Public Engagement and Carbon Dioxide Removal

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Abstract

As atmospheric carbon dioxide concentrations continue to rise, policymakers 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 in recent years because of its potential to permanently store large quantities of carbon. Although DACS' energy requirements and high costs have limited its deployment to date, planning and construction efforts have rapidly expanded in recent years, thanks to generous government support. DACS facilities are not always welcomed by local communities or environmental advocates, however, 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 policymaking. 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 concerns about land, energy, and water requirements, carbon dioxide leakage, and groundwater contamination.

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As atmospheric carbon dioxide (CO_2) concentrations continue to rise, policymakers increasingly view carbon dioxide removal (CDR) as essential to combating climate change. California's plan for achieving carbon neutrality, for example, assumes the removal of 100 million metric tons of CO_2 annually by 2045 in order to counter residual greenhouse gas (GHG) emissions.[1] The European Union includes carbon removal involving forestry and land use in its 2030 emissions reduction strategy,[2] and it is proposing to meet its 2040 emissions reduction goal in part by removing 280 million metric tons of CO_2 annually via direct air capture and storage (DACS) and other techniques.[3] And notwithstanding the Trump administration's attacks on climate programs, Republican lawmakers have expressed hope that the administration will extend federal support for carbon removal.[4]

DACS in particular has attracted policymakers' attention because of its potential to remove and store large quantities of carbon on a permanent basis. Until recently, DACS' high costs and substantial energy requirements had prevented its deployment.[5] But thanks to generous government support, DACS planning and construction efforts have expanded.[6] The 2021 Bipartisan Infrastructure Law established a $3.5 billion program to launch four regional DACS hubs, each of which could capture and sequester one million metric tons of CO_2 a year.[7] Further government support includes funding for engineering, design, and feasibility studies, as well as tax credits for geologic storage of CO_2 via DACS.[8]

DACS offers only an imperfect and partial solution to climate change. DACS requires significant amounts of energy, water, and land, poses risks of CO_2 leakage and groundwater contamination, and—like other CDR techniques—could undermine efforts to reduce GHG emissions directly.[9]

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[1] California Air Resources Board, 2022 Scoping Plan for Achieving Carbon Neutrality 94 (2022).

[2] Council of the European Union, press release, Fit for 55 Package: Council Adopts Regulations on Effort Sharing and Land Use and Forestry Sector, Mar. 28, 2023.

[3] 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, Feb. 6, 2024; Climeworks, EU Sets Ambitious 2040 Climate Target and Highlights Need for Carbon Removals, Feb. 6, 2024, https://climeworks.com/news/eu-sets-ambitious-2040-climate-target-including-carbon-removals.

[4] Corbin Hiar, *Will Trump Cut the Oil Industry's Favorite Climate Subsidies?*, CLIMATEWIRE, Feb. 11, 2025.

[5] *See infra* Part I.A.

[6] *See infra* Part I.A.

[7] *See infra* Part I.A.

[8] *See infra* Part I.A.

[9] *See infra* Part I.B.

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 on 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 eliminate, reduce, or capture GHG emissions before they can escape into the atmosphere.[10] CDR techniques, in contrast, remove CO_2 already found in the atmosphere.[11] CDR is viewed as inferior to emissions mitigation because it is generally less effective, riskier, and more expensive.[12] CDR also has the potential to undermine society's willingness to reduce emissions.[13] However, limited progress in mitigating emissions,[14] along with the potentially high cost of completely eliminating them, has led to a growing consensus that CDR is essential to achieve the temperature

[10] STEPHEN M. SMITH ET AL., THE STATE OF CARBON DIOXIDE REMOVAL 2024—2d ed., at 9 (2024).
[11] Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, 13 ENV'T RSCH LETTERS 063001, at 4, 13 (2018). 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, 688 (2022). As almost all negative emission technologies under consideration aim to remove CO_2, this Article refers to carbon dioxide removal or carbon removal.
[12] National Research Council, Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration 3 (2015).
[13] National Academies of Sciences, Engineering, and Medicine, Negative Emissions Technologies and Reliable Sequestration: A Research Agenda ("NAS NET"), at 4 (2019).
[14] Zhu Liu et al., *Global Carbon Emissions in 2023*, NATURE REV. 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).

targets established by the 2015 Paris Agreement.[15] According to experts, CDR must take place on an immense scale—several gigatons per year by 2050—to avoid some of climate change's most catastrophic effects.[16]

Land-based CDR techniques fall into two basic categories: nature-based carbon removal and engineered carbon removal.[17] Nature-based carbon removal techniques, such as forest carbon management and soil carbon sequestration, generally are more mature but offer more limited and transitory carbon storage capacity.[18] Engineered carbon removal techniques include DACS, bioenergy with carbon capture and storage (BECCS), and enhanced weathering.[19] Engineered carbon removal generally involves greater and more permanent storage capacity, though at higher costs, and requires further technological development in order to be feasible.[20]

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[15] SMITH ET AL., *supra* note 10, at 9-10; NAS NET, *supra* note 13, at 2-3.

[16] SMITH ET AL. at 9 (estimating central range of CDR deployment of 7 to 9 Gt per year in 2050 under "more sustainable" scenarios); Sara Nawaz et al., American University Institute for Responsible Carbon Removal ("AU IRCR"), Agenda for a Progressive Political Economy of Carbon Removal at 6 (2024); James Boyd et al., Resources for the Future, Policy Incentives to Scale Carbon Dioxide Removal: Analysis and Recommendations, at 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 IPCC conclusion that keeping global warming below 1.5C 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 National Laboratory, Roads to Removal: Options for Carbon Dioxide Removal in the United States, at ES-2 (2023).

[17] Lin, *supra* note 11, at 689; *see also* SMITH ET AL., *supra* note 10, 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 ENV'T SCI. 1360, 1363-64 (2022).

[18] Pett-Ridge et al., *supra* note 16, at ES-6; Lin, *supra* note 11, at 689. Most of the estimated 2 Gt 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 10, at 10.

[19] BECCS 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 11, at 690-91.

[20] Lin, *supra* note 11, at 690-92; Boyd et al., *supra* note 16, at 5-7, 9-10; Pett-Ridge et al., *supra* note 16, at 1-6 to 1-7. 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*

The public tends to perceive nature-based CDR as simpler, more natural, and more open to personal involvement.[21] Nonetheless, in recent years policymakers have devoted greater attention to engineered CDR because of its potential to reduce atmospheric GHG concentrations on the immense scales needed.[22] Technical estimates suggest that DACS might eventually enable the storage of tens of gigatons of carbon per year.[23] 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.

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 CO_2 in it. The resulting material is then subjected to heat or a vacuum, thereby regenerating the capture agent and releasing a concentrated stream of CO_2.[24] The concentrated CO_2 can be used in manufacturing low-carbon cement or, as more typically envisioned, stored underground.[25] For underground storage, CO_2 is compressed into a supercritical fluid and injected into a

Plant Is About to Open, CLIMATEWIRE, Feb. 6, 2024; *see also* Michael Toman et al., Resources for the Future, Policies for Scaling Up Carbon Dioxide Removal in the United States, at 2 (2024) (discussing biomass carbon removal and storage).

[21] Smith et al., *supra* note 10, at 110; Sean Low et al., *Public Perceptions on Carbon Removal from Focus Groups in 22 Countries*, 15 NATURE COMMUNICATIONS 3453, at 2-3, 6-7 (2024).

[22] AU IRCR, *supra* note 16, at 6-7; Boyd et al., *supra* note 16, at 13-18. One estimate suggests that 1.5 Gt CO_2 could be removed globally each year through forest management and 3 Gt through soil carbon sequestration. NAS NET, *supra* note 13, at 6 Table S.1. DACS' carbon storage capacity is difficult to gauge because of uncertainty surrounding its development but some estimates range up to 40 Gt 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 121485, at 5 (2023).

[23] Mohammed Al-Jualed & Adam Whitmore, Prospects for Direct Air Carbon Capture and Storage: Costs, Scale, and Funding, 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 GAS SCI TECHNOL. 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 16, at ES-9. Note, however, that energy requirements, costs, and other factors may limit removals to a small fraction of current GHG emissions. *Id.* at ES-17.

[24] NAS NET, *supra* note 13, at 190, 196, 213 (discussing desorption process).

[25] Erans et al., *supra* note 17, 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).

geologic formation.[26] 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.[27] Carbon storage can occur in depleted hydrocarbon reservoirs, deep saline aquifers, and coal seams.[28] Most CO_2 storage so far has occurred as a by-product of enhanced oil recovery operations. Operators inject CO_2 in underground oil fields, forcing oil trapped in pore spaces towards production wells and leaving CO_2 behind.[29]

Compared with other CDR techniques, DAC offers advantages of locational flexibility and a relatively small footprint.[30] In addition, underground geological storage of CO_2 is relatively permanent, although even properly selected storage sites can leak.[31] On the flip side, DAC presently faces much higher costs than other types of CDR.[32] DAC requires large amounts of energy to extract CO_2, which is present in the ambient air in relatively dilute concentrations.[33] 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.[34] Indeed, removing carbon via DACS is generally far more expensive than mitigating carbon emissions directly.[35] Although DAC facilities can be sited in a wide range of locations, their high energy demands and storage needs point toward siting near cheap energy

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[26] NAS NET, *supra* note 13, at 319.
[27] NAS NET at 319.
[28] 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 less developed and more expensive than underground storage. Jiashun Luo et al., *Advances in Subsea Carbon Dioxide Utilization and Storage*, 2 ENERGY REV. 100016, at 14 (2023); James R. Collins et al., Ocean Carbon Dioxide Removal Methods, at 14 (2022), https://www.edf.org/sites/default/files/documents/Ocean%20Carbon%20Dioxide%20Removal%20Methods.pdf.
[29] Righetti, *supra* note 28, at 921-22.
[30] NAS NET, *supra* note 13, at 189, 224
[31] NAS NET at 367.
[32] NAS NET at 189, 365 ("The primary impediment to direct air capture is high cost."); Yang Qiu et al., *Environmental Trade-Offs of Direct Air Capture Technologies in Climate Change Mitigation toward 2100*, 13 NATURE COMMUNICATIONS 3635, at 2 (2022).
[33] NAS NET, *supra* note 13, at 189, 365; Qiu et al., *supra* note 32, at 2.
[34] Mihrimah Ozkan et al., *Current Status and Pillars of Direct Air Capture Technologies*, 25 ISCIENCE 103990, at 9 (2022); Nicola Jones, *As Carbon Air Capture Ramps Up, Major Hurdles Remain*, Yale Environment 360, Mar. 20, 2024, https://e360.yale.edu/features/direct-air-capture; Robert F. Service, *U.S. Unveils Plans for Large Facilities to Capture Carbon Directly from Air*, SCIENCE, Aug. 11, 2023. Technological advances and economies of scale could eventually lower DACS' per ton cost to between $100 and $200 or less. Ozkan et al., *supra*, at 10.
[35] Bloomberg NEF, Global Carbon Market Outlook 2024, https://about.bnef.com/blog/global-carbon-market-outlook-2024/ (reporting market prices of carbon credits under $100 per ton).

generation sites and suitable geological storage reservoirs.[36] DACS projects could also be located in marine environments.[37] Powered by offshore wind, offshore DACS facilities would inject CO_2 below the seafloor and might sidestep objections regarding local impacts and risks.[38]

DACS builds on carbon capture and storage (CCS) technologies developed to capture CO_2 emissions from power plants, cement plants, and other significant emission sources.[39] 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 concentrated form.[40] The main difference 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.[41] The fact that costs, technical difficulties, and public opposition have hampered

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[36] Qiu et al., *supra* note 32, at 2.

[37] Proposed ocean-based carbon removal approaches other than DACS, such as iron fertilization, artificial upwelling, seaweed cultivation, and ocean alkalinity enhancement, are relatively immature and not ready for deployment. Scott Doney & Jane Lubchenco, OSTP, Marine Carbon Dioxide Removal: Potential Ways to Harness the Ocean to Mitigate Climate Change, Oct. 6, 2023, https://www.whitehouse.gov/ostp/news-updates/2023/10/06/marine-carbon-dioxide-removal-potential-ways-to-harness-the-ocean-to-mitigate-climate-change/; NOAA, Charter of the Marine Carbon Dioxide Removal Fast Track Action Committee of the Subcommittee on Ocean Science and Technology National Science and Technology Council (2023), https://www.noaa.gov/sites/default/files/2023-10/mCDR_FTAC_charter_2023_09_19_approved.pdf; National Academies of Sciences, Engineering, and Medicine, A Research Strategy for Ocean-Based Carbon Dioxide Removal and Sequestration 2-5, 17 (2022) (noting "substantial uncertainties" surrounding ocean CDR approaches and setting out research agenda).

[38] 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 14, at 3-4. (2023); Erans et al., *supra* note 17, at 1393; *see also* CarbonGap, Carbon Removal Policy in Germany, https://tracker.carbongap.org/region/germany/ (last visited Nov. 18, 2024) (explaining that Germany has opted for offshore geological storage of CO_2 while maintaining a prohibition of onshore storage); *but cf.* Bouke Wiersma & Patrick Devine-Wright, *Public Engagement with Offshore Renewable Energy: A Critical Review*, 5 WIRES CLIMATE CHANGE 493-94, 502 (2014) (arguing for further research on public responses to offshore renewable energy projects rather than assuming that onshore projects more readily trigger NIMBY opposition).

[39] Erans et al., *supra* note 17, at 1363.

[40] Erans et al. at 1365-66; Holly Jean Buck, *Social Science for the Next Decade of Carbon Capture and Storage*, 34 ELECTRICITY J. 107003, at 2 (2021).

[41] International Energy Agency, Direct Air Capture, 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).

CCS deployment nonetheless raises concerns that DACS might encounter similar difficulties.[42]

Only a handful of relatively small DAC projects are currently in operation, but deployment of the technology is rapidly expanding.[43] Over 100 DAC plants are in development worldwide.[44] The first commercial DAC plant in the U.S., operated by Heirloom Carbon Technologies, opened in November 2023 and has an estimated removal capacity of 1,000 tons of CO_2 per year.[45] A DAC facility under construction in Texas promises to remove 500,000 metric tons of CO_2 per year beginning in 2025.[46] And as described below, government-funded DAC facilities are expected to remove one million metric tons of CO_2 per year.[47] 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.[48]

Generous government support is fueling DAC's rapid expansion. The 2021 Bipartisan Infrastructure Law established a $3.5 billion program to launch four regional DAC "hubs."[49] These hubs will 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."[50] Each hub must capture and sequester at least one million metric tons of CO_2 a year, and at least two hubs must be "located in economically distressed communities in the regions of the United States with high levels of coal, oil, or natural gas resources."[51]

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[42] Erans et al., *supra* note 17, at 1391; Buck, *Social Science*, *supra* note 40, at 1. Recently, the number of CCS projects planned or operating worldwide has grown substantially. Carlos Anchondo, *Planned CCS Projects Jump 102%--Report*, ENERGYWIRE, Nov. 9, 2023.

[43] Jones, *supra* note 34. Most existing plants use captured CO_2 to make a product rather than sequestering it underground. *Id.*

[44] Jones.

[45] Corbin Hiar, *First U.S. Direct Air Capture Plant Opens in California*, CLIMATEWIRE, Nov. 10, 2023.

[46] Jones, *supra* note 34.

[47] Jones.

[48] Jones.

[49] 42 U.S.C. § 16298d(j); Corbin Hiar, *DOE Awards $1B for 2 Carbon Removal Projects on Gulf Coast*, E&E NEWS, Aug. 11, 2023.

[50] 42 U.S.C. § 16298d(j)(1)(B).

[51] 42 U.S.C. § 16298d(j)(2)(B)(ii); 16298d (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.

In 2023, the Department of Energy (DOE) selected two DAC hubs for potential grants totaling $1.2 billion: a south Texas hub to be operated by Occidental Petroleum, and a southwest Louisiana hub (Project Cypress) to be operated by Batelle Memorial Institute.[52] Grant awards to these two hubs will occur in phases and are contingent on negotiations between the project developers and DOE.[53] DOE also awarded $100 million in matching funds for 19 other DAC hub proposals that are not as far along in the development pipeline. 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 location, ownership structure, and business model."[54] DOE presumably expects some of these efforts will lead to full-scale DAC hub projects down the road.[55]

Tax credits and government-sponsored prizes are also aimed at boosting DACS. A federal tax credit of $180 per ton is available for permanent geologic storage via DACS of at least 1,000 tons of CO_2 per year at any U.S. facility.[56] Furthermore, California's Low Carbon Fuel Standards (LCFS) allow DACS projects located anywhere in the world to generate carbon credits that fuel distributors in the state can use to satisfy LCFS requirements. DOE is also offering a suite of monetary prizes aimed at spurring innovation in DAC.[57] Extensive government support for DACS—

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[52] Hiar, *supra* note 49.

[53] Coral Davenport, *U.S. to Fund a $1.2 Billion Effort to Vacuum Greenhouse Gases from the Sky*, N.Y. TIMES, Aug. 11, 2023 (reporting DOE official's comments that the projects are subject to a "go, no-go" procedure). DOE, Regional Direct Air Capture Hubs Selected and Awarded Projects, https://www.energy.gov/oced/regional-direct-air-capture-hubs-selected-and-awarded-projects, last visited Dec. 29, 2024 ("DOE's selection of an application for award negotiations is not a commitment by DOE to issue an award or provide funding. DOE and each selectee will negotiate a cooperative agreement, and any DOE funding would be provided only after negotiations are complete and DOE's Contracting Officer executes the funding agreement."); Department of Energy, Award Negotiations, https://www.energy.gov/oced/award-negotiations. DOE will select the other two other hubs after soliciting a subsequent round of applications. Hiar, *supra* note 49.

[54] Department of Energy, Regional Direct Air Capture Hubs, https://www.energy.gov/sites/default/files/2023-08/Project%20Selections%20for%20FOA%202735%20Regional%20Direct%20Air%20Capture%20Hubs%20TA1%20and%20TA2_1.pdf; *see also* Corbin Hiar, *What's Next for Direct Air Capture*, CLIMATEWIRE, Oct. 11, 2023.

[55] Meyer, *supra* note 16.

[56] 26 U.S.C. § 45Q(b)(1)(B), (d)(2), (h); Bipartisan Policy Center, Inflation Reduction Act Summary at 9 (2022) (explaining that the 2022 Inflation Reduction Act lowered the threshold for facility size eligibility and more than tripled the applicable tax credit).

[57] Department of Energy, American Made Challenges: Direct Air Capture Prizes, https://americanmadechallenges.org/challenges/direct-air-capture; Department of Energy,

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."[58] Pilot projects sponsored by the program might remove carbon through biomass cultivation, mineralization, marine techniques, or a combination of pathways.[59] Thus, while federal CDR policy concentrates on improving and scaling up DACS technology, it is also fostering the development of other CDR techniques.[60]

Government support for CDR innovation and deployment is complemented by private funding. Private support includes funding from private investors and venture capital firms as well as $100 million in prizes offered by the nonprofit XPrize.[61] Private sector support also has taken the form of commitments by major companies to pay above-market prices for voluntary carbon offsets that DACS projects will generate.[62]

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.[63] Despite promises of economic investment and employment opportunities,[64]

American Made Challenges: Direct Air Capture Commercial Prize, https://americanmadechallenges.org/challenges/direct-air-capture/commercial.

[58] Department of Energy, Carbon Negative Shot, https://www.energy.gov/fecm/carbon-negative-shot.

[59] Chelsea Harvey, *DOE Offers $100M for Carbon Removal Pilot Projects*, CLIMATEWIRE, Feb. 13, 2024. The program also aims to pilot a competitive program for purchasing CDR credits. Department of Energy, Commercial Direct Air Capture Prize: Carbon Dioxide Removal Purchase Pilot Prize Modification 3, Nov. 22, 2023, https://americanmadechallenges.org/challenges/direct-air-capture/docs/DAC-Commercial-CDR-Purchase-Pilot-Prize-Official-Rules.pdf.

[60] Meyer, *supra* note 16.

[61] Smith et al., *supra* note 10, at 60 ("DACCS has become a primary focus for corporate and other large investors in CDR."); Bipartisan Policy Center, Navigating the Stages of Commercialization to Deploy Direct Air Capture at Scale, at 14, 16-18 (2023); Corbin Hiar, *XPrize Names 20 Finalists in $100M Carbon Removal Contest*, CLIMATEWIRE, May 8, 2024.

[62] Bipartisan Policy Center, *supra* note 61, at 14.

[63] Satterfield et al., *supra* note 38, at 15; Smith et al., *supra* note 10, at 112.

[64] Celina Scott-Buechler & Simone H. Stewart, Data for Progress, Charting a Path to Just Direct Air Capture Hubs, at 3 (2022).

DACS projects have triggered environmental, economic, and other concerns. 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.[65] Local residents have turned an especially wary eye toward promises from fossil fuel companies that their DACS projects will avoid health and environmental impacts.[66] Such concerns have blocked the construction of pipelines and other components of carbon removal systems.[67]

DAC facilities have a smaller footprint than other CDR techniques but still demand significant amounts of energy, land, and other resources.[68] The facilities themselves require steel, concrete, and raw chemical sorbents.[69] Land requirements depend on a facility's technical design as well as its energy source.[70] Water requirements can be substantial, as some DAC techniques use up to 13 tons of water to capture one ton of CO_2.[71] 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.[72] Burning fossil fuels to generate this energy would undermine DACS' benefits and expose nearby communities to harmful pollution.[73] Even facilities that rely on renewable energy could generate noise and air emissions.[74]

The transport and storage of captured CO_2 can raise environmental and safety concerns.[75] CO_2 is often transported through pipelines in a high-density, high-pressure supercritical state that poses heightened risks of

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[65] Celina Scott-Buechler et al., *Communities Conditionally Support Deployment of Direct Air Capture for Carbon Dioxide Removal in the United States*, 5 COMMUNICATIONS EARTH & ENV'T 175, at 2 (2024); Pett-Ridge et al., *supra* note 16, at 7-23.
[66] Evan Halper, *Biden and Oil Companies Like This Climate Tech. Many Americans Do Not*, WASH. POST, May 11, 2024.
[67] Jeffrey Tomich et al., *Scuttled CO_2 Pipeline Renews Debate about State Hurdles*, E&E NEWS, Oct. 23, 2023, (reporting cancellation of 1,300-mile CO_2 pipeline after South Dakota regulators rejected permit application).
[68] NAS NET, *supra* note 13, at 224.
[69] Ozkan et al., *supra* note 34, at 15.
[70] Ozkan et al. at 8.
[71] Ozkan et al. at 2.
[72] Giulia Realmonte et al., *An Inter-Model Assessment of the Role of Direct Air Capture in Deep Mitigation Pathways*, 10 NATURE COMMUNICATIONS 3277, at 7 (2019); Andreas Malm & Wim Carton, *Seize the Means of Carbon Removal: The Political Economy of Direct Air Capture*, 29 HISTORICAL MATERIALISM 3, 28 (2021).
[73] Scott-Buechler & Stewart, *supra* note 64, at 4.
[74] Pett-Ridge et al., *supra* note 16, at 7-23 tbl. 7-3.
[75] Scott-Buechler et al., *supra* note 65, at 2.

pipeline damage, corrosion, and leaks.[76] The CO_2 may contain toxic impurities such as hydrogen sulfide and sulfur dioxide.[77] Furthermore, if leaked into the air, CO_2 becomes a dense gas that displaces oxygen and can cause asphyxiation at extreme concentrations.[78] 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.[79] That accident left dozens of people shaking, unconscious, and unable to breathe.[80] Some vehicles stopped running, hampering emergency responses, and a number of victims continued to suffer respiratory and neurological impairment long after CO_2 concentrations returned to normal levels.[81] Environmental justice advocates worry that the safety risks of CO_2 pipelines will disproportionately burden disadvantaged communities located near carbon removal and storage infrastructure.[82]

Further environmental concerns arise from the underground storage of CO_2 in geologic formations, which can lead to groundwater contamination.[83] Injected CO_2 can mobilize contaminants previously trapped in underground rock and facilitate their movement into drinking water aquifers.[84] 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 aquifers.[85] Impurities in the injected CO_2 itself also can contaminate

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[76] Martin Lockman, Sabin Center for Climate Change Law, Permitting CO_2 Pipelines: Assessing the Landscape of Federal and State Regulations, at 46 (2023). Transport in a supercritical state is more cost-effective for pipeline operators than transport in gas or liquid form. National Association of Regulatory Utility Commissioners (NARUC), Onshore U.S. Carbon Pipeline Deployment: Siting, Safety, and Regulation 11 (2023).
[77] NARUC, *supra* note 76, at 30.
[78] Wesley Mathews, Pipeline and Hazardous Materials Safety Administration, Failure Investigation Report—Denbury Gulf Coast Pipelines, LLC—Pipeline Rupture/Natural Force Damage, May 26, 2022, at 2-3, 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 76, at 20, 30.
[79] Julia Simon, *The U.S. Is Expanding CO_2 Pipelines. One Poisoned Town Wants You to Know its Story*, NPR, Sept. 25, 2023; Mathews, *supra* note 78, at 2.
[80] Simon, *supra* note 79.
[81] Simon.
[82] NARUC, *supra* note 76, at 9.
[83] EPA, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration Wells; Proposed Rule, 73 Fed. Reg. 43492, 43497 (2008); NAS NET, *supra* note 13, at 346.
[84] 73 Fed. Reg. at 43497.
[85] 73 Fed. Reg. at 43497.

aquifers, and pressure from injected CO_2 can force naturally occurring salty water to enter aquifers.[86]

Local residents also worry that CO_2 pipelines or storage facilities will damage farmland, trigger seismic activity, and reduce property values.[87] They also express concern that their communities could lose traditional ways of life or be saddled with the costs of building and maintaining facilities.[88] Although the promise of tangible economic benefits could boost public support for DACS facilities, affected communities sometimes fear that powerful companies will profit at locals' expense.[89] Pipelines in particular offer few jobs or other local economic benefits.[90] Opposition from landowners has hampered developers' efforts to obtain pipeline rights-of-way voluntarily.[91] Absent voluntary agreement, developers can turn to eminent domain authority, but its use or threatened use to acquire rights-of-way may trigger further opposition.[92]

At a broader policy level, opponents contend that CDR "will extend reliance on fossil fuels and delay the transition to cleaner energy sources."[93] The concern, often phrased in terms of mitigation deterrence or moral hazard,[94] is that CDR will divert resources and policies away from mitigating GHG emissions—a more direct, proven, and effective means of addressing climate change.[95] Even in the absence of significant CDR activity, CDR's

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[86] *Id.* at 43497.

[87] Mike Soraghan & Carlos Anchondo, *Biden Releases Plan to Avoid "Dangerous" CO_2 Pipeline Failures*, E&E NEWS, May 27, 2022; NARUC, *supra* note 76, at 8; WRI, CCS and Community Engagement: Guidelines for Community Engagement in Carbon Dioxide Capture, Transport, and Storage Projects 59 (2010); Peter Kelemen et al., *An Overview of the Status and Challenges of CO_2 Storage in Minerals and Geological Formations*, 1 FRONTIERS IN CLIMATE, art. 9, at 10-11 (2019).

[88] Scott-Buechler et al., *supra* note 65, at 3; WRI, *supra* note 87, at 70.

[89] Scott-Buechler et al., *supra* note 65, at 3, 6.

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

[91] Paul W. Parfomak, Congressional Research Service, Carbon Dioxide Pipelines: Safety Issues (2022).

[92] Soraghan & Anchondo, *supra* note 87; NARUC, *supra* note 76, at 8; Parfomak, *supra* note 91 (noting that eminent domain authority typically accompanies state siting permits).

[93] NARUC, *supra* note 76, at 8; Chemnick 8/22/23, *supra* note 51 (noting environmental justice advocates' concerns that CCS and CDR efforts "work[] against their objective of putting polluting industries out of business").

[94] Nils Markusson et al., *Carbon Removal and the Empirics of Climate Delay*, 161 ENV'T SCI. & POL'Y 103884, at 1 (2024); Malm & Carton, *supra* note 72, at 13; Albert C. Lin, *Does Geoengineering Present a Moral Hazard?*, 40 ECOL. L.Q. 673 (2013).

[95] Chelsea Harvey & Corbin Hiar, *Carbon Removal Isn't Weird Anymore. That Worries Scientists.*, CLIMATEWIRE, Dec. 18, 2023; Markusson et al., *supra* note 94, at 2 (identifying three main processes by which CDR contributes to mitigation deterrence).

mere potential "to bail us out" might blunt mitigation efforts, though any such effect is difficult to measure.[96] 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 concerns that CDR will facilitate the continued burning of fossil fuels.[97] This concern helps to explain the frequent opposition to carbon capture infrastructure in communities that have suffered disproportionately from fossil fuel pollution.[98] Not surprisingly, such communities express especially heated opposition to DACS projects led by fossil fuel companies.[99] Residents worry about the direct environmental consequences of DAC projects as well as the extended lifespans of fossil fuel facilities that DACS projects may enable.[100]

C. Regulation Potentially Applicable to CDR

Notwithstanding the relatively limited deployment of engineered CDR, various laws may govern these projects or their components. CDR 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."[101] Major federal actions include projects directly undertaken by the federal government as well as federally funded and federally permitted projects.[102] In preparing an EIS, the federal government invites likely affected persons to participate in scoping, a process that determines the issues to be analyzed.[103] The government must also take public comments once a draft EIS is completed and respond to any comments before issuing a final EIS.[104]

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[96] Malm & Carton, *supra* note 72, at 13; *but cf.* Duncan McLaren, *Quantifying the Potential Scale of Mitigation Deterrence from Greenhouse Gas Removal Techniques*, 162 CLIMATIC CHANGE 2411, 2418-2424 (2020) (offering preliminary estimates of possible extent of mitigation deterrence effect resulting from CDR).

[97] Harvey & Hiar, *supra* note 95; Malm & Carton, *supra* note 72, at 14-15; AU IRCR, *supra* note 16, 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 ENV'T SCI. & POL'Y 103640, at 6-8 (2024) (explaining how petrochemical industry frames CDR as part of circular carbon imaginary that assumes increased plastic and chemical production).

[98] Chemnick 8/22/23, *supra* note 51.

[99] Scott-Buechler et al., *supra* note 65, at 7.

[100] Toman et al., *supra* note 20, at 5.

[101] 42 U.S.C. § 4332(C).

[102] 40 C.F.R. § 1508.1.

[103] 40 C.F.R. § 1502.4(c).

[104] 40 C.F.R. § 1503.1, 1503.4.

A handful of states have NEPA analogues that apply to decisions by state and local governments.[105] In addition, specific components of DACS projects—in particular, pipelines and CO_2 storage facilities—may require federal and 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.[106]

1. Pipelines

Regulation of CO_2 pipelines consists of a patchwork of approvals and reviews by multiple agencies focused on various sets of impacts.[107] The federal government lacks general siting authority over CO_2 pipelines and exercises no regulatory authority over their operation.[108] States may impose siting and operating requirements on CO_2 pipelines but in many cases have not done so.[109] Moreover, although existing laws may apply in specific circumstances, such laws often were not adopted with CO_2 pipelines in mind.[110] The result is a regulatory hodgepodge that has slowed development of CO_2 transportation and storage networks.[111]

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).[112] The CWA requires a permit for the discharge of dredged or fill material into waters of the United States.[113] Nationwide Permit 58, which allows for construction of pipelines that cause the loss of a ½ acre or less of waters of the U.S., may cover the construction

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[105] *See, e.g.,* Cal. Pub. Res. Code §§ 21000-21189.70.10 (California Environmental Quality Act).

[106] DOE Best Practice Manual: Public Outreach and Education for Geologic Storage Projects 22 (2018).

[107] Lockman, *supra* note 76, at 56; *see also* Righetti, *supra* note 28, at 924 (explaining that most aspects of CO_2 pipelines, other than safety, are not subject to comprehensive federal regulation).

[108] Lockman, *supra* note 76, at 9-10 (noting contrast with pipelines carrying oil, natural gas, and other materials). One commentator has suggested that federal regulation of CO_2 pipeline siting is not yet 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." Righetti 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).

[109] Righetti, *supra* note 28, at 927, 937, 940; Lockman, *supra* note 76, at 10-15 (discussing variety of approaches to regulating CO_2 pipelines among selected states).

[110] Lockman, *supra* note 76, at 50-53.

[111] Lockman at 50-53.

[112] Lockman at 28-30.

[113] 33 U.S.C. §§ 1311, 1344; Lockman, *supra* note 76, at 28-29.

of some CO_2 pipelines.[114] Projects not covered by this general permit must obtain an individual permit, which involves public interest review based on environmental criteria.[115] Separately, the RHA requires a permit for building a structure in, over, or affecting any water of the United States.[116] Review of permit applications under the RHA involves a balancing of costs and benefits to determine if the project is in the public interest.[117]

Pipeline projects requiring a federal permit or right-of-way are potentially subject to NEPA's analysis and disclosure requirements.[118] However, CO_2 pipelines are eligible for streamlined federal permitting and coordinated NEPA review.[119] Further, pipelines that cross only private land and that lack significant federal involvement may avoid federal environmental review altogether.[120] 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.[121]

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.[122] CO_2 pipelines are governed by design, operation, and other safety requirements that apply generally to hazardous liquid pipelines.[123] States are generally preempted from regulating the safety of pipelines under the PHMSA's jurisdiction but may impose

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[114] Lockman at 29.
[115] Righetti, *supra* note 28, at 933-34.
[116] 33 U.S.C. § 403.
[117] Lockman, *supra* note 76, at 30.
[118] Lockman at 31-34.
[119] Parfomak, *supra* note 91, 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 FAST Act).
[120] Righetti, *supra* note 28, at 932.
[121] Lockman, *supra* note 76, at 36-41.
[122] 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 76, 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").
[123] Righetti, *supra* note 28, at 925.

additional safety requirements on intrastate pipelines under specified conditions.[124]

In response to the Satartia accident, the federal government announced that it would issue new safety rules specific to CO_2 pipelines—but those rules have yet to be issued as of December 2024.[125] Worries about pipeline safety prompted a petition urging a moratorium on federal permitting of CO_2 pipelines until the PHMSA revises its safety regulations.[126] California has banned CO_2 pipelines until the PHMSA finishes its rulemaking.[127]

2. Storage

EPA regulates underground carbon storage through its Class VI underground injection well permitting program, established under the Safe Drinking Water Act.[128] Class VI permits may be issued by EPA or by states that have been delegated permitting authority.[129] Permit applicants must demonstrate that CO_2 will not leak or contaminate underground sources of drinking water.[130] 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.[131] Agency guidance further counsels EPA to identify and reach out to communities with

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[124] Righetti, *supra* note 28, at 925-27; Lockman, *supra* note 76, at 48-49.

[125] Soraghan & Anchondo, *supra* note 87; Columbia Law School Sabin Center for Climate Change Law, PHMSA Advances CO_2 Pipeline Safety Regulations, https://climate.law.columbia.edu/content/phmsa-advances-co2-pipeline-safety-regulations (reporting submission of proposed Notice of Proposed Rulemaking by PHMSA on February 1, 2024).

[126] CO_2 Pipeline Moratorium Now, May 30, 2023, *available at* https://www.foodandwaterwatch.org/wp-content/uploads/2023/05/CCS-Pipeline-Moratorium-Org-Letter-to-Biden-.pdf.

[127] Lockman, *supra* note 76, at 49.

[128] EPA, Class VI- Wells Used for Geologic Sequestration of Carbon Dioxide, https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide (last modified Oct. 2, 2024); 40 C.F.R. Subpart H (146.81-146.95).

[129] Angela C. Jones, Congressional Research Service, Class VI Carbon Sequestration Wells: Permitting and State Program Primacy, at 8-9, https://crsreports.congress.gov/product/pdf/R/R48033 (noting that several states have been granted or are applying for authority to issue permits).

[130] EPA, *supra* note 128.

[131] 40 C.F.R. §§ 124.10-124.12; EPA, *supra* note 128; EPA, Geologic Sequestration of Carbon Dioxide – UIC Quick Reference Guide: Additional Considerations for UIC Program Directors on the Public Participation Requirements for Class VI Injection Wells, at 1, 5, 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 129, at 6 (noting that "EPA has not issued specific regulatory requirements for public participation for the Class VI permit application process").

environmental justice concerns, assess disproportionate impacts on them, and minimize such impacts.[132] Applicants themselves are not required to conduct public engagement but are advised to identify stakeholders, develop messages, and consider environmental justice issues.[133]

II. Public Engagement

DACS proposals at times have encountered skepticism and community resistance. The potentially broad scope and extent of CDR needed, however, have led to a growing recognition that 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 CDR over the long term.

A. Rationales for Public Engagement

Public engagement is supported by normative, instrumental, and substantive rationales.[134] Normatively, engagement is "the right thing to do"; instrumentally, engagement can help project proponents achieve desired outcomes; and substantively, engagement can lead to objectively better results.[135]

First, as a normative matter, public engagement and participation can advance democratic values and social justice.[136] Fair engagement procedures strive to include relevant stakeholders and affected publics in dialogues and decision making.[137] Offering citizens an opportunity to express their views

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[132] EPA, Environmental Justice Guidance for UIC Class VI Permitting and Primacy, Aug. 17, 2023.

[133] EPA, Additional Considerations, *supra* note 131, at 2-3. This 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. As of April 2024, EPA had issued 8 Class VI permits and was in the process of reviewing 130 pending applications for 44 projects. Jones, *supra* note 129, at 8.

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

[135] Stirling at 220.

[136] ALBERT C. LIN, PROMETHEUS REIMAGINED: TECHNOLOGY, ENVIRONMENT, AND LAW IN THE 21ST CENTURY 20 (2013); Daniel J. Fiorino, *Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms*, 15 SCI. TECH. & HUMAN VALUES 226, 227-28 (1990).

[137] 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 (stating that common themes of procedural justice include consistency of treatment, impartiality, voice, and transparency).

in decision processes on public matters fosters fair decision making, political equality, and an informed and active citizenry.[138]

Second, public engagement can legitimize decisions and secure support for particular outcomes.[139] Public engagement, in other words, can serve instrumental purposes and generate a social license.[140] 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."[141] Through engagement, communities may gain a sense of control and a better understanding of health and environmental risks.[142] Just as robust public engagement can build trust, inadequate or unsuccessful community engagement can foster distrust.[143] Trust serves as a foundation for ongoing relationships that facilitate future decision making and project implementation.[144]

Frequent opposition to CCS projects exemplifies the potential consequences of inadequate engagement and trust.[145] 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

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[138] THOMAS DIETZ & PAUL C. STERN, PUBLIC PARTICIPATION IN ENVIRONMENTAL ASSESSMENT AND DECISION MAKING 46 (2008).
[139] LIN, *supra* note 136, at 20; Fiorino, *supra* note 136, at 228.
[140] Peter Psarras et al., Advancing the Social License for Carbon Management in Achieving Net-Zero GHG Emissions, at 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 through attention to interested parties' concerns); 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).
[141] 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, at 5 (2024), *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 (paper submitted to NASEM).
[142] 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, [at 16] (F.H.J.M. Coenen et al. eds., 1998).
[143] Hirsch et al., *supra* note 141, at 9; Anchondo, *supra* note 41; *see also* Huitema, *supra* note 142, at [13] (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").
[144] DIETZ & STERN, *supra* note 138, at 51.
[145] Anchondo, *supra* note 41.

projects.[146] CDR projects could face similar opposition—and failure—in the absence of sufficient community engagement.[147]

Public trust in decarbonization efforts is essential. Decarbonization will be a protracted and transformational process requiring sustained political, social, and financial support.[148] The process will involve new or unfamiliar technologies—such as DAC and carbon sequestration—that can trigger fear, uncertainty, and opposition.[149] Left unaddressed, opposition may slow or block the extensive infrastructure and policies needed to deploy CDR and other decarbonization technologies at scale.[150] Public engagement is necessary to build and maintain support for phasing out fossil fuels, establishing carbon removal systems, and making other systemic changes.[151]

Third, public engagement may contribute to better substantive outcomes.[152] Public engagement can yield useful insights, improve project design, identify risks, and establish mechanisms for resolving community concerns.[153] Information and opinions generated in the engagement process can help adapt technologies and projects to local needs and conditions.[154] Furthermore, members of the public may express judgments about risk that

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[146] Philippa Parmiter & Rebecca Bell, *Public Perception of CCS: A Review of Public Engagement for CCS Projects* at 7-8, (2020), https://ccuszen.eu/sites/default/files/TG1_Briefing-Report-Public-Perception-of-CCS.pdf (discussing cancellation of Barendrecht project in 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*, PLOS ONE 17(8): e0272409, at 22 (2022) (discussing lack of transparency as contributing factor in cancellation of Vattenfall project in Brandenburg, Germany as well as Barendrecht project).

[147] Matthias Honegger et al., *The ABC of Governance Principles for Carbon Dioxide Removal Policy*, 4 FRONTIERS IN CLIMATE 884163, at 5 (2022) (explaining that "[t]ransparent and public deliberation processes can help address and alleviate concerns" that could prompt local or national opposition to CDR).

[148] NAS, ACCELERATING DECARBONIZATION IN THE UNITED STATES: TECHNOLOGY, POLICY, AND SOCIETAL DIMENSIONS 244 (2024); 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 40, at 5.

[149] Sara Nawaz et al., *An Independent Public Engagement Body Is Needed To Responsibly Scale Carbon Removal in the US*, 19 ENV'T RESEARCH LETTERS 011002, at 2 (2024); WRI, *supra* note 87, at 20, 75 (noting "common perception . . . that new technologies are always more risky than established practices").

[150] Buck, *Mining*, *supra* note 90, at 1100; NAS, *supra* note 148, at 247.

[151] NAS, *supra* note 148, at 244.

[152] DIETZ & STERN, *supra* note 138, at 50; LIN, *supra* note 136, at 20.

[153] WRI, *supra* note 87, at 20.

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

reflect social and political values overlooked in expert judgments.[155] 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."[156]

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.[157] Additional outreach and resources may be necessary to ensure participation by marginalized and disadvantaged groups.[158] Individual participants typically lack political accountability, and they may not represent community views accurately.[159] Also, project developers worry that "too early" engagement can reveal confidential information.[160]

Furthermore, public engagement will not necessarily foster mutually or socially beneficial outcomes. In some instance, engagement processes can lead to group think and less rational decisions.[161] Engagement processes also may yield confusion, delay, or further conflict.[162] For example, participants may be confused if project sites have not yet been chosen or are subject to change.[163] Or worse, participatory processes that lack meaningful engagement can become a form of manipulation.[164] Engagement exercises carried out merely for show can leave participants frustrated, polarized, and feeling powerless.[165]

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.

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[155] Fiorino, *supra* note 136, at 227.
[156] NAS, *supra* note 148, at 244.
[157] DIETZ & STERN, *supra* note 138, at 54; Tina Nabatchi & Lisa Blomgren Amsler, *Direct Public Engagement in Local Government*, 44 AM. REV. PUB. ADMIN. 63S, 75S (2014).
[158] Julie L. MacArthur, *Challenging Public Engagement: Participation, Deliberation and Power in Renewable Energy Policy*, 6 J. ENV'T STUDIES & SCI. 631, 638 (2016).
[159] Nicholas A. Fromherz, *From Consultation to Consent: Community Approval as a Prerequisite to Environmentally Significant Projects*, 116 W. VA. L. REV. 109, 146 (2013) (noting concerns that NGOs are vulnerable to capture and may not be accountable or representative).
[160] Carbon Capture Coalition, comment letter DOE-HQ-2023-0054-0023, at 5, Nov. 8, 2023, *available at* https://www.regulations.gov/comment/DOE-HQ-2023-0054-0023.
[161] Nabatchi & Amsler, *supra* note 159, at 75S; DIETZ & STERN, *supra* note 138, 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).
[162] DIETZ & STERN, *supra* note 138, at 10, 53-54; Buhr & Wibeck, *supra* note 154, at 9.
[163] Carbon Capture Coalition, *supra* note 160, at 6.
[164] DIETZ & STERN, *supra* note 138, at 10, 52; Nielsen et al., *supra* note 146, at 13.
[165] DIETZ & STERN, *supra* note 138, at 10, 52; Nabatchi & Amsler, *supra* note 159, at 75S.

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' influence over ultimate decisions.[166] Notification and information-sharing processes simply inform the public but allow for little or no public voice.[167] Consultative processes offer members of the public an opportunity to express their views and be heard but usually involve limited public influence.[168] 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.[169] In other arrangements, such as collaboration, cooperation, and partnership, the public and "traditional powerholders" share power and negotiate decisions.[170]

The ladder of participation suggests several distinct components of public engagement: communication, public discussion and deliberation, and involvement in decision making.[171] 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.[172] Participation opportunities may be open only to directly affected citizens, include selected representatives of community interests, or allow anyone to participate.[173]

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

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

[167] Arnstein at 217, 219.

[168] Arnstein at 217, 219.

[169] Arnstein at 217; Hirsch et al., *supra* note 141, at 5.

[170] Arnstein at 217; *see* Livia Fritz et al., *Public Engagement for Inclusive and Sustainable Governance of Climate Interventions*, 14 NATURE COMMUNICATIONS 4168, at 3 (2024).

[171] 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 (F.H.J.M. Coenen ed. 2009); *see also* DIETZ & STERN, *supra* note 138, 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 process); NAS, *supra* note 148, at 253; McLaren, *supra* note 137, at 346 (suggesting that fair procedures at a minimum should "include information (notification), voice (participation or representation), and consistent and impartial decision making").

[172] NAS, *supra* note 148, at 254.

[173] Huitema, *supra* note 171, at 115.

viewpoints to developers or policymakers in a meeting, public hearing, or survey.[174] In multilateral communications, citizens, developers, and regulators exchange information and viewpoints with each other.[175] Typically, the public receives little or no support in processing the information it receives or in navigating the engagement process.[176] More inclusive and expansive communication efforts may provide financial or technical support to participants and offer outreach in multiple languages and diverse formats.[177]

Participatory mechanisms in public engagement processes involve varying amounts of public discussion and deliberation.[178] Traditional communication mechanisms, such as TV or newspaper announcements, simply convey information without active public deliberation.[179] Public hearings, frequently used by local governments, allow members of the public to express their views.[180] 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.[181] In addition, public hearings and meetings do not necessarily impact actual decisions and may leave participants frustrated.[182] Participatory processes that involve greater deliberation include focus groups and study circles, which convene a relatively small number of people on multiple occasions for in-depth discussions. Action planning workshops and citizens' juries incorporate into discussions experts who can answer questions from public participants.[183] Online forums and other online 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.[184]

Members of the public rarely have the authority to decide the details of a proposal or the criteria for evaluating it.[185] However, public participation

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[174] Gene Rowe & Lynn J. Frewer, *A Typology of Public Engagement Mechanisms*, 30 SCI. TECH. & HUMAN VALUES 251, 255 (2005); Arnstein, *supra* note 166, at 217, 219.
[175] Huitema, *supra* note 171, at 115.
[176] Huitema at 115.
[177] NAS, *supra* note 148, at 273.
[178] Fiorino, *supra* note 136, at 229-30; Rowe & Frewer, *supra* note 174, at 256-57, 276-82 Table 3. Methods of engagement include public hearings, town hall meetings, open houses, informal "chats," focus groups, one-on-one meetings, mediated discussion, and virtual workshops. WRI, *supra* note 87, at 61.
[179] Rowe & Frewer, *supra* note 174, at 278 Table 3.
[180] Rowe & Frewer at 278 Table 3.
[181] Rowe & Frewer at 278 Table 3; McLaren, *supra* note 137, at 351.
[182] Nabatchi & Amsler, *supra* note 159, at 76S.
[183] Rowe & Frewer, *supra* note 174, at 280-81 Table 3.
[184] Nabatchi & Amsler, *supra* note 159, at 79S.
[185] Fiorino, *supra* note 136, at 236.

must be "more than therapeutic, oppositional, or pleading" if it is to be meaningful.[186] One measure of the efficacy of public engagement is the use of information provided by the public.[187] Members of the public serving on an advisory committee may provide input that decision makers consider along with other inputs.[188] Or citizens may directly shape proposals, decisions, or the processes for reaching an outcome.[189] The public might even help to set goals and design and implement policy decisions.[190]

Public engagement on specific projects can include negotiations on a community benefit agreement to address collective benefits and compensation.[191] Community benefit agreements are legally enforceable agreements in which project developers commit to mitigation measures and employment and equity benefits for host communities.[192] In return, community groups—including neighborhood associations, faith-based organizations, environmental groups, and labor unions—agree to support or not oppose the project.[193] Specific benefits in an agreement might include access to employment and business opportunities, job training, revenue distribution, childcare or transportation subsidies, access to education programs or electricity discounts, and environmental and energy benefits.[194] In environmentally burdened communities, CDR project benefits might redress past harms caused by industry.[195] Because CDR 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 for CDR.[196] Ultimately, community benefit agreements provide developers a social license to operate while enabling communities to hold developers accountable for promised benefits.[197]

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[186] Fiorino, *supra* note 136, at 229.
[187] Peter W.B. Phillips, *Democracy, Governance, and Public Engagement*, *in* PUBLIC ENGAGEMENT AND EMERGING TECHNOLOGIES 46, 57 (Kieran O'Doherty & Edna F. Einsiedel eds., 2013).
[188] Rowe & Frewer, *supra* note 174, at 254.
[189] Huitema, *supra* note 171, at 115; NAS, *supra* note 148, at 273.
[190] NAS at 246 (suggesting public input on how the energy system transition should occur).
[191] NAS at 264-65.
[192] Carbon180, *supra* note 137, at 44; Chemnick 8/22/23, *supra* note 51.
[193] DOE, About Community Benefit Plans, https://www.energy.gov/infrastructure/about-community-benefits-plans, last visited Dec. 29, 2024.
[194] U.S. Department of Energy, Community Benefits Plan Template for Demonstration and Deployment, at 7-8, version 3, Apr. 19, 2024, *available at* https://www.energy.gov/infrastructure/about-community-benefits-plans; Carbon180, *supra* note 137, at 44.
[195] Carbon180, *supra* note 137, at 30 (discussing example of reparative justice).
[196] Scott-Buechler et al., *supra* note 65, at 2.
[197] Carbon180, *supra* note 137, at 44.

C. Public Engagement in Current CDR Efforts

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

1. Mandated Public Engagement

In some circumstances, public engagement is legally mandated. Most notably, DOE requires applicants for regional DAC hub grants to incorporate a community benefit plan demonstrating that a proposed hub will provide societal benefits and mitigate negative impacts.[198] In addition, a key factor considered in evaluating applications is "[t]he extent to which the project demonstrates a clear and appropriately robust plan to meaningfully engage local stakeholders."[199] 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.[200] DOE recognizes that the bulk of engagement will occur after it has awarded grant funding but expects that public input will feed into decisions on whether to proceed with further phases of each project.[201]

Project Cypress, the first regional DAC hub awarded funding, illustrates how mandated public engagement might proceed.[202] In the initial

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[198] Department of Energy Office of Fossil Energy and Carbon Management, Financial Assistance Funding Opportunity Announcement (DE-FOA-0002735) at 36-37, 95 (2022), https://www.fedconnect.net/FedConnect/default.aspx?ReturnUrl=%2ffedconnect%3fdoc%3dDE-FOA-0002735%26agency%3dDOE&doc=DE-FOA-0002735&agency=DOE (noting that community benefit plan component constitutes 20% 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% of grant funds for community engagement, education, and risk-benefit analysis. California Energy Commission, Grant Funding Opportunity: Direct Air Capture Research, Demonstration, and Community Engagement, GFO-24-303, Oct. 2024, *available at* https://www.energy.ca.gov/solicitations/2024-10/gfo-24-303-direct-air-capture-research-demonstration-and-community-engagement.

[199] Department of Energy, Financial Assistance Funding Opportunity Announcement, *supra* note 198, at 95.

[200] Department of Energy, DAC Hubs Local Engagement Opportunities, https://www.energy.gov/oced/dac-hubs-local-engagement-opportunities.

[201] *Id. (*https://www.energy.gov/oced/dac-hubs-local-engagement-opportunities).

[202] Public engagement by developers of the South Texas DAC hub offers a further example. The developers report that they conducted multiple meetings with key stakeholders, including community-based organizations and environmental advocacy organizations. South Texas DAC Hub Community Briefing, at 26, 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

project phase, the project developers are conducting planning, design, and community and labor engagement.[203] Initial outreach efforts have included open houses in communities where the project's DAC plants will be located—though local resident attendance at the open houses was modest.[204] The developers are in the process of establishing community engagement councils of stakeholders at its two site locations.[205] The councils will include members of disadvantaged communities, limited English proficiency communities, local workforce development organizations, labor organizations, workforce training providers, and community groups concerned about DAC and CO_2 transportation and storage.[206] The councils are to assist project developers in identifying community priorities and addressing community concerns and to serve as a communication channel between the broader community and the developers.[207] The developers have committed to providing construction and operations employment opportunities for local residents and to hiring ten percent of workers with a history of employment in the fossil fuel or plastics industries.[208]

The influence of the community engagement councils and the distribution of project benefits and burdens are yet to be determined, however.[209] The Alliance for Affordable Energy (AAE), a local organization

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efforts. Chemnick; *see also* Kingsville Chamber of Commerce press release, https://www.kingsville.org/news/2023/09/14/local-business/local-officials-officially-celebrate-1pointfive-dac-project/. 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, at 40.

[203] Department of Energy, OCED Issues $50M to Direct Air Capture Hub Project Cypress, Mar. 27, 2024 https://www.energy.gov/oced/articles/oced-issues-50m-direct-air-capture-hub-project-cypress; Office of Clean Energy Demonstrations, Regional Direct Air Capture Hubs Selected and Awarded Projects, https://www.energy.gov/oced/regional-direct-air-capture-hubs-selected-and-awarded-projects (last visited Nov. 17, 2024).

[204] Corbin Hiar, *Trump Win Forces Carbon Removal Developers to Reconsider Oil*, CLIMATEWIRE, Nov. 25, 2024 (discussing October 2024 open houses in Shreveport and Lake Charles, Louisiana).

[205] Department of Energy, Project Cypress Community Benefits Commitments Summary, at 3 (2024) https://www.energy.gov/sites/default/files/2024-06/Project%20Cypress%20Community%20Benefits%205.30.24.pdf; see also Project Cypress, Community Engagement Council, https://www.projectcypress.com/community-engagement-council (describing purpose of council and timeline for establishing council).

[206] DOE, Project Cypress, *supra* note 205, at 3.

[207] *Id.* at 3.

[208] *Id.* at 5.

[209] Carbon180, With Project Cypress, Community Benefit Plans Begin To Take Shape, May 2, 2024, https://carbon180.org/blog/with-project-cypress-community-benefits-plans-

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."[210] In addition, environmental justice groups have criticized DOE's limited outreach prior to selecting Project Cypress for award negotiations.[211] The groups complain that the community engagement promised by DOE and project developers is taking place too late, only after site selection.[212] These groups also assail DOE's refusal to disclose projects' community benefit plans until after the agency concludes negotiations with project developers.[213] At that point, they worry, plan details will already be final, and any community engagement could be moot.[214]

2. Voluntary Public Engagement

In some instances, applicable laws may not require public engagement. Project organizers nonetheless may undertake public engagement on a voluntary basis. Voluntary engagement for DACS has taken the form of conventional project-based outreach, community centered engagement, and engagement in the absence of project proposals.

a. Conventional Project-Based Outreach

Public engagement efforts conducted for STRATOS, a Texas facility being built by a subsidiary of Occidental Petroleum (Oxy), illustrate conventional project-based outreach.[215] Upon completion, STRATOS promises to be the "world's largest direct air capture plant."[216] The facility

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begin-to-take-shape/ (noting that the Councils were scheduled to be seated in September 2024).[UPDATE]

[210] Alliance for Affordable Energy, An Opportunity to Provide Your Input on Project Cypress, https://www.all4energy.org/watchdog/project-cypress-community-briefing; https://www.all4energy.org/who.html.

[211] Jean Chemnick, *"False Promise": DOE's Carbon Removal Plans Rankle Community Advocates*, CLIMATEWIRE, Sept. 25, 2023.

[212] Chemnick 9/25/23

[213] Chemnick 9/25/23

[214] Chemnick 9/25/23

[215] Oxy, Community Engagement and Environmental Justice Assessment (2024), file:///C:/Downloads/EPA-R06-OW-2024-0410-0031_attachment_2.pdf.

[216] Amanda Drane, *Permian Basin Pivot*, HOUSTON CHRON., Apr. 29, 2023; 1PointFive (press release), 1PointFive Holds Groundbreaking for World's Largest Direct Air Capture (DAC) Plant, Apr. 28, 2023, https://www.1pointfive.com/news/1pointfive-holds-groundbreaking; 1PointFive Fast Facts (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 to balance out GHG emissions associated with oil and gas production and use. Natasha White et al., *Oxy Quietly Ditched a West Texas Carbon Capture Plant*, MIDLAND REPORTER-TELEGRAM, Oct. 30, 2023.

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.[217]

STRATOS is located in a somewhat remote area in the Permian Basin, approximately 20 miles southwest of the city of Odessa.[218] The site is surrounded by existing fossil fuel extraction infrastructure,[219] and the nearest home is over six miles away.[220] Engagement efforts have included two public meetings with the community, meetings with community leaders, and informational presentations and booths at community events.[221] Oxy reports that only a few businesses and local landowners attended community meetings even though they were widely publicized.[222] The primary participants in engagement have been businesses, business professionals, and local organizations such as the Odessa Chamber of Commerce.[223] In general, engagement efforts appear focused on providing information about the project, although the developer has also solicited public comment.[224] Oxy claims that it has "not encountered or been made aware of any organized opposition to the Project," which it attributes to its "comprehensive approach to meaningful public engagement" and efforts to "mitigate community impacts and provid[e] local benefits."[225] Additional public outreach efforts associated with STRATOS include hearings on issuing a Class VI injection well permit to store captured carbon.[226] EPA held these hearings over a year after Oxy broke ground on the air capture portion of the project.[227]

Outreach efforts at Heirloom Carbon Technologies' Tracy, California facility offer a further example of voluntary community engagement.[228]

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[217] Amanda Drane, *BlackRock Boosts Oxy's Decarbonization Project*, HOUSTON CHRON., Nov. 8, 2023 (reporting $550 million investment by BlackRock); Susanna Twidale & Peter Henderson, *Amazon Makes First Investment in Direct Air Capture Climate Technology*, REUTERS, Sept. 12, 2023; *AT&T Agrees to Purchase Carbon Credits from Occidental's 1PointFive*, REUTERS, Mar. 13, 2024.
[218] Oxy, *supra* note 215, at 2.
[219] *Id.* at 5.
[220] *Id.* at 1.
[221] *Id.* at 1, 8.
[222] *Id.* at 8.
[223] *Id.* at 8.
[224] *Id.* at 9.
[225] *Id.* at 9.
[226] Carlos Nogueras Ramos, *The Largest Carbon Capture Project in the U.S. Could Be in West Texas. Do Residents Want It?*, TEXAS TRIB., Oct. 2, 2024; Carlos Anchondo, *EPA Proposes First-of-a-Kind CO_2 Storage Permits in Texas*, ENERGYWIRE, Sept. 5, 2024.
[227] Ramos, *supra* note 226 (reporting on October 2024 public meetings).
[228] Brad Plumer, *In a U.S. First, a Commercial Plant Starts Pulling Carbon from the Air*, N.Y. TIMES, Nov. 9, 2023.

Touted as the first commercial DAC plant in the U.S., the facility captures a relatively modest quantity of CO_2 and mixes it into concrete.[229] Heirloom views the Tracy facility as a blueprint for the larger DAC facilities it is planning to build.[230] 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."[231] 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."[232]

Shortly after opening the Tracy facility, Heirloom launched a "community governance model" to convene community groups in quarterly meetings.[233] According to Heirloom, these groups will "gather routine community feedback on the facility and its operations and help to steer input for how Heirloom will provide financial and programmatic investments in community organizations."[234] The community governance council for the Tracy facility, which includes representatives from local environmental organizations, environmental justice groups, labor unions, and the county board of education, meets quarterly to offer feedback on facility operations (such as air and noise monitoring needs) and develop a community benefit plan.[235]

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 has received $3 million in DOE funding, has launched an especially comprehensive engagement effort to explore the

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[229] Plumer (reporting plant's capacity to remove 1,000 tons of carbon annually); Heirloom press release, https://www.heirloomcarbon.com/news/heirloom-unveils-americas-first-commercial-direct-air-capture-facility.

[230] Clare Fonstein, *A Surprising Green Technology Rises in the San Joaquin Valley*, S.F. CHRON., Nov. 10, 2023

[231] Heirloom, The New Climate Economy Needs Rules of the Road. Here's a Start., Oct. 2, 2023, https://www.heirloomcarbon.com/news/the-new-climate-economy-needs-rules-of-the-road; *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.

[232] Heirloom, New Climate Economy, *supra* note 231.

[233] Heirloom, Heirloom Unveils America's First Commercial Direct Air Capture Facility, Nov. 9, 2023, https://www.heirloomcarbon.com/news/heirloom-unveils-americas-first-commercial-direct-air-capture-facility; Allsup, *supra* note 231.

[234] *Id*.

[235] [Tel Con w/Theuer]

feasibility of establishing a DAC hub in California's San Joaquin Valley.[236] Led by UC Berkeley's Center for Law, Energy, and the Environment (CLEE), CALDAC is a "coalition of universities, nongovernmental organizations (NGOs), and companies with ambitions to create a community-led DAC hub."[237] 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.[238] 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.[239]

CALDAC is unique in attempting to develop a "community-centered and potentially community owned" DAC hub from the outset.[240] Carbon180, a nonprofit organization that advocates for CDR,[241] has been tasked with developing this model and, if appropriate, co-creating a community benefit agreement.[242] 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.[243] 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."[244] For-profit companies may participate in CALDAC, subject to the community's ability to veto any company's involvement.[245]

In "Phase 0a," the coalition will assess technological feasibility and establish a community oversight council composed of "stakeholders,

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[236] Carbon180, *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.

[237] *Id*.

[238] Berkeley Law, CALDAC—A Feasibility Assessment of an Equity-Focused Regional Direct Air Capture Hub, Sept. 2024, https://www.law.berkeley.edu/research/clee/research/other-research-initiatives/caldac/; DOE, Project Selections for FOA 2735: Regional Direct Air Capture Hubs Topic Area 1 (Feasibility) and 2 (Design), https://www.energy.gov/fecm/project-selections-foa-2735-regional-direct-air-capture-hubs-topic-area-1-feasibility-and. 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.

[239] Jean Chemnick, *The Carbon Removal Project that Puts Communities in the Driver's Seat*, CLIMATEWIRE, Oct. 26, 2023; Berkeley Law, CALDAC Technical Volume, at 21 (2023), https://www.law.berkeley.edu/wp-content/uploads/2024/01/Technical-Volume.pdf.

[240] Carbon180, *supra* note 236.

[241] Carbon180, About, https://carbon180.org/about/ (last visited Dec. 30, 2024).

[242] Carbon180, *supra* note 236.

[243] *Id.*

[244] *Id.*

[245] *See* Chemnick 10/26/23, *supra* note 239.

residents, and representatives from historically disadvantaged and environmental justice community groups."[246] Council members will be compensated, and the council will have input over key decisions throughout the process.[247] If the project advances to "Phase 0b," CALDAC will establish a community benefit plan and decide on an ownership structure.[248] 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 "tak[ing] a long-term outlook."[249]

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,[250] held workshops in four geographically diverse communities.[251] 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 opportunity zones.[252] Anticipating DOE's specific interest in the Gulf Coast region, the organization held additional workshops in several Gulf Coast communities.[253]

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."[254] While many workshop participants thought that their

[246] *Id.* at 1; CALDAC Technical Volume, *supra* note 239, at 21.
[247] CALDAC Technical Volume at 9.
[248] *Id.* at 1, 9-10.
[249] *Id.* at 19-20.
[250] Data for Progress, Our Mission, https://www.dataforprogress.org/what-is-data-for-progress (last visited Dec. 30, 2024).
[251] Data for Progress, DAC Hubs Resource Guide, https://www.dataforprogress.org/dac-hubs-resource-guide (listing workshop locations of Houston, TX**;** Beaver County, PA**;** Bakersfield, CA**;** and Rock Springs, WY); Scott-Buechler et al., *supra* note 65, at 5.
[252] Scott-Buechler et al., *supra* note 65, at 5; *see* Data for Progress, DAC Hubs in Fossil Fuel Country: Recommendations from the Gulf Coast 3 (2023).
[253] Data for Progress, *supra* note 252; Chemnick 9/25/23, *supra* note 211.
[254] Celina Scott-Buechler et al., Data for Progress, Advancing Equitable Deployment of Regional DAC Hubs, at 4 (2023); Data for Progress, *supra* note 252, at 2-3.

community would support hosting a DAC hub,[255] 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.[256]

The Department of Energy also has held several community workshops on carbon management—broadly understood to encompass carbon capture, DAC, CO_2 transportation, and CO_2 storage.[257] Locations for the initial workshops were chosen based on favorable geology and conditions for carbon management and an absence of prior public engagement on the issue.[258] These workshops, which included presentations, question-and-answer sessions, and facilitated discussions with community members, focused on carbon capture, utilization, and storage rather than DACS.[259] 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.[260] DOE held similar workshops in three Texas communities in October 2024, though environmental justice groups characterized these workshops as public relations efforts held "under the guise of a community workshop."[261]

Other DOE-sponsored outreach on CDR has included "expert-led stakeholder conversations and symposiums" held or scheduled at several universities in 2024 and 2025.[262] While open to interested community members, these events are aimed primarily at researchers, policymakers, and local experts.[263] Discussions at these meetings consider the results of a

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[255] Data for Progress, Advancing Equitable Deployment of Regional DAC Hubs, One-Pager (2023) (reporting that between 47% and 75% of participants in the initial set of workshops thought that their community would support hosting a DAC hub).
[256] Data for Progress, *supra* note 252, at 5-6.
[257] U.S. Department of Energy, Workshop Synthesis and Recommendations: Insights from the 2022 Carbon Interactive Workshop Series, at 1-2 (2023), https://www.energy.gov/sites/default/files/2023-03/Carbon%20Interactive%20Workshops%20Report%20March%202023.pdf (describing pilot program of interactive workshops on carbon management held in Corpus Christi, TX; Pittsburgh, PA; Tulsa, OK; and Richland, WA, in addition to a virtual workshop).
[258] *Id.* at 2.
[259] *Id.* at 2.
[260] *Id.* at 3-5.
[261] Jean Chemnick, *DOE Carbon Capture Workshops Omit "Naysayers," Community Advocates Say*, CLIMATEWIRE, Sept. 16, 2024.
[262] https://roads2removal.org/events/; https://web.cvent.com/event/66d34618-bc62-48ed-a37b-d73687828d53/summary (promoting March 2024 symposium at University of California Merced); https://news.ucmerced.edu/news/2024/climate-and-carbon-dioxide-%E2%80%98roads-removal%E2%80%99-discussion-set-uc-merced (same).
[263] https://web.cvent.com/event/66d34618-bc62-48ed-a37b-d73687828d53/websitePage:5b64410b-96f3-47b8-80dc-f877c39e8a66 (Merced);

nationwide technical analysis on CDR options, with a focus on options specific to each region.[264]

To supplement direct public engagement, CDR policymakers might also look to public surveys.[265] 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.[266] These surveys generally found favorable views of CDR, with some preference for capturing carbon in long-lived materials rather than storing it underground.[267] Respondents also expressed concerns about the costs of implementing CDR and a desire for community engagement.[268] In addition to the state surveys, Data for Progress conducted a national survey on desired features for DAC facilities.[269] This survey found a preference that facilities be "owned by a DAC company and funded by a tax on polluting industries."[270] 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.[271]

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Survey findings can inform policies and planning efforts but do not obviate the need for public engagement on CDR policy or DAC projects. Public engagement on CDR has generally occurred with respect to individual project proposals, although recent engagement efforts have also taken place in potential host communities for 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.

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https://web.cvent.com/event/f2fdbb45-3e05-4a8b-b7db-eb8a7b272943/summary (Philadelphia).

[264] https://roads2removal.org/events/ (noting that events build on *Roads to Removal* report); https://news.iu.edu/live/news/37797-epas-janet-mccabe-to-join-national-climate-change-disc (Indianapolis); https://web.cvent.com/event/f2fdbb45-3e05-4a8b-b7db-eb8a7b272943/summary (Philadelphia); https://web.cvent.com/event/66d34618-bc62-48ed-a37b-d73687828d53/websitePage:5b64410b-96f3-47b8-80dc-f877c39e8a66 (Merced).

[265] *See* Chilvers et al., *supra* note 148, at 251 Fig. 1 (categorizing public opinion surveys as a form of institution-led, issue-focused public participation).

[266] Data for Progress, Public Perceptions of Carbon Dioxide Removal in Wyoming, Texas, Louisiana, and Colorado (2024).

[267] *Id.* at 48.

[268] *Id.* at 49.

[269] Scott-Buechler et al., Advancing Equitable Deployment, *supra* note 254, at 20.

[270] *Id.* at 20.

[271] *Id.* at 20.

III. Designing Public Engagement for CDR

What should public engagement for CDR look like? As a general matter, public engagement efforts should aspire to 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."[272] Features of a fair process might include an opportunity to voice concerns, access to information and resources for analyzing it, a neutral forum, trustworthy authorities, and respectful treatment of participants and their views.[273] 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.[274] These features are important elements in building the trust essential to effective engagement and successful decarbonization.[275] 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.[276]

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 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.

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[272] DIETZ & STERN, *supra* note 138, at 60.

[273] DIETZ & STERN, *supra* note 138, at 60; Roger E. Kasperson et al., *Social Distrust as a Factor in Siting Hazardous Facilities and Communicating Risks*, *in* THE SOCIAL CONTOURS OF RISK: PUBLICS, RISK COMMUNICATION AND THE SOCIAL AMPLIFICATION OF RISK Vol. I, at 29, 49 (Jeanne X. Kasperson & Roger E. Kasperson eds., 2005).

[274] NAS, *supra* note 148, at 273. Similarly, Carbon180 urges "inclusive and open dialogues with community members" that ultimately respect community wishes and concerns, as well as "robust public engagement . . . structured to facilitate input and feedback." Carbon180, *supra* note 137, at 32-33. *See also* Hirsch et al., *supra* note 141, 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.").

[275] *Cf.* Parmiter & Bell, *supra* note 146, at 8 (observing that trust "can be earned by open and honest communication about risks, and risk mitigation and management").

[276] McLaren, *supra* note 137, at 353.

Ultimately, the appropriate levels and modes of public engagement for CDR will depend on the goals of engagement, the decisions to be made, the type of CDR at issue, project location and scale, and affected communities.[277] Perhaps most important are the goals of engagement in a specific instance. These goals may include identifying public concerns, empowering participants, recommending policies, improving decision quality and decision making capacity, and legitimizing decisions.[278] Policy-level decision processes, as opposed to project-level decisions, call for broad involvement of the general public.[279] 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.[280] 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.[281]

Ideally, public engagement on CDR would occur at both a policy level—national or regional—and a community-based project level.[282] National or regional policy discussions might consider CDR's role within an overall climate strategy, pros and cons of different CDR techniques, appropriate regulations, research priorities, planning for a network of CDR facilities and infrastructure, and other overarching policy questions. Public engagement at this level would consist of "a broader, more general interaction with the wider public" and involve a wide variety of stakeholders.[283] 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 narrowly on the needs, concerns, and values of those directly impacted by a specific project.[284]

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[277] Low et al., *supra* note 21, at 9 (suggesting that "meaningful consultation can be nuanced by kind of carbon removal"); *see* DIETZ & STERN, *supra* note 138, 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").
[278] DIETZ & STERN, *supra* note 138, at 43-44, 65-66.
[279] DIETZ & STERN, *supra* note 138, at 18.
[280] Hirsch et al., *supra* note 141, at 9.
[281] DIETZ & STERN, *supra* note 138, at 18.
[282] *Cf.* Buck, *Mining*, *supra* note 90, at 1086-88, 1100 (discussing disconnect between carbon professionals' vision of a circular carbon economy and local publics' participation in project-specific processes).
[283] Hirsch et al., *supra* note 141, at 4.
[284] Hirsch et al. at 4.

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.[285] However, public engagement at the policy level is equally important.[286] Public engagement at this earlier stage allows for input into foundational decisions on developing and deploying technologies that will shape our communities, society, and environment for decades to come.[287] Such engagement should include the broader public and reflect the full range of stakeholders and individuals affected by fundamental policy decisions.[288]

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—environmental impact statements under NEPA.[289] Programmatic analyses enable consideration of environmental concerns early in the planning process, prior to the commitment of resources.[290] 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 a broad or programmatic level."[291] Programmatic analyses—and public engagement

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[285] Nawaz et al., *supra* note 149, 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 141, at 2 (observing that government requirements that funding applicants propose community benefit plans pay "scant attention" to the engagement process).

[286] DOE Workshop Synthesis, *supra* note 257, 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").

[287] LIN, *supra* note 136, at 21-22.

[288] DIETZ & STERN, *supra* note 138, 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.").

[289] Michael Boots, CEQ, Memorandum re Effective Use of Programmatic NEPA Reviews, at 6-7, 24-25, Dec. 18, 2014; *see generally* 40 C.F.R. § 1501.11 (discussing programmatic environmental documents and tiering). 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. Boots, *supra*, at 7.

[290] 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 ENV'T L. REV. 89, 94 (1993).

[291] 40 C.F.R. § 1501.11(a).

at this stage—give the public "a chance to see the big picture early."[292] 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.[293]

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 for CDR projects—can "break the cycle of NIMBYism" that often characterizes siting controversies.[294] An approach that seeks out community voices upfront acknowledges people's attachments to where they live.[295]

Admittedly, stimulating robust public engagement at the policy making stage is no simple task. Members of the public may view their involvement in policy discussions as premature, costly, or futile.[296] Organizers may struggle to secure participation that adequately reflects and represents potentially affected stakeholders and communities.[297] Engaging environmental justice advocates, community organizations, and local governments can help but does not guarantee representation of local concerns.[298] Nonetheless, delaying public engagement until after a site-specific proposal is made can foster community resentment at being excluded

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[292] Boots, *supra* note 289, at 25.

[293] Boots at 25. 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 Public Information v. Atomic Energy Comm'n, 481 F.2d 1079, 1093-94 (D.C. Cir. 1973).

[294] Patrick Devine-Wright, *Public Engagement with Large-Scale Renewable Energy Technologies: Breaking the Cycle of NIMBYism*, 2 WIREs CLIMATE CHANGE 19, 23 (2011).

[295] Devine-Wright at 23-24.

[296] *See* DIETZ & STERN, *supra* note 138, 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").

[297] *Id.* at 195.

[298] *Id.* at 195-96.

from decision making processes and forced to host projects with adverse local impacts.[299]

2. Current DACS Policies Provide for Inadequate Engagement

Unfortunately, little public engagement has accompanied the adoption of CDR policies thus far. The specific provisions that established DAC hubs and boosted tax credits for DACS were included in omnibus legislation addressing infrastructure generally.[300] Through these provisions, Congress prioritized DACS over other CDR techniques. This prioritization may be warranted by DACS' carbon storage potential, but it was made without a public discussion of the relative merits and flaws of the various CDR options. Nor has DOE conducted much public engagement in administering DAC funding programs, despite having the leeway to do so.[301] The Bipartisan Infrastructure Law, which sets out the process for selecting DACS hubs, leaves DOE broad discretion on the criteria to apply and the procedures to follow.[302] The agency is required to consider proximity to carbon-intensive industry and potential for carbon sequestration, and it also may weigh additional criteria that, in its judgment, are "necessary or appropriate."[303] These additional criteria seemingly allow the agency to conduct public engagement before selecting hubs for award negotiations.[304] However, rather than conducting such engagement, DOE promised that community dialogues, local engagements, and NEPA processes will take place after the agency's negotiations with selected developers are

[299] Chemnick 8/22/23, *supra* note 51; Devine-Wright, *supra* note 294, 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 opportunities to participate, the invalidation of emotional response and the pre-occupation with financial benefit").

[300] Corbin Hiar, *Major Carbon-Removal Bill Unlikely To Pass This Year*, E&E DAILY, Nov. 16, 2022 (describing section that provided $3.5 billion for DAC hubs as "provision tucked into the bipartisan infrastructure package" and suggesting that bipartisan energy policy requires "low political profile")

[301] DOE's 2022 carbon management workshops, *see supra* Part II.C.2.c, focused on carbon capture, utilization, and storage (rather than DACS) and were limited to four locations. *See* DOE, Workshop Synthesis, *supra* note 257, at 2.

[302] 42 U.S.C. § 16298d(j)(3)(C); Scott-Buechler & Stewart, *supra* note 64, at 3.

[303] 42 U.S.C. § 16298d(j)(3)(C)(7).

[304] Chemnick 9/25/23, *supra* note 211 (reporting that announcement of regional DAC 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").

complete.[305] 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 publicly until completing negotiations with selected developers.[306] No wonder 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.[307]

In effect, DOE has treated the DAC hub selection process as a technical matter warranting no public input, despite the danger of overlooking community concerns and fostering public distrust.[308]

In an effort to educate the public about DACS and CCS, DOE has conducted three workshops in Texas communities that might host future projects.[309] However, this outreach falls short of the broad and meaningful engagement that should occur. Environmental justice and community group representatives complain that DOE excluded them from workshop planning and presentations.[310] 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.[311]

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[305] *Id.* [Chemnick]; Corbin Hiar, *Direct Air Capture Funding Hits Snag as Applicants Await $1.2B*, CLIMATEWIRE, June 30, 2023 (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"); Office of Clean Energy Demonstrations, DOE, DAC Hubs Local Engagement Opportunities, https://www.energy.gov/oced/dac-hubs-local-engagement-opportunities (diagram depicting engagement opportunities after project of interest selected); *see also* DOE Funding Opportunity Announcement, *supra* note 198, at 99-100 (describing process for evaluating funding applications, without mention of pre-selection public engagement).

[306] Chemnick 9/25/23, *supra* note 211.

[307] Chemnick 8/22/23, *supra* note 51.

[308] Roger E. Kasperson, *Siting Hazardous Facilities: Searching for Effective Institutions and Processes*, *in* THE SOCIAL CONTOURS OF RISK, *supra* note 273, at 281, 288-89 (discussing siting of controversial facilities based on evaluation of technical criteria).

[309] Chemnick 9/16/24, *supra* note 261; DOE, Carbon Management Workshop, Oct. 8, 2024, https://www.energy.gov/fecm/events/carbon-management-workshop-beaumont-port-author-texas; *see* Part II.C.2.c.

[310] Chemnick 9/16/24, *supra* note 261.

[311] Chemnick 9/16/24.

3. Potential Models for Policy-Level Public Engagement

Carbon removal is a global public good, analogous to other public goods like national defense.[312] Public goods require strong government support—and public control.[313] Indeed, the analogy to national defense argues not only for establishing public control of CDR siting decisions but also for situating 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 especially instructive here. CDR siting decisions—like base closure decisions—should respond primarily to national prerogatives while accounting for economic, social, and environmental impacts on local communities.[314]

The BRAC process is designed to minimize the politicization of base closures.[315] 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.[316] The criteria for selecting bases for closure prioritize military value but also consider environmental and economic impacts on nearby communities.[317] The commission deliberates on the recommended closures and then issues a final report for the President's approval.[318] Once approved, the report's recommendations take effect unless Congress rejects the recommendations in their entirety.[319] 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.[320]

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[312] Moya Chin, What Are Global Public Goods?, International Monetary Fund, Dec. 2021, https://www.imf.org/en/Publications/fandd/issues/2021/12/Global-Public-Goods-Chin-basics.

[313] *Id.*

[314] Defense Base Closure and Realignment Act of 1990, Pub. L. No. 101-510, *amended by* National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107; Christopher T. Mann, CRS, Base Closure and Realignment (BRAC): Background and Issues for Congress 2 (2019).

[315] Mann, *supra* note 314, at 1-2.

[316] Defense Base Closure and Realignment Act, §§ 2902, 2903.

[317] Mann, *supra* note 314, at 4-5 (quoting Defense Base Closure and Realignment Act § 2913); 2005 Defense Base Closure and Realignment Commission Report to the President v (2005).

[318] Mann, *supra* note 314, at 2.

[319] Mann at 2.

[320] 2005 Commission Report, *supra* note 317, at iv; *see also* Defense Base Closure and Realignment Act § 2903(d) (requiring Commission to conduct public hearings).

Participatory mechanisms employed in Germany's transition away from a coal-dependent economy offer a further example of the successful integration of community-based concerns and participation into policy-level decision processes.[321] Over the course of several decades, Germany adopted a decentralized process that incorporated local stakeholder and resident participation in conferences, workshops, and grant committees to consider regional solutions.[322] Stakeholder participants have included representatives from the public sector, private companies, community organizations, labor, and research institutions.[323] Regional and local opportunities for participation helped to overcome opposition to initial top-down policies and led to collaboration in crafting subsequent policies.[324]

DOE or a newly established federal "Carbon Removal Administration" could implement a similar approach to CDR.[325] This entity would not only organize and oversee CDR efforts but also conduct and support policy and project-level engagement.[326] Such an entity would identify potential CDR project locations with public buy-in and assess CDR infrastructure needs from a systemwide perspective.[327] It would also build capacity in communities to engage with specific CDR project proposals.[328] Policy-level public engagement could also take place outside of policymaking agencies. Independent engagement bodies established with government support could assist the public in evaluating the risks, benefits, and tradeoffs of CDR options in their areas.[329]

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[321] AU IRCR, *supra* note 16, at 37.

[322] Andrea Furnaro et al., RFF, German Just Transition: A Review of Public Policies to Assist German Coal Communities in Transition 37-39 (2021); Nawaz et al., *supra* note 149, at 3. Not all efforts 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 process that has not adequately incorporated local concerns and participation. Furnaro et al., *supra*, at 39; Jörg Radtke & Martin David, *How Germany is Phasing Out Lignite: Insights from the Coal Commission and Local Communities*, 14 ENERGY, SUSTAINABILITY & SOC'Y 7, 14 (2024); Felix Heimann & Rebekka Popp, E3G, How (Not) to Phase-Out Coal: Lessons from Germany for Just and Timely Coal Exits, at 7-8, 10 (2020).

[323] Furnaro et al., *supra* note 322, at 37-39.

[324] Furnaro et al. 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).

[325] AU IRCR, *supra* note 16, at 35-37; John Larsen et al., Rhodium Group, Capturing Leadership: Policies for the US to Advance Direct Air Capture Technology, at 7, 38 (2019) (proposing establishment of such an entity).

[326] AU IRCR, *supra* note 16, at 35-37; Larsen et al., *supra* note 325, at 7, 38.

[327] AU IRCR, *supra* note 16, at 37.

[328] AU IRCR at 37.

[329] AU IRCR at 36-37.

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.[330] Regional engagement apart from specific project proposals can combine somewhat centralized planning with participation and viewpoint exchange from a range of communities.[331] 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 private property rights.[332] Although public engagement takes time, it can ultimately facilitate project deployment.[333] Without meaningful engagement, communities and individuals may resist projects through lawsuits, administrative delays, and protests.[334] Early engagement sends a message that community concerns will be taken seriously, and ongoing engagement can build and maintain community support.[335]

Public engagement at the community level—community engagement—does not guarantee consensus. In the absence of consensus, community engagement might aim to foster debate and negotiation.[336] Ultimately, "there are no perfect solutions for public engagement to deliver speedy and conflict-free industrial siting decisions in an open democratic society."[337] Community engagement nevertheless can and should be incorporated into DACS project decision making—whether that engagement

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[330] Nawaz et al., *supra* note 149, at 2.
[331] Nawaz et al. at 2.
[332] *See supra* Part I.B; NAS, *supra* note 148, at 213-14. Other types of CDR also may warrant project-level engagement, with the possible exception of techniques—such as afforestation—that raise few or no community concerns.
[333] NAS, *supra* note 148, at 195; Nawaz et al., *supra* note 149, at 1.
[334] NAS, *supra* note 148, at 195, 212; Nawaz et al., *supra* note 149, at 1-2; Hirsch et al., *supra* note 141, at 5 (noting frequent resistance when community engagement occurs only "after key decisions are already made").
[335] Nielsen et al., *supra* note 146, at 12; Scott-Buechler et al., *supra* note 65, at 5, 8.
[336] Fritz et al., *supra* note 170, 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.").
[337] NAS, *supra* note 148, at 212.

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.[338] "[P]rojects are conceived of behind closed doors, announced to communities as complete plans, and defended against opposition through public and legal processes."[339] Within this paradigm, government permitting processes define phases of public participation, prescribe decision-making endpoints, and limit disclosure of confidential business information.[340] Engagement often takes the form of public hearings, which participants may find ineffective and alienating.[341] Indeed, operating within the confines of a developer-driven approach may hamper communities' ability to identify alternative options and engage in informed and meaningful ways.[342] Despite the risks of alienating or provoking community members, DACS projects have largely followed this "decide, announce, defend" model.[343]

The Department of Energy's ongoing efforts to expand public engagement largely adhere to this developer-driven model. At the heart of these efforts is the agency's Responsible Carbon Management Initiative, which offers guidance to project developers on responsibly managing CDR and CCS projects.[344] Several of the ten voluntary principles identified in the initiative directly address public engagement.[345] The first principle, community engagement, counsels project developers to undertake "robust, early, and consistent outreach" to persons a project may affect.[346] Other

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[338] Nawaz et al., *supra* note 149, at 1.

[339] Nawaz et al., *supra* note 149, at 1; *see also* Kasperson *Siting*, *supra* note 308, at 281, 286-88 (describing this approach).

[340] Memo from Carbon Capture Coalition to Office of Fossil Energy and Carbon Management, DOE, DOE-HQ-2023-0054, Sept. 29, 2023, at 4-5 (commenting on proposed Responsible Carbon Management Initiative).

[341] Kasperson et al., *supra* note 273, at 47.

[342] Nawaz et al., *supra* note 149, at 2.s

[343] AU IRCR, *supra* note 16, at 29-30; Nawaz et al., *supra* note 149, at 1-2.

[344] Department of Energy, Responsible Carbon Management Initiative Resources ("RCMI Resources") (2024); DOE, Notice of Intent and Request for Information Regarding Launching a Responsible Carbon Management Initiative, 88 Fed. Reg. 54608 (2023) (requesting feedback from stakeholders regarding draft principles for responsible carbon management).

[345] 88 Fed. Reg. at 54609; RCMI Resources, *supra* note 344, 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. 88 Fed. Reg. at 54609.

[346] RCMI Resources at 4.

principles also relating to public engagement include principles of tribal engagement, environmental justice, and transparency.[347] 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, national origin, or income," and a siting process that "is open to public input and transparent with respect to how decisions are made."[348]

DOE offers additional guidance on creating community and stakeholder engagement plans for energy-related and carbon management projects.[349] This guidance emphasizes that project developers should not only transmit information but also create and maintain relationships with relevant communities.[350] 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.[351] DOE's guidance is complemented by NGO recommendations that engagement efforts focus on disadvantaged local communities, provide resources for transportation, child care, and the like to support community participation, and continue throughout a project life cycle to account for changes in a community's composition and views.[352]

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 has promised to ensure that developers of the projects it funds will engage with communities, address societal concerns, and prepare community benefit plans.[353] Moreover, federal assistance and funding may be available

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[347] RCMI Resources 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.*
[348] 88 Fed. Reg. at 54609-10.
[349] Department of Energy, Fossil Fuel and Carbon Management, Creating a Community and Stakeholder Engagement Plan (2022).
[350] DOE, Creating, at 1.
[351] DOE, Creating, at 2, 4; *cf.* Letter from Sasha Stashwick, Carbon180, at 5 (Sept. 11, 2023), https://www.regulations.gov/comment/DOE-HQ-2023-0054-0031 (making recommendations for community engagement).
[352] Carbon180*, supra* note 137, at 37; WRI, *supra* note 87, at 77.
[353] RCMI Resources, *supra* note 344, at 4.

to bolster the ability of disadvantaged communities to participate in public engagement.[354]

Similar oversight and assistance should also be applied to DACS projects not funded by DOE.[355] A board of local representatives and stakeholders can monitor whether projects are consistent with DOE's standards for community engagement and make its findings publicly available.[356] Developer adherence to transparency principles also can facilitate community and stakeholder review of engagement efforts.[357]

Community Veto

Under one variation on developer-driven engagement, local communities would have the ability to veto project proposals.[358] Requiring developers to obtain community consent represents an expansion of prior informed consent, a principle of international law that recognizes the right of indigenous peoples to withhold consent to projects that impact their lands and communities.[359] Such a requirement would be consistent with self-determination principles that undergird the environmental and climate justice movements.[360] 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.[361] It also would reduce the number of DACS projects. In light of DACS' locational flexibility, a community veto of an individual DACS project would not necessarily preclude its implementation elsewhere.[362] However, a general community veto right might encourage reflexive NIMBY

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[354] Carbon180, *supra* note 137, at 47; EPA, 2023-24 Environmental Justice Thriving Communities Technical Assistance Centers Program (EJ TCTAC), at 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").

[355] RCMI Resources, *supra* note 344, at 4.

[356] Christopher Allen et al., Carbon 180, Setting DAC on Track, at 18 (2022).

[357] RCMI Resources, *supra* note 344, at 22.

[358] Huitema (1998), *supra* note 142, at 8.

[359] Scott-Buechler & Stewart, *supra* note 64, at 4; *see* Fromherz, *supra* note 159, at 156; Ciprian N. Radavoi, *Fenceline Communities and Environmentally Damaging Projects: An Asymptomatically Evolving Right to Veto*, TULANE ENV'T L.J. 1, 6-7 (2015).

[360] Stashwick, *supra* note 351, at 4.

[361] Fromherz, *supra* note 159, at 153-69.

[362] Fromherz at 190. *Cf.* Radavoi, *supra* note 359, 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").

responses, deterring investment in DACS and ultimately crippling 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.[363] The presence of concentrated local environmental impacts, or a substantial disconnect between those who enjoy a project's benefits and those who bear its costs, also may warrant a consent requirement.[364] In other circumstances, 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.[365] A government-led process is more likely to be impartial than a process driven by a developer, whose primary motivation for engagement is to advance a project.[366] A public authority, if perceived as a neutral player, can better foster the trust essential for meaningful and successful engagement.[367] All the same, government-run participatory processes may undermine trust if the government treats them as a mere formality or provides inadequate support.[368] As noted above, public hearings sometimes attract limited participation and frustrate those who do participate.[369] Where trust in local decision makers is lacking, engagement might be better carried out by a public entity independent of the permitting process.[370] Through recurring involvement in multiple DACS projects, entities specializing in engagement can build up public goodwill and develop expertise.[371]

France's National Commission for Public Debate (CNDP) offers one example of this approach.[372] The CNDP conducts public engagement on

[363] Scott-Buechler & Stewart, *supra* note 64, at 4.
[364] Fromherz, *supra* note 159, at 170.
[365] 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, at 2-3 (2023), https://www.regulations.gov/comment/DOE-HQ-2023-0054-0021.
[366] Nawaz et al., *supra* note 149, at 2; McLaren, *supra* note 137, at 354.
[367] Nawaz et al., *supra* note 149, at 2; McLaren, *supra* note 137, at 354.
[368] DIETZ & STERN, *supra* note 138, at 227.
[369] *See supra* text accompanying nn.181-182.
[370] Scott-Buechler et al., *supra* note 65, at 3; McLaren, *supra* note 137, at 354.
[371] Nawaz et al., *supra* note 149, at 2-3.
[372] Nawaz et al., *supra* note 149, at 3.

major projects with environmental impacts.[373] 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."[374] Public participation occurs early on, when a proposal still may be modified or abandoned.[375] After public consultations and in some cases public debates, the CNDP issues a report to which developers must respond.[376] Commission members must remain neutral and avoid expressing an opinion or position on proposed projects.[377]

The effectiveness of a neutral-led approach to public engagement, as exemplified by the CNDP, is uncertain. The CNDP process, which is not designed to culminate in a decision or consensus, adds an element of unpredictability.[378] Furthermore, the quality of engagement and extent of participation vary.[379] Some engagement efforts have stimulated keen public interest, whereas others have prompted minimal participation outside of groups already engaged in the decision making process.[380] A majority of project proposals have gone forward after CNDP consultation, usually with design modifications.[381] This outcome is somewhat comparable to the U.S. 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.[382] Unlike NEPA, however, which requires the government agency undertaking a proposed action to perform the analysis and public outreach, the CNDP process is run by an independent body with no substantive authority over final project 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

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[373] Nawaz et al., *supra* note 149, at 3; The CNDP, an Independent Entity, https://www.debatpublic.fr/en/cndp-independent-entity-1285.

[374] 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).

[375] The CNDP, an Independent Entity, https://www.debatpublic.fr/en/cndp-independent-entity-1285.

[376] *Id.*

[377] *Id.*

[378] Rose-Ackerman & Perroud, *supra* note 374, at 259; Tim Marshall, Learning from France: Using Public Deliberation to Tackle Infrastructure Planning Issues, at 13-14, https://radar.brookes.ac.uk/radar/file/b5856c9f-8b48-4e2e-a7d5-a08724a71a74/1/fulltext.pdf.

[379] Rose-Ackerman & Perroud, *supra* note 374, at 259.

[380] *Id.* at 259.

[381] Nawaz et al., *supra* note 149, at 3; Marshall, *supra* note 378, at 14.

[382] Fromherz, *supra* note 159, at 133-34.

invited to react or respond to already formed proposals. Community engagement also can take less hierarchical forms, however.[383] For instance, stakeholders and members of the public may jointly produce the informational foundation for decision making.[384] And rather than responding to developers' plans, communities may develop their own visions and strategies for decarbonization.[385] Bottom-up engagement also can take the form of protests, activism, and digital engagement.[386] Labor unions, community groups, regional institutions, and grassroots organizations can initiate and guide such efforts.[387]

Bottom-up engagement can enable exploration of community preferences before planning for a specific project has begun.[388] Communities that develop an interest in hosting DACS then can solicit proposals from project developers.[389] Once a project is proposed, the community can participate in information and engagement sessions before deciding how to proceed.[390]

A bottom-up approach can even involve community ownership of a DACS facility. 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.[391] Furthermore, policy makers generally look to the private sector to drive the innovation needed to develop economically and

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[383] Fritz et al., *supra* note 170, at 4.
[384] Fritz et al. at 13.
[385] Buck, *Mining*, *supra* note 90, at 1101.
[386] Chilvers et al., *supra* note 148, at 251-52 & Fig. 1; Fritz et al., *supra* note 170, at 4.
[387] Buck, *Mining*, *supra* note 90, at 1101; Chilvers et al., *supra* note 148, at 252.
[388] Scott-Buechler & Stewart, *supra* note 64, at 6.
[389] Huitema 1998, *supra* note 142, at [8].
[390] Huitema 1998, *supra* note 142, at 8.
[391] 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 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.

technically feasible carbon removal techniques.[392] Competition incentivizes private actors to take risks and develop less costly ways of delivering requested services.[393] Indeed, the main U.S. policy initiatives to promote DACS—tax credits and DOE funding for DAC hubs—establish powerful economic incentives for private innovation.[394] These government-directed technology initiatives aim to foster partnerships that rely on the private sector's technical knowledge and innovation skills.[395]

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.[396] 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.[397] 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.[398] Like sewer and solid waste disposal systems, carbon removal is a form of waste management.[399] These systems provide a public good and, in the U.S., are largely under public control.[400] Carbon removal is also a public good and could be managed similarly.[401] Public management would alleviate concerns that private entities would operate DACS facilities in a self-interested manner, disregard

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[392] AU IRCR, *supra* note 16, at 20, 23; *see also* McKinsey, Carbon Removals: How To Scale a New Gigaton Industry, at 34 (2023) (discussing cost-reducing CDR innovations by suppliers and developers).
[393] David Haarmeyer, *Environmental Infrastructure: An Evolving Public-Private Partnership*, *in* AMERICA'S WATER, *supra* note 391, at 23, 23; Nunzia Carbonara & Roberta Pellegrino, *The Role of Public Private Partnerships in Fostering Innovation*, 38 CONSTRUCTION MGMT. & ECON. 140, 143 (2020).
[394] *See supra* Part I.A.
[395] Lena Broggard, *Innovative Outcomes in Public-Private Innovation Partnerships: A Systematic Review of Empirical Evidence and Current Challenges*, 23 PUBLIC MGMT. REV. 135, 135-36 (2021) (describing such partnerships).
[396] Scott-Buechler et al., *supra* note 65, at 4 (reporting focus group participants' views that direct community oversight would make DAC projects fairer and safer).
[397] *See supra* Part II.C.2.b.
[398] Andrew Bergman et al., *Give Communities Control of Carbon Removal*, THE NEW REPUBLIC, Apr. 11, 2022.
[399] *Id.*
[400] *Id.*
[401] *Id.*

community impacts, or use DACS as an excuse to continue fossil fuel operations.[402] However, publicly managed waste disposal systems are hardly free from private domination or corruption, either.[403] The process of contracting with private companies to collect and manage solid waste can be vulnerable to bribery, fraud, and other forms of corruption.[404]

Public ownership *and* operation of DACS facilities—without private involvement—may be less susceptible to corruption.[405] In the U.S., most sewage treatment plants—also known as "*publicly owned* treatment works"—and water supply systems are locally owned and operated as pure public utilities.[406] 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 address local needs and benefit local communities.[407] 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.[408] The same is true for water supply systems, which are funded by a combination of customer revenues and federal and state grants.[409]

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[402] *Id.*; AU IRCR, *supra* note 16, at 23 (warning of danger that public funding for private CDR could "end up a boon to corporates" or "prolong[] . . . harmful industries.").
[403] Nancy Isarin et al., Basel Inst. on Governance, Case Studies on Corruption in Waste Management and Trade, at 27 (2023), https://baselgovernance.org/sites/default/files/2023-11/231130_WP-49.pdf (discussing corruption risks surrounding public procurement processes for waste management).
[404] *Id.*
[405] *Cf.* AU IRCR, *supra* note 16, at 23 (advocating public development, operation, and ownership of CDR facilities and infrastructure); Bergman et al., *supra* note 398 (advocating ownership of CDR facilities by government or local communities); *but cf.* Frederic Boehm et al., *Privatization and Corruption*, *in* LIMITS TO PRIVATIZATION: HOW TO AVOID TOO MUCH OF A GOOD THING 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).
[406] GAO, Private Water Utilities: Actions Needed to Enhance Ownership Data 8 (2021) (noting estimate that almost 80% of U.S. population receives drinking water from community water systems owned by local government utilities); CISA, Water and Wastewater Systems, https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors/water-and-wastewater-sector (noting that 75% of U.S. population is served by publicly owned wastewater treatment systems); National Research Council, Privatization of Water Services in the United States 14 (2002).
[407] 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).
[408] National Research Council, *supra* note 406, at 35-36.
[409] NRC at 38.

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, control of which is centered at a national rather than local level.[410] However, because these facilities have significant local impacts, local communities 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 well-established techniques.[411] While further innovation may make these systems more effective, involvement of the private sector in their operation does not have innovation as a primary goal.[412] 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.[413] To be sure, reliance on the private sector to drive innovation is not without pitfalls. Such an approach can favor more commercially viable technologies and lock them in, to the detriment of more transformational technologies that might subsequently become available.[414] Nonetheless, the private sector's comparative advantage at innovating argues

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[410] 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 (discussing New York's Climate Change Superfund Act, which mandates payments by companies responsible for past carbon emissions).

[411] NRC at 35-37 (discussing widely used sewage treatment methods); GAO, *supra* note 406, at 6-7 (discussing drinking water collection and treatment methods).

[412] *Cf.* Broggard, *supra* note 395, 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. GAO, *supra* note 406, at 8-9.

[413] Meyer, *supra* note 16.

[414] AU IRCR, *supra* note 16, 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 MANAGEMENT, 2292111, at 4, 15 (2023).

in favor of a significant private role in CDR development and deployment—but subject to public oversight and control.[415]

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 in the hands of communities risks a failure to account adequately for global and national interests in carbon removal.

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Community engagement is essential for DACS projects and can be driven by developers, the government, publicly funded bodies, or communities themselves. Developer-driven engagement, which is most common, is challenging to do in a way that respects communities and responds to their concerns. Nevertheless, early, proactive, and continuous engagement efforts by developers can establish ongoing relationships with communities and promote cooperation in shaping projects that advance societal goals and respond to community concerns. Government-led engagement offers a seemingly more neutral approach but may likewise struggle to attract deep community involvement, particularly if community trust is lacking. Incorporating an independent, publicly funded body to conduct engagement may help build the trust needed for effective engagement. Alternatively, bottom-up approaches may maximize engagement opportunities and community influence but are relatively unproven. Regardless of the approach taken, policymakers, stakeholders, and participants in community 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 develop and 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. Project level engagement runs

[415] *Cf.* Grubert & Talati¸ *supra* note 414, 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).

the risk of functioning as a public relations exercise or limiting itself to standardized bureaucratic processes. Community engagement on DACS projects must involve outreach to potentially affected communities, deliberative discussions, and meaningful responses to community concerns.