RESEARCH ARTICLE

# Climate Justice Futures: Carbon Management Risks and Alternatives

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## ABSTRACT

Environmental justice (EJ) communities, often overburdened by generations of disproportionate pollution, have long called for a transformative climate mitigation agenda focused on climate justice. However, "carbon management" approaches have become increasingly popular in U.S. climate policies, despite opposition from EJ organizations who cite their risks. Factors contributing to this ascendancy of carbon management approaches include: (1) fossil fuel industry influence, (2) climate modeling's reliance on carbon management in mitigation scenarios, and (3) federal agencies serving as catalytic investors. These factors are shaped by new political and legal mandates that promote investments and constrain oversight by federal agencies. The drivers raise EJ concerns and deflect resources from alternatives to carbon management and more just mitigation pathways. While forms of support for carbon management may shift with an administration change, the drivers analyzed have created policy and economic momentum, and EJ risks will likely persist around the projects and investments already underway.

## CLIMATE JUSTICE FUTURES

Debates on how to combat climate change focus on the urgency of the climate crisis and the need to respond quickly to avert irreversible climate impacts. Meanwhile, the most vulnerable and least responsible communities around the globe suffer the impacts of climate change, pollution, and economic inequality. Environmental justice (EJ) communities, many of which are overburdened by generations of disproportionate pollution and intersecting systems of inequality, have long called for a more transformative and ambitious climate mitigation agenda focused on climate justice.[1] These communities endure substantial environmental health impacts and disparities, given the mutually exacerbating, compounding effects of social

[1] In this article, the term EJ community refers to low-income communities and communities of color. This is consistent with the definition of an EJ community that was adopted by the Equitable and Just National Climate Platform for the purposes of achieving mandatory emissions reductions in climate mitigation policies. That definition specifies: "An EJ community is a census tract or census block group: whose percentage of color population is equal to or greater than the average percentage of color population in the state; or whose percentage of population households living at or below twice the federal poverty level is equal to or greater than the state's percentage of population households living at or below twice the federal poverty level" (Equitable and Just National Climate Forum, 2021).

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disadvantage combined with higher exposures to noxious land uses and pollution sources and other hazards (Morello-Frosch et al., 2011).

This climate justice vision has a long history, reflected in the 2002 Bali Principles of Climate Justice (International Climate Justice Network, 2002), the 2008 Environmental Justice Leadership Forum on Climate Change (Environmental Justice Leadership Forum on Climate Change, 2008), the 2013 formation of the National Climate Justice Alliance (https://climatejusticealliance.org/), and in 2018 the Equitable and Just National Climate Platform (https://ajustclimate.org). Frontline EJ organizations and marginalized communities worldwide have called for a rapid transition away from an extractive fossil fuel–based economy, toward a regenerative, just, and democratic economic system. These groups have variously articulated policies for pollution-free, renewable energy futures that provide an alternative to industrial carbon management approaches that are ascendant. To achieve transformative climate justice goals, these alternatives must be prioritized over carbon management approaches currently being promoted in U.S. climate mitigation policies.

#### Climate Mitigation Pathways Past and Present

A wide range of climate mitigation pathways aim to decarbonize the economy on a trajectory to reach the Paris Agreement goal of 1.5 degrees Celsius above preindustrial levels (United Nations Climate Change, n.d.). The specific policies and timelines used to meet climate goals vary greatly. The Biden-Harris administration pledged to reduce greenhouse gas emissions 50–52% below 2005 levels by 2030, achieve 100% carbon-free electricity by 2035, and achieve net zero emissions by 2050 (The White House, 2021). At the subnational level, states also propose diverse climate mitigation targets and policies to achieve these goals, from renewable portfolio standards to carbon trading systems. Among these climate mitigation plans, questions of equity and justice are often relegated to discussions focused on the distribution of climate investments (National Caucus of Environmental Legislators, 2023). Meanwhile, distributional considerations and responsibility for historical emissions are obscured by the "net" of net zero goals (Khosla et al., 2023). Climate mitigation policies rarely embed equity goals into the mechanisms for drawing down carbon emissions and delivering multiple mitigation benefits.

The most ambitious climate mitigation goals seek a rapid and complete transition away from fossil fuels. Yet some climate mitigation pathways can extend the use of fossil fuels (Gürsan & de Gooyert, 2021) and may fail to reduce or even increase locally harmful emissions. In the 1990s and early 2000s, policymakers and industries drove the narrative that natural gas was a necessary "bridge" fuel that would help economies transition from coal to renewable energy sources (International Energy Agency, 2011; Lin, 2016). In the decades since the shift to natural gas, there is evidence that this bridge became a roadblock, slowing down the renewable energy transition and extending the life of fossil fuels in the global economy (As You Sow & Energy Innovation, 2020; Brauers, 2022; Howarth, 2014; Kemfert et al., 2022). U.S. policymakers' more recent articulations of climate mitigation strategies have included the Clean Power Plan (2015) (U.S. Environmental Protection Agency [EPA], n.d.); carbon trading systems such as the Northeast's Regional Greenhouse Gas Initiative (RGGI); carbon pricing proposals such as the Energy Innovation and Carbon Dividend Act (2018) (Kaufman, 2018); and clean energy standard proposals such as the CLEAN Future Act (CLEAN Future Act, 2021). These climate mitigation pathways largely focus on ways to incentivize decarbonization using market-based mechanisms with minimal attention to equity.

In June 2021, several EJ groups submitted a letter to congressional leaders debating a national climate bill. The letter urged the adoption of pollution-free renewable energy

standards as one component of a national climate agenda (Center for Earth, Energy and Democracy [CEED] et al., 2021). This vision included ambitious targets supported by significant public investments similar to those implemented in the Inflation Reduction Act (IRA, 2022):

> A pollution-free renewable energy standard would, or at least could, include or incentivize solar energy, wind power, tidal power, low-impact hydro projects and energy efficiency (EE). The standard should encourage the diversification of power sources in our electricity system and the timeline for achieving 100% pollution-free energy should be ambitious; no later than 2050 with an aggressive benchmark of 80% by 2030. (CEED et al., 2021, p. 2)

The pursuit of a federal clean energy standard such as through the CLEAN Future Act or other renewable energy standard was ultimately replaced with a pivot toward investment-focused policies, including the Infrastructure Investment and Jobs Act (IIJA, 2021) and the IRA (2022). These policies cemented a new climate mitigation approach emphasizing investments across a spectrum of energy and climate programs, totaling over $400 billion, including investments in carbon management technologies such as carbon capture and sequestration (CCS) (McKinsey, 2022). These historic federal investments elevated carbon management alongside renewables like wind and solar in a new national climate agenda (U.S. Department of the Treasury, n.d.).

Carbon management is an umbrella term often used to describe a suite of technologies that remove carbon dioxide from point sources and the atmosphere for permanent storage or use in other industries (White House Environmental Justice Advisory Council [WHEJAC], 2023).[2] Carbon management became a new version of the "bridge" narrative that framed carbon management as a necessary stepping stone to net zero or decarbonization targets. These policies catalyzed the deployment of carbon management through significant federal spending such as tax subsidies in the USE IT Act, which extended the 45Q tax credit for CCS (USE IT Act, 2019).[3] This turn toward carbon management in climate mitigation presents significant risks to EJ and climate justice goals. There are important insights from the natural gas bridge narrative of the past that can be applied to carbon management narratives today, including the harms that re-entrenchment of fossil fuel infrastructures can inflict on already overburdened EJ communities that are discussed further in this article.

## ENVIRONMENTAL JUSTICE CONCERNS WITH INDUSTRIAL CARBON MANAGEMENT

As the Intergovernmental Panel on Climate Change (IPCC) describes, carbon management approaches can have adverse socioeconomic and environmental impacts (IPCC, 2022, p. 49), and technologies like CCS/CCUS have low mitigation potential and high costs relative to renewables even before considering environmental and public health externalities (IPCC, 2022, p. 51). Two major carbon management examples include CCS and hydrogen fuels for industrial applications (e.g., chemical manufacturing, power plants and power generation, and

[2] The WHEJAC carbon management report (2023, p. 5) lists the following under the carbon management term: CCS, carbon capture, utilization and sequestration (CCUS); bioenergy with carbon capture and sequestration (BECCS); biochar, hydrogen fuels, direct air capture (DAC); blue carbon, renewable natural gas (RNG); and so on.

[3] Established in 2008, 45Q is a tax credit for $CO_2$ sequestration to incentivize carbon capture and sequestration. It can be applied to $CO_2$ that is geologically sequestered and $CO_2$ used for enhanced oil recovery (Congressional Research Service [CRS], 2023).

other industrial facilities). Here, we summarize several of the key EJ concerns and risks that arise along the various stages of their deployment.[4]

First, various environmental and health risks are introduced during $CO_2$ capture, as the most commonly used method for capture relies on amine-based solvents to facilitate the chemical absorption of $CO_2$ (Chai et al., 2022). Amine solvents are potential carcinogens (European Environment Agency [EEA], 2011, p. 70), and one of the most commonly used amines for $CO_2$ separation has a toxicity comparable to that of cyanide (Supekar & Skerlos, 2015; Veltman et al., 2010). Risks arise from the disposal of amine-based solvents (Anderson & Saunders, 2022; Chen et al., 2018; Fostås et al., 2011). Another concern at the point of capture is the potential for co-pollutant emissions, such as $NO_x$, given the additional energy required to power the capture process, otherwise known as the energy penalty (Aghel et al., 2022; EEA, 2011; Wang et al., 2022).[5] There are also risks associated with the transport of $CO_2$ via pipelines, such as $CO_2$ leakage or ruptures that can harm nearby communities (see, e.g., Simon, 2023). In the long term, stored $CO_2$ can also leak (Hauber, 2023; Williamson, 2023) and impact sources of drinking water (Alcalde et al., 2018; Gholami et al., 2021; Koornneef et al., 2012).

For hydrogen fuels, both hydrogen deployment and combustion present risks to EJ communities. Hydrogen produced using fossil fuels will include all the risks associated with fossil fuel extraction, production, transport, and storage, such as air and water pollution and health risks (Donaghy et al., 2023). It also presents risks of methane and hydrogen leakage along the hydrogen life cycle (Burns & Grubert, 2021; Lockman, 2023; Ocko & Hamburg, 2022), and pipeline explosions during transport (Kuprewicz, 2022). Notably, the majority of hydrogen produced today is fossil-based hydrogen (International Energy Agency, 2019, p. 203). Even if hydrogen production were paired with carbon capture, producing so-called blue hydrogen, researchers have shown that such hydrogen would still be extremely greenhouse gas (GHG)-intensive (Howarth & Jacobson, 2021). Importantly, all the aforementioned risks around carbon capture would still apply. The deployment of "green hydrogen," which uses renewable energy sources to separate hydrogen from water in a process called electrolysis (Yu et al., 2021), has significant water and energy demands (International Renewable Energy Agency, 2020; Shi et al., 2020). Moreover, regardless of how the hydrogen is produced, the transport of hydrogen entails significant risks to surrounding communities, such as pipeline explosions and leakage of hydrogen, which is highly flammable and ignites at a low temperature (Kuprewicz, 2022).

Industrial and power generation facilities and infrastructure are currently disproportionately sited in EJ communities (Cushing et al., 2023; Donaghy et al., 2023; Tessum et al., 2021). This suggests that future CCS and hydrogen projects located in these facilities may follow a similar pattern. For example, an analysis of proposed CCS projects in the power generation sector found that the overwhelming majority of them will be sited in EJ communities, disproportionately exposing these communities to the aforementioned risks (Tishman Environment and Design Center [TEDC], 2023a). We have documented these risks in more detail elsewhere (TEDC et al., 2023, 2024).

[4] We use the term carbon management as an umbrella term that encompasses a range of technologies used to capture, store, transport, and use $CO_2$ emissions from industrial and power sector facilities as well as to remove $CO_2$ from the atmosphere directly. This is also sometimes referred to as "industrial carbon management" defined by the EU as "the range of technologies to capture, store, transport and use $CO_2$ emissions from industrial and energy production facilities, as well as to remove $CO_2$ from the atmosphere" (European Commission, n.d.).

[5] Co-pollutants is a term often ascribed to air pollutant emissions that are typically emitted along with carbon dioxide emissions at point sources. These air pollutants can include criteria air pollutants: $NO_x$, $SO_x$, CO, PM, Pb, ozone as well as other air pollutants like hazardous air pollutants (i.e., benzene, mercury, etc.) that are detrimental to human health (Ash et al., 2009).

Disconcertingly, these risk-scapes are heightened by a deficient regulatory environment for all stages of the carbon capture and hydrogen deployment process (Commission Shift, 2021; CRS, 2024; Earthjustice, n.d.). A prominent example of how current regulatory frameworks fail to adequately address EJ concerns related to the risks of carbon management can be noted in the EPA's 2023 proposed power sector rule (EPA, 2023b). Despite acknowledging their potential to increase co-pollutant emissions, the agency proposed to use CCS and hydrogen cofiring as best systems of emissions reduction (BSER) at existing coal and existing and new natural gas plants (TEDC et al., 2023).[6] Adding to these concerns, current $NO_x$ standards for new gas plants have not been reviewed since 2006 and do not provide sufficiently protective emission limits for communities exposed to their air pollution (Mindock, 2023). But the 2023 proposed rule and the 2024 final rule promulgated assert that EJ concerns can be largely addressed through "meaningful engagement" of communities in the state implementation process and that any pollution resulting from the implementation of the BSER can be addressed by other Clean Air Act (1963) rules (i.e., EPA's New Source Review [NSR]) which may trigger sources to install emission control technologies (EPA, 2023b, p. 33413; 2024b, p. 39804). However, rules like NSR may not prevent higher levels of co-pollutant emissions because these retrofits are not triggered until a certain emissions threshold is reached (EPA, 2015). From an EJ perspective, imposing any additional pollution burden on already overburdened communities is unacceptable.

$CO_2$ and hydrogen transport and storage have similarly deficient regulatory environments. The risks of $CO_2$ transport are compounded by the lack of uniform siting authority for pipelines (Public Sector Consultants, 2023) and the absence of strong, comprehensive, or up-to-date pipeline safety regulations from the Pipeline and Hazardous Materials Safety Administration (PHMSA) (Pipeline Safety Trust, n.d.). While the rulemaking is still pending for $CO_2$ pipeline safety standards, recent $CO_2$ pipeline ruptures in Mississippi and Louisiana highlight the dangers of these regulatory gaps (Baurick, 2024; U.S. Department of Transportation, 2022) and of projected expansion of $CO_2$ pipelines (Fahs et al., 2023).

Hydrogen transport presents similar safety, environmental, and public health concerns (Kuprewicz, 2022). Because pipeline infrastructure is often located in communities with higher social vulnerability, these deficiencies are likely to impact EJ populations (Emanuel et al., 2021; Strube et al., 2021; Weller et al., 2022). The regulatory environment for $CO_2$ storage also presents challenges for EJ communities because these rules are poorly developed and the risks are not fully characterized (Lane et al., 2021). Further, the EPA has granted some states with a history of weak environmental regulation primacy over well permitting, such as Louisiana (Earthjustice, n.d.; EPA, 2024c).

## DRIVERS OF CARBON MANAGEMENT APPROACHES AND ENVIRONMENTAL JUSTICE CONCERNS

The IPCC warns that an overreliance on carbon dioxide removal (CDR) and large-scale deployment of CDR comes with inherent risks to meet ambitious mitigation targets:

> CDR deployed at scale is unproven, and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with a particularly strong emphasis on energy efficiency and low demand. (IPCC, 2018)

[6] See also Cellek and Pınarbaşı (2018) and McNamara (2020), who have pointed out that for the application of hydrogen fuels to the power sector in particular, co-firing hydrogen in natural gas plants results in higher levels of $NO_x$ compared to combusting natural gas on its own.

It further warns that CCS and CCUS applied to fossil $CO_2$ is not even considered CDR for climate mitigation. Stating CCS/CCUS "can only be part of CDR methods if the $CO_2$ is biogenic or directly captured from ambient air, and stored durably in geological reservoirs or products" (IPCC, 2022, p. 127).

Despite this, the United States continues to invest heavily in carbon management technologies through Department of Treasury tax credits like Sections 45Q and 45V of the Internal Revenue Code (2022), as well as through direct investments originating largely from the U.S. Department of Energy's (DOE) Office of Clean Energy Demonstrations (OCED) and Fossil Energy and Carbon Management Office. The ascendency of carbon management approaches in national climate mitigation policies is due to several factors, including: (1) fossil fuel industry influencing, (2) climate modeling promoting carbon management in mitigation scenarios, and (3) federal agencies serving as catalytic investors. These factors are also shaped by current political and legal mandates that promote investments and constrain oversight powers by federal agencies. For example, climate laws like the IRA include mandates for federal investment in technologies and fuels like hydrogen and CCS, to incentivize the widespread adoption and scaling up of these approaches. At the same time, recent Supreme Court rulings limit the ability of federal agencies, such as the EPA, to exercise their oversight powers (Lindwall, 2024). In particular, the Court's 2024 decision in the case of *Loper Bright Enterprises v. Raimondo* reduces judicial deference to government agencies in their interpretation and execution of laws, bestowing more power to federal judges and shrinking the ability of regulatory bodies like the EPA to establish rules and environmental protections (Lindwall, 2024; *Loper Bright Enterprises v. Raimondo*, 2024).

#### Fossil Fuel Industry Influence

Fossil fuel industries are actively shaping an energy transition agenda that accommodates the extended use of fossil infrastructures beyond what current climate goals would dictate (Earthjustice, 2023; Halper, 2022; Kusnetz, 2021; Si et al., 2023). These companies are drivers of climate change and major contributors to disproportionate pollution burdens in EJ communities (Boyce & Pastor, 2013; Cushing et al., 2023; Tessum et al., 2021). They are also key industry players and beneficiaries of carbon management investments, and their outsized influence in climate policy presents challenges to EJ communities. Several studies have also demonstrated the colocation of EJ communities and actual or planned carbon management infrastructure. For example, $CO_2$ pipelines, $CO_2$ geologic storage sites, and power plants or industries are located in areas where CCS has been implemented or planned (Schooley et al., 2024; TEDC, 2023a, 2024). Other studies have demonstrated how carbon management strategies such as CCUS could perpetuate fossil fuel use and continue to produce health-harming pollution for nearby EJ communities (see, e.g., Donaghy et al., 2023; Stephens, 2014). Another study used scenarios to model emissions based for CCS power sector retrofits, which factor in the 45Q tax credit found that in some cases. Due to the economics, the installation of CCS could prompt power plants to run for a longer lifespan, contributing to increased emissions (Grubert & Sawyer, 2023).

Fossil fuel firms are also the biggest beneficiaries of federal tax incentives and subsidies to support carbon management approaches like CCS (Center for International Environmental Law, 2021; George, 2020; Oil Change International, 2017). For example, Occidental Petroleum was one of the top beneficiaries of the 45Q tax credit in 2022, receiving over $148 million for enhanced oil recovery projects tied to their operations (Environmental Integrity Project, 2023). The Congressional Budget Office (CBO) has projected that for CCS alone,

appropriations total over $8 billion from 2023 to 2026 and $5 billion in tax credits from 2023 to 2027, allocated largely to fossil fuel firms (CBO, 2023). The fossil fuel industry has backed efforts to garner support for CCS, including awarding funding to universities and research centers to conduct CCS research and advocacy (McKenna, 2024), endorsing pro-CCS bills (Carbon Capture Coalition, 2023), and supporting legislators who are CCS champions (Drugmand, 2023; OpenSecrets, 2024).

The influence of fossil fuel firms in promoting carbon management risks further entrenching fossil fuel interests and infrastructure that disproportionately harm EJ communities. This could lead to firms using carbon management to portray their activities as "clean," "carbon neutral," or "low carbon," when in fact they are not and instead extend the life of fossil fuel infrastructure and delay the transition to truly renewable energy sources that can benefit EJ communities and the broader public (Earthjustice, 2023).

#### Climate Models Promote Carbon Management in Climate Mitigation Policies

Policymakers often look to climate models (see, e.g., Evolved Energy Research, 2022; Rhodium Group, 2025) to understand the impact of different climate mitigation policies and use modeling scenarios to make a case for particular policy approaches. However, climate models are laden with economic and technological performance assumptions that do not typically account for equity or EJ concerns (Clean Energy States Alliance, 2023; Rubiano Rivadeneira & Carton, 2022). Rather than prioritize climate mitigation in EJ communities, they are primarily designed to identify least-cost pathways (i.e., they are market-driven models) (Rubiano Rivadeneira & Carton, 2022). Although it is beyond the scope of this article to suggest specific modifications that may or may not even be possible with the modeling capabilities available, the important broader point here is the problematic nature of overreliance on modeling as a decision-making tool, which already has clear known deficiencies with respect to EJ considerations.

Several public and private sector institutions have focused on modeling the implementation of key policies, including the Inflation Reduction Act (2022) and the EPA's GHG (greenhouse gas) Rule (2023b), to explore the impacts of these policies on projected climate targets. For example, the EPA uses the National Electric Energy Data System (NEEDS) database to construct the "model" plants that represent existing and planned/committed units, and then utilizes this set of plants in its Integrated Planning Model (IPM) (EPA, 2024a). The EPA's recent round of modeling that is based on IPM has been updated with a reference case that includes the IRA provisions reflecting supply-side impacts, the proposed Good Neighbor Plan (GNP),[7] and other on-the-books federal and state rules.[8] The modeling fails to account for potential negative, localized public health impacts such as air pollution from co-pollutant emissions of carbon management deployment at specific facilities. This oversight is a chief EJ concern, as the

[7] The GNP proposed in February 2022 was a federal regulatory measure to address ozone-forming emissions of $NO_x$ from power plants that would affect downwind states. The final GNP was issued in March 2023 (EPA, 2022, 2023a).

[8] The IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides projections of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. The IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide ($SO_2$), nitrogen oxides ($NO_x$), carbon dioxide ($CO_2$), hydrogen chloride (HCl), and mercury (Hg) from the electric power sector. Generation facility information is available in NEEDS for EPA Post-IRA 2022 Reference Case: rev: 10-14-22 (xlsx) (3.74 MB), https://www.epa.gov/power-sector-modeling/post-ira-2022-reference-case.

imposition of additional burdens in any measure on communities already facing disproportionate and cumulative impacts is unacceptable.

An additional concern is that these models embed assumptions about the costs, application, and performance of carbon management technologies like CCS and hydrogen fuels. For example, EPA's IPM model assumed a carbon capture rate of 90% at natural gas combined cycle combustion turbines, despite such rates never being demonstrated at scale (see, e.g., EPA, 2023a, Chapter 6). These models can promote idealized assumptions about the performance of carbon management technologies for carbon dioxide reductions, without weighing the potential for negative, localized impacts.

Climate modeling can inform climate policymaking and has been used to justify the adoption of carbon management investments without much attention to potential shortcomings or EJ concerns related to these strategies. For example, the Biden-Harris administration, in its fact sheet on the IRA, cites a study[9] reviewing several climate models to make the following statement:

> [T]he United States is now on a path to achieve President Biden's ambitious goal of cutting emissions 50–52 percent below 2005 levels by 2030 and reaching net-zero emissions by no later than 2050. This is consistent with external researchers, who project that US greenhouse gas emissions will fall 43–48 percent below 2005 levels by 2035 thanks to laws already on the books. (The White House, 2023)[10]

The ZERO Lab at Princeton University and Evolved Energy's REPEAT study was also used to inform the IIJA and IRA, with *The Wall Street Journal* deeming the influence of university researchers on how the federal government was spending billions of dollars as "an outsized role" (Patterson, 2023). A publication of the Institute of Electrical and Electronics Engineers described the research team's operation of a "climate-modeling war room that provided rapid-fire analyses of the likely effects of shifting investments among a smorgasbord of clean-energy technologies," with policymakers using the modeling results to promote their agendas (Fairley, 2023).

#### Federal Agencies as Catalytic Investors in Carbon Management

Compounding the influence of the fossil fuel industry and the use of models to justify the deployment of carbon management approaches, the federal government is catalyzing unprecedented investment in these technologies. Congress has passed bills that funnel investments into carbon management, mandating agencies like DOE and the Department of Treasury to play major roles in executing on those investments. One example is the USE IT Act, mentioned earlier in this article, that extended the 45Q CCS tax credit. These laws facilitate the allocation of major public funding that agencies are then required to distribute, even if evidence shows that other technologies may be more effective at climate mitigation or have fewer negative outcomes for EJ communities. While DOE has invested in carbon management technologies

[9] See Bistline et al. (2023).

[10] Among the specific carbon management investments in the IRA is the significant expansion of the 45Q tax credit for CCS, which is projected to cost taxpayers nearly $5 billion over the next 5 years (Taxpayers for Common Sense, n.d.). More details on how CCS operations and related technologies can contribute to EJ externalities are described in the WHEJAC Carbon Management Working Group recommendations (WHEJAC, 2023, 2024).

for several decades, the agency under the Biden-Harris administration exponentially increased efforts to launch catalytic investment in the sector. In addition to the DOE, the Department of Treasury has also scaled their efforts, estimating a 45Q tax expenditure of $30.3 billion from 2022 to 2032 (CRS, 2023). Its 45V tax credit aims to create a 10-year incentive of up to $3.00/kg for the production of "clean hydrogen" (DOE, 2023). While Congress continues to allocate significant funding to DOE, the Supreme Court is dismantling regulatory agencies' power, undermining their ability to effectively oversee the implementation of carbon management projects and protect communities. Its 2022 decision in *West Virginia v. EPA* held that EPA could not direct power plants to transition to cleaner sources of energy (Turrentine, 2022), while its fateful June 2024 decision in *Loper Bright Enterprises v. Raimondo* overturned the Chevron doctrine, which had previously afforded judicial deference to agencies' interpretation of laws (Howe, 2024).

The juxtaposition of supercharged investment and debilitated regulatory capacity creates enormous peril for environmental justice. As described above, the regulatory environment is ill-suited to overseeing the implementation of carbon management at a large scale and protecting communities from the numerous risks that arise at every stage of deployment. There is already ample evidence that existing environmental laws and regulations do not adequately protect EJ and other disadvantaged communities from long-standing sources of pollution, as evidenced by the significant health disparities (Boyce & Pastor, 2013; Clark et al., 2014; Tessum et al., 2021) and cumulative impacts (Lam et al., 2022; Miranda et al., 2011; Morello-Frosch et al., 2011) that these communities face. With the ascendancy of carbon management technologies, whose risks are not fully known or accounted for (WHEJAC, 2023), there are many unanswered and concerning questions about how public health and local EJ concerns will be safeguarded. The situation is now exacerbated by the *Loper* decision and the continued push by DOE to achieve commercial "lift off" of carbon management technologies (DOE, n.d.-b). The government's role as an investor in, rather than as a regulator of, carbon management, leaves EJ concerns to the periphery of or even at odds with the mission to rapidly deploy these technologies.

#### *Federal Financing for Carbon Management and Opportunity Costs for Climate Justice*

The significant public financing of carbon management by the DOE and Treasury tax credits presents several challenges for EJ and climate justice. One of the most significant equity concerns related to these investments is that they represent an opportunity cost, deflecting much-needed public financing from climate justice alternatives required for EJ communities to have a just transition. The second problem with this type of federal investment is the designation of the funding as a fulfillment of Justice40 mandates.[11] This means that disadvantaged EJ communities are targeted for carbon management projects that communities themselves may oppose, and that comes with an accompanying set of risks and potential long-term impacts. Several EJ organizations and the WHEJAC (2021) have registered their opposition to the designation of carbon management projects as a means of fulfilling the Justice40 mandate (Baptista & Johnson, 2023; EJLF, 2022; TEDC, 2023b).

Significant federal spending on carbon management projects has also been flagged for a lack of oversight and accountability, including oversight of the technical risks of project failure

[11] Justice40 is a federal initiative implemented by the Biden administration to designate 40% of the benefits from climate and energy programs to disadvantaged communities (https://www.whitehouse.gov/environmentaljustice/justice40/).

(U.S. Government Accountability Office [GAO], 2024). These risks may harm EJ communities where projects are proposed and produce stranded assets, should they fail, which can further blight disadvantaged communities or contribute to existing cumulative impacts. In 2020, the U.S. Treasury Inspector General for Tax Administration (TIGTA) found fossil fuel companies improperly claimed nearly $1 billion in clean air tax credits (George, 2020). A 2024 GAO report on DOE's carbon capture programs found that "the DOE office that handled nearly 70% of funding didn't always follow guidance on reducing project risks when selecting and managing projects. This is crucial given the $12 billion DOE will dispense for carbon capture projects in coming years" (GAO, 2024). Federal funding of carbon management also represents opportunity costs that could produce tangible benefits for EJ communities, such as investments in renewable energy that can have a more positive trajectory in terms of efficacy, lowering costs, and penetration over time (Ulterino, 2012). The IPCC's *Sixth Assessment Report* found that wind and solar both had a much higher $CO_2$ mitigation potential and lower cost compared to CCS (IPCC, 2022) and thus represented a more secure and just pathway for climate mitigation, stating that "Other technologies show mostly positive mitigation costs, the highest mitigation costs are for CCS and bioelectricity with CCS, (for details see Supplementary Material 12.SM.1.2.)" (IPCC, 2022, p. 1265). Costs include social costs that account for externalities related to greenhouse gas emissions and "positive mitigation costs" means the costs are higher than the benefits (IPCC, 2022).

***DOE's Carbon Management Funding Lacks EJ Guardrails***

There is currently no mandate for EJ communities to substantively weigh in and make determinative contributions to DOE's carbon management investments. While DOE requires Community Benefit Plans (CBP) for a range of carbon management projects, these CBPs lack basic information about the EJ risks and uncertainties related to proposed projects (DOE, n.d.-a). These CBPs are focused almost entirely on workforce and economic development opportunities and lack an independent analysis or review of the potential harms to disadvantaged host communities. Some EJ advocates describe CBPs and related community benefit agreements as coercive tools to perversely cast carbon management investments as Justice40 benefits, and to co-opt and deflect opposition or questions raised during the project's early phases around risks, safety, and better alternatives (see, e.g., New Jersey Environmental Justice Alliance [NJEJA], 2024). As pointed out by the Initiative for Energy Justice (2024):

> It remains unclear how public accountability mechanisms will be incorporated into the DOE CBP process. ... This lack of transparency appears to leave enforcement of the details of the CBP in the hands of the DOE, as the CBP is not a legally binding agreement itself, but part of a developer's funding application. (p. 20)

In addition to the CBPs, the OCED often uses "go/no-go" to describe decision points in their project process, most commonly associated with investment and funding decision points, since funding is typically allocated in phases. DOE describes this process in the following manner:

> OCED's phased approach to projects incorporates well-established principles employed by government and the private sector. From conceptual design through construction and operations, each phase includes integrated stages and checks. Funding will be released in tranches and projects must past investment "go/no-go" decision points prior to receiving the next tranche of funding. (OCED, n.d.)

There is no documentation detailing exactly how communities can intervene during "go/no-go" points in the project or how community opposition factors into DOE funding approvals (NJEJA, 2024; OCED, 2024). There is also no clear set of guidelines that describe when projects are technically "ready" to move to the next phase. Federal agencies like DOE are tasked with driving carbon management projects to "lift off" utilizing significant public investments. There are few tangible safeguards to protect already overburdened, disadvantaged EJ communities. There is no commitment that a project will be stopped if a community objects or contributions to cumulative risks to local communities are unacceptable.

While the National Environmental Policy Act of 1969 (NEPA, 1970) imposes a legal requirement on federal agencies, including DOE, to undertake assessments of potential impacts and prepare Environmental Impact Statements (EISs) prior to their actions (NEPA, 1970) there is considerable concern as to whether EISs will be required for carbon management and whether the full scope of public participation and engagement will be realized within the NEPA regulatory framework, which has been undergoing recent revisions (WHEJAC, 2024). Such concerns stem from the government's emphasis on expediting federal permitting and accelerating environmental reviews, the broader use of categorical exclusions from full NEPA reviews, and certain "costs and timeframe" limitations on gathering information to determine whether an EIS is needed (WHEJAC, 2024). The WHEJAC issued multiple NEPA-specific recommendations in its October 2024 report on carbon management, such as requiring an EIS for all carbon management projects sited in overburdened, disadvantaged EJ communities, and requiring federal agencies involved in NEPA for carbon management projects to establish Community Advisory Groups and provide Technical Assistance Grants to allow communities to hire independent experts for the NEPA process (WHEJAC, 2024). As of the writing of this article, the government's compliance with these or any of the other WHJAC NEPA recommendations has yet to be shown. It remains to be seen how the new 2025 federal administration will approach carbon management. Moreover, it also remains to be seen the extent to which the new administration will uphold environmental justice, environmental regulations, and public health protections more broadly. The risks and concerns described above will likely remain highly relevant, as significant momentum has already been generated for carbon management projects and approaches and it is important to understand the drivers that have led to this point. Moreover, to the extent that fossil fuel companies, who have advocated for and benefited from carbon management investments, are in favor by the new administration, policies promoting carbon management are likely to persist in some form.

## CLIMATE JUSTICE POLICY PATHWAYS AND FUTURES

Climate change mitigation policy can significantly change the social and physical infrastructure of our society. However, if we develop and implement it in a "business as usual manner" it also has the ability, and perhaps the likelihood of perpetuating or exacerbating inequalities that are rooted in race and income. To ensure that climate change mitigation policy helps to create a more just society, there must also be a transformation of the energy sector, such as through moving away from our current fossil fuel energy production systems and their attendant infrastructures.

Despite the ascendancy of carbon management, there is still ample opportunity for creatively advancing an ambitious, multipronged approach to achieving climate and environmental justice mitigation goals. Many climate mitigation pathways that EJ advocates propose have

multiple positive impacts on public health, economic justice, and ecological sustainability. Some of these proposals are already being implemented at the subnational level, along with federal bills that continue to be introduced. The following represent a few examples of climate and environmental justice policies that can be considered for achieving a just climate mitigation pathway:

1. Environmental justice and cumulative impacts policies that mandate consideration of EJ in agency decision-making (A. Donald McEachin Environmental Justice For All Act, 2023; NJ Environmental Justice Law, 2020)
2. Targeted investments in renewable energy systems such as solar, wind, micro-grids, and battery storage in EJ communities (Climate Leadership and Community Protection Act, 2019)
3. Policies that promote community-owned and distributed renewable energy systems like community-owned solar (Community Solar Consumer Choice Act, 2023; DOE's National Community Solar Partnership Targets, n.d.-d)
4. Targeted investments in energy efficiency and weatherization of low- and middle-income housing units (Home Energy Rebates Program [DOE, n.d.-c]; Inflation Reduction Act, 2022)
5. Mandatory emissions reduction policies for the electric power, transportation, and industrial/chemical sectors that require the reduction of emissions from those sources that are concentrated in overburdened environmental justice communities (Illinois Climate and Equitable Jobs Act, 2021; Rhode Island Act on Climate, 2020; TEDC & Kean John S. Watson Institute for Urban Policy & Research, 2023)

In contrast to carbon management approaches like CCS and hydrogen co-firing, these policies prioritize EJ and climate justice goals and do not extend the life of polluting facilities in EJ communities. For example, mandatory emissions reductions (MER) policies would require power plants or industries whose emissions detrimentally impact an EJ community to be forced to reduce their carbon dioxide emissions, as well as co-pollutant emissions (TEDC & Kean John S. Watson Institute for Urban Policy & Research, 2023). In this way, the policy makes reducing GHG co-pollutants that contribute to disproportionate pollution loads in EJ communities as important as reducing GHGs.[12]

The concerns outlined above, about the drivers of carbon management and both the known and unknown risks of these technologies and approaches, underscore the need for a more transformative and justice-centered approach to climate mitigation. Carbon management risks deflecting precious resources and attention from proven, equitable approaches to climate mitigation. This is a critical moment that requires laser focus and collective harnessing of immense resources to avert climate and environmental injustices. Equitable climate mitigation policies are not only possible but necessary to achieve an enduring climate just future.

[12] To be clear, this point does not concede that carbon management achieves the GHG reduction goals purported from a climate change perspective, as there is significant doubt on that matter, as well (see, e.g., TEDC et al., 2024).

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