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# Reducing US industrial emissions under budgetary uncertainty

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## I. EXECUTIVE SUMMARY

Despite a transformative shift in policy and financial, technical, and regulatory support for low-carbon energy deployment in the United States, the pathway to deep decarbonization for the pillars of the US industrial economy remains unclear.

Through legislative and executive efforts at the federal level, combined with those of numerous state and local governments, the United States has fostered a historically favorable environment for clean energy technology development. However, intent is one matter, and execution is another. Over the last two years, inflationary challenges, uncertainty over the issuance of permits, delayed federal guidelines, and volatile energy-demand trends have undermined the anticipated American clean energy and manufacturing renaissance. The speed bumps have been especially problematic for industrial decarbonization, where key sectors are considered “hard to abate” with existing, mature low-carbon technologies.

This study was conducted in conjunction with expert analysts and private sector investors who represent key stakeholders in these emerging industries. It considers a fundamental question: How can these high-emitting industrial sectors, foundational to the US and global economy, decarbonize primarily through nascent and presently expensive technology suites in the potentially constrained fiscal environment ahead? Discussions revealed three overarching themes as the most prominent challenges to achieving industrial decarbonization. First, uncertainty over policy consistency and the durability of US decarbonization incentives elevates risk for private-sector investors in emerging technologies. Similarly, there is a profound mismatch between the longer time scales at which investors and project developers need to operate, and the much shorter ones which

politicians and legislatures must consider. Finally, and perhaps most crucially, inconsistent price signals and demand generation for industrial decarbonization tools and products—potentially for decades to come—can serve as a chilling consideration for these multibillion-dollar project proposals.

This analysis is the first part of a broader Atlantic Council study that aims to provide realistic recommendations for expediting US industrial decarbonization. It specifically considers the advent of new presidential leadership, a new Congress, and thus an uncertain fiscal environment at the federal level. It also identifies the essential conditions needed to accelerate US industrial decarbonization, and which new tools or policy measures can be layered onto the existing framework. While subsequent analyses will yield more detailed recommendations, four key focus areas have emerged through an initial exploration of these issues:

- the need for a credible analysis of US industry's "starting point" on emissions and carbon intensities
- the galvanizing benefits of voluntary industrial standards
- the incentives and stability created by clean electricity and fuels standards
- the importance of a national carbon-management strategy

## II. INTRODUCTION: ENABLING ENVIRONMENT FOR LOW-CARBON ENERGY DEVELOPMENT

It is difficult to overstate the breadth of change the United States has spurred through executive and legislative actions in the realm of energy and climate policy, particularly in the form of federal incentives and direct investment throughout the emerging clean energy economy. The Infrastructure, Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), the latter representing $300 billion in public investment, have together instigated a renaissance in renewable energy manufacturing, electric vehicles (EVs), battery storage, hydrogen, and carbon management infrastructure among many other emissions-reducing technologies.[1] To be sure, state-led and regional efforts to promote clean energy adoption, such as renewable portfolio standards, laid critical groundwork for the mature technologies (particularly onshore wind and solar energy) that have accelerated dramatically in the wake of these major laws. Estimates suggest a combined impact of over 330 announced projects (largely in manufacturing capacity) valued at more than $125 billion throughout US clean energy sectors. These projects are expected to create over a hundred thousand new American jobs.[2]

While these transformative laws were a necessary condition to scale the US clean energy economy, they are not sufficient to meet the moment—especially when considering the unique challenges facing industrial sectors. Indeed, there remain key questions on how to convert the vast federal investments and announced private investments into shovels in the ground and, by extension, real emissions reductions toward the US net-zero targets. Speed bumps have abounded: Recent analysis argues that 40 percent of the major post-IRA manufacturing projects have experienced delays or postponements, largely due to inflationary pressures, and fiscal and demand uncertainties.[3] The federal government has experienced its own critical delays as key regulatory and tax guidance, such as for hydrogen tax credits detailed within the 45V section of the IRA, have become mired in controversy from potential hydrogen investors.[4] Lingering over each of these issues is long-delayed comprehensive federal permitting reform, which governs nearly all aspects of siting and building major manufacturing and energy projects in the United States—further hobbling private investors keen to take advantage of the newly available clean energy incentives. Permitting uncertainty is especially detrimental to addressing the United States' historically slow transmission and distribution infrastructure growth, as well as grid modernization—considered crucial to maximizing the potential of new low-carbon energy generation, improving efficiency, and lowering energy costs. Studies suggest that US transmission capacity must grow between 150 percent and 400 percent by 2050 to meet net-zero targets.[5]

1 Curt Mueller, "Executive Leaders Embrace U.S. Manufacturing Renaissance," *Forbes*, May 18, 2023, https://www.forbes.com/sites/curtmueller/2023/05/18/executive-leaders-embrace-us-manufacturing-renaissance/.

2 "Major Clean Energy Project Announced Since the Passage of IRA," E2, accessed September 6, 2024, https://e2.org/announcements/.

3 Amanda Chu, Alexandra White, and Rhea Basarkar, "Delays Hit 40% of Biden's Major IRA Manufacturing Projects," *Financial Times*, August 12, 2024, https://www.ft.com/content/afb729b9-9641-42b2-97ca-93974c461c4c.

4 Catherine Clifford, "Why the Hydrogen Tax Credit Has Become a Lightning Rod for Controversy," CNBC, October 13, 2023, https://www.cnbc.com/2023/10/13/why-ira-hydrogen-tax-credit-is-lightning-rod-for-controversy.html.

5 Richard Schmalensee, "Crossed Wires: Modernizing the US Electric Grid," *Resources Magazine*, May 16, 2024, https://www.resources.org/archives/crossed-wires-modernizing-the-us-electric-grid/.

While these problems are relevant throughout the clean energy industries, they are especially impactful to those industrial sectors that still lack mature, commercially scaled, and affordable fuels and technologies. These sectors include chemicals, steel, and other metals production, cement, shipping, and aviation. This study, therefore, examines the specific barriers to scaling the most attractive and functional solutions for these sectors and understanding the forces that presently limit the speed and breadth of US industrial decarbonization.

## III. CHALLENGES FOR US INDUSTRIAL DECARBONIZATION

Through this study's series of interviews with stakeholders in various industrial sectors, it became immediately clear that there are numerous problems at hand. There is no singular, sweeping solution that might resolve the issues faced by those engaged in industrial decarbonization, and the various industries examined have their own competing priorities and goals. Throughout these conversations, however, three overarching themes emerged as relevant to nearly all the stakeholders, indicating clear patterns and thus areas of focus for potential recommendations. These themes are policy uncertainty, timescale, and demand generation.

### Policy uncertainty

The last several years of US politics have confirmed that policy volatility is often a feature, not a bug, of this democratic system. The impetus for US industrial decarbonization is itself largely a product of the Biden administration's political leadership. It has complemented legislative achievements with regulatory updates and new rulemakings, wholesale reorganization of key agencies around decarbonization objectives, and a slate of executive orders for everything from federal purchasing guidelines to the elevation of climate disclosure requirements in the public and private sectors. The durability of any of this, however, is largely subject to the outcomes of the 2024 elections and how aggressively any future administration would cement, or unwind, the Biden administration's legacy.

Executive orders can be rescinded by a superseding order; rulemakings are vulnerable to overturn within the federal court system and can be changed by a new administration with enough patience regardless of legal intervention. Once promulgated and clear of legal challenges, federal rules tend to stick. Revising or replacing them requires drafting of a new rule, restarting the lengthy notice and comment process, then justifying the change and surviving new legal challenges.[6] This process can take years to complete. When a single party holds both chambers of Congress, however, and has the ability to pass legislation, more dramatic change can occur more quickly. If the Republican party gains full control of the presidency and both chambers of Congress, however, and is intent on undermining the IRA, it could have the power to do so through the budget reconciliation process, which only requires a simple majority in both chambers.

Outside the federal government, however, there is not yet a unified public consensus sufficient to drive major industries toward decarbonization. Indeed, focus and pressure on emissions-reduction efforts vary widely throughout the United States even within states and cities. Motivators among key stakeholders (such as energy consumers) tend to be influenced by multiple factors, but especially broader economic conditions and cost perceptions. A recent survey on attitudes toward climate change mitigation efforts, conducted by Resources for the Future and Stanford University, found that favorability toward some economy-wide decarbonization policies—such as tax breaks for EV production, increasing energy efficiency in buildings, and tax breaks to utilities in exchange for making more electricity from renewable sources—has seen statistical declines or record-low support.[7] While the same data confirmed that people in the United States are broadly concerned about climate change and favor programs to reduce emissions, there are significant divides over approaches and their details. It is reasonable to assume that similar disunity and reticence would apply to low-carbon industrial fuels and products if they resulted in elevated costs for consumers (for instance, because of more expensive new-build homes or higher costs for family flights).

6 This is why, despite attempts by the Trump administration and the Biden administration to revise environmental rules, there remain some rules promulgated by the Obama administration (which had the benefit of two terms to produce) which are binding federal regulations.

7 Jon A. Krosnick and Bo MacInnis, "Climate Insights 2024: American Climate Policy Opinions," Resources for the Future, August 27, 2024, https://www.rff.org/publications/reports/climate-insights-2024-american-climate-policy-opinions/.

This volatility elevates risks for project developers and investors, for whom durable policies and long-term market signals are key to maintaining investments in emerging sectors over many years. Without a clear public consensus and consumer pressure for change, and with federal initiatives subject to either overturn or overrule at a moment's notice, the scale of uncertainty becomes difficult to reconcile with profitable and sustainable business strategies.

## Timescale

The volatility problem is compounded by that of timescale. Deep decarbonization of any major economy, especially one as complex as that of the United States, will be a multidecade project. Indeed, the internationally popular "midcentury" marker for reaching net-zero is twenty-six years away but implies a systemic shift in that deceptively short time frame.

A profound mismatch between political and economic timescales underlies the industrial decarbonization discussion. For example, 2035 is potentially a landmark year: This is the Biden administration's target date for achieving a 100 percent carbon-free US power grid, as well as the year that each of the Department of Energy's designated "hydrogen hubs" (H2Hubs) are required to achieve commercial output.[8] Either of these would represent a historic development achieved within an ambitious timeline. However, three entirely different presidential administrations could come and go by that year, to say nothing of potentially dozens of new members of Congress, state governors, and justices and judges scattered throughout the federal benches. This undertow of constant change, revision, and new perspectives is almost certain to impact the trajectories of these and any other long-term decarbonization targets.

While political cycles are alarmingly brief, investment cycles for large-scale projects are far longer. The hydrogen hub example is again instructive; the Department of Energy estimates that the seven billion dollars in federal funding committed for the seven chosen H2Hub projects has catalyzed a total fifty billion dollars in public-private investment to realize the hubs' full potential.[9] Investments at the scale of multiple billions of dollars require long and consistent time frames of operation to ensure return on investment and, ideally, profitability over a period of decades. This requirement is especially salient given that many of these "first mover" projects in emerging sectors like hydrogen have high up-front costs and uncertain cost-decline trajectories for key inputs. But whereas a project developer must consider the next decade (at the bare minimum), a politician must consider the next election.

Long-term market certainty and policy durability could theoretically ease the time mismatch problem. The IRA represented Congress's best attempt at such a solution: It provided a ten-year runway to 2032 for the majority of its incentives to be accessible to whichever entities qualify. The decade-long ramp represents the length of the budget reconciliation bill that Congress passed in 2022 and provides as much political resilience as possible. But whereas ten years is a lifetime in US politics, that ramp is relatively short in comparison to the timescale of the projects intended to function for thirty years or longer. It is these projects that most rely on benefits from the IRA, other pieces of legislation, and federal support. Reaching a final investment decision (FID) on a given project can itself take years, to say nothing of complex local, state, and federal permitting processes, then construction and any setbacks that may arise. In summary, the IRA has a ten-year cliff. For an investor, ten years can easily pass before a project has become operational or turned a profit—but its foundational economics may have changed entirely if key laws and regulations have since been altered or scrapped.

## Demand generation

Perhaps the most salient challenge identified by nearly every stakeholder is that of demand generation for low-carbon fuels and products. In the United States, the major decarbonization programs are overwhelmingly supply-side oriented: eased financing, tax breaks, loan guarantees, public-private partnerships, and other tools intended to grow the commercial supply of decarbonized products or associated services.

In the US context, there is both a legal and political calculus underpinning this approach: From a constitutional perspective, there are significant limitations to the federal government's ability to issue mandates to the private sector apart from matters of public health and safety. Ongoing litigation

8 White House, "FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies," April 22, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/; and Susan Cosier, "Can Hydrogen Help Combat the Climate Crisis?," Natural Resources Defense Council, May 18, 2024, https://www.nrdc.org/stories/can-hydrogen-help-combat-climate-crisis.

9 "Biden-Harris Administration Announces $7 Billion for America's First Clean Hydrogen Hubs, Driving Clean Manufacturing and Delivering New Economic Opportunities Nationwide," US Department of Energy (DOE), October 13, 2023, https://www.energy.gov/articles/biden-harris-administration-announces-7-billion-americas-first-clean-hydrogen-hubs-driving.

surrounding the Environmental Protection Agency's power plant regulations, as well as the Securities and Exchange Commission's climate disclosure rules, are examples of these limitations.[10] A requirement that private businesses, such as airlines, purchase a low-carbon alternative to their current fuel of choice would be vulnerable to challenge and overturn absent clear legislative authorization. On the other hand, incentives and partnerships tend to be more palatable politically. They are far less likely to engender a concerted opposition and thus electoral danger.

Apart from government requirements ensuring demand for a given low-carbon alternative, it is unclear how suppliers can hope to overcome the "green premium" for these products.

One reason for the intense focus on hydrogen as an industrial decarbonization solution, in addition to its potentially diverse applications, is that multiple low-carbon pathways to produce it are technically feasible. However, each of these pathways varies considerably in price: While "gray" hydrogen produced using fossil fuels in the United States costs about one to two dollars per kilogram (kg), the cost of hydrogen from renewable energy is about five dollars per kg.[11] The cost of blue hydrogen, where fossil fuel emissions are captured and sequestered, can vary widely depending on the commercial price of the fuel input. As a result, there are diverse outlooks for the future competitiveness of these and other hydrogen production pathways in the US context without a clear price signal. A further complication is the need for adjacent infrastructure, such as storage facilities and pipelines, which will be necessary to realize hydrogen consumption in industry at scale—adding costs and risks, and increasing the fuel's actual price.

Without enforceable mandates from governing authorities, or price signals from some form of direct or indirect carbon pricing, it remains to be seen how demand for higher-cost products can be spurred, then sustained, throughout the policy shifts and long timelines previously noted. Internal business pressures, within the private sector, may in some cases ameliorate these concerns: Stakeholder, investor, and shareholder pressures have historically driven behavioral changes for large companies and are increasingly leveraged as a tool to create change within the private sector. It is unclear, however, if and how these pressures are a factor for the diverse businesses involved in the hotly competitive industrial and manufacturing sectors of the US economy. Another authority, such as an industry umbrella organization or a block of overseas purchasers, could take up the mantle of ensuring demand for a given product instead of US government intervention. However, the credibility and resilience of that assurance, in the face of economic and geopolitical uncertainty, could be dubious. It is unclear who exactly is steering the ship on the most fundamental requirement for industrial decarbonization—that the products of this transition will actually be consumed and, eventually, paid for.

## IV. OPPORTUNITIES

To be sure, the United States has a robust slate of inherent advantages when it comes to addressing these challenges, and boasts a highly competitive, growing economy with tremendous natural and human capital favorable to its own energy transition. These standing advantages are now paired with a federal incentive system that has encouraged investors in the industrial decarbonization space.

However, a great deal of work remains to bring all of these advantages to bear: perhaps most importantly, an improved macroeconomic environment and eased inflationary pressure would assist the many post-IRA manufacturing projects that have been snagged in delays and postponements. Also crucial are the delayed tax guidelines, promulgated by the Internal Revenue Service, which provide the fine details of how various projects may qualify for IRA credits. In addition to significant delays in their final release, these guidelines have been the subject of intense controversy over their substance and could invite legal action soon.[12]

Overcoming these immediate hurdles, unfortunately, is insufficient to overcome the deeper, systemic challenges previously identified. Unless those are addressed, it is unclear whether the United States can come anywhere close to its stated national targets for economy-wide decarbonization.

Much more will be needed, and the potential opportunities detailed below could accelerate industrial decarbonization in an uncertain political and economic outlook. These actionable

10 Clark Mindock, "US Republican Attorneys General Sue to Stop EPA's Carbon Rule," Reuters, May 9, 2024, https://www.reuters.com/sustainability/climate-energy/25-us-states-challenge-epa-power-plant-emissions-rule-court-2024-05-09; and "The Case Against the SEC's Final Climate Rules Begins in Earnest (and What It Means)," Latham & Watkins, April 8, 2024, https://www.lw.com/en/insights/the-case-against-sec-final-climate-rules-begins-in-earnest.

11 "Hydrogen Shot™: Reducing the Cost of Clean Hydrogen," US DOE, accessed September 19, 2024, https://www.energy.gov/eere/fuelcells/hydrogen-shot.

12 Christian Robles, "Hydrogen Industry Preps Legal Challenge to Biden Tax Rules," *E&E News*, February 26, 2024, https://www.eenews.net/articles/hydrogen-industry-preps-legal-challenge-to-biden-tax-rules/.

prescriptions meet a set of key criteria: the ability to secure bipartisan support, or at least acceptance, in a likely divided government; the absence of reliance on extensive new federal financial interventions or budgetary largesse; their capacity to build upon already enacted laws and statutes; and their lack of dependance on expansive, creative interpretations of federal authorities with "Chevron deference," or generous judicial deferral to agency interpretations of their authorities in existing statutes, now ended.[13]

## Economy-wide analysis of industrial emissions

Any industrial decarbonization strategy must begin with credible, economy-wide quantitative analysis of the current state of industrial emissions—ideally on a sectoral basis, and to the most detailed extent possible. The various industrial sectors which undergird the US economy differ in their sources of direct and indirect emissions, efficiencies gained over recent decades, and the future outlook for emissions intensity given the current trajectory. Indeed, emissions trends (and opportunities to reduce them) can vary widely from state to state, even facility to facility—to say nothing of variation in existing holistic data. A recent report from the Congressional Budget Office, published earlier this year, highlights the problem: It estimates that the manufacturing sector is responsible for 12 percent of US greenhouse gas emissions, and projects that emissions from manufacturing will increase 17 percent between 2024 and 2050.[14] However, the analysis relies on data from 2021—three years ago—in the absence of more recent, comprehensive data. Alternative estimates exist but leverage different metrics and methodologies, and thus reach different conclusions: The Environmental Protection Agency (EPA) analysis of US industrial emissions, using data from 2022, concludes they represent 30 percent of all US emissions when explicitly considering both direct and indirect emissions.[15]

Clarity and granularity are urgently needed, as a matter of both industrial and trade policy. The European Union's recently initiated carbon border adjustment mechanism (CBAM) will target imports of high-emission industrial products and fuels, imposing novel reporting requirements followed by fees in later stages of implementation.[16] US industries which sell into the European Union will, pending a diplomatic breakthrough, be subject to these requirements in 2026.

With the growing interest in a US border adjustment mechanism in Congress, the problem of diverse, inconsistent data has garnered fresh attention. One bipartisan bill proposes a partial solution: the Providing Reliable, Objective, Verifiable Emissions Intensity & Transparency (PROVE IT) Act, introduced by Senators Chris Coons (D-DE) and Kevin Cramer (R-ND). It assumes that US industrial emissions intensities are lower when compared to those of many other global industrial hubs, and therefore the United States and allies "should quantify the advantage of our environmental stewardship and investments in cleaner manufacturing practices and highlight the shortfalls of countries with little to no environmental standards."[17] It would direct the Department of Energy to conduct a definitive analysis of US industrial emissions across key sectors within two years of enactment, identifying average emissions intensities of "covered products" (to be updated every five years).

This bill, which enjoys bipartisan support among thirteen senators and has a companion House version introduced, would provide consistently improved data sets and perhaps confirm a gold standard methodology. In the interim, the White House has recently announced a new Climate and Trade Task Force, which intends to move forward on quantifying "embodied emissions" in key industrial products—an effort to make progress with or without the PROVE IT Act.[18]

Even so, neither approach represents a silver bullet in addressing existing knowledge gaps (such as products or services not covered by the legislation) and unknown variables (such as the future pace of efficiency improvements), let alone

13 David L. Goldwyn and Andrea Clabough, "Chevron Deference Is Dead—and US Climate Action Hangs in the Balance," *EnergySource*, Atlantic Council blog, July 11, 2024, https://www.atlanticcouncil.org/blogs/energysource/chevron-deference-is-dead-and-us-climate-action-hangs-in-the-balance/.

14 "Emissions of Greenhouse Gases in the Manufacturing Sector," Congressional Budget Office, February 2024, https://www.cbo.gov/publication/60030.

15 "Sources of Greenhouse Gas Emissions," US Environmental Protection Agency, lasted updated July 8, 2024, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

16 European Commission Representation in Cyprus, "Commission Adopts Detailed Reporting Rules for the Carbon Border Adjustment Mechanism's Transitional Phase," August 17, 2023, https://cyprus.representation.ec.europa.eu/news/commission-adopts-detailed-reporting-rules-carbon-border-adjustment-mechanisms-transitional-phase-2023-08-17_en.

17 The Office of Senator Chris Coons, "PROVE IT Act," Sponsored by Coons and Senator Kevin Cramer, https://www.coons.senate.gov/imo/media/doc/prove_it_act_v2.pdf.

18 "Remarks as Prepared for John Podesta: Columbia Global Energy Summit," White House, April 16, 2024, https://www.whitehouse.gov/briefing-room/speeches-remarks/2024/04/16/remarks-as-prepared-for-john-podesta-columbia-global-energy-summit/?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosgenerate&stream=top.

resolving the accounting challenges which US industries exporting to Europe will imminently face. Likewise, sector-wide estimates may not necessarily incentivize individual companies to produce lower emissions products. To avoid sectoral free riders, it would be helpful to have a system that measures emissions intensity at the product level.

### Voluntary standards

Another opportunity, voluntary standards, exists more firmly in the realm of private-sector direct engagement, both within industries and public-private partnership models. Voluntary standards have long been used by government and industry umbrella organizations to galvanize action toward mutually agreed outcomes.

An illustrative example is that of maritime shipping. The International Maritime Organization (IMO) is a United Nations body which governs global security of shipping and regulates pollution by ships. It boasts 176 member states and has promulgated dozens of conventions and protocols governing its members' fleets.[19] One of its recent protocols, known colloquially as IMO 2020, placed historic limitations on sulfur content used onboard compliant ships. The IMO argues that since this regulation entered into effect, there have been "major health and environmental benefits for the world, particularly for populations living close to ports and coasts."[20] More recently, in July 2023, IMO member states adopted a revised IMO Strategy on Reduction of GHG Emissions from Ships, referring to greenhouse gas emissions and affirming a pathway for deepening reductions in carbon intensity averages for international fleets, by at least 40 percent by 2030.[21]

The example of the IMO's various regulations shows how voluntary standards can drive change by setting ambitious but achievable targets, securing broad buy-in from key stakeholders, and leveraging compliance and enforcement tools to dissuade potential free riders. Importantly, the IMO is a uniquely influential organization with several decades of industry leadership; there are few comparable umbrella organizations in key industrial sectors, such as steelmaking or chemicals production.

Another form of voluntary standards assumes a public-private component, where a governing body develops a particular standard, usually in conjunction with representatives of the industry in question, and uses incentives or punitive measures to enforce it. One example, under the Biden administration, has been climate disclosure requirements among federal contractors. In November 2022, the Biden administration proposed the Federal Supplier Climate Risks and Resilience Rule which (if it proceeds into a final version) would require large contractors to disclose climate-related financial risks, their businesses' climate impacts across quantifiable scopes of emissions, and adopt emissions reductions targets.[22] While the federal government cannot demand that private contractors take any of these actions, the enforcement mechanism in this case is access to upward of seven hundred billion dollars in federal contracts in a given year.[23] Participation is thus voluntary, but comes with enormous benefits.

Voluntary standards, however they are designed, can potentially ease the challenge of being the first mover within an industry to adopt the difficult and costly strategies required for deep decarbonization. No company, after all, can survive as a competitor within its sector while taking on unrewarded costs that its peers simply shrug off. Widely accepted standards, however, especially when paired with enforcement tools and credible leadership from a governing body, fundamentally change the risk calculus for firms contemplating these steps. If low-performing, unmotivated competitors are prevented from overwhelming superior, highly efficient industry leaders with their cheaper products, then the necessary investments and operational changes necessary to decarbonize become a competitive advantage.

### Clean fuels standards

A variation on the theme of standards is the category of clean energy and fuels standards, also known as CESs and CFSs. CESs are based on a simple premise: that a governing body

19 "IMO Secretary-General Assesses Progress on Sulphur Limit Implementation," International Maritime Organization (IMO), January 21, 2020, https://www.imo.org/en/MediaCentre/PressBriefings/pages/01_IMO-Secretary-General-assesses-progress-on-sulphur-limit-implementation.aspx .

20 "IMO 2020—Cutting Sulphur Oxide Emissions," IMO, accessed September 21, 2024, https://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx.

21 "IMO's Work to Cut GHG Emissions from Ships," IMO, accessed September 21, 2024, https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx.

22 Michael R. Littenberg, Marc Rotter, and Peter Witschi, "Another U.S. Climate Disclosure and GHG Emissions Reduction Rule Delayed," Ropes and Gray, July 24, 2024, https://www.ropesgray.com/en/insights/viewpoints/102jef1/another-u-s-climate-disclosure-and-ghg-emissions-reduction-rule-delayed.

23 "A Snapshot of Government-Wide Contracting for FY 2023," US Government Accountability Office, June 25, 2024, https://www.gao.gov/blog/snapshot-government-wide-contracting-fy-2023-interactive-dashboard.

determines a technology-neutral percentage or portfolio standard (for instance, for a utility purchasing electricity) which must be low-emission, low-carbon, low-GHG intensity or just "clean" depending on the exact design and definitions.[24] These programs can vary enormously in style and outcome.

In the United States, CESs are already well-tested: Thirty-one states and the District of Columbia had renewable portfolio standards (RPSs) or clean energy standards by 2022, which played a key role in the rapid expansion of renewable energy throughout the country.[25] California, notably, has long deployed its own Low Carbon Fuel Standards (LCFS) targeting the transportation sector, which—despite its controversies—has been a model for other states such as Oregon, Washington, and New Mexico.[26] The California LCFS is managed at the state-level by the California Air Resources Board (CARB) and sets consistently more robust life cycle carbon intensity (CI) standards for transportation fuels than in its prior iterations.[27]

While leveraging CESs and their variations for promoting power-sector and transportation decarbonization is one matter, applying such an approach to industrial decarbonization may be another entirely. Unlike power generation and transportation, low-carbon and low-intensity fuels for industrial use are relatively immature, not yet produced at scale, and expensive. Policymakers should proceed with caution. To be effective, a federal version of a CES or CFS targeting key industrial sectors might mirror the most effective components of state-level variations: staying technology neutral, ensuring high flexibility in terms of how the standard is achieved, and encouraging improved performance utilizing clear, achievable, temporal benchmarks. Such a design could also include components usually associated with carbon markets (also deployed at the state and regional levels in the United States) in the form of well-regulated trading mechanisms for earned credits. Notably, this approach offers multilateral engagement opportunities over optimal designs of such systems—especially with the European Union, which has its own ambitious industrial decarbonization plan in the Net Zero Industry Act (NZIA), in addition to the incoming CBAM.

Even with robust planning, the potential for adverse or unintended outcomes is high—not least of which are potential inflationary pressures on consumer goods and energy prices at a time of macroeconomic uncertainty. Market interactions with other sectors, as well as outcomes in social and environmental justice areas, would need to be carefully observed. The lesson of recent history is perhaps instructive: States have been powerful laboratories for clean power and fuels standards, and could host local and regional pilot programs for a similar industrial fuels approach. These could be developed at a small scale, targeting a sector or a series of interconnected projects (such as one of the hydrogen hubs, or a specific fuel like low-carbon ammonia production in a high-demand region). Federal technical and regulatory support could be made available. A more concrete and comprehensive federal program could then follow on the testing and lessons learned from these small-scale, lower-risk CES programs, hopefully as the same low-carbon inputs inch closer to commercial viability. Design and details will be critically important to success, making close coordination among levels of government and stakeholders all the more important at the outset.

### National $CO_2$ infrastructure strategy

The imperative for a comprehensive approach to the United States' future carbon capture, utilization, and sequestration (CCUS) industries is perhaps the most important and most challenging of these recommendations. Carbon management as a sector is an increasingly complex field with a vast array of players and stakeholders, as well as considerable mistrust among and within those groups. The politics surrounding the sector are no less fraught. The Biden administration has significantly improved the national policy framework to support CCUS through its marquee laws and major federal partnerships and investments, such as $1.2 billion to realize

24 Kathryne Cleary, Karen Palmer, and Kevin Rennert, "Clean Energy Standards," Resources for the Future, January 24, 2019, https://www.rff.org/publications/issue-briefs/clean-energy-standards/.

25 "Five States Updated or Adopted New Clean Energy Standards in 2021," Energy Information Administration, February 1, 2022, https://www.eia.gov/todayinenergy/detail.php?id=51118.

26 Kiki Velez, "CARB Must Reform LCFS Program to Meet Climate Goals," National Resources Defense Council, August 23, 2023, https://www.nrdc.org/bio/kiki-velez/carb-must-reform-lcfs-program-meet-climate-goals-0.

27 Sudeshna Mohanty and Marie McNamara, "Understanding California's Low Carbon Fuel Standards Regulation," Rocky Mountain Institute, October 4, 2023, https://rmi.org/understanding-californias-low-carbon-fuel-standards-regulation/.

two commercial-scale direct air capture facilities in Texas and Louisiana, and a further $251 million to support new and existing carbon storage projects in seven states.[28] These moves have not been without controversy, particularly among progressive voices within the Democratic Party and impacted communities wary of carbon management infrastructure; these perspectives largely align with analysts who view the CCUS industries as promising unviable solutions which only prolong the use the fossil fuels.

CCUS industries have much yet to prove and are a considerable distance from doing so: Recent Congressional Budget Office estimates suggest that fifteen operating carbon storage facilities in the United States are capturing about twenty-two million metric tons of $CO_2$, or just 0.4 percent of US emissions.[29] More than 120 facilities are theoretically planned but face myriad challenges from concept to operation. Chief among these is cost, as well as regulatory and permitting delays. The midstream of carbon management infrastructure is a serious barrier on its own: The federal agency responsible for updating key guidance in this area, the Pipeline and Hazardous Materials Safety Administration (PHMSA), has been long delayed in finalizing its Pipeline Safety Regulations pertaining to carbon dioxide midstream infrastructure. A lengthy federal review process, to be followed by notice and comment periods, is still ongoing.[30] In the interim, several major pipeline projects planned in the agricultural Midwest have been stalled, while some states (most recently Illinois) have attempted to proffer their own statewide regulations while awaiting federal ones.[31]

A cogent strategy, promulgated at the federal level and aligned with existing supportive policies and incentives, could expedite the pathway to gigaton-scale carbon capture in the United States. Such a strategy would entail an unequivocal endorsement from the White House for specific carbon-capture capacity targets (based on technology type) and unique pathways to achieve them over time with benchmarks for progress. Enhanced natural sequestration technologies, as well as "Blue Carbon," or oceanic sequestration, might be included. Midstream infrastructure targets, coordinated with any existing state- and regional-level planning, should also be elucidated. Such a strategy could build off existing carbon-capture projects and the planned $CO_2$ hubs (originally authorized in the IIJA) and the hydrogen hubs, where appropriate. The strategy should also be informed by, and highlight, the roles of carbon trading and other voluntary carbon-market mechanisms, and how these components of the wider carbon-management sector fit into US priorities. The Biden administration has expressed support for credible, functional carbon markets aligned with the principles of Article VI of the 2015 Paris Agreement and the most robust accounting methodologies and standards available.[32] As carbon markets continue to evolve, and hopefully improve amid well-founded controversies and criticisms, their role in a national carbon-management plan will be important to clarify early on.

Perhaps most crucially, a national $CO_2$ infrastructure strategy should offer a comprehensive plan for stakeholder engagement and managing environmental and intergenerational justice considerations. New regulatory processes in this vein, for example, might be detailed along with clear timelines for finalization of other key regulatory pieces (such as PHMSA's updated guidance and the future of the EPA's Class VI well permitting programs). To be sure, a national strategy cannot possibly address or predict every potential barrier to scaling carbon management in the United States; likewise, it cannot and should not overwhelm state and local engagement, where some stakeholders are best represented. Ultimately, the perfect cannot be the enemy of the good, especially when clear signals are critical to growing emerging businesses in uncertain fiscal and economic situations.

The Biden administration, through the Department of Energy, has recently taken steps toward crafting a policy document in the spirit described above: The Carbon Management Strategy (published in October) offers an extensive and

28 "Biden-Harris Administration Announces Up to $1.2 Billion for Nation's First Direct Air Capture Demonstrations in Texas and Louisiana," US DOE, August 11, 2023, https://www.energy.gov/articles/biden-harris-administration-announces-12-billion-nations-first-direct-air-capture; and Drew Costley, "Biden Administration Invests in Carbon Capture, Upping Pressure on Industry to Show Results," Associated Press, May 17, 2023, https://apnews.com/article/carbon-climate-biden-co2-pollution-environment-ccs-0678057d3bd003bcfd9a7ba0d61a477d.

29 "Carbon Capture and Storage in the United States," Congressional Budget Office, December 2023, https://www.cbo.gov/system/files/2023-12/59345-carbon-capture-storage.pdf.

30 "New Rules for $CO_2$ Pipelines Under Review in the United States," Global CCS Institute, February 15, 2024, https://www.globalccsinstitute.com/news-media/latest-news/new-rules-for-co$_2$-pipelines-under-review-in-the-united-states/.

31 Jeffrey Tomich, "Illinois Set to Adopt 'Nation-leading' Carbon Pipeline, Storage Rules," *E&E News*, May 29, 2024, https://subscriber.politicopro.com/article/eenews/2024/05/29/illinois-set-to-adopt-nation-leading-carbon-pipeline-storage-rules-00160186.

32 "Voluntary Carbon Markets Joint Policy Statement and Principles," White House, May 2024, https://www.whitehouse.gov/wp-content/uploads/2024/05/VCM-Joint-Policy-Statement-and-Principles.pdf.

thorough description of the present state of carbon capture systems and infrastructure throughout the United States.[33] It articulates an important and necessary vision for what carbon capture systems in the US might achieve, and how the Department of Energy can prioritize the most cost-effective use cases and potential regional hub locations, while optimizing employment and community benefits associated with this emerging industry. That said, this proposal is relatively limited in its temporal scope and focuses on near-term actions only out to 2030. It also is primarily a federally focused document centering actions specifically at the Department of Energy. While there is some discussion of interagency partnerships and the roles of state, local, and tribal governments, this is not necessarily a comprehensive, whole-of-government strategy with clear commitments and timelines for key achievements over decades of this sector's development. The latter would be a more effective and robust signal, both to state and local governments as well as the private sector, of intent for this industry.

## V. LOOKING FORWARD

Although the past four years have brought a tidal shift in the policy environment favorable to the United States' wider decarbonization goals, there are worrying signs that progress in industry is not happening at the pace or scale needed to achieve real, lasting change. This discussion and its recommendations represent the beginning, not the end, of this timely conversation. The suggestions and approaches described are intended to provide the basis for determining a viable pathway forward as industrial decarbonization faces an uncertain future. This analysis will continue to be informed by engagement with investors and stakeholders in these industries through workshops and other forums. While significant challenges lie ahead for any industrial decarbonization strategy, it is hoped that further refinement of these approaches will yield actionable opportunities and viable mechanisms to realize the depth and pace of change needed in US industry.

33 US DOE, *Carbon Management Strategy*, October 2024, https://www.energy.gov/sites/default/files/2024-10/Carbon Management Strategy_10.10.24.pdf.

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