capture-tracy-heirloom-18473186.php.

264. Samala et al., *supra* note 262; *see* Maeve Allsup, *Direct Air Capture Has Arrived at the Community Buy-in Hurdle*, LATITUDE MEDIA (Oct. 7, 2024), https://www.latitudemedia.com/news/direct-air-capture-has-arrived-at-the-community-buy-in-hurdle.

265. Samala et al., *supra* note 262.

266. *Heirloom Unveils America's First Commercial Direct Air Capture Facility*, *supra* note 261; Allsup, *supra* note 264.

on the facility and its operations and help to steer input for how Heirloom will provide financial and programmatic investments in community organizations."[267] The community governance council for the Tracy facility includes representatives from local environmental organizations, environmental justice groups, labor unions, and the county board of education.[268] The council meets quarterly to offer feedback on facility operations (such as air and noise monitoring needs) and develop a community benefit plan.[269]

b. Community-Centered DAC

Voluntary community engagement may also occur prior to identifying a project developer. The Community Alliance for Direct Air Capture (CALDAC), which received $3 million in DOE funding, has launched an especially comprehensive engagement effort to explore the feasibility of establishing a DAC hub in California's San Joaquin Valley.[270] Led by the University of California, Berkeley's Center for Law, Energy, and the Environment (CLEE), CALDAC is a "coalition of universities, [nongovernmental organizations], and companies with ambitions to create a community-led DAC hub."[271] Planning for the hub, in its initial phases, involves exploring not only the technical details of a DAC facility but also governance and ownership options.[272] The coalition plans to work with local residents first to decide whether to build a facility and then to incorporate a community oversight council that would provide input on design, operation, risk mitigation, and community benefits.[273]

CALDAC is unique in attempting to develop a "community-centered and potentially community owned" DAC hub from the outset.[274] Carbon180, a

267. *Heirloom Unveils America's First Commercial Direct Air Capture Facility*, *supra* note 261.

268. Telephone Interview with Christian Theuer, Dir. of Pol'y & External Affs., Heirloom (Nov. 20, 2024).

269. *Id.*

270. Vanessa Suarez, *In the Central Valley, Exploring Community-Led DAC*, MEDIUM (Aug. 7, 2023), https://carbon180.medium.com/in-the-central-valley-exploring-community-led-dac-4b2565b7eec4; *Project Selections for FOA 2735: Regional Direct Air Capture Hubs – Topic Area 1 (Feasibility) and Topic Area 2 (Design)*, U.S. DEP'T OF ENERGY, https://www.energy.gov/hgeo/project-selections-foa-2735-regional-direct-air-capture-hubs-topic-area-1-feasibility-and (last visited Jan. 24, 2026).

271. Suarez, *supra* note 270.

272. *CALDAC – A Feasibility Assessment of an Equity-Focused Regional Direct Air Capture Hub*, UC BERKELEY LAW (Jan. 2025), https://www.law.berkeley.edu/research/clee/research/other-research-initiatives/caldac; *Project Selections for FOA 2735: Regional Direct Air Capture Hubs Topic Area 1 (Feasibility) and 2 (Design)*, *supra* note 270. The CALDAC planning efforts are at a much more rudimentary stage than planning for the Cypress and South Texas regional hubs selected for much larger grants by DOE.

273. Jean Chemnick, *The Carbon Removal Project that Puts Communities in the Driver's Seat*, CLIMATEWIRE (Oct. 26, 2023) [hereinafter Chemnick, *Carbon Removal Project*], https://www.eenews.net/articles/the-carbon-removal-project-that-puts-communities-in-the-drivers-seat; BERKELEY LAW CTR. FOR LAW, ENERGY, & THE ENV'T, CALDAC TECHNICAL VOLUME 21 (2023), https://www.law.berkeley.edu/wp-content/uploads/2024/01/Technical-Volume.pdf.

274. Suarez, *supra* note 270.

nonprofit organization that advocates for CDR,[275] has been tasked with developing this model and, if appropriate, co-creating a community benefit agreement.[276] This work will take place over a two-year period, during which Carbon180 intends to engage with community groups and environmental justice stakeholders to gauge their support for a DAC hub.[277] Perhaps most radically, project leaders have committed to ending the project if "community members decide a DAC hub will not serve their wants and needs."[278] For-profit companies may participate in CALDAC, subject to the community's ability to veto any company's involvement.[279]

In "Phase 0a," the coalition will assess technological feasibility and establish a community oversight council composed of "stakeholders, residents, and representatives from historically disadvantaged and environmental justice community groups."[280] Council members will be compensated, and the council will have input over key decisions throughout the process.[281] If the project advances to "Phase 0b," CALDAC will establish a community benefit plan and decide on an ownership structure.[282] The ownership structure could involve a public authority comparable to a transit authority or municipal utility district that CALDAC promises "would operate the DAC hub as a public good—one that maximizes safety and the strongest environmental standards while minimizing costs" and "takes a long-term outlook."[283]

c. Engagement Without a Project Proposal

Public engagement may also take place in the absence of a specific proposal. In an effort to identify community views on DAC and bring communities into planning processes early on, Data for Progress, a think tank and polling firm,[284] held workshops in four geographically diverse communities.[285] Workshop sites were chosen because they met DOE's criteria for selecting DAC hubs: access to geological storage and low-carbon electricity, economic reliance on the fossil fuel industry, and location within economic

275. *About*, CARBON180, https://carbon180.org/about (last visited Dec. 30, 2024).
276. Suarez, *supra* note 270.
277. *Id.*
278. *Id.*
279. *See* Chemnick, *Carbon Removal Project*, *supra* note 273.
280. *Id.*; CALDAC TECHNICAL VOLUME, *supra* note 273, at 21.
281. CALDAC TECHNICAL VOLUME, *supra* note 273, at 21.
282. *Id.* at 23, 31, 40.
283. *Id.* at 20, 31.
284. *Our Mission*, DATA FOR PROGRESS, https://www.dataforprogress.org/our-mission (last visited Dec. 30, 2024).
285. *DAC Hubs Resource Guide*, DATA FOR PROGRESS, https://www.dataforprogress.org/dac-hubs-resource-guide (last visited Jan. 10, 2026) (listing workshop locations of Houston, Texas; Beaver County, Pennsylvania; Bakersfield, California; and Rock Springs, Wyoming); Scott-Buechler et al., *Communities*, *supra* note 77, at 2, 5.

opportunity zones.[286] Anticipating DOE's specific interest in the Gulf Coast region, the organization held additional workshops in several Gulf Coast communities.[287]

At the community workshops, participants discussed "what a DAC hub might look like in their community, what their preferences for such a project would be, how they think their community would respond, and how they might use a [community benefit agreement] to negotiate local benefits."[288] While many workshop participants thought that their community would support hosting a DAC hub,[289] Gulf Coast workshop participants expressed concern that powerful fossil fuel players would run DAC facilities for their own benefit and to the detriment of already overburdened communities.[290]

DOE also held several community workshops on carbon management—broadly understood to encompass carbon capture, DAC, $CO_2$ transportation, and $CO_2$ storage.[291] DOE chose locations for the initial workshops based on favorable geology and conditions for carbon management and an absence of prior public engagement on the issue.[292] These workshops—which included presentations, question-and-answer sessions, and discussions with community members—focused on carbon capture, utilization, and storage rather than DACS specifically.[293] However, the workshops touched on many issues also raised by DACS, including local economic benefits, pipeline safety, environmental and health impacts, and distribution of harms and benefits.[294] DOE held similar workshops in three Texas communities in October 2024, though environmental

286. *See* Scott-Buechler et al., *Communities*, *supra* note 77, at 8; DATA FOR PROGRESS, DAC HUBS IN FOSSIL FUEL COUNTRY: RECOMMENDATIONS FROM THE GULF COAST 3 (2023) [hereinafter DAC HUBS IN FOSSIL FUEL COUNTRY], https://www.dataforprogress.org/memos/2023/9/dac-hubs-in-fossil-fuel-country-recommendations-from-the-gulf-coast.

287. DAC HUBS IN FOSSIL FUEL COUNTRY, *supra* note 286, at 2-3; Chemnick, *False Promise*, *supra* note 230.

288. CELINA SCOTT-BUECHLER ET AL., DATA FOR PROGRESS, ADVANCING EQUITABLE DEPLOYMENT OF REGIONAL DAC HUBS 4 (2023) [hereinafter SCOTT-BUECHLER ET AL., ADVANCING], https://www.dataforprogress.org/memos/advancing-equitable-deployment-of-regional-dac-hubs; DAC HUBS IN FOSSIL FUEL COUNTRY, *supra* note 286, at 2-3.

289. DATA FOR PROGRESS, ADVANCING EQUITABLE DEPLOYMENT OF REGIONAL DAC HUBS, ONE-PAGER 1 (2023), https://www.filesforprogress.org/memos/dfp_regional_dac_hubs_one_pager.pdf (reporting that between 47 percent and 75 percent of participants in the initial set of workshops thought that their community would support hosting a DAC hub).

290. DAC HUBS IN FOSSIL FUEL COUNTRY, *supra* note 286, at 5-6.

291. U.S. DEP'T OF ENERGY, WORKSHOP SYNTHESIS AND RECOMMENDATIONS: INSIGHTS FROM THE 2022 CARBON INTERACTIVE WORKSHOP SERIES 1-2 (2023), https://www.energy.gov/sites/default/files/2023-03/Carbon%20Interactive%20Workshops%20Report%20March%202023.pdf [hereinafter DOE WORKSHOP SYNTHESIS] (describing pilot program of interactive workshops on carbon management held in Corpus Christi, Texas; Pittsburgh, Pennsylvania; Tulsa, Oklahoma; and Richland, Washington, in addition to a virtual workshop).

292. *Id.* at 2.

293. *Id.* at 2.

294. *Id.* at 3-5.

justice groups characterized these workshops as public relations efforts held "under the guise of a community workshop."[295]

Other DOE-sponsored outreach on CDR included "expert-led stakeholder conversations and symposiums" held at several universities in 2024.[296] While open to interested community members, these events were aimed primarily at researchers, policy makers, and local experts.[297] Discussions at these meetings considered the results of a nationwide technical analysis of CDR options, with a focus on options specific to each region.[298]

To supplement direct public engagement, CDR policy makers might also look to public surveys.[299] Data for Progress has conducted state surveys on whether CDR should go forward, what to do with captured carbon, and whether states or the federal government should oversee carbon storage.[300] These surveys generally found favorable views of CDR, with some preference for capturing carbon in long-lived materials rather than storing it underground.[301] Respondents also expressed concerns about the costs of implementing CDR and a desire for community engagement.[302] In addition to the state surveys, Data for Progress conducted a national survey on desired features for DAC facilities.[303] This survey found respondents preferred that facilities were "owned by a DAC company and funded by a tax on polluting industries."[304] Respondents also voiced support for community voting power over DAC project decisions, long-term local job guarantees with a commitment to unionization, sourcing of energy from new or expanded wind and solar, and underground $CO_2$ storage onsite using mineralization.[305]

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295. Jean Chemnick, *DOE Carbon Capture Workshops Omit "Naysayers," Community Advocates Say*, CLIMATEWIRE (Sept. 16, 2024) [hereinafter Chemnick, *DOE Carbon Capture Workshops*], https://subscriber.politicopro.com/article/eenews/2024/09/16/doe-carbon-capture-workshops-omit-naysayers-community-advocates-say-00179208.

296. *Events*, ROADS TO REMOVAL, https://roads2removal.org/events (last visited Jan. 10, 2026); *Climate and Carbon Dioxide 'Roads to Removal' Discussion Set for UC Merced*, UC MERCED (Feb. 23, 2024), https://news.ucmerced.edu/news/2024/climate-and-carbon-dioxide-%E2%80%98roads-removal%E2%80%99-discussion-set-uc-merced (promoting March 2024 symposium at University of California, Merced).

297. *See* ROADS TO REMOVAL, *supra* note 296.

298. *See 296* (noting that events build on *Roads to Removal* report); *see also EPA's Janet McCabe to Join National Climate Change Discussion at IU Indianapolis*, NEWS AT IND. UNIV. (Indianapolis), Sept. 3, 2024, https://news.iu.edu/live/news/37797-epas-janet-mccabe-to-join-national-climate-change-disc.

299. *See* Chilvers et al., *supra* note 169, at 251 fig.1 (categorizing public opinion surveys as a form of institution-led, issue-focused public participation).

300. GRACE ADCOX & CATHERINE FRASER, DATA FOR PROGRESS, PUBLIC PERCEPTIONS OF CARBON DIOXIDE REMOVAL IN WYOMING, TEXAS, LOUISIANA, AND COLORADO 5-7 (2024).

301. *Id.* at 48.

302. *Id.* at 49.

303. SCOTT-BUECHLER ET AL., ADVANCING, *supra* note 288, at 20.

304. *Id.*

305. *Id.*

Survey findings can inform policies and planning efforts but do not obviate the need for public engagement on CDR policy or DACS projects. Public engagement has generally occurred with respect to individual project proposals, although engagement efforts have also taken place in communities that might host future DACS proposals. The extent and breadth of these efforts vary, and their success in advancing normative, instrumental, and substantive objectives of engagement remains to be seen.

## III. DESIGNING PUBLIC ENGAGEMENT FOR CDR

What should public engagement for CDR look like?

As a general matter, public engagement efforts should aspire to promote a fair decision process where "those affected by a decision have an opportunity to participate meaningfully . . . [and] those empowered to decide take participants' views seriously."[306] Features of a fair process might include an opportunity to voice concerns, access to information and resources for analyzing that information, a neutral forum, trustworthy authorities, and respectful treatment of participants and their views.[307] A National Academy of Sciences report on decarbonization recommends that public engagement in siting and permitting processes: (1) incorporate inclusive and expansive communications; (2) treat local perspectives as constructive expertise and empower locals to shape processes and outcomes; (3) adapt to context; and (4) be clear, transparent, and accountable.[308] These features are important elements to build the trust essential to effective engagement and successful decarbonization.[309] Indeed, the degree of public trust in project developers and regulators may have a greater influence on public attitudes toward a project than the risks and costs of the project itself.[310]

Although the features mentioned above set out useful general principles in designing public engagement for CDR, they do not purport to establish concrete standards. In addition, they offer little guidance for situations where principles come into conflict with each other. For example, delegating decisions to local

306. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 60.

307. *Id.*; Roger E. Kasperson et al., *Social Distrust as a Factor in Siting Hazardous Facilities and Communicating Risks*, *in* THE SOCIAL CONTOURS OF RISK, VOLUME 1: PUBLICS, RISK COMMUNICATION AND THE SOCIAL AMPLIFICATION OF RISK 29, 49 (Jeanne X. Kasperson & Roger E. Kasperson eds., 2005) [hereinafter Kasperson et al., *Social Distrust*].

308. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 243, 273. Similarly, Carbon180 urges "inclusive and open dialogues with community members" that ultimately respect community wishes and concerns, as well as "[r]obust public engagement . . . structured to facilitate input and feedback." KOSAR & SUAREZ, *supra* note 158, at 32-33. *See also* Hirsch et al., *supra* note 162, at 9 ("Engagement should be two-way, continuous, and adaptable, allowing community perspectives and expertise to influence project trajectories significantly. Such engagement is not a one-off event but an ongoing process, necessitating transparency, collaborative leadership, and inclusivity at every stage.").

309. *Cf.* PARMITER & BELL, *supra* note 167, at 8 (observing that trust "can be earned by open and honest communication about risks, and risk mitigation and management").

310. McLaren, *supra* note 158, at 353.

citizens may empower communities but also undermine accountability. Principles of public engagement also may conflict with goals of efficacy and cost containment. Nonetheless, these principles can make public engagement fairer and more effective and should inform the design of CDR engagement processes.

Ultimately, the appropriate levels and modes of public engagement for CDR will depend on the goals of engagement, decisions to be made, type of CDR at issue, project location and scale, and affected communities.[311] Perhaps most important are the goals of engagement on a specific occasion. These goals may include identifying public concerns, empowering participants, recommending policies, improving decision quality and decision-making capacity, and legitimizing decisions.[312] Policy-level decision processes, as opposed to project-level decisions, call for broad involvement of the general public.[313] High levels of controversy, large projects with far-reaching impacts, the use of unfamiliar or novel technologies, or the presence of more vulnerable populations may warrant especially extensive outreach and dialogue.[314] Conversely, more limited outreach to a narrower set of participants may be appropriate when ironing out the details of a proposed facility and negotiating community benefits.[315] Whether a policy-level or project-level decision is at issue, engagement should occur when it can be meaningful and before a decision is made.

Ideally, public engagement on CDR would occur at both a policy level—national or regional—and a community-based project level.[316] National or regional policy discussions might consider CDR's role within an overall climate strategy, appropriate regulations, research priorities, plans for a network of CDR facilities and infrastructure, and other overarching policy questions. These discussions also might weigh the pros and cons of different CDR techniques, including the danger that DAC in particular might prolong reliance on fossil fuels. Public engagement at this level would consist of "a broader, more general interaction with the wider public" and involve a variety of stakeholders.[317] Community-based project level discussions, in contrast, would center on site-specific proposals for individual facilities and infrastructure. Public engagement at this level, better termed as community engagement, would focus more

311. *See* Low et al., *supra* note 30, at 9 (suggesting that "meaningful consultation can be nuanced by kind of carbon removal"); PANEL ON PUB. PARTICIPATION, *supra* note 159, at 237 (recommending a "best process regime for selecting and adjusting tools and techniques" of public participation rather than "best practices," which "too easily turn into standard operating procedures that are implemented formulaically").

312. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 43-44, 65-66.

313. *Id.* at 18.

314. *See* Hirsch et al., *supra* note 162, at 9.

315. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 18.

316. *Cf.* Buck, *Mining the Air*, *supra* note 103, at 1086-88, 1100 (discussing disconnect between carbon professionals' vision of a circular carbon economy and local communities' participation in project-specific processes).

317. Hirsch et al., *supra* note 162, at 4.

narrowly on the needs, concerns, and values of those directly impacted by a specific project.[318]

### *A. Policy-Level Engagement*

Most CDR public engagement efforts to date have taken place at the project level and under the lead of project developers.[319] However, public engagement at the policy level is equally important.[320] Public engagement at this earlier stage allows for input on foundational decisions for developing and deploying technologies that will shape our communities, society, and environment for decades to come.[321] Such engagement should include the broader public and reflect the full range of stakeholders and individuals affected by fundamental policy decisions.[322]

#### *1. Programmatic NEPA Processes as a Potential Locus for Policy Engagement*

Federal agencies recognize the importance of public participation at the policy stage when they prepare programmatic, as opposed to site-specific, EISs under NEPA.[323] Programmatic analyses enable consideration of environmental concerns early in the planning process, prior to the commitment of resources.[324] Through such analyses, agencies "conduct a broad or holistic evaluation of effects or policy alternatives; evaluate widely applicable measures; or avoid duplicative analysis for individual actions by first considering relevant issues at

318. *Id.*

319. Nawaz et al., *Independent*, *supra* note 170, at 1 (noting that most public engagement efforts in the emerging carbon removal sector "assume that engagement should be led by private project developers"); Hirsch et al., *supra* note 162, at 2 (observing that government requirements that funding applicants propose community benefit plans do not mandate that applicants give much attention to engagement processes).

320. DOE WORKSHOP SYNTHESIS, *supra* note 291, at 13 (noting with respect to carbon management that "[c]ommunities are seeking information on not just project-level or technology-specific risks but trying to figure out how these particular techniques fit into their overall visions of where they want to go in their energy future").

321. *See* LIN, *supra* note 156, at 21-22.

322. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 18 ("[I]f broad directions for policy are being set and trade-offs are being made among public values, it makes sense to have very broad engagement of all elements of the public.").

323. Memorandum from Michael Boots, Council on Envt'l Quality, to Heads of Fed. Dep'ts and Agencies re Effective Use of Programmatic NEPA Reviews 6-7, 24-25 (2014) (available at https://ceq.doe.gov/docs/ceq-regulations-and-guidance/Effective_Use_of_Programmatic_NEPA_Reviews_Final_Dec2014_searchable.pdf); *see generally* 40 C.F.R. § 1501.11 (discussing programmatic environmental documents and tiering) (repealed by Removal of National Environmental Policy Act Implementing Regulations, 90 Fed. Reg. 10610, 10616 (Feb. 25, 2025)). Programmatic NEPA reviews "assess the environmental impacts of proposed policies, plans, programs, or projects for which subsequent actions will be implemented" based on the programmatic review or subsequent NEPA reviews. Memorandum from Michael Boots, *supra*, at 7.

324. Jon C. Cooper, *Broad Programmatic, Policy and Planning Assessments under the National Environmental Policy Act and Similar Devices: A Quiet Revolution in an Approach to Environmental Considerations*, 11 PACE ENVT'L L. REV. 89, 94 (1993).

a broad or programmatic level."[325] Programmatic analyses and public engagement at this stage give the public "a chance to see the big picture early."[326] Thus informed, the public can "provide fresh perspectives and new ideas before determinations are made that will shape the programmatic review" as well as subsequent site-specific actions.[327]

This is not necessarily to suggest that NEPA requires programmatic environmental analyses of federal CDR policies. Rather, regardless of what NEPA may require, DOE and other relevant federal agencies should undertake programmatic NEPA analyses of their CDR policies and include public engagement in doing so. Incorporating public engagement at a broad policy level—and taking community views into account before selecting sites and technologies for CDR projects—can break "the cycle of NIMBYism" that often characterizes siting controversies.[328] An approach that seeks out community voices upfront acknowledges people's attachments to where they live.[329]

Admittedly, stimulating robust public engagement at the policy-making stage is no small task. Members of the public may view their involvement in policy discussions as premature, costly, or futile.[330] Organizers may struggle to secure participation that adequately reflects and represents potentially affected stakeholders and communities.[331] Engaging environmental justice advocates, community organizations, and local governments can help, but these measures do not guarantee representation of local concerns.[332] Nonetheless, delaying public engagement until after a site-specific proposal is made can foster community resentment at being excluded from decision-making processes and forced to host projects with adverse local impacts.[333]

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325. 40 C.F.R. § 1501.11(a) (repealed by Removal of NEPA, 90 Fed. Reg. at 10616).

326. Memorandum from Michael Boots, *supra* note 323, at 25.

327. *Id.* In holding that a federal research program on nuclear breeder reactors required a programmatic EIS, the D.C. Circuit observed: "In the early stages of research, when little is known about the technology and when future application of the technology is both doubtful and remote, it may well be impossible to draft a meaningful impact statement[,]" but that "by the time commercial feasibility of the technology is conclusively demonstrated, . . . the purposes of NEPA will already have been thwarted" because NEPA analysis at that point "will be of little help in ensuring that decisions reflect environmental concerns." Scientists' Inst. for Pub. Info. v. Atomic Energy Comm'n, 481 F.2d 1079, 1093-94 (D.C. Cir. 1973).

328. Patrick Devine-Wright, *Public Engagement with Large-Scale Renewable Energy Technologies: Breaking the Cycle of NIMBYism*, 2 WIREs CLIMATE CHANGE 19, 23 (2011). "The NIMBY label ('not in my backyard') is a succinct way of pejoratively describing local opposition to unwanted land uses." *Id.* at 21.

329. *Id.* at 23-24.

330. *See* PANEL ON PUB. PARTICIPATION, *supra* note 159, at 195, 197 (discussing practical challenges to "[d]etermining the relative role of local and national interests" and "sense of disconnection and powerlessness among many").

331. *Id.* at 195.

332. *Id.* at 195-96.

333. Chemnick, '*Down Your Throat'*, *supra* note 61; Devine-Wright, *supra* note 328, at 22-23 (suggesting that developers' and policy makers' adoption of engagement practices aimed at allaying NIMBY responses may instead provoke more local opposition "arising from discontent at limited

*2. Current Policies Provide for Inadequate Engagement*

Unfortunately, little public engagement has accompanied the adoption of CDR policies thus far. The specific provisions that established DACS hubs and boosted tax credits for DACS were included in federal omnibus legislation addressing infrastructure generally.[334] Through these provisions, Congress prioritized DACS over other CDR techniques. This prioritization may be warranted by DACS's carbon storage potential, but Congress made it without a public discussion of the relative merits and flaws of the various CDR options. Nor did DOE conduct much public engagement in administering DAC funding programs, despite having the leeway to do so.[335] The Bipartisan Infrastructure Law, which set out the process for selecting DACS hubs, left DOE broad discretion on the criteria to apply and the procedures to follow.[336] The agency was required to consider proximity to carbon-intensive industry and potential for carbon sequestration, and it also could weigh additional criteria that, in its judgment, were "necessary or appropriate."[337] These additional criteria seemingly allow the agency to conduct public engagement before selecting hubs for award negotiations.[338] However, rather than conducting such engagement, DOE promised that community dialogues, local engagements, and NEPA processes would take place after the agency's negotiations with selected developers were complete.[339] Furthermore, instead of conducting a transparent selection process, DOE required outside reviewers of applicants' community benefit plans to sign nondisclosure agreements and refused to release the plans

opportunities to participate, the invalidation of emotional response and the pre-occupation with financial benefit").

334. Corbin Hiar, *Major Carbon-Removal Bill Unlikely to Pass This Year*, E&E DAILY (Nov. 16, 2022), https://subscriber.politicopro.com/article/eenews/2022/11/16/major-carbon-removal-bill-unlikely-to-pass-this-year-00067017 (describing the section that provided $3.5 billion for DAC hubs as a "provision tucked into the bipartisan infrastructure package" and suggesting that bipartisan energy policy requires "low political profile").

335. DOE's 2022 carbon management workshops focused on carbon capture, utilization, and storage (rather than DACS) and were limited to four locations. *See supra* Part II.C.2.c; DOE WORKSHOP SYNTHESIS, *supra* note 291, at 2.

336. *See* 42 U.S.C. § 16298d(j)(3)(C); *see also* SCOTT-BUECHLER & STEWART, *supra* note 76, at 3.

337. 42 U.S.C. § 16298d(j)(3)(C)(vii).

338. *See* Chemnick, *False Promise*, *supra* note 230 (reporting that the announcement of regional DACS hubs in Louisiana and south Texas for award negotiation "came as a surprise" to environmental justice groups, who asserted that DOE and project developers "did scant outreach before the projects were selected" and expressed concerns that "the window for the public to have its say has already effectively closed").

339. *Id.*; Corbin Hiar, *Direct Air Capture Funding Hits Snag as Applicants Await $1.2B*, CLIMATEWIRE (June 30, 2023), https://subscriber.politicopro.com/article/eenews/2023/06/30/direct-air-capture-funding-hits-snag-as-applicants-await-1-2b-00104027 (reporting in June 2023, several weeks before initial selection of hubs for negotiation, that "DOE hasn't indicated where the hubs have been proposed, or identified who has applied for funding"); *DAC Hubs Local Engagement Opportunities*, *supra* note 228 (diagram depicting engagement opportunities after project of interest selected); *see also* U.S. DEP'T OF ENERGY, FUNDING OPPORTUNITY, *supra* note 226, at 99-100 (describing the process for evaluating funding applications, without mention of pre-selection public engagement).

publicly until completing negotiations with selected developers.[340] Commenting on Biden administration efforts to promote carbon management, one climate justice activist complained: "The vibe that we've been getting now for a while is like, this is happening. It's happening whether you like it or not. . . . It feels like there's no room for discussion or flexibility. It's more like, we're forcing something down your throat with, like, some sugar."[341] In effect, DOE treated the DACS hub selection process as a technical matter not warranting public input, despite the danger of overlooking community concerns and fostering public distrust.[342]

In an effort to educate the public about DACS and CCS, DOE conducted three workshops in Texas communities that might host future projects.[343] However, this outreach fell short of the broad and meaningful engagement that should occur. Environmental justice and community group representatives complained that DOE excluded them from workshop planning and presentations.[344] Rather than cultivating a broad dialogue on a range of policy issues, the workshops focused narrowly on "equip[ping] the public to demand safeguards and community benefits" for projects that ultimately go forward.[345]

*3. Potential Models for Policy-Level Public Engagement*

Carbon removal is a global public good, analogous to other public goods like national defense and immunity from infectious disease.[346] Public goods require strong government support as well as government control to address associated economic and environmental concerns.[347] Indeed, the analogy to national defense suggests the need to establish public control of CDR siting decisions and to situate those decisions primarily at the national level rather than the community level. The federal government's decision-making process for closing military bases, formally known as the Base Realignment and Closure (BRAC) process, is instructive here. Granted, communities faced with base closures are most likely to be concerned with economic impacts, not environmental impacts. Specifically, the locally concentrated nature of base

340. Chemnick, *False Promise*, *supra* note 230.

341. Chemnick, *'Down Your Throat'*, *supra* note 61.

342. Roger E. Kasperson, *Siting Hazardous Facilities: Searching for Effective Institutions and Processes*, *in* THE SOCIAL CONTOURS OF RISK, *supra* note 307, at 281, 288-89 [hereinafter Kasperson, *Siting Hazardous Facilities*] (discussing siting of controversial facilities based on evaluation of technical criteria).

343. Chemnick, *DOE Carbon Capture Workshops*, *supra* note 295; *see Carbon Management Workshop: Beaumont – Port Author, Texas*, U.S. DEP'T OF ENERGY (Oct. 8, 2024), https://www.energy.gov/fecm/events/carbon-management-workshop-beaumont-port-author-texas; *see also supra* Part II.C.2.c.

344. Chemnick, *DOE Carbon Capture Workshops*, *supra* note 295.

345. *See id.*

346. *See* Moya Chin, *What Are Global Public Goods?*, INT'L MONETARY FUND (Dec. 2021), https://www.imf.org/en/Publications/fandd/issues/2021/12/Global-Public-Goods-Chin-basics.

347. *Id.*

closures' economic impacts suggests the appropriateness of the BRAC process as a potential model for public engagement on DACS. In the end, siting decisions for DACS and other CDR techniques with concentrated local impacts—like base closure decisions—should respond primarily to national prerogatives while accounting for economic, social, and environmental impacts on local communities.[348]

The BRAC process is designed to minimize the politicization of base closures.[349] The Secretary of Defense initiates the process by submitting a list of recommended base realignments and closures to an independent commission appointed by the President in consultation with congressional leaders.[350] The criteria for selecting bases for closure prioritize military value but also consider environmental and economic impacts on nearby communities.[351] The commission deliberates on the recommended closures and then issues a final report for the President's approval.[352] Once approved, the report's recommendations take effect unless Congress rejects the recommendations in their entirety.[353] The process incorporates extensive public and community engagement: For the most recent round of closures, the commissioners conducted twenty regional hearings and twenty deliberative hearings, held hundreds of meetings with public officials, and received hundreds of thousands of public comments.[354]

Participatory mechanisms employed in Germany's transition away from a coal-dependent economy offer another example of the successful integration of community participation into policy-level decision processes.[355] Over the course of several decades, Germany adopted a decentralized process that included conferences, workshops, and grant committees with local stakeholder and resident participation to consider regional solutions.[356] Stakeholder participants

348. *See* Defense Base Closure and Realignment Act of 1990, Pub. L. No. 101-510, 104 Stat. 1808 (1990), *amended by* National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107, 115 Stat. 1342 (2001); CHRISTOPHER T. MANN, CONG. RSCH. SERV., R45705, BASE CLOSURE AND REALIGNMENT (BRAC): BACKGROUND AND ISSUES FOR CONGRESS 2 (Apr. 25, 2019).

349. MANN, *supra* note 348, at 1-2.

350. Defense Base Closure and Realignment Act §§ 2902, 2903.

351. MANN, *supra* note 348, at 4-5 (quoting Defense Base Closure and Realignment Act § 2913); DEF. BASE CLOSURE & REALIGNMENT COMM'N, REPORT TO THE PRESIDENT v (2005).

352. *Id.* at 1.

353. *Id.*

354. *Id.* at iv; *see also* Defense Base Closure and Realignment Act § 2903(d) (requiring Commission to conduct public hearings).

355. NAWAZ ET AL., AGENDA, *supra* note 23, at 37.

356. ANDREA FURNARO ET AL., RES. FOR THE FUTURE & ENVT'L DEF. FUND, GERMAN JUST TRANSITION: A REVIEW OF PUBLIC POLICIES TO ASSIST GERMAN COAL COMMUNITIES IN TRANSITION 37-39 (2021); Nawaz et al., *Independent*, *supra* note 170, at 3. Not all efforts during Germany's transition have effectively engaged local communities. The German Coal Commission, charged with making recommendations for transitioning the country away from coal, has been characterized as a top-down, expert-focused entity that has not adequately incorporated local concerns and participation. FURNARO ET AL., *supra*, at 39; *see also* Jörg Radtke & Martin David, *How Germany is Phasing Out Lignite: Insights from the Coal Commission and Local Communities*, 14 ENERGY SUSTAINABILITY &

have included representatives from the public sector, private companies, community organizations, labor unions, and research institutions.[357] Regional and local opportunities for participation helped to overcome opposition to initial top-down policies and led to collaboration in crafting subsequent policies.[358]

DOE or a newly established federal "Carbon Removal Administration" could implement a similar approach to CDR.[359] This entity would not only organize and oversee CDR efforts but also conduct and support policy and project-level engagement.[360] Such an entity would identify potential CDR project locations with public buy-in and assess CDR infrastructure needs from a systemwide perspective.[361] It would also bolster communities' ability to engage with specific CDR project proposals.[362] Policy-level public engagement could also take place outside of policy-making agencies. Independent bodies charged with fostering public engagement and established with government support could assist the public in evaluating the risks, benefits, and tradeoffs of CDR options in their areas.[363]

Regional-level engagement can explore a broad suite of issues pertinent to carbon removal. These issues include CDR pathways best suited for the region, CDR activities with regional public support, and conditions under which such activities might take place.[364] Regional engagement apart from specific project proposals can combine somewhat centralized planning with participation from a range of communities.[365] To counter the typically weak incentives for individuals to participate in national or regional policy planning, organizers should make clear that these engagement efforts will serve as the public's primary opportunity to participate in technology and site selection.

### *B. Project-Level Engagement*

Public engagement is essential for individual DACS projects as well as general CDR policies. Individual DACS projects often pit carbon reduction benefits for society against community safety concerns, existing land uses, and

SOC'Y, 2024, at 14; FELIX HEILMANN & REBEKKA POPP, E3G, HOW (NOT) TO PHASE-OUT COAL: LESSONS FROM GERMANY FOR JUST AND TIMELY COAL EXITS 7-8, 10 (2020).

357. FURNARO ET AL., *supra* note 356, at 37-39.

358. *Id.* at 40; Pao-Yu Oei et al., *Lessons from Germany's Hard Coal Mining Phase-Out: Policies and Transition from 1950 to 2018*, 20 CLIMATE POL'Y 963, 973-74 (2019).

359. NAWAZ ET AL., AGENDA, *supra* note 23, at 35-37; JOHN LARSEN ET AL., RHODIUM GRP., CAPTURING LEADERSHIP: POLICIES FOR THE US TO ADVANCE DIRECT AIR CAPTURE TECHNOLOGY 7, 38 (2019) (proposing establishment of such an entity).

360. NAWAZ ET AL., AGENDA, *supra* note 23, at 35-37; LARSEN ET AL., *supra* note 359, at 7, 38.

361. NAWAZ ET AL., AGENDA, *supra* note 23, at 37.

362. *Id.* at 37.

363. *Id.* at 36-37.

364. Nawaz et al., *Independent*, *supra* note 170, at 2.

365. *Id.*

private property rights.[366] Although public engagement takes time, it promotes procedural justice and can ultimately facilitate project deployment.[367] Without meaningful engagement, communities and individuals may resist projects through lawsuits, administrative delays, and protests.[368] Early engagement sends a message that community concerns will be taken seriously, and ongoing engagement can build and maintain community support.[369]

Community engagement does not guarantee consensus. In the absence of consensus, community engagement might aim to foster debate and negotiation.[370] Ultimately, "there are no perfect solutions for public engagement to deliver speedy and conflict-free industrial siting decisions in an open democratic society."[371] What makes that society open and democratic, however, is public participation. Thus, community engagement can and should be incorporated into DACS project decision making—whether that engagement is driven by private developers, government entities, or communities themselves.

*1. Developer-Driven Engagement*

Under the predominant mode of infrastructure planning today, developers drive project planning processes.[372] "[P]rojects are conceived of behind closed doors, announced to communities as complete plans, and defended against opposition through public and legal processes."[373] Within this paradigm, government permitting processes define phases of public participation, prescribe decision-making endpoints, and limit disclosure of confidential business information.[374] Engagement often takes the form of public hearings, which participants may find ineffective and alienating.[375] Indeed, operating within the

366. *See supra* Part I.B; NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 274. Other types of CDR also may warrant project-level engagement, with the possible exception of techniques like afforestation that raise few or no community concerns.

367. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 272; Nawaz et al., *Independent*, *supra* note 170, at 1.

368. *See* NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 274; Nawaz et al., *Independent*, *supra* note 170, at 1-2; Hirsch et al., *supra* note 162, at 5 (noting frequent resistance when community engagement occurs only "after key decisions are already made").

369. Nielsen et al., *supra* note 167, at 12; *see* Scott-Buechler et al., *Communities*, *supra* note 77, at 5, 8.

370. Fritz et al., *supra* note 196, at 3, 13 ("Given fundamental differences in perspectives and at times incommensurable values the quest for consensus has, however, been called into question in the case of sustainability issues and transformation pathways.").

371. NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION, *supra* note 169, at 272.

372. Nawaz et al., *Independent*, *supra* note 170, at 1.

373. *Id.*; *see also* Kasperson, *Siting Hazardous Facilities*, *supra* note 342, at 281, 286-88 (describing this approach).

374. *See* Carbon Capture Coalition Comment Letter, *supra* note 186, at 4-5 (commenting on proposed Responsible Carbon Management Initiative).

375. Kasperson et al., *Social Distrust*, *supra* note 307, at 47.

confines of a developer-driven approach may hamper communities' ability to identify alternative options and engage in informed and meaningful ways.[376] Despite the risks of alienating or provoking community members, DACS projects have largely followed this "decide, announce, defend" approach.[377]

a. DOE Guidance on Public Engagement

Under President Biden, DOE attempted to expand public engagement within the framework of a developer-driven model. At the heart of DOE's efforts was the Responsible Carbon Management Initiative, which offered guidance to project developers on responsibly managing CDR and CCS projects.[378] Several of the ten voluntary principles identified in the initiative directly address public engagement.[379] The first principle, community engagement, counsels project developers to undertake "robust, early, and consistent outreach" to persons a project may affect.[380] Other principles relating to public engagement include commitments to tribal consultation, environmental justice, and transparency.[381] The guidance counsels developers to put the principles into practice through "robust two-way community engagement plans, including training on carbon management technology risks and benefits," "clear mechanisms for modifying . . . projects in response to community priorities and concerns," "fair treatment and meaningful involvement of all people regardless of race, color,

376. *See* Nawaz et al., *Independent*, *supra* note 170, at 2.

377. *See* NAWAZ ET AL., AGENDA, *supra* note 23, at 29-30; Nawaz et al., *Independent*, supra note 170, at 1-2.

378. DEP'T OF ENERGY, OFF. OF FOSSIL ENERGY & CARBON MGMT., RESPONSIBLE CARBON MANAGEMENT INITIATIVE RESOURCES 3 (2024) [hereinafter RCMI Resources], https://www.energy.gov/sites/default/files/2024-08/Responsible%20Carbon%20Management%20Initiative%20Resources.pdf; Notice of Intent and Request for Information Regarding Launching a Responsible Carbon Management Initiative, 88 Fed. Reg. 54608 (Aug. 11, 2023) (requesting feedback from stakeholders regarding draft principles for responsible carbon management). The Responsible Carbon Management Initiative appears to be de-prioritized under President Trump's second term, though not necessarily dismantled. *See* Korey Silverman-Roati et al., *100 Days of Trump 2.0: Carbon Management and Negative Emissions*, SABIN CTR. FOR CLIMATE CHANGE L. (May 1, 2025), https://blogs.law.columbia.edu/climatechange/2025/05/01/100-days-of-trump-2-0-carbon-management-and-negative-emissions; *Carbon Dioxide Removal*, U.S. DEP'T OF ENERGY (last updated Sept. 19, 2025), https://www.energy.gov/fecm/carbon-dioxide-removal); *see also* Nico Portuondo, *Trump Budget Plan Floats Massive Cuts to DOE Programs*, GREENWIRE (May 2, 2025), https://subscriber.politicopro.com/article/eenews/2025/05/02/trump-budget-plan-floats-massive-cuts-to-doe-programs-00323262 (noting reduced funding for the DOE office responsible for carbon management under President Trump's fiscal 2026 proposal).

379. NOI and RFI Regarding RCMI, 88 Fed. Reg. at 54609; *see also* RCMI RESOURCES, *supra* note 378, at 3. DOE identified these principles in the first phase of the initiative and promised technical assistance to project developers in implementing the principles in the second phase of the initiative. NOI and RFI Regarding RCMI, 88 Fed. Reg. at 54609.

380. RCMI RESOURCES, *supra* note 378, at 4.

381. *Id.* at 9-13, 22. Other principles address workforce development and quality jobs, environmental responsibility, air and water quality, regulatory requirements, health and safety, emergency response, and long-term stewardship. *See generally id.*

national origin, or income," and siting processes that are "open to public input and transparent with respect to how decisions are made."[382]

DOE offered additional guidance in 2022 on creating community and stakeholder engagement plans for energy-related and carbon management projects.[383] This guidance emphasizes that project developers should not only transmit information but also create and maintain relationships with relevant communities.[384] The guidance spells out key steps in creating an engagement plan: mapping the history, interests, and context of a project area; identifying stakeholders; discussing engagement goals; choosing methods of engagement and a timeline for implementing them; designating persons responsible for conducting engagement; and developing strategies for evaluating engagement efforts.[385] Recommendations from nongovernmental organizations complement DOE's guidance. These recommendations include focusing on disadvantaged local communities, providing resources for transportation, childcare, and the like to support community participation, and accounting for changes in a community's composition and views throughout a project's life cycle.[386]

Both the Responsible Carbon Management Initiative and DOE's engagement plan guidance assume existing planning and permitting processes in which project developers take the lead in engagement efforts. DOE promised to ensure that developers of the projects it funds will engage with communities, address societal concerns, and prepare community benefit plans.[387] Moreover, federal assistance and funding may be available to bolster the ability of disadvantaged communities to participate in public engagement.[388]

While DOE's DACS hub selection process has lacked sufficient engagement,[389] the agency's guidance documents on community engagement offer worthwhile suggestions for DACS developers.[390] Whether or not a DACS project is funded by DOE, a board of local representatives can monitor whether a project is consistent with DOE's standards for community engagement and

382. NOI and RFI Regarding RCMI, 88 Fed. Reg. at 54609-10.

383. *See generally* U.S. DEP'T OF ENERGY, OFF. OF FOSSIL ENERGY & CARBON MGMT., FOSSIL FUEL AND CARBON MANAGEMENT DOMESTIC ENGAGEMENT FRAMEWORK (2022).

384. *Id.* at 1.

385. *Id.* at 2, 4; *cf.* Comment Letter from Sasha Stashwick, Dir. of Pol'y, Carbon180 5 (Sept. 11, 2023) [hereinafter Carbon180 Comment Letter] (available at https://www.regulations.gov/comment/DOE-HQ-2023-0054-0031) (making recommendations for community engagement).

386. KOSAR & SUAREZ, *supra* note 158, at 37; WORLD RES. INST., *supra* note 105, at 77.

387. RCMI RESOURCES, *supra* note 378, at 4.

388. KOSAR & SUAREZ, *supra* note 158, at 47; EPA, 2023-24 ENVIRONMENTAL JUSTICE THRIVING COMMUNITIES TECHNICAL ASSISTANCE CENTERS PROGRAM (EJ TCTAC) 1 (2024), https://www.epa.gov/system/files/documents/2024-05/ej-tctac-project-summaries-updated-april-2024.pdf (describing centers that provide "technical assistance, training, and capacity-building support to communities and organizations to advance environmental and energy justice priorities").

389. *See supra* Part II.C.1.

390. *See* RCMI RESOURCES, *supra* note 378, at 4.

make its findings publicly available.[391] Developer adherence to transparency principles can also facilitate community and stakeholder review of engagement efforts.[392]

b. Community Veto

Under one variation of developer-driven engagement, local communities would have the ability to veto project proposals.[393] Requiring developers to obtain community approval represents a new application of prior informed consent, a principle of international law that recognizes the right of Indigenous peoples to withhold consent from projects that impact their lands and communities.[394] Such a requirement would be consistent with self-determination principles that undergird the environmental and climate justice movements.[395] A community consent requirement for DACS projects would shift power to local communities, encourage integration of community interests and concerns, and foster legitimacy and acceptance of resulting decisions.[396] It also would reduce the number of DACS projects.[397] In light of DACS's locational flexibility, a community veto of an individual DACS project would not necessarily preclude its implementation elsewhere.[398] However, a general community veto right might encourage reflexive NIMBY responses, deterring investment in DACS and ultimately impeding widespread DACS implementation.

As a matter of corrective justice, a community consent requirement may be appropriate for DACS projects in marginalized communities that have already borne disproportionate harms from polluting industries.[399] In other places, the presence of concentrated local environmental impacts may warrant close attention to such impacts and efforts to mitigate them, but not necessarily a consent requirement.[400] A substantial disconnect between those who enjoy a project's benefits and those who bear its costs may also justify greater scrutiny.

391. CHRISTOPHER ALLEN ET AL., CARBON180, SETTING DAC ON TRACK 18 (2022), https://static1.squarespace.com/static/5b9362d89d5abb8c51d474f8/t/6261d1890b76863f1047a2dd/1650577901659/Carbon180-SettingDAConTrack.pdf.

392. RCMI RESOURCES, *supra* note 378, at 22.

393. Huitema, *Hazardous Decisions*, *supra* note 163, at 228-30.

394. *See* SCOTT-BUECHLER & STEWART, *supra* note 76, at 4; Fromhertz, *supra* note 185, at 156; Ciprian N. Radavoi, *Fenceline Communities and Environmentally Damaging Projects: An Asymptomatically Evolving Right to Veto*, 29 TUL. ENVT'L L. J. 1, 6-7 (2015).

395. Carbon180 Comment Letter, *supra* note 385, at 4.

396. Fromhertz, *supra* note 185, at 153-69.

397. *See id.* at 190 (acknowledging that consent requirements for development projects would "represent a hurdle to many projects and activities that require or could require government action or permitting").

398. *Id.*; *cf.* Radavoi, *supra* note 394, at 11-12 (discussing issues surrounding recognition of veto right "when either (1) several locations have been correctly identified as suitable and none is willing to trade off for compensation, or (2) only one location is possible . . . and the community is not willing to accept the trade-off proposed").

399. *See* SCOTT-BUECHLER & STEWART, *supra* note 76, at 4.

400. Fromhertz, *supra* note 185, at 170.

Absent a history of disproportionate harm, society's interest in decarbonization should prevail, and policy-level engagement ideally would attend to siting concerns prior to project-level engagement.

*2. Government-Driven Engagement*

The government, rather than project developers, can take the lead in conducting community engagement for DACS projects.[401] A government-led process is more likely to be impartial than a developer-driven process where the primary motivation for engagement is to advance a project.[402] A public authority, if perceived as unbiased, can better foster the trust essential for meaningful and successful engagement.[403] All the same, government-run participatory processes may undermine trust if the government treats them as a mere formality or provides inadequate support for the processes or for participants engaging in them.[404] As noted above, public hearings sometimes attract limited participation and frustrate those who do participate.[405] Where trust in decision makers is lacking, engagement might be better carried out by a public entity independent of the permitting process.[406] Through recurring involvement in multiple DACS projects, entities specializing in engagement can build up public goodwill, develop expertise, and earn credibility as trusted and impartial facilitators.[407]

France's National Commission for Public Debate (CNDP) offers one example of this approach.[408] The CNDP conducts public engagement on major projects with environmental impacts.[409] Engagement takes the form of "open-ended consultations in which there is give and take that permits a real discussion with concerned citizens and organized groups."[410] Public participation occurs early on, when a proposal could still be modified or abandoned.[411] After public consultations, and in some cases public debates, the CNDP issues a report to

401. *See* Comment Letter from Sara Nawaz et al., Response to DOE FECM RFI 2023-17218: DOE FECM Should Fund Public and Community Organizations to Lead on Responsible Carbon Management 2-3 (2023) (available at https://www.regulations.gov/comment/DOE-HQ-2023-0054-0021).

402. *See* Nawaz et al., *Independent*, *supra* note 170, at 2; McLaren, *supra* note 158, at 354.

403. Nawaz et al., *Independent*, *supra* note 170, at 2; *see* McLaren, *supra* note 158, at 354. As noted earlier, marginalized communities often do not view the government as a neutral player. *See supra* text accompanying notes 341-342.

404. PANEL ON PUB. PARTICIPATION, *supra* note 159, at 227.

405. *See supra* text accompanying notes 207-208.

406. *See* Scott-Buechler et al., *Communities*, *supra* note 77, at 3-4; *see also* McLaren, *supra* note 158, at 354.

407. *See* Nawaz et al., *Independent*, *supra* note 170, at 2-3.

408. *Id.* at 3.

409. *Id.*; *The CNDP, an Independent Entity*, CNDP, https://www.debatpublic.fr/en/cndp-independent-entity-1285 (last updated May 16, 2025).

410. Susan Rose-Ackerman & Thomas Perroud, *Policymaking and Public Law in France: Public Participation, Agency Independence, and Impact Assessment*, 19 COLUM. J. EUR. L. 225, 257 (2013).

411. *The CNDP, an Independent Entity*, *supra* note 409.

which developers must respond.[412] Commission members must remain neutral and avoid expressing an opinion on proposed projects.[413]

The effectiveness of a neutral-led approach to public engagement, as exemplified by the CNDP, is uncertain. The CNDP process is not designed to culminate in a decision or consensus and adds an element of unpredictability.[414] Furthermore, the quality of engagement and extent of participation vary.[415] Some engagement efforts have stimulated keen interest, while others have prompted minimal participation outside of groups already engaged in the decision-making process.[416] A majority of project proposals have gone forward after CNDP consultation, usually with design modifications.[417] This outcome is somewhat comparable to the United States' experience under NEPA, which has prompted federal agencies to modify some projects in response to public feedback and to shy away from a few projects altogether.[418] Unlike NEPA, however, which requires the government agency undertaking a proposed action to perform the analysis,[419] the CNDP process is run by an independent body with no substantive authority over final project decisions.[420] A similar mechanism in the United States would likely protract approval processes with limited impacts on ultimate decisions.

*3. Bottom-Up Engagement*

Whether driven by project developers or government bodies, the predominant approach to community engagement is top-down: the public is invited to react or respond to already-formed proposals. Community engagement also can take less hierarchical forms, however.[421] For instance, stakeholders and members of the public may jointly produce the informational foundation for decision making.[422] And rather than responding to developers' plans, communities may develop their own visions and strategies for decarbonization.[423] Bottom-up engagement also can take the form of protests,

412. *Id.*

413. *Id.*

414. *See* Rose-Ackerman & Perroud, *supra* note 410, at 259; Tim Marshall, *Learning from France: Using Public Deliberation to Tackle Infrastructure Planning Issues*, 21 INT'L PLAN. STUD. 329, 335-36 (2016).

415. Rose-Ackerman & Perroud, *supra* note 410, at 259.

416. *Id.*

417. Nawaz et al., *Independent*, *supra* note 170, at 3; *see also* Marshall, *supra* note 414, at 336.

418. Fromhertz, *supra* note 185, at 133-34.

419. 40 C.F.R. § 1506.5 (stating that decision-making agency "is responsible for the accuracy, scope, and content of environmental documents and shall ensure they are prepared with professional and scientific integrity, using reliable data and resources") (2024) (repealed by Removal of National Environmental Policy Act Implementing Regulations, 90 Fed. Reg. 10610, 10616 (Feb. 25, 2025)).

420. *The CNDP, an Independent Entity*, *supra* note 409.

421. *See* Fritz et al., *supra* note 196, at 4.

422. *Id.* at 1, 13.

423. Buck, *Mining the Air*, *supra* note 103, at 1101.

activism, and digital engagement.[424] Labor unions, community groups, regional institutions, and grassroots organizations can initiate and guide such efforts.[425]

Bottom-up engagement can enable exploration of community preferences before planning for a specific project has begun.[426] Communities that develop an interest in hosting DACS then can solicit proposals from project developers.[427] Once a project is proposed, the community can participate in information and engagement sessions before deciding how to proceed.[428] A bottom-up approach can even involve community ownership of a DACS facility.

However, community ownership would stand in stark contrast to the dominant model of private ownership and development. The private sector is often touted as more efficient, experienced, effective, and knowledgeable than the public sector.[429] Furthermore, policy makers generally look to the private sector to drive the innovation needed to develop economically and technically feasible carbon removal techniques.[430] Competition incentivizes private actors to take risks and develop less costly ways of delivering requested services.[431] Indeed, the main U.S. policy initiatives to promote DACS—tax credits and DOE funding for DAC hubs—established powerful economic incentives for private innovation.[432] These government-directed technology initiatives aimed to foster partnerships that rely on the private sector's technical knowledge and innovation skills.[433]

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424. Chilvers et al., *supra* note 169, at 251-52; Fritz et al., *supra* note 196, at 6.

425. *See* Buck, *Mining the Air*, *supra* note 103, at 1101; Chilvers et al., *supra* note 169, at 252.

426. *See* SCOTT-BUECHLER & STEWART, *supra* note 76, at 6.

427. Huitema, *Hazardous Decisions*, *supra* note 163, at 228-30.

428. *Id.*

429. Steve Rayner et al., *The Oxford Principles*, 121 CLIMATIC CHANGE 499, 502 (2013) (declaring that geoengineering should be regulated as a public good but adding that private sector involvement may "be encouraged to ensure that deployment . . . can be effected in a timely and efficient manner"); *see also* Janine M. Landow-Esser & Melissa A. Manuel, *Environmental and Contracting Issues in Municipal Wastewater Treatment Outsourcing*, *in* AMERICA'S WATER AND WASTEWATER INDUSTRIES: COMPETITION AND PRIVATIZATION [hereinafter AMERICA'S WATER] 41, 44 (Paul Seidenstat et al. eds., 2000) ("outsourced companies may have more experienced personnel and better access to the latest technologies"); Randall G. Holcombe, *Privatization and Incentives for Efficiency: The Case of Wastewater Treatment*, *in* AMERICA'S WATER, *supra*, at 239, 240 (noting "primary justifications given for privatization are cost savings and improvements in the quality of output"). Whether privatization in fact reduces costs depends on the incorporation of incentives into government contracts with private firms. *Id.* at 245, 249-50.

430. *See* NAWAZ ET AL., AGENDA, *supra* note 23, at 20, 23; PETER MANNION ET AL., MCKINSEY, CARBON REMOVALS: HOW TO SCALE A NEW GIGATON INDUSTRY 34 (2023) (discussing cost-reducing CDR innovations by suppliers and developers).

431. David Haarmeyer, *Environmental Infrastructure: An Evolving Public-Private Partnership*, *in* AMERICA'S WATER, *supra* note 429, at 23; Nunzia Carbonara & Roberta Pellegrino, *The Role of Public Private Partnerships in Fostering Innovation*, 38 CONSTR. MGMT. & ECON. 140, 143-44 (2020).

432. *See supra* Part I.A.

433. *See* Lena Brogaard, *Innovative Outcomes in Public-Private Innovation Partnerships: A Systematic Review of Empirical Evidence and Current Challenges*, 23 PUB. MGMT. REV. 135, 135-36 (2021) (describing such partnerships).

Notwithstanding the benefits of private sector involvement, publicly owned and managed DACS facilities might better promote public values. Although public ownership does not necessarily equate to public engagement, publicly controlled facilities are more likely to be managed in ways that reflect the public interest and public preferences.[434] CALDAC's efforts to involve local residents in deciding whether to build a facility, and if so, how to design and operate it, illustrate how a publicly controlled process with serious community engagement might work.[435] As contemplated by CALDAC, community ownership and ongoing engagement would channel benefits to local communities while attending to local concerns.

Public control of DACS and other carbon removal facilities would mirror public control of other types of infrastructure.[436] Like sewer and solid waste disposal systems, carbon removal is a form of waste management.[437] Waste management systems provide a public good and, in the United States, are largely under public control.[438] Carbon removal is also a public good and could be managed similarly.[439] Public management would alleviate concerns that private entities would operate DACS facilities in a self-interested manner, disregard community impacts, or use DACS as an excuse to continue fossil fuel operations.[440] However, publicly managed waste disposal systems are hardly free from private domination or corruption, either.[441] The process of contracting with private companies to collect and manage solid waste can be vulnerable to bribery, fraud, and other forms of corruption.[442]

Public ownership *and* operation of DACS facilities—without private involvement—may be less susceptible to corruption.[443] In the United States, most sewage treatment plants—also known as "*publicly owned* treatment works"—and water supply systems are locally owned and operated as pure

434. Scott-Buechler et al., *Communities*, *supra* note 77, at 4 (reporting focus group participants' views that direct community oversight would make DAC projects fairer and safer).

435. *See supra* Part II.C.2.b.

436. Andrew Bergman et al., *Give Communities Control of Carbon Removal*, THE NEW REPUBLIC (Apr. 11, 2022), https://newrepublic.com/article/166067/public-carbon-capture-climate.

437. *See id.*

438. *Id.*

439. *See id.*

440. *See id.*; NAWAZ ET AL., AGENDA, *supra* note 23, at 23 (warning of danger that public funding for private CDR could "end up a boon to corporates" or "prolong[] . . . harmful industries").

441. *See* NANCY ISARIN ET AL., BASEL INST. ON GOVERNANCE, DIRTY DEALS: CASE STUDIES ON CORRUPTION IN WASTE MANAGEMENT AND TRADE 27 (2023), https://baselgovernance.org/sites/default/files/2023-11/231130_WP-49.pdf (discussing corruption risks surrounding public procurement processes for waste management).

442. *Id.*

443. *Cf.* NAWAZ ET AL., AGENDA, *supra* note 23, at 23 (advocating public development, operation, and ownership of CDR facilities and infrastructure); Bergman et al., *supra* note 436 (advocating ownership of CDR facilities by government or local communities); *but cf.* Frederic Boehm et al., *Privatization and Corruption*, *in* LIMITS TO PRIVATIZATION 263, 264 (Ernst Ulrich von Weizsäcker et al. eds., 2005) (suggesting that state-owned enterprises are subject to corruption because they place significant resources under politicians' control).

public utilities.[444] However, *local* public ownership and operation of DACS facilities may not be appropriate because they are not completely analogous to sewage treatment or water supply systems. Communities have an incentive to properly develop and manage sewage treatment and water supply systems, which largely benefit local communities.[445] Although many sewage treatment plants were built in response to generous federal and state grants and federal wastewater treatment standards, a sewage plant can be supported at least in part by the customers it serves.[446] The same is true for water supply systems, which are funded by a combination of customer revenue and federal and state grants.[447]

In contrast to facilities that address largely local needs, DACS facilities deal with global wastes. A community has a relatively weak interest in a local facility's removal of GHGs from the global atmosphere, which provides little direct environmental benefit to that community. Because DACS facilities lack a direct customer base, financing for them necessarily will differ from financing for typical public utilities. In this regard, DACS facilities are more like national defense facilities and military personnel. The general public, rather than the local community, typically pays for these national public goods, and control is centered at a national rather than local level.[448] However, because these facilities have significant local impacts, local communities should rightfully have a voice in decisions regarding their establishment and management—whether these decisions involve the closure of military bases or siting of DACS facilities.

Notwithstanding the case for public ownership and management of facilities that generate public goods, one important factor—the need for innovation—argues in favor of a significant private sector role with respect to CDR facilities specifically. Sewage treatment and water supply systems rely on

444. U.S. GOV'T ACCOUNTABILITY OFF., GAO-21-291, PRIVATE WATER UTILITIES: ACTIONS NEEDED TO ENHANCE OWNERSHIP DATA 8 (Mar. 2021) [hereinafter PRIVATE WATER UTILITIES] (noting estimate that almost 80 percent of U.S. population receives drinking water from community water systems owned by local government utilities); *Water and Wastewater Systems*, CYBERSECURITY & INFRASTRUCTURE SEC. AGENCY, https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors/water-and-wastewater-sector (last visited Jan. 11, 2026) (noting that 75 percent of U.S. population is served by publicly owned wastewater treatment systems); NAT'L RSCH. COUNCIL, PRIVATIZATION OF WATER SERVICES IN THE UNITED STATES: AN ASSESSMENT OF ISSUES AND EXPERIENCE 14 (2002).

445. In other words, clean water is a local public good, where local governments determine, at least in part, the water quality that local residents enjoy. H. Spencer Banzhaf, *The Market for Local Public Goods*, 64 CASE W. RSRV. L. REV. 1441, 1443 (2014).

446. *See* NAT'L RSCH. COUNCIL, *supra* note 444, at 35-36.

447. *Id.* at 38.

448. In addition to general tax revenues, liability regimes could serve as sources of funding for CDR facilities. *Cf.* Hilary Howard, *Hochul Signs Law That Penalizes Companies for Greenhouse Gas Emissions*, N.Y. TIMES (Dec. 26, 2024), https://www.nytimes.com/2024/12/26/nyregion/hochul-climate-change-superfund-law.html (discussing New York's Climate Change Superfund Act, which mandates payments by companies responsible for past carbon emissions).

well-established techniques.[449] While further innovation may make these systems more effective, innovation is not the primary goal of private sector involvement.[450] Effective deployment of CDR, in contrast, requires further innovation, and current policy initiatives aim to harness the private sector's technical expertise and initiative to spark that innovation.[451] To be sure, reliance on the private sector to drive innovation is not without pitfalls. Such an approach, if designed to favor more commercially viable technologies, can lock them in, to the detriment of more transformational technologies that might subsequently become available.[452] Nonetheless, the private sector's comparative advantage at innovating argues in favor of a significant private role in CDR development and deployment—but subject to public oversight and control.[453]

A bottom-up approach to DACS has the potential to foster community engagement and community control of DACS projects. Whether such an approach will remove carbon in significant amounts remains to be seen, however. Leaving removal efforts solely to communities risks failing to adequately account for global and national interests in carbon removal.

Community engagement is essential for DACS projects and can be driven by developers, the government, publicly funded bodies, or communities themselves. Developer-driven engagement, though most common, is challenging to undertake in a way that respects communities and responds to their concerns. Nevertheless, early, proactive, and continuous engagement by developers can establish ongoing relationships with communities and give rise to projects that advance societal goals and respond to community concerns. Government-led engagement offers a seemingly more impartial approach but may likewise struggle to attract deep community involvement, particularly if community trust is lacking. An independent, publicly funded body to conduct engagement may be better able to build the trust needed for effective community involvement. Alternatively, bottom-up approaches may maximize engagement opportunities and community influence but are relatively unproven. Regardless of the approach taken, policy makers, stakeholders, and participants in community

449. NAT'L RSCH. COUNCIL, *supra* note 444, at 35-37 (discussing widely used sewage treatment methods); PRIVATE WATER UTILITIES, *supra* note 444, at 6-7 (discussing drinking water collection and treatment methods).

450. *Cf.* Brogaard, *supra* note 433, at 135-36 (noting that public procurement and public-private partnerships typically do not have innovation as a primary goal). Innovation in water supply system operations could help address challenges of aging infrastructure and new contaminants. PRIVATE WATER UTILITIES, *supra* note 444, at 8-9.

451. Meyer, *supra* note 23.

452. NAWAZ ET AL., AGENDA, *supra* note 23, at 20; Emily Grubert & Shuchi Talati, *The Distortionary Effects of Unconstrained For-Profit Carbon Dioxide Removal and the Need for Early Governance Intervention*, 15 CARBON MGMT., 2023, at 4, 15.

453. *Cf.* Grubert & Talati, *supra* note 452, at 13-14 (advocating "a publicly funded and publicly accountable CDR sector" in light of concerns that profit-driven CDR can incentivize poor verification practices and facilitate continued GHG emissions).

engagement should act in good faith while acknowledging the need for decarbonization at scale.

## CONCLUSION

Successful decarbonization—including the removal of carbon from the atmosphere in substantial quantities—will require public and community engagement. Such engagement must occur both at a broader policy level and at a community-based project level. Policy-level engagement should not only educate the general public about CDR technologies and plans but also incorporate public views regarding the proper scope of CDR deployment, choices of specific technologies, location of CDR infrastructure, and other fundamental issues. Engagement processes deployed in the course of U.S. military base closures and the German energy transition can serve as models for public engagement on CDR policy. At the project level, engagement risks serving merely as a public relations exercise or a procedural box to check. Notwithstanding an express commitment to community engagement, DOE's process for selecting DACS hubs largely fell victim to such risks. Community engagement on DACS projects should involve early and ongoing outreach to potentially affected communities, deliberative discussions, and meaningful responses to community concerns.